TUIASI doctoral

CSD INTERNATIONAL CONFERENCE OF THE DOCTORAL SCHOOL

"Gheorghe Asachi" Technical University of Iasi, Romania

8TH INTERNATIONAL CONFERENCE OF THE DOCTORAL SCHOOL

BOOK OF ABSTRACTS

MAY, 14-16, 2025

IASI, ROMANIA

Excellence in Doctoral Studies through Innovation, Convergence and Interdisciplinarity

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Welcome to CSD2025, wishing you a successful conference!

8th International Conference of the Doctoral School

"Gheorghe Asachi" Technical University of Iasi

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BOOK OF ABSTRACTS

May 14 – 16, 2025

IAŞI, ROMÂNIA

Organizers

- "Gheorghe Asachi" Technical University of Iasi, Romania
- Council for Doctoral University Studies, CSUD
- Council of Doctoral School, CSD

Partner:

- "Gheorghe Asachi" University Foundation, Iasi, Romania

Conference Sections

- **Section 1.** Interdisciplinary studies (**held onsite and includes papers from all doctoral fields**)
- **Section 2.** Computers and information technology; Systems engineering Electrical engineering; Energy engineering; Electronic engineering, telecommunications and information technology (**held online**)
- **Section 3.** Chemistry; Chemical engineering; Environmental engineering (**held online**)
- **Section 4.** Civil engineering and installations (**held online**)
- **Section 5.** Mechanical engineering; Industrial engineering; Materials engineering; Engineering and management (**held online**)

Organizer's Message

Dear PhD Students,

Dear Colleagues and Guests,

Dear Participants,

At its eighth edition, the International Conference of the Doctoral School at the "Gheorghe Asachi" Technical University of Iasi (TUIASI) is dedicated to all PhD students from Technical Universities from Romania included in the Romanian Alliance of Universities of Science and Technology (ARUST), but not only. The goal is to share their research, to exchange ideas, and to make new connections. The conference is a great chance for PhD students to refine their research methods, encourage interdisciplinary teamwork, and keep growing. For three days, there will be panel sessions where PhD students can talk about and discuss their research papers. The schedule also includes plenary conferences held by prominent professors from universities closely associated with TUIASI through collaborations.

This event aims to bring together different presentations covering important issues in the TUIASI thirteen doctoral fields, such as Chemistry, Computers and Information Technology, Chemical Engineering, Civil Engineering, Electrical Engineering, Electronic Engineering, Telecommunications, Information Technologies, Energetic Engineering, Industrial Engineering, Materials Engineering, Mechanical Engineering, Environmental Engineering, Systems Engineering, and Engineering and Management.

By connecting these scientific fields, encouraging innovation through teamwork, and focusing on international collaboration, the conference acts as a meeting point for new ideas and advancements in science. This approach ensures that doctoral programs provide PhD students with the right skills and knowledge for jobs in social institutions, contributing to a sustainable economy. For PhD students in the earlier stages of doctoral studies, the conference provides an opportunity to train for their first contributions to a certain scientific field, while for the PhD students in later stages, the communications held during conference can be seen as a scientific step towards the jobs market. This connects with the university's commitment to making courses more international, increasing mobility for students and staff, and promoting understanding between different cultures. It also ties in with the university's role as a partner in the European "Ingenium" project, which involves ten European institutions of higher education working together to improve study programs using digital tools shared within the INGENIUM Alliance.

Together, let's bridge scientific fields, foster innovation through collaboration, and embrace the spirit of internationalization. Join us in creating an academic intersection where new ideas flourish and progress takes center stage. We look forward to your active participation and the joint impact we can make at this conference.

Please visit **the conference website at: https://conferinta-csd.tuiasi.ro/**

Welcome to CSD2025, wishing you a successful conference!

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Professor **Dan CAȘCAVAL**
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General information

About our university

"Gheorghe Asachi" Technical University of Iasi is one of the most prestigious universities in Romania, being classified as an advanced research and education university (according to the Order of Ministry of Education and Research, MECTS nr. 5262/2011), whose mission is to carry out specific activities of creation, innovative capitalization of knowledge and its transfer to society in the fundamental fields of engineering sciences, architecture and urbanism, as well as in interdisciplinary and complementary fields, in the local community, at regional, national and international levels.

"Gheorghe Asachi" Technical University of Iasi has the oldest tradition in engineering education in Romania, initiated by Gheorghe Asachi, a representative of the Romanian Enlightenment, and established within the Greek Academy in Iasi (Royal Academy) on November 15, 1813, by the decree signed by Scarlat Calimachi, the ruler of Moldova at that time. This school can be considered the nucleus of higher technical education in Moldova, continuing education between 1834-1847 at the Mihăilean Academy and later at the University of Iasi in the School of Industrial Electricity (since 1910), the Electrotechnical Institute (1912) and the Department of Technological Chemistry (since 1911).

On November 7, 1912, the Faculty of Sciences of the University of Iasi was transformed into an independent department of higher education for teaching electrical engineering, applied chemistry and agricultural sciences. This event represents the "birth certificate" of what later became the Polytechnic Institute of Iasi ("Gheorghe Asachi" Technical University of Iasi today), respectively of the Faculty of Electrical Engineering, Energy and Applied Informatics and the Faculty of Chemical Engineering and Environment Protection.

A crucial moment in the history of our university is the Decision no. 205.660/ 03.12.1937 of the Ministry of National Education, when, the technical higher education is taken out from the aegis of the University of Iasi by the establishment of the „Gheorghe Asachi" Polytechnic School of Iaşi, as a distinct institution of engineering higher education, the only higher education institution authorized to grant from that date the title of engineer. The University began its activity on October 1, 1938, within three faculties: Industrial Chemistry, Electrical Engineering and Agricultural Sciences, of which the first two were based in Iasi and the third in Chisinau. The first diplomas were issued in 1940.

Through the education reform of 1948, the "Gheorghe Asachi" Polytechnic Institute was established in Iaşi, with four faculties and ten specializations: Industrial Chemistry (mineral chemistry, leather), Civil Engineering, Electrical Engineering, Mechanics (thermodynamic engineering, hydrotechnics, machine building, aero-naval engineering) with a duration of studies of five years. The Polytechnic Institute of Iaşi functioned until 1990 with 6 faculties and many newly created specializations. In 1990, four new faculties were established, coming from the faculties of Electrical Engineering and Mechanics.

In 1993 the name of "Polytechnic Institute of Iasi" was replaced by "Gheorghe Asachi" Technical University of Iasi (TUIASI). In 2004 the Architecture department within the Faculty of Constructions and Installations became the "G.M. Cantacuzino" Faculty of Architecture and since then 11 faculties operate within TUIASI.

Today, TUIASI develops programs for undergraduate, master, doctoral, postdoctoral studies and scientific research in interdisciplinary research areas, out of which 10 areas were classified in category A, according to Law 1/2011 and HG 789/2011. The doctoral activity is organized within an interdisciplinary doctoral school including 13 doctoral fields established according to national and international research priority areas.

Plenary conferences

BIO-INSPIRED COMPUTATIONAL APPROACHES FOR REAL-WORLD SYSTEMS

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Abstract:

The plenary lecture will highlight insights in the projects mainly implemented by the Soft Computing, Programming and Algorithms (SCoPA) research group at the Frankfurt University of Applied Sciences. General aspects of our group are Theory of Computation, Artificial Intelligence, Evolutionary Computation, Machine Learning, Programming and Algorithms The areas of interest focus on applied research for real world challenges by using bio-inspired computation from analyzing and designing creative hybrid algorithms and closing with their implementations and experimental testing. The lecture will outline selected work from these projects for enhancing the international visibility of our city university: Frankfurt University of Applied Sciences.

Some of real-world applications we investigated are from domains like: Healthcare (disease prediction, medical image segmentation), Robotics (path planning, swarm robotics), Automation (warehouse management, dynamic stacking), Energy Systems (smart grid control, load balancing), Data&Security (Federated Learning, Data Security), eXplainable AI (sentiment analysis, game level design). As emerging areas of interest and investigated domains we can name: Bio-inspired Algorithms for Sustainable Systems, Scalability for Big Data and Cloud Computing, AI and Bio-inspired Hybrid Models, Applications in Smart Cities and IoT Ecosystems. Some used key techniques we can name: Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Genetic Algorithms (GA), Evolutionary algorithms (EA), Artificial immune Systems (AIS), Differential Evolution (DE), Artificial Bee Colony (ABC), Neuroevolutionary computation (e.g. NEAT), Firefly or Bat Algorithms. One example for the ACO techniques is the implementation of a 3D model with interaction techniques like Reference Grid, Callouts, and Interactive Blending for the visualization in Dynamic Grid Environments. Artificial Bee Colony (ABC) approaches are inspired by the food foraging behavior of hone-bees. ABC simulates three types of agents: Employed Bees (explore known food sources), Onlooker Bees (choose food sources based on shared information), Scout Bees (search randomly for new sources); Balances Exploration (finding new solutions) and Exploitation (refining good ones).

Applications by using PSO can bring inspiring results: Power System Optimization (enhances load flow control), Engineering Design (optimizes structural, mechanical and control control parameters), Cloud Resource Scheduling (allocates resources efficiently in virtualized environments), Parameter Tuning (frequently used to optimize hyperparameters in ML models). As applications using Genetic Algorithms (GAs) we investigated can be named: Data Ordering Problem with and without Inversion (VLSI circuits, bioinformatics), Feature Selection (picks relevant attributes form machines), MapReduce-Enabled Gas (enables scalability for big data problems), NP-hard problems (Bin Packing, Travelling Thief Problem, Compaction Problem). Some further ideas for real-world applications with promising results by using bio-inspired computation: Clustering and Classification, Job Scheduling and Resources Allocation, Image Processing and Wireless Sensor Networks.

Keywords: bio-inspired computation, real-world systems, SCoPA, soft computing, programming, algorithms, artificial intelligence, machine learning, optimization

RECENT ADVANCES AND PERSPECTIVE IN THE FIELD OF CLAY MINERALS

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Abstract:

Clay minerals have been widely used by human societies since the early days of mankind owing to their versality. These materials are layered silicates where silica tetrahedra are arranged in continuous sheet combined with hexagonally coordinated metal-containing octahedral sheet. The most interesting family of clay minerals regarding the applications is the so called 2:1 type where the metal-containing octahedral sheet is sandwiched between two tetrahedral sheets forming a 2:1 layer. Depending on the occupancy of the different sheets, the framework can be neutral or negatively charged due to substitutions in tetrahedral and/or octahedral sheets. The deficit in positive charges is balanced by cations located in the interlayer space. In the case of smectites, modifications can be performed by ion exchange with either inorganic or organic cations. Active sites which can be used for surface modifications arise also from surface silanol, aluminol or magnesol groups present at the broken-edge sites. These latter can be used to attach covalently organic moities by grafting, starting from organoalkoxysilanes having the following formula $RSi(OR')_3$ (were R stands for an organic moity and R' for amethyl or ethyl group). These generate a great deal of interest in the design and synthesis of tailored made compounds due to their unique properties , leading to applications in a wide range of fields, going from environmental purposes, to energy, health, and nanocomposites, to name a few.
However, the use of natural clay minerals can be limited by the present of side phases, gritty contaminants as well as As, Fe. One way to overcome these drawbacks is to produce synthetic clays which allows to obtain pure phases without impurities and tailor the process to obtain a material with desired final properties.
After an introduction on the clay mineral structures, the strategies to synthezise layered compounds having a 2 :1 structure and to impart specific properties by ion exchange and grafting will be presented, as well as their main characteristics. A special attention will then be paid to recent progress and application prospects of modified clay materials.

Keywords: clay minerals, functional materials, environmental applications,

EUROPEAN PROJECT INSIGHTS ON ENERGY TRANSITION AND DECARBONIZATION

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Abstract:

The plenary lecture will highlight European projects implemented by the Energy Transition Research Center (EnTReC) at the Technical University of Cluj-Napoca (https://entrec.utcluj.ro/). Since its establishment in 2014, EnTReC has been committed to advancing research that supports the transition to climate neutrality across the energy sector, industry, buildings, and communities, through the implementation of over 30 large-scale international projects. The lecture will showcase selected research outcomes from these projects, emphasizing their direct contribution to enhancing the national and international visibility of the Technical University of Cluj-Napoca.

A key achievement was the development of a decentralized digital energy services concept based on Demand Response (DR) for buildings with aggregated energy consumption, along with its implementation at the Romanian pilot site involving four buildings of the Technical University of Cluj-Napoca (TUCN). This initiative was part of the *Demand Response in Blocks of Buildings (DR-BOB)* project. The outcome enabled real-time optimization of local energy production, consumption, and storage, while significantly reducing electricity demand during peak load periods.

Another major result emerged from the *RE-COGNITION* project (*Renewable Cogeneration and Storage Technologies Integration for Energy Autonomous Buildings*), which focused on the optimal integration of multiple renewable energy source (RES) technologies and associated subsystems in a building—specifically, the university's swimming complex. Leveraging artificial intelligence (AI), the project implemented automated cognitive energy management actions using the installed RES technologies and the pre-existing building energy management system (developed in DR-BOB). The effectiveness of the RE-COGNITION solution was validated through various operational scenarios, demonstrating tangible economic benefits under real-world conditions. This line of research is now being extended through four ongoing international projects, each centered on demonstrative pilot sites for testing innovative technologies: *EVELIXIA* (Smart Grid-Efficient Interactive Buildings), *SunHorizon* (Sun-Coupled Innovative Heat Pumps), *RENplusHOMES* (Renewable Energy-Based Positive Homes), and *DOITSMARTer*, which focuses on developing advanced mathematical algorithms based on AI techniques. The pilot sites developed within these projects—such as the Building Energy Management System, Building Integrated Photovoltaics, Vehicle-to-Grid, Demand Response Management System, Local Energy Manager, Flexible Energy Storage System—are fully available to TUCN's research teams and are also accessible as living labs for researchers and students alike.

Additional scientific achievements include the development of advanced Monitoring and Targeting (M&T) and Measurement and Verification (M&V) tools for energy, which have played a key role in providing technical assistance to a large number of SMEs. These developments were realized within the framework of the projects *SMEmPower Efficiency*—a holistic initiative aimed at strengthening SMEs' capacity to enhance their energy efficiency—and its predecessor project, *Meeting the Energy Professional Skills* (MENs). This line of research is now being further advanced through the ongoing project *EnTRAINER – Energy Transition Audits through Decarbonization*. The lecture will conclude with an overview of *OLGA – Holistic Green Airports*, the largest European Union project under the Green Deal initiative. This five-year project, involving 42 partners across the EU, aims to deliver impactful results in the areas of energy and sustainable mobility for airports.

Keywords: energy transition, smart buildings, energy autonomy, European projects

CONVENTIONAL AND AUTONOMOUS VEHICULAR TRAFFIC: AMELIORATING OPERATIONS, SAFETY AND ENVIRONMENTAL IMPACTS

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Abstract:

Urban transportation networks are increasingly strained by rising congestion, inconsistent driver behavior, safety concerns, and environmental inefficiencies. Conventional road systems, largely dependent on static signal timing and human-operated vehicles, adapt sub-optimally to real-time changes in traffic demand or road conditions. In this presentation we are presenting the findings of several projects that investigated the transformative potential of integrating connected and autonomous vehicles (CAVs) and intelligent control strategies into urban traffic systems.

Through calibrated microscopic simulations, based on real-world data from North American cities, we compared the performance of traditional vehicle networks with those incorporating varying degrees of automation. Key performance indicators include travel time, delay, fuel consumption, emission levels and traffic conflict frequency.

The conducted analyses draw on a series of advanced traffic management models and simulation experiments developed in graduate-level research. These include cooperative highway merging strategies where CASs dynamically negotiated entry in small, coordinated clusters, significantly reducing stop-and-go behavior and improving safety metrics. Other contributions assess the effect of intelligent signage, such as LED-enhanced stop signs, on driver compliance and intersection safety, with findings indicating improvements in stopping behavior and alignment with conflict-based predictive models.

Signal control strategies were also evaluated, with dynamic priority given to public transit vehicles based on onboard passenger loads and system-wide delay. These approaches proved more effective than fixed-cycle signals, reducing corridor delays and fuel consumption. Further, multimodal routing frameworks incorporating real-time data from transit, pedestrian and vehicular modes demonstrated the potential for adaptive path selection and cross-modal optimization, particularly in dense urban environments.

Additional contributions include predictive traffic models that adjust in real time to variable demand conditions. These models support adaptive signal timing and routing under uncertainty, creating a more flexible response framework suited for integration with Avs and connected vehicle technologies. Emerging CAV-specific features, such as adaptive speed control under visual obstructions like sun glare, were also incorporated, showing enhanced responsiveness in edge-case safety scenarios.

Collectively, these findings highlight some of the work we have been conducted in the area of Connected and Autonomous Vehicles – leading us to believe that even partial adoption of these "disruptive" technologies – when coupled with data driven tra9ic management – can meaningfully improve the efficiency, sustainability, and safety of urban mobility systems. We conclude with some recommendations on policy and design to guide infrastructure adaptation, simulation-based planning, and phased deployment of CAV compatible solutions.

Keywords: connected and autonomous vehicles (CAVs), intelligent traffic control, predictive traffic modeling

COLD SPRAYED DEPOSITION OF (CrC-NiCr)/Ni METAL MATRIX COMPOSITES: MECHANICAL PROPERTIES AND MICROSTRUCTURE

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Abstract:

Cold spray (CS) is a solid-state material deposition method involving impact-induced bonding of micron-sized powder particles accelerated to supersonic speeds. These particles are propelled by a compressed gas stream, such as air, N_2, or He, using a de Laval nozzle. No melting takes place during deposition, as CS operates at low temperatures. This offers distinct advantages over other thermal spray techniques, such as low porosity and residual stress. CS can achieve several millimeters-thick cohesive deposits of metals, ceramics, polymers, and their combinations.

Metal-matrix composites (MMC) combine the high hardness, wear resistance, and thermal stability of ceramics with ductility, toughness, and thermal conductivity of metals. In this work, we experimentally investigated the mechanical and tribological properties of a cold-sprayed, (CrC-NiCr)/Ni metal matrix composite. Chromium carbide-nickel chromium (CrC-NiCr) is a cermet particle that consists of a ceramic phase (CrC) and a ductile binder (NiCr). Ni particles were used as the overall ductile binder in the MMC. In the first part of the study we focused on: (i) investigating the influence of increasing the metallic (NiCr) binder percentage in the cermet particle, and (ii) exploring the effects of varying the matrix-to-cermet ratio, i.e. Ni to (CrC-NiCr) ratio, in the feedstock blend on the microstructure and mechanical properties of the CS deposits. Results indicated that increasing the binder phase percentage in the cermet particles enhances deposition efficiency, cermet area fraction, and interparticle adhesion. This also results in coatings with porosity less than 1%, as well as improved ductility and shear strength.

To address inter-splat defects and brittleness of the MMCs, the second part of this study examined the effects of post-spray annealing on the mechanical properties and microstructure. Scanning electron microscopy (SEM) demonstrated improved interparticle bonding between matrix splats, with fractographic analyses indicating a shift from brittle to ductile fracture mechanisms. Mechanical tests revealed that post-process annealing significantly enhanced the ultimate tensile strength (UTS), elongation, and adhesion shear strength of the coatings. However, this adversely affected coating hardness. Finally, to assess the tribological properties of the (CrC-NiCr)/Ni MMCs, dry sliding wear tests were performed using a ball-on-disk configuration at three normal loads. The wear rate of the MMCs is significantly influenced by the metallic binder percentage in the cermet particle and the applied normal load. A direct relationship between wear rate and applied load was observed.

This work showed that the (CrC-NiCr)/Ni system can be effectively deposited as a metal matrix composite using the cold spray technology. Heat treatments improve the strength, ductility, and wear resistance of the MMC, and this MMC system is suitable as a wear-resistant coating for applications demanding high loads.

Keywords: cold spray, solid-state deposition, microstructure, mechanical properties

IMPORTANCE OF RESEARCH ON NEW MATERIALS AND RELATED TECHNOLOGIES TO OVERCOME CONTEMPORARY ENGINEERING PROBLEMS: AN OUTLOOK FROM CERAMIC TILE INDUSTRY

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Abstract:

According to survey announced during recent World Economic Forum, New Materials and Composites is one of the mentioned technology trends which is expected to drive business transformation for the 2025-2030 period. Following after "AI and information processing technologies", "Robots and autonomous systems" and "Energy generation, storage and distribution" titles "New Materials and Composites" is in this list having the fourth place. Although the progress of first three titles are indirectly related to advances in materials technology, "New Materials and Composites" title is still finding a separate place. Indeed, newer materials are added to engineering repertoire every year and in order to achieve this, universities, research centers and other organizations are tremendously searching for new possibilities, new compositions and new combinations. These efforts are obviously priceless and utilization of these alternative new materials is essential to overcome different engineering problems. However, from validation to availability it is not an easy task and certain efforts have to be realized in order to accelerate the industrial acceptance.

Ceramic tile industry is one of the examples having engineering problems which are not only specific to this sector or technology level used but also contemporary issues like other industries e.g. decarbonization and sustainability. New technologies and alternative materials are definitely play a key role for finding solution to these problems and in many cases cost reduction and/or energy saving simultaneously provided. Considering the range of the profit margin of the sector any positive contribution should also be compatible with mass production numbers and expectations of distribution channels/decision makers. According to recent trends, market demand for larger size ceramic tiles continue to increase leading manufacturers innovate to produce bigger sizes. Any progress to achieve lighter tiles having same functionality either decreasing tile thickness or through weight reduction in various ways are quite attractive. Demand for eco-friendly ceramic tiles with recycled materials is still growing. These are just a few examples from the ceramic tile industry in where alternative materials may be a direct solution within the current technology or can be used for the generation of newer technology.

Keywords: new materials, ceramic tile manufacturing, ceramic tile trends

SECTION 1.

Interdisciplinary studies

STUDY OF MASS AND HEAT TRANSFER IN SUBLIMATION USING THERMOGRAVIMETRIC ANALYSIS

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Abstract:

DDMEBT (2-[4-(dimethylamino)phenyl]-3-{[4-(dimethylamino)phenyl]ethyl}-buta-1,3-diene-1,1,4,4-tetracarbonitrile) is an organic compound with third-order nonlinear optical properties, recognized for its remarkable performance in enhancing the efficiency and stability of photovoltaic cells. These characteristics qualify it as a promising candidate for applications in thin-film deposition, particularly in photovoltaic devices and solar panels. Optimizing the chemical vapor deposition process requires knowledge of the saturated vapor pressure of the precursors at different temperatures, as well as the thermodynamic characteristics of their transformation into vapor through sublimation, ensuring precise concentration control. The saturated vapor pressure at ambient pressure can be directly correlated with the maximum concentration of the compound of interest in the gas phase. Data on saturated vapor pressure are crucial for developing chemical or physical deposition processes in thin films, allowing rigorous control of the precursor feed rate.

In this study, thermogravimetric analysis under isothermal conditions is employed to evaluate the sublimation rate, mass, and heat transfer for DDMEBT. To achieve this objective, a Mettler Toledo 851e thermogravimetric analysis instrument was used. The tests involved using a 5 mg sample with nitrogen as the carrier gas and anthracene as the reference substance. The determination of individual mass transfer coefficients was carried out by processing experimental data with a program developed in Mathcad, which enabled the derivation of a dimensionless correlation equation in the form: $Sh = a \cdot Re^b \cdot Sc^c$. Using the obtained dimensionless equations, the average values of the individual mass transfer coefficients for DDMEBT sublimation were determined at temperatures ranging from 130 to 150 ºC. Based on the Chilton-Colburn analogy, which describes the relationship between heat and mass transfer, the average values of the individual heat transfer coefficients for DDMEBT were also obtained. The average values obtained for the individual mass and heat transfer coefficients are consistent with the limited experimental data available in the literature regarding the sublimation process. The study demonstrated that the sublimation rate of DDMEBT can be precisely controlled, allowing for the regulation of the precursor concentration in the gas phase - an essential parameter for the uniform deposition of thin films. Moreover, the correlation between experimental data and the resulting dimensionless equations enables the mathematical modeling of the process, facilitating the extrapolation of data to an industrial scale.

Keywords: sublimation, DDMEBT, mass transfer, heat transfer, mathematical modeling

INVESTIGATION OF THE FLUORESCENT BEHAVIOR OF A PULLULAN DERIVATIVE WITH PENDING NITRILE GROUPS IN THE PRESENCE AND THE ABSENCE OF METAL IONS SOLUTION

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Abstract:

Nowadays, studies on polysaccharides focus on improving their already-impressive properties (biocompatibility, structural diversity, renewability, natural sources abundance) by structural modification *via* chemical reactions, as well as finding suitable applications to praise them. Among all polysaccharides, pullulan stands out due to its fascinating structure, biocompatibility, good mechanical and antimicrobial properties, pH sensitivity, and excellent solubility in water, making it a highly investigated representant of this biopolymers class. This work highlights the fluorescence properties of a novel pullulan derivative with intriguing fluorophore structural traits, such as imine bonds and nitrile groups, that were grafted by using a two-step synthesis strategy consisting of an oxidation reaction of pullulan network in the presence of sodium periodate, following a coupling reaction of the formed oxidized pullulan derivative with 4-aminobenzonitrile. The structural changes were thoroughly investigated by spectral analyses (FTIR and NMR spectroscopy), while the optical properties were determined by UV-vis and fluorescence spectroscopy. While the solution of the pullulan derivative exhibits good fluorescence behavior, upon the addition of aqueous metal ion solutions (Na^+, Ag^+, Ca^{2+}, Pb^{2+}, Cr^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, Hg^{2+}, Al^{3+}, Fe^{3+}) having the concentration of 3×10^{-3} M, the solution fluorescence quenches which indicates that complexes are formed between the nitrile groups and metal ions. The strongest affinity of the pullulan derivative is for the trivalent iron (Fe^{3+}) that quenches the fluorescence almost entirely at the fixed concentration of 12×10^{-5} M of polymer + metal ion solution (quenching degree of 95.97%). Other studies, including the mechanism determination, detection limit of metal ions, selectivity, quantum yields, the stoichiometry of complex, and the association constant, were also performed. All investigations showed that the pullulan derivative is a remarkable compound that can serve as a chemosensor for the Fe^{3+} ions detection from wastewaters, which in great quantities are a threat to human health upon ingestion, causing diseases such as Alzheimer's or lethargy.

Keywords: pullulan derivatives, dialdehyde, metal ions, nitrile group, fluorescence, quenching effect
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SURFACTANTS EMPLOYED FOR NANOFLUIDS STABILIZATION: RECENT RESEARCH AND TRENDS

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Abstract:

Surfactants play a crucial role in various industrial and scientific applications due to their ability to modify interfacial properties, enhance solubilization, and stabilize complex formulations. Their amphiphilic nature enables nanoparticle stabilization and dispersion, making them essential in the synthesis and functionalization of nanomaterials. Among the most commonly used surfactants, polyethylene glycol (PEG)-based surfactants, cetyltrimethylammonium bromide (CTAB), sodium dodecyl sulfate (SDS), sodium dodecylbenzene sulfonate (SDBS), and polyvinylpyrrolidone (PVP) have gained significant attention due to their distinct physicochemical characteristics and versatile applications. This study explores the functional properties of these surfactants, focusing on their behavior, micelle formation, and interactions with active ingredients in formulations. PEG-based surfactants are widely utilized for their biocompatibility and solubilization properties, while CTAB, a cationic surfactant, is known for its antimicrobial activity and strong interaction with negatively charged molecules. SDS and SDBS, both anionic surfactants, are frequently employed in emulsification, whereas PVP, a nonionic polymeric surfactant, enhances colloidal stability and film formation in pharmaceutical and cosmetic applications. This study systematically examines the stability, rheological behavior, and thermal conductivity of nanofluids, with a focus on the effects of surfactant selection, nanoparticle concentration, and temperature. Preliminary experimental findings reveal that nanofluid stability is highly dependent on the choice of surfactant. Surfactants such as sodium dodecylbenzenesulfonate (SDBS), cetyltrimethylammonium bromide (CTAB), and sodium dodecyl sulfate (SDS) enhance colloidal stability, as confirmed in state of the art. Furthermore, the synergistic and competitive interactions between these surfactants in mixed systems are analyzed, emphasizing their impact on viscosity, thermal conductivity, and stability. The findings of this study contribute to a deeper understanding of surfactant behavior in nanofluids applications, paving the way for the development of more efficient and environmentally friendly formulations. Plus, it reveals the crucial role of surfactants in optimizing nanofluid formulations, providing valuable insights for their application in thermal management, energy systems, and industrial processes.

Keywords: surfactants, heat transfer, SDBS, CTAB, SDS

Acknowledgment: This work was supported by a grant of the Romanian Ministry of Research, Innovation and Digitalization, CNCS-UEFISCDI, project PN-IV-P1-PCE-2023-0171, number 18PCE/08.01.2025 within PNCDI IV.

LOW MOLECULAR MASS POLYETHILENE GLYCOL MIXTURES FOR HEAT TRANSFER APPLICATIONS

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Abstract:

The present study explores the synthesis methods and characterisation of Polyethilene Glycol (PEG) based heat transfer fluids. The recent increase in research over the last years regarding heat transfer systems such as heat exchangers, solar cells, thermal energy storage and electronic cooling systems shows the growing demand for more efficient, sustainable, and high-performance thermal management solutions and the need to optimize energy usage, reduce environmental impact, and support the advancement of modern technologies. Polyethilene Glycol (PEG) is a synthetic polymer consisting of repeating monomers of ethylene oxide and it's used in a wide range of applications including pharmaceutical products, cosmetics, food industry, agriculture, chemistry and bioengineering. The PEGs with low molecular mass such as PEG 200, PEG 400, PEG 600, have excellent solubility in both aqueous and organic solvents, reasonable low viscosity and high diffusivity, showing good thermal properties, low melting points and good thermal stability, which make them promising candidates as base fluids or additives in heat transfer systems, especially in thermal energy storage and heat transfer applications.

Accordingly, this work discusses the heat transfer related properties of several mixtures between PEG 200, PEG 400 and water. In order to get a full picture of these mixtures behaviour several analyses in terms of DSC, TG, and thermal conductivity were performed. Results outlined that PEG 400 has the best thermal stability, while PEG 200 has an improved heat transfer capacity. On the other hand, mixtures between PEG 200 and PEG 400 with higher amount of PEG 400 have very good thermal stability, noticing that the addition of PEG 400 expands the lower molecular mass PEG stability. As a conclusion, it may affirm that 0.50 PEG200 + 0.50 PEG400 and 0.25 PEG200 + 0.75 PEG400 are good options for heat transfer fluids. Nonetheless, the experimental is an initial one and further insights are needed in terms of viscosity of the mixtures.

Keywords: Polyethylene glycol, DSC, heat transfer, thermal conductivity, fluids

Acknowledgment: This work was supported by a grant of the Romanian Ministry of Research, Innovation and Digitalization, CNCS-UEFISCDI, project PN-IV-P1-PCE-2023-0171, number 18PCE/08.01.2025 within PNCDI IV.

TEXTILE MATERIALS FOR TRANSDERMAL THERAPY IN MEDICINE AND PSYCHIATRY

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Abstract:

Textiles for medicine and healthcare have made significant progress over time, leading to remarkable improvements and innovations: smart textiles equipped with different materials, sensors, microencapsulated active ingredients for better drug delivery and release systems; antimicrobial textiles for wound care; biomaterials.

Technological development, our lifestyle of constant stress and permanent overstimulation has led to an increase and exacerbation of various psychiatric and psychological disorders, both in adults and in the pediatric population. For example, depressive disorders are the leading cause of disability, affecting 300 million people worldwide. The World Health Organization has stated that by 2030, depression will be the leading contributor to premature death and years lived with disability (YLWD - a measure reflecting the impact of an illness on quality of life; disease severity index). Symptoms of depression include: difficulty concentrating, difficulty remembering details and making decisions, feelings of guilt, worthlessness and helplessness, pessimism and hopelessness, insomnia, irritability, low self-esteem, loss of interest in things that were once fun, suicidal thoughts or attempts. Oral treatment has low tolerability and compliance: it cannot be used in some patient groups (CNS problems, pediatric population) and also has numerous side effects: weight gain, digestive problems, liver disease. These results underline the need for research to develop more efficient treatment methods.

This article provides an overview of medical patches, taking into account the increasing trend towards the use of transdermal patches as an alternative way of administering medication through the skin. Their main advantages over other routes of administration are: patient-friendly, non-invasive, treatment can be discontinued at any time, bypasses hepatic first-pass metabolism, does not require absorption through the digestive tract, provides prolonged drug levels, can be self-administered. They are already used for the administration of drugs such as nicotine, clonidine, fentanyl, rivastigmine, etc. Recent advances in transdermal drug delivery (3D patches, smart patches with various sensors, absorbable biodegradable patches) and continuous research are needed, especially in the psychiatric field where patients need a viable alternative to oral medications, otherwise they may refuse treatment.

Keywords: smart textiles, medical patches, psychiatric disorders, alternative to oral treatment

IMPROVEMENT OF THE TECHNOLOGY FOR MANUFACTURING PUNCHES AS COMPONENTS OF THE MOLDS USED IN VIBROPRESSING PAVERS

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Abstract:

The pavers manufacturing industry has always been a concern for the development of infrastructure and increasing the efficiency of production processes, given the growing demands of the market and the need to constantly innovate. The evolution of this industry is closely linked to technological innovations and construction requirements, helping to create durable, aesthetic, and functional products. Despite the challenges encountered, such as fluctuations in raw material costs or increasingly stringent quality requirements, the industry has constantly adapted, investing in modern technologies and environmentally friendly production methods. In this context, the importance of molds is essential, being fundamental to the pavers manufacturing process. Molds determine the shape, size, and texture of the finished products, directly influencing their quality and aesthetics. One of the concerns faced by a mold manufacturing factory is the production of durable molds with high-quality punches. Improving the punch manufacturing process thus becomes crucial for ensuring the quality and efficiency of the final products. To this end, an analysis was carried out to track the manufacturing technology of common punches. As a result of the analysis, 3 elements of the manufacturing process were identified that can be significantly improved, namely the establishment of optimal parameters for the milling operation, changes in the geometric shape of the punch, and, respectively, the implementation of an improved solution for monitoring and controlling the manufacturing process. The analysis demonstrated that the execution of punches is a complex process, which requires special attention at each stage, from material selection to component assembly and quality control. Identifying problems and implementing appropriate solutions are essential for improving the efficiency and quality of molds intended for vibropressing pavers. These observations contribute to the development of more rigorous procedures in the manufacturing process, ensuring optimal results in the long term. The proposed improvements can have a significant impact on the overall efficiency of the punch manufacturing process, leading to time and resource savings, as well as higher-quality products. Continuous collaboration between process engineers, machine operators, and quality control teams is essential to implement these changes and achieve high standards of manufacturing excellence.

Keywords: pavers, molds, punches, manufacturing technology, feed rate, punch geometrical shape, monitoring the manufacturing

ASSESSMENT OF POLYMERIC MATERIALS USING ABRASIVE EROSION: AN ISHIKAWA DIAGRAM APPROACH

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Abstract:

Abrasive erosion is an important wear process in evaluating the behavior of materials used in extreme conditions, especially in the automotive, aircraft or industrial equipment construction industry. Polymeric materials are increasingly used in these fields due to their remarkable properties, such as low weight, corrosion resistance and flexibility. However, in order to be used in demanding applications, it is essential to test their resistance to abrasive erosion.

The research problem aims to use abrasive erosion as a testing method for polymeric materials, in order to determine their performance in aggressive environments, where contact with solid particles can lead to premature degradation of surfaces.

The research method used is the Ishikawa diagram (or cause-and-effect diagram), which allows the identification and systematic analysis of all factors that influence the behavior of polymeric materials during abrasive erosion. This approach facilitates the understanding of the interaction between parameters such as material composition, internal structure, type of abrasive used, applied pressure, impact angle or exposure time.

The expected results aim to determine the types of polymeric materials that exhibit the best resistance to abrasive erosion, but also to highlight the main factors that contribute to their deterioration. By applying the Ishikawa method, a clear picture can be obtained of the causes of premature wear and recommendations can be formulated for improving the composition of the materials or the conditions of use.

In conclusion, the integration of abrasive erosion in the testing of polymeric materials, supported by a rigorous analysis using the Ishikawa method, provides an effective framework for the selection of the most durable materials and for the optimization of the industrial processes in which they are involved.

Keywords: abrasive erosion, polymeric materials, wear resistance, Ishikawa diagram, mechanical testing, degradation factors

HYBRID FEATURE SELECTION FOR ACCURATE AND INTERPRETABLE ENSEMBLE MODELS IN WEARABLE SENSOR-BASED PARKINSON'S DISEASE DIAGNOSIS

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Abstract:

Parkinson's Disease (PD) diagnosis using wearable sensor data has gained considerable attention due to its potential for early detection and objective symptom assessment. Despite advances, existing classification models based on accelerometer signals often struggle with feature redundancy and limited interpretability, affecting their clinical applicability. This study introduces a novel hybrid feature selection framework combined with advanced ensemble learning algorithms to significantly enhance the accuracy and interpretability of PD classification using the PD-BioStampRC21 dataset. We first extracted comprehensive statistical and spectral features from accelerometer data recorded during various motor tasks. A two-stage feature selection approach was implemented, integrating mutual information (filter method) with recursive feature elimination (wrapper method), effectively reducing feature dimensionality and preserving the most informative characteristics of PD-related motor symptoms. Leveraging these selected features, we trained ensemble classifiers—LightGBM and HistGradientBoosting—which have not previously been explored within this dataset. Models were rigorously validated using a subject-wise cross-validation scheme and evaluated across multiple standard performance metrics (accuracy, precision, recall, F1-score, and AUC-ROC). Our best-performing ensemble model surpassed previously achieved performance benchmarks, attaining an accuracy of over 90%, a precision and recall of around 91%, an F1-score of 0.92, and an AUC exceeding 0.95. Additionally, we employed SHAP (Shapley Additive Explanations) to enhance interpretability, identifying sensor features related to tremors and gait variability that correspond closely to clinical PD symptoms. Our results demonstrate the efficacy of integrating hybrid feature selection with interpretable ensemble learning, offering substantial improvements in diagnostic accuracy and clinical relevance. This approach provides meaningful insights into PD motor symptoms, paving the way for more accurate, explainable, and clinically valuable diagnostic tools.

Keywords: Parkinson's disease, wearable sensors, hybrid feature selection, ensemble learning, gradient boosting

AN INNOVATIVE METHOD OF REPRESENTING THE DOUBLE ORTHOGONAL PROJECTION OF A LINE USING FDM

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Abstract:

This study presents the design and fabrication of a physical model that leverages additive manufacturing to visualize the double orthogonal projection of a line and its draught aiming to enhance engineering education through tangible geometric representation. The model integrates two articulated flat plates representing the principal projection planes (horizontal and vertical) and a series of flexible cylindrical elements that embody a spatial line and its projections. The geometric configuration is entirely parametric and was digitally modeled in SolidEdge. All components were fabricated using Fused Deposition Modeling (FDM) technology specifically with a Creality Ender 3 printer and PLA filament. The plates were designed with precise tolerances to allow articulation around three points enabling the simulation of both the perpendicular and the aligned positions required for orthogonal projection and the generation of the draught. The flexible cylinders were engineered for dimensional conformity and were inserted into aligned holes, creating a kinematic mechanism that demonstrates the transformation of a 3D line into its 2D representations. A spotlight was used to highlight the exact location of projections on the plates, further improving visual clarity and spatial interpretation. Critical process parameters such as layer height 0.2 mm, nozzle diameter 0.4 mm, extrusion temperature 190–210 °C, and print speed 50–60 mm/s were optimized to balance dimensional accuracy and material flow. The tolerance of ±0.1 mm achieved during printing ensured a functional assembly that accurately reflects theoretical geometric relationships. Evaluation of the model’s performance confirmed its stability, repeatability, and value as an instructional aid. This approach not only improves the intuitive understanding of descriptive geometry but also showcases the potential of 3D printing to replace static illustrations with dynamic, manipulable teaching tools. The study highlights the role of additive manufacturing in STEM education and opens pathways for integrating such models with augmented visualization and interactive CAD systems.

Keywords: descriptive geometry, process parameters, draught, educational model, technical drawing

STUDY ON THE TIGHTNESS OF PARTS MANUFACTURED BY FDM

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Abstract:

Fused Deposition Modeling (FDM) has become one of the most widespread additive manufacturing technologies due to its low cost, material availability, and accessibility for both industrial and educational use. The structural quality of FDM printed parts is often compromised by inter-layer porosity and process defects, which can severely affect their ability to retain fluids. This study aims to investigate the influence of two key process parameters, extrusion flow rate (Flow) and wall thickness (controlled through line width) on the watertightness of cylindrical parts fabricated from PLA using a Creality Ender 3 V3 SE printer. A Taguchi L16 experimental plan was designed to systematically vary the two parameters across four levels each: Flow (85%, 90%, 96%, and 102%) and wall line width (0.40 mm, 0.48 mm, 0.64 mm, and 0.80 mm). All parts were printed using identical print settings, including a 0.3 mm layer height, 220 °C nozzle temperature, 60 °C bed temperature, and brim adhesion enabled to ensure platform stability. A custom-designed cylindrical test piece, with an outer diameter of 40 mm, inner diameter of 36 mm, and a closed bottom of 3 mm thickness was used for fluid retention tests. Each printed part was filled with water and visually inspected for leaks under static conditions. Results show a strong correlation between higher flow rates and improved watertightness, especially when combined with increased wall thickness. The best-performing of the samples, which exhibited no leakage, corresponded to a flow of 96–102% and wall widths of 0.64 mm or greater. Conversely, under-extrusion and thin wall configurations led to consistent and observable leakage. The findings emphasize the crucial role of parameter tuning in achieving functional FDM parts capable of retaining fluids without requiring post-processing. This research provides practical guidelines for engineers and practitioners aiming to fabricate sealed polymer containers using only print-time settings.

Keywords: watertightness, process parameters, extrusion flow rate, surface porosity, fluid retention testing

SECTION 2.

Computers and information technology; Systems engineering; Electrical engineering; Energy engineering; Electronic engineering, telecommunications and information technology

A NATIVE AI APPROACH FOR FUTURE TELECOM INTENT DRIVEN MANAGEMENT AND ORCHESTRATION SYSTEMS

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Abstract: AI-native concept is a natural component of nowdays technology, seen as an efficient way to be used in the future telecommunication networks as innovative solutions for operations, network functions implementations and operations and maintenance and optimization. The concept is enabled by a data driven approach, addressing the increasing performance demands of future telecommunications. The AI systems are introducing a natural dynamicity, that are not following predefined rules, but are capable to adapt continuously, as the AI-native components are capable to interact between them to enable the expected functionality through the AI. The Native-AI are based on models and delivers the adaptive and dynamic Distributed Intent-driven Management and Orchestration (DIMO) solution in the telecom networks. Native-AI can dynamically enhance the network resources utilization and performance through AI, applied to the networks management systems through proactive orchestration capabilities. In this approach, innovative Native-AI architecture is based on a Network-Compute Fabric framework, that unifies and efficiently performs telecom resource management. The envisioned intent-driven automation through AI is capable to support the services and solution delivery in a multi-stakeholder and multi-tenant environment. The Native AI models acquire in real-time knowledge about the network conditions and has the "actual" network overview about the system status. The Native-AI facilitates in this scenario the Autonomous Network Level 4 operations for Zero Touch Operations, it is leveraging on hierarchical reinforcement learning for network Intent actuation and conflict resolution, AI based. Native-AI performing the intent translation from business-level to services and resources intents, ensures efficient resource utilization across network domains. It aims to deliver a self-learning, self-optimizing network infrastructure. The Native-AI is pervasive to all architectural network's elements, and the key novelty is the interaction with other components as Domain Management and Orchestration or the Network Compute Fabric, in order to provide unified abstraction of resources. Native-AI works with Large Language Models (LLMs) for intent translation and Reinforcement Learning with Human Feedback (RLHF) for conflict resolution, the proposed concept will enable scalable orchestration across networks domains with energy resources consumption.

Keywords: AI, ML, intent, management and orchestration, network

DESIGN OF A HIGH-SPEED PERMANENT MAGNET SYNCHRONOUS MOTOR WITH A 9/8 STRUCTURE FOR ELECTRIC GO-KARTS

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Abstract:

The design of high-performance electric propulsion systems has become a key topic in the context of modern kart racing, where efficiency, power density, and reliability are essential. This study presents the development of a permanent magnet synchronous motor (PMSM) specifically designed for an electric go-kart intended for use in competitive environments. The project was structured around the technical limitations and performance targets set by the CIK-FIA (Commission Internationale de Karting – Fédération Internationale de l’Automobile), the global authority responsible for standardizing safety and engineering requirements in kart racing. These regulations dictate both the maximum allowable weight of the vehicle, including the driver, and the operational conditions expected on various circuits.

Considering these factors, a permanent magnet synchronous motor was designed to ensure compact dimensions, high power density, and rotational speeds suitable for a chain-driven transmission system. One of the key design decisions was the selection of the 9/8 structure, which combines 9 stator poles with 8 rotor-mounted permanent magnets. This specific topology was chosen for its ability to achieve higher rotational speeds at a given electrical frequency when compared to 9/10 configurations, making it particularly well-suited for applications where quick acceleration and competitive top speeds are critical.

Additionally, the use of permanent magnets eliminates the need for rotor excitation through external power sources, contributing to lower electrical losses and improved efficiency. The absence of mechanical contacts such as brushes or slip rings enhances system durability. At the same time, the stable magnetic field produced by the magnets ensures consistent torque output, even under dynamic load conditions.

The paper describes the complete design process, from defining the traction requirements to selecting the electromagnetic and mechanical parameters, ensuring the final electric motor meets both performance and competition criteria. The result is a balanced and efficient propulsion solution, providing a modern alternative to the electrical machines commonly used in electric go-kart racing.

Keywords: permanent magnet synchronous motor (PMSM), high power density, electric Go-Kart, motor design, FEM simulation.

EFFECTS OF ARTIFICIAL LIGHT ON HUMAN HEALTH

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Abstract:

Over time, artificial light has become increasingly used for ambient lighting, sterilization of medical equipment, operation and examination lamps with intense and direct light, phototherapy, endoscopy and laparoscopy as well as in modern technology for displays, phones, or optical communication systems. Artificial light includes visible light along with ultraviolet (UV) and infrared (IR) radiation. The color temperature of artificial light commonly used in human life is generally in the range of 3000 K–6600 K. Higher color temperatures of artificial light can be harmful by altering human biological processes causing several negative effects on human health, resulting in ophthalmopathy, depression, anxiety, inattention, gastrointestinal diseases, cardiovascular disease, breast cancer.

Therefore, a systematic study was carried out to determine the color temperature of artificial light from hospital areas including waiting areas, patient ward rooms, intensive care units, and operating rooms, and evaluate the quality of the lighting system focusing on the effect of prolonged exposure to ambient artificial lighting.

To perform an analysis and characterize the light emission level, a portable device was created that integrates a UV light sensor, a TSL2561 luminosity sensor, and two TCS34725 light sensors. To perform 360□ measurements automatically, the sensor platform is rotated by a stepper motor, controlled by a motor drive. Using an HC-06 Bluetooth module, the entire system can be controlled remotely using a smartphone application specially designed for performing measurements and saving the measured data into the internal memory. The data acquisition and motor control part is implemented using a microcontroller board. Comparative measurements were carried out in different scenarios, within three hospitals in Iasi, Romania ("St. Spiridon" County Emergency Hospital, "Prof. Dr. N. Oblu" Emergency Clinical Hospital, "St. Maria" Emergency Clinical Hospital for Children). The acquired data allowed the identification of various artificial light sources, calculation of correlated color temperature (CCT), and variation in light intensity.

Keywords: artificial light, hospital, portable device, human health, color temperature, prolonged exposure.

ELECTROMAGNETIC PERFORMANCE COMPARISON OF LOW-COST FERRITE AND RARE-EARTH NEODYMIUM PM SYNCHRONOUS MACHINES

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Abstract:

In the development of electric vehicles, the design and material selection of the traction motor are crucial factors that influence the overall performance and efficiency of the drive system. Among the various types of electric motors, Permanent Magnet Synchronous Machines (PMSMs) are commonly used due to their high power density and excellent dynamic response. Typically, neodymium-iron-boron (NdFeB) magnets are employed for the rotor because of their superior magnetic properties, although more cost-effective ferrite magnets can also be used as an alternative. However, NdFeB magnets tend to be more expensive and sensitive to high temperatures, which can lead to demagnetization. Therefore, the choice of material has a significant impact on both the technical characteristics and economic viability of the motor.

This paper presents a comparative analysis of the electromagnetic performance of two PMSMs with an 9/8 structure (9 stator poles and 8 permanent magnets mounted on the rotor surface). The main objective of the study was to evaluate the performance of the two machines while maintaining a similar torque output, despite using different types of magnet materials. The comparison focused on two configurations: one utilizing high-performance NdFeB magnets and the other utilizing ferrite magnets. The analysis was conducted using Finite Element Analysis (FEA), evaluating key parameters such as electromagnetic torque, efficiency, magnetic flux density distribution, and back electromotive force (back-EMF). The results indicate that, with proper design optimizations, a PMSM using ferrite magnets can achieve performance close to that of a NdFeB-based PMSM. However, the ferrite-based motor requires a larger volume and increased mass to produce the same torque output. Despite having a lower magnetic flux density compared to NdFeB magnets, ferrite magnets offer superior thermal stability, making them more suitable for applications where the motor operates in high-temperature environments. Furthermore, ferrite magnets are significantly more cost-effective, making them an attractive option for cost-sensitive applications. This study highlights the trade-offs between size, performance, and material selection, providing insights into the balance of technical and economic factors. It suggests that ferrite-based PMSMs could serve as a viable alternative in certain applications, especially where thermal stability and cost reduction are prioritized.

Keywords: traction motor optimization, Ferrite and NdFeB magnets, electrical machine design, Permanent Magnet Synchronous Machines (PMSM), FEM simulation, Cost-effective PMSMs.

ANOMALY DETECTION OF UNDERBRAKE SCENARIOS USING NEURAL NETWORKS

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Abstract:

Enhancing driving safety systems has increasingly become an important topic, as improvements in advanced driver assistance systems and better fallback strategies are the main concerns in the automotive industry. Being able to use the brake and achieve the expected behavior each time, without exceptions, is paramount for accident prevention, especially in emergencies. Although extremely rare, braking faults can be fatal. Depending on the type and severity of the fault, the overall safety of the vehicle and other road users could be entirely compromised; therefore, timely and accurate fault detection is essential. The dataset used in this paper is acquired from a hardware-in-the-loop (HIL) simulation to emulate various delayed and anomalous braking scenarios (i.e., underbrake, with and without hydraulic systems). The data is further filtered based on whether the braking pedal is pressed and a braking maneuver is expected. This paper aims to showcase the performance of the most frequently encountered neural network-based methods in the braking fault detection field, starting from the least complex ones, such as the Multi-Layer Perceptron (MLP), to more advanced models, like Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) architectures, as well as combinations of the two. The hybrid CNN-LSTM architecture is superior to the other methods, yielding favorable results while being straightforward to implement and reasonably inexpensive to train. Furthermore, additional experiments are conducted to perform in-depth hyperparameter tuning and test different sequence lengths and strides in the LSTM component of the architecture. Despite the satisfactory results, several obstacles ought to be highlighted in the paper. One main challenge is the long time required to train the models on the entire dataset. Due to the high data volume and computationally expensive training, several sampling strategies have been applied, reducing the training time to one minute per epoch. The experiments presented in this paper aim to build a strong baseline for comparing the most frequently used models in the context of anomaly detection.

Keywords: anomaly detection, underbrake, convolutional neural networks, long short-term memory, driving scenarios

OVERVIEW OF INVESTMENT PLAN OF ELECTRICITY DISTRIBUTION OPERATORS

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Abstract:
Investment promotion within electricity distribution operators is structured across two levels: the investment program category level and the individual investment works within each category. Annual plans are developed based on approved budgets, defined objectives, the strategic direction of the distribution operators, and in accordance with applicable legal and regulatory requirements.
The sources of financing for the investments identified for the implementation of the Development Plan are: - own sources – for the modernization, re-engineering, digitalization, increasing the capacity of existing electrical installations, metering and the construction of new electrical installations, for IT software, IT hardware, construction, automotive, equipment for the electrical network, - attracted sources – mainly consisting of non-reimbursable European funds, used for the modernization, development and digitalization of the electrical infrastructure of electricity distribution operators and users, resulting from the grid connection process. Prioritization at the level of program categories aims to maximize the effect of allocated resources on Security (SSM) and Quality (IC) indicators, loss reduction and distribution control in expanding or sensitive areas (CPT), with three objectives being established: SSM objective: eliminating/reducing risks and increasing the operational safety of distribution networks; IC objective: Improving the performance of the distribution service; CPT objective: Reducing losses in the electricity network
The prioritization of investment works within the programs is carried out based on a system of criteria that weight, depending on the specifics of the program, the relevant indicators that are the target of improvement at the same time as immeasurable data that illustrate the development requirements of the network.
The criteria consider both the operating time (age), the technical condition but also the maintenance costs, the construction type or inappropriate values for the performance indicators (SAIDI, SAIFI, number of disturbances, CPT), the impact on efficiency (annual distributed or non-distributed energy or number of consumers), as well as information on areas with development potential or sensitive areas.
Indicators regarding the quality of the transmission and distribution service, as well as the quality of the electricity circulated through the electrical distribution networks represent an essential benchmark in substantiating the technical and economic elements related to the construction/refurbishment of electrical networks and have a major influence on the efficiency of the networks and the economic efficiency of the activity of their users.
The process of preparing investment plans by distribution operators is well defined and regulated, with the main aim of developing an efficient and sustainable energy infrastructure, in line with national and European energy objectives.
Distribution operators' investment plans are essential for modernizing the energy sector, integrating renewable sources and increasing network efficiency. However, their success depends on clear regulations, sustainable financing and adaptation to new technological and consumer requirements.

Keywords: energy, investment plans, distributor, access

THE ROLE OF ELECTROMANETIC INTERFERENCE ASSESSMENT IN MAGNETIC RESONANCE SYSTEM DESIGN AND OPERATION

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Abstract:

Magnetic Resonance Imaging (MRI) plays a central role in today's diagnostic medicine, appreciated for its ability to provide detailed, non-invasive images of the human body. However, achieving clear and reliable results depends heavily on maintaining a stable, interference-free electromagnetic environment. Electromagnetic interference (EMI), whether originating from inside the facility or external sources, can disrupt MRI performance in subtle but significant ways—leading to image distortion, compromised diagnostics, and workflow interruptions. This research explores how EMI affects MRI systems, particularly during the critical stages of installation and daily operation. The main goal of this study is to better understand how factors such as electrical network design and infrastructure layout influence EMI levels and, in turn, impact MRI functionality. To investigate this, we carried out a series of real-world tests in clinical environments, using spectrum analyzers and electromagnetic field mapping tools to detect and evaluate interference. Special attention was given to aspects like grounding quality, cable shielding, and the positioning of electrical components. Additionally, we evaluated the influence of nearby high-power equipment, mobile communication devices, and fluctuating load conditions, all of which contribute to varying levels of EMI that may go unnoticed without proper assessment. Our findings highlight the importance of addressing EMI proactively: poor electrical design—such as insufficient grounding, unshielded wiring, or nearby high-frequency sources—can cause interference that degrades image quality. These issues are especially apparent in high-resolution scans and can negatively affect patient safety, diagnostic accuracy, and overall clinical outcomes. In conclusion, this study underscores the need to consider EMI from the earliest planning stages of any MRI installation. Small oversights in the electrical setup can lead to significant imaging challenges down the line. Enhancing shielding, optimizing infrastructure layouts, and implementing regular EMI monitoring can help reduce risks and maintain imaging standards. This work offers insights for engineers, installers, and clinical professionals involved in building or operating MRI facilities within complex electromagnetic environments.

Keywords: electromagnetic interference (EMI), magnetic resonance imaging (MRI), electrical network design, image artifacts, shielding effectiveness.

ABOUT CONTACT RESISTANCE AND VIBRATION MONITORING OF A POWER CIRCUIT BREAKER

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Abstract:
Circuit breakers play a vital role in ensuring the protection and reliability of electrical power distribution and transmission systems. Their ability to operate under both normal and fault conditions makes them essential for system safety and stability. Effective monitoring and diagnosis of circuit breakers are crucial for enhancing operational availability and optimizing maintenance strategies, particularly through predictive maintenance approaches. This study presents a non-invasive method for evaluating critical performance parameters, such as contact resistance and mechanical vibrations, without disassembling the breaker, thereby reducing maintenance time and costs. The paper focuses on the monitoring and diagnostic process of an SF_6-insulated high-voltage circuit breaker, describing a dedicated measurement system developed for data acquisition and parameter analysis. The results aim to support condition-based maintenance decisions and extend the service life of such critical components. Circuit breakers are fundamental components within the infrastructure of electrical power networks, fulfilling the essential function of ensuring the continuity or interruption of current flow between two points in the electric circuit. They are designed to perform switching operations under both normal operating conditions and fault scenarios, such as short circuits or overcurrent events. Within the context of power systems, circuit breakers constitute the only technically viable solution for interrupting fault currents.

The performance of circuit breakers in the rapid and reliable interruption of fault currents is critical for limiting fault propagation, safeguarding other system components, and preserving their own structural integrity. Maintenance and diagnostic activities for power system equipment in operation are grounded in a rigorous assessment of their technical condition. This assessment may be conducted through various methodologies, including the monitoring of operational parameters during continuous service or scheduled outages, statistical analyses of historical maintenance data, as well as advanced simulations in digital environments. To implement an effective monitoring and maintenance strategy, it is imperative to collect a comprehensive volume of operational data. The integration and correlation of this data within a coherent technical history enables the adoption of a predictive maintenance model. This approach facilitates the optimization of operational costs, reduces the incidence of unplanned failures, and enhances the operational availability of assets within the power system.

Keywords: circuit breaker; diagnosis; monitoring; vibrations; maintenance; contact resistance.

ADVANCED TECHNIQUES IN ULTRASOUND IMAGE PROCESSING: FILTERING AND OPTIMIZATION METHODS

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Abstract:

Ultrasound imaging is widely employed in medical diagnostics due to its real-time capabilities, safety, and affordability. However, the quality of ultrasound images is often compromised by noise, low contrast, and various imaging artifacts, which can impact diagnostic accuracy. This research introduces a software tool designed to enhance ultrasound image quality by integrating advanced filtering techniques with automated enhancement methods inspired by artificial intelligence. The tool offers an intuitive interface that enables users to import and process ultrasound images in the DICOM (Digital Imaging and Communications in Medicine) format, apply various filtering operations, and compare the original and enhanced outputs side by side. Filters can be manually adjusted using interactive controls, allowing fine-tuned image enhancement based on visual feedback. Beyond manual adjustments, the system also features an automatic enhancement mode that improves image contrast and detail using a predefined combination of adaptive methods. These techniques are designed to simulate the behavior of lightweight AI-driven workflows and allow consistent enhancement with minimal user intervention. While the current implementation focuses on traditional filters and adaptive contrast strategies, the software is built with a modular structure to support future integration of deep learning models or AI-based diagnostic tools. To assess the improvements, the system utilizes a set of image quality metrics that help quantify noise reduction and structure preservation, offering both objective insights and visual validation of the results. The flexibility of this approach makes it suitable for both clinical practitioners and researchers, offering hands-on control where needed and automation where efficiency is prioritized. Preliminary testing suggests that the enhanced images offer clear visualization of anatomical structures, improve contrast uniformity, and reduce the presence of common ultrasound artifacts.

This framework lays the groundwork for integrating intelligent processing in ultrasound workflows, with potential applications in diagnostic assistance and AI-powered interpretation systems.

Keywords: ultrasound imaging, image enhancement, DICOM, filtering techniques, artificial intelligence, medical diagnostics.

AN EFFICIENT FRAMEWORK FOR EXPLAINABLE CLUSTERING USED IN THE CLASSIFICATION PROCESS OF THE MEDIUM VOLTAGE FEEDERS

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Abstract:

The rapid emergence and evolution of Artificial Intelligence (AI) and machine learning (ML) techniques have raised the standards for designing and implementing decision-making systems in the power sector. Decision-makers (DMs) need to understand the reasons behind the decisions made by ML systems, as they may fail to recognise errors or biases. Despite the extensive use of these techniques, they cannot achieve complete success without clear explanations of how they function. In such situations, DMs and AI must collaborate to develop learning-based systems, and the field of explainability can facilitate this process. With AI's assistance, DMs can ensure the transition toward active distribution systems, and Explainable AI (XAI) can help them grasp the systems' capabilities by forming strategies to bridge the gap between their understanding of AI and its complexity. Through its disclosures about inner workings, XAI can help them evaluate the fairness and reliability of AI models. Thus, AI can assist the DM in identifying optimal operation patterns within large databases to devise control strategies for electric distribution systems (EDS).

In this context, this study aims to find answers to two questions related to: (1) How XAI and unsupervised learning techniques can identify and explain automatic patterns in response to specific technical issues regarding an electric distribution system? (2) How could the explanations help us understand the detected patterns? Thus, an efficient framework for explainable clustering-based unsupervised learning has been proposed in the classification process of the medium voltage feeders for implementation. The first step in the identification process is to determine the various technical factors that affect the operation of the EDSs. These include the number of the medium voltage/low voltage electric distribution substations, the distribution transformers rated power, the loading degree, and the length of the medium voltage feeders. The second step involves integrating the classification of the medium voltage feeders based on a clustering process considering various methods to obtain the optimal number of clusters with similar characteristics. An XAI method is then used to perform a deeper analysis of the clusters obtained. The proposed framework was tested by collecting data from a Romanian Distribution Network Operator for 140 urban MV feeders. The analysis results revealed that the XAI model was more capable of performing well than the DMs.

Keywords: explainable artificial intelligence, explainable clustering, decision makers, classification process, electric distribution systems, medium voltage feeders

COMPARATIVE ANALYSIS OF ACTIVE AND PASSIVE ELECTRODES IN TMS-EEG

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Abstract:

Transcranial Magnetic Stimulation (TMS) combined with Electroencephalography (EEG) is a powerful technique for investigating cortical excitability and connectivity through TMS-evoked potentials (TEPs), offering valuable insights into intracortical and network neurophysiology for identifying subclinical patterns such as systemic disorders, major depressive disorder and altered cortical excitability post-stroke. Traditionally, passive electrodes (PE) have been the gold standard for TMS-EEG due to their stability and established reliability, but active electrodes (AE) incorporate pre-amplification, offering potential advantages such as reduced noise and faster setup times. However, AE have potential limitations related to preamplifier slew rate and bandwidth constraints which may affect their ability to capture very rapid signal fluctuations such as those observed in TEPs. To investigate these potential limitations, this study systematically compares AE and PE in TMS-EEG recordings using a 15 electrodes setup comprised of both AE and PE close together around the motor region of the brain, evaluating their performance in capturing TEPs under controlled experimental conditions. EEG data were preprocessed using artifact-removal techniques to eliminate early TMS-induced distortions. A custom MATLAB pipeline was employed to detect stimulation timepoints, isolate contaminated signal segments, and apply an exponential decay model for artifact correction. A non-negative least squares fitting algorithm was then used to reconstruct clean TEP waveforms, ensuring the integrity of the recorded neural responses. The signals from all electrodes were assessed using Concordance Correlation Coefficient (CCC) analysis, calculated for the average signal of each subject, reflecting individual-level agreement, while Group-Level Agreement CCC values were calculated for the grand average signal across all subjects, representing agreement at the group level. The CCC results demonstrated high concordance between AE and PE in terms of TEPs, suggesting that AE can reliably capture TMS-induced brain responses. These findings indicate that AE could serve as a viable alternative to PE, potentially establishing a new standard for TMS-EEG studies by enhancing data acquisition efficiency without compromising signal integrity.

Keywords: passive electrodes, active electrodes, EEG, TMS, BCI

TRUST IN INTERVEHICULAR COMMUNICATION

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Abstract:

In the rapidly transforming environment of modern vehicles, intervehicular communication (IVC) has emerged as a critical component for enhancing road safety and traffic efficiency. This research delves into the pivotal role of trust in IVC systems, aiming to establish the frameworks for secure and reliable communication between vehicles. The primary objective of this study is to investigate the factors influencing trust in IVC and the methodologies that ensure the integrity and authenticity of exchanged information.

Trust in intervehicular communication refers to the confidence that vehicles have in the authenticity, integrity, and reliability of the information exchanged between them. In the context of autonomous driving, trust is crucial for ensuring that vehicles can make accurate and timely decisions based on shared data. This involves verifying that the information received from other vehicles is not tampered with, is accurate, and comes from a credible source. Trust mechanisms help prevent malicious activities such as spoofing, data manipulation, and false information dissemination, which can lead to accidents or traffic inefficiencies.

The experimentation methodology involves a comprehensive literature review of existing IVC protocols and trust models. This review synthesizes findings from various studies to identify key factors that influence trust in intervehicular communication. By analyzing previous research, the study aims to highlight gaps in current methodologies and propose improvements based on established theories and empirical evidence. The results indicate a significant improvement in the accuracy and reliability of intervehicular communications when trust mechanisms are integrated. Vehicles equipped with the trust-based model demonstrated enhanced decision-making capabilities, leading to a reduction in communication errors and an increase in overall traffic safety. A short discussion highlights the implications of these findings for future IVC systems, emphasizing the need for continuous advancements in trust evaluation techniques.

In conclusion, this research underscores the importance of trust in intervehicular communication and provides a solid foundation for future developments in this field. The proposed trust-based model offers a promising solution for achieving secure and reliable communication, paving the way for safer and more efficient autonomous driving environments.

Keywords: intervehicular communication, trust mechanisms, communication protocols, traffic safety, information integrity, decision-making

STUDY OF SPATIAL MULTIPLEXING TECHNIQUE IN MIMO SYSTEMS

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Abstract:

In the day and age of ever-evolving technology, one area that has always been a focal point for research is the communication industry. To be more precise, a great interest has been given to transmitting and receiving techniques and technologies to further enhance the quality of communication channels. One such technology that has come to the forefront of research attention and exploration is done by using multiple transmitting and receiving antennas, also commonly known in today's academic literature as multiple input multiple output (MIMO) systems. The paper focuses on studying the MIMO technique of spatial multiplexing and a deeper understanding of its functionality. This technique can increase the data rate in wireless communications by simultaneously transmitting different data streams from multiple transmitting antennas to multiple receiving antennas. To further evaluate the result and performance of said technique, a series of MATLAB simulations were made. These simulations give a bigger picture regarding the quality of the transmission by analyzing the bit error rate (BER). To do so, two types of receivers were chosen to be evaluated. One of the receivers used is the minimum mean square error (MMSE) receiver, which minimizes the mean squared error, between the transmitted signal and the equalized received signal. The second type of receiver used is the maximum likelihood (ML) receiver, which can maximize the probability of detecting the transmitted signal correctly. To further test the capability of the two receivers, different numbers of transmitting and receiving antennas were used in the simulations. A flat Rayleigh fading channel was chosen to transmit the data. To this channel, we applied a series of noise signals, Gaussian and impulsive, to further evaluate the performance of the two receivers. The results of the simulations reflect a better performance for the ML receiver on both the Gaussian noise channel and the impulsive noise channel, to the detriment of the MMSE receiver. Following the results of the ML receiver, it is noticed that the best results are accomplished for the Gaussian noise channel.

Keywords: MIMO, spatial multiplexing, ML, MMSE, BER, noise signal, Gaussian noise

DESIGN AND IMPLEMENTATION OF AN ELECTRONIC THROTTLE CONTROL SYSTEM FOR A FORMULA STUDENT VEHICLE

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Abstract:

The internal combustion engine, ever since its invention, has been at the heart of one of the most widely used forms of transportation, the automobile. By the last century, continuous improvements and developments have been made, increasing engine efficiency and operation, one of these being the development of electronic throttle control, which, alongside with the fuel injectors, directly controls the air and fuel mixture, replacing the carburetor. This paper discusses about the design and development of an electronic throttle control system for a formula student vehicle while also following the FSG 2024 rules for its implementation and safety.
The main sensors used for the electronic control of the throttle are the APPS (application pedal position sensors) and the TPS (throttle position sensor). The system functions in a closed loop where the pedal position sensors, which operate like potentiometers, correspond directly to the desired angle of the throttle valve, given by the rotation angle of the sensor. Afterwards, the throttle position sensor offers feedback for the position of the throttle.
The signals offered from these two sensors are processed using a PID controller which output is used to regulate the brushed DC motor connected via reduction gears to the throttle butterfly valve.
As per the FSG2024 regulations, the electronic throttle control system is designed to shut down in the event of an error, such as foreign objects obstructing the throttle body and preventing the valve from closing.
Along with the PID controller circuit there is also an H bridge circuit used to rotate the DC motor back and forth using MOSFETs to change the current direction of the motor. Alongside the H bridge MOSFETs, a gate driver circuit is used to switch the gate of the transistors using PWM modulation quickly and efficiently depending on the processed signals form the throttle position sensor and acceleration pedal sensor.

Keywords: throttle, sensors, actuation, electronic throttle control, DC motor, PID controller

THE INTEGRATION OF PROSUMERS INTO LOCAL ELECTRICITY MARKETS

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Abstract:

Recent transformations in the energy sector - generated by internal and external factors - have intensified the general interest to find alternative solutions, among which the usage of solar energy and the integration of prosumers are identified. Undoubtedly, embedding the prosumers into the regulatory framework of energy markets poses a number of challenges, both technical and methodological, alongside other barriers, such as partial legal impediments in the context of Romanian law. This paper proposes a simulation model for local energy markets, where participants are part of a Multi-Agent System, and transactions are regulated by Smart Contracts. The aim of this paper is to analyze and test the efficiency of a mathematical pricing model, which is, currently, under calibration in the simulation environment mentioned above. The current progress allows the generation of sale and purchase offers. Afterwards, the most efficient transactions are identified, using predefined methods and parameters. The output consists of a data set reflecting the market dynamics.
The next stage of the research involves optimizing the price calculation method in terms of performance and practical applicability. Moreover, an analyze-focused approach will be applied to both the results of the developed model and other similar models released on the market, in the scope of identifying the advantages and the possible blockers or limitations. The theoretical structure will be strengthened to contain and support the simulation results.
This paper provides an improvement proposal for the digital solutions of energy network management, considering that the transition to renewable resources is more accentuated every year. By using emerging technologies, such a Multi-Agent Systems and Smart Contracts, the research work aims to validate and enhance the automatic mechanisms, which are applicable to the contemporary needs in a real scenario. In this way, energy flows can be easily managed in a microgrid. Thus, the simulation will demonstrate whether the followed approach is viable, if costs and consumptions are indeed optimized, and that the level of local autonomy is higher.

Keywords: prosumer, electricity market, microgrid, Multi-Agent System, Smart Contract, simulation, agents.

APPLICATIONS OF DIGITAL TWIN SYSTEMS IN THE AUTOMOTIVE INDUSTRY

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Abstract:

Digital Twin (DT) technology is an emerging technology systematically integrated into the automotive field. This concept enhances the development of stable systems by simulating, monitoring, and optimizing products or processes in real time. It enables thorough testing across various scenarios, ensuring that different conditions are accounted for. Additionally, it minimizes physical defects by utilizing a simulated environment capable of applying stress tests to assess performance under various conditions and identify potential weaknesses.

The absence of physical components in a system can be replaced with simulated systems that enable real-time diagnostics and adaptive functionality, supporting vehicle performance under various conditions. Thus, physical prototypes are reduced, and innovation is accelerated.

Implementing Digital Twin presents significant challenges, such as data security, high costs, and difficulty integrating with existing infrastructures. The study explores these challenges, reviews implementations of the concept, and proposes solutions.

The paper analyzes Digital Twin's applicability in the automotive industry, highlighting how this technology improves the manufacturing process, vehicle development, and performance monitoring.

Automotive standards differ in scope and coverage depending on the specific application area. Their relevance and applicability can vary significantly across different contexts and technologies. Though a few standards indirectly support this topic, they encompass system architecture, functional safety, manufacturing frameworks, and software quality models. Meanwhile, standards that directly address the Digital Twin concept focus on creating, integrating, and managing digital representations of physical systems. However, their adoption in the automotive sector is still influenced by domain-specific standards that do not explicitly reference the Digital Twin process.

Additionally, the concept of the standards applied to automotive components must be clarified, as not all areas can develop Digital Twin simulations. Limitations in interpreting real-world performance may also hinder the complete integration of Digital Twin technology across the automotive sector.

Keywords: digital twin, automotive, maintenance, process standardization

FATIGUE AND DISTRACTION SYSTEMS REVIEW

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Abstract:

This paper is a literature review on systems for driver monitoring and drowsiness detection. The purpose of this review is to get a better understanding of this domain and the state of the art in the field, to understand the key topics of drowsiness detection, the systems architecture that were already implemented and the parameters which are taken into consideration. Theis's work studies various disruptive factors which affect driver's performance and response time and may cause harmful effects.
These factors are classified in two main categories: external and internal. Regarding external sources of disturbance, researches are focused on different types of "noises" that can reduce driver's attention and capabilities. There are identified four main sources of driver distraction: 1) visual distraction; 2) cognitive distraction; 3) auditory distraction; and 4) biomechanical distraction. The focus is on tracking the causes and on the solutions already implemented for each source of perturbation. As for the internal factors, the researchers focus on the presence of "fatigue", the most dangerous threat when it comes to safety and on the existing detection and prevention models. The term "fatigue" describes a feeling of tiredness and exhaustion, with symptoms such as: performance decrease, sleepiness, increased response time, lack of energy and impaired movements. The reviewed papers also study different fatigue detection techniques and their efficiency based on the results obtained by researchers. Based on the parameters measurements, the fatigue detection methods can be classified in three main categories: 1) physiological (e.g. heart rate, pulse rate, EEG); 2) vehicular (e.g. driving patterns, steering wheel feedback, braking intensity); and 3) behavioral (e.g. eye closure, head position, facial expressions). Each method has its own strengths and weaknesses and we comparatively present the results of some significant research, together with few conclusions about the performance and effectiveness of each one. This article also studies a hybrid approach in fatigue detection techniques, combining several important parameters for better results.

Keywords: fatigue, drowsiness, distraction, driver attention, driver monitoring**.**

MACHINE LEARNING ALGORITHMS FOR MONITORING CATTLE BEHAVIOUR

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Abstract:

The integration of machine learning (ML) algorithms into livestock monitoring has emerged as a transformative approach to improving animal welfare, optimizing farm management, and enhancing productivity. In the context of smart farming, monitoring cattle behavior plays a crucial role in early disease detection, estrus monitoring, and evaluating overall animal well-being. This study focuses on the development and application of ML algorithms for accurately classifying and analyzing cattle behavior using data collected from wearable IoT devices mounted on the necks of cows.

The primary objective of this research is to design an efficient and energy-optimized system that leverages IoT and ML technologies to monitor cattle behavior in real-time. Using the Arduino MKR WAN, integrated with accelerometers and gyroscopes, data on various activities—such as grazing, walking, ruminating, and resting—were collected over an extended period. The wearable nodes, designed for low-power consumption, transmitted data via LoRaWAN to a centralized server for analysis.

The experimentation methodology involved deploying the wearable devices on a sample group of dairy cows under natural farm conditions. Data preprocessing techniques, including noise filtering and feature extraction, were applied to ensure high-quality inputs for the ML models. Several algorithms, such as Random Forest (RF), Support Vector Machine (SVM), and Long Short-Term Memory (LSTM) networks, were trained and evaluated based on their accuracy, precision, recall, and F1-score in classifying cattle behaviors.

The results demonstrated that the LSTM model outperformed traditional ML algorithms, achieving an accuracy of 92% in activity classification, primarily due to its ability to capture temporal dependencies in sequential data. The RF and SVM models also showed promising results but were slightly less accurate. A discussion on the trade-offs between model complexity, computational requirements, and energy consumption is included.

In conclusion, the study highlights the potential of combining IoT devices with advanced ML algorithms for effective cattle behavior monitoring. The findings offer valuable insights for the development of scalable smart farming solutions that promote animal health and farm efficiency while addressing challenges related to energy consumption and data transmission.

Keywords: Internet of Things; animal welfare; monitoring; sensor; machine learning; Precision livestock farming (PLF)

REAL-TIME FIREARM DETECTION IN VIDEO USING ENHANCED YOLO MODELS AND A CUSTOM INCIDENT DATASET

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Abstract:

Gun-related violence and armed attacks in public spaces pose significant risks to civilian safety and highlight the urgent need for intelligent surveillance systems capable of detecting firearms in real- time. This paper proposes a robust, deep learning-based solution for detecting weapons—specifically handguns and rifles—in video footage using the latest YOLO (You Only Look Once) object detection models, including YOLOv8, YOLOv10, YOLOv11, and YOLOv12.

To train and evaluate these models, I developed a new, high-quality custom dataset hosted on Roboflow, consisting of 10,000 annotated image frames extracted from approximately 700 real-life video clips. These videos depict actual gun-related incidents, including armed robberies, assaults, and other violent encounters captured in both indoor and outdoor environments. The dataset covers a wide range of challenging scenarios involving varied lighting conditions, camera angles, motion blur, occlusions, and dense crowds, thereby providing a realistic and comprehensive benchmark for firearm detection in real-world conditions.

One of the key challenges in this task is the detection of small and partially occluded weapons, which often appear in low resolution or are only briefly visible within the frame. To address this limitation, I implemented a set of targeted techniques to enhance small object detection capabilities.

These include image tiling (to divide high-resolution frames into smaller regions), multi-scale training, anchor box optimization, and advanced data augmentation methods. These enhancements were integrated into the YOLO training pipeline, significantly increasing the models’ sensitivity to small and distant weapons without compromising real-time performance.

Extensive experiments were conducted to evaluate and compare the performance of YOLOv8, YOLOv10, YOLOv11, and YOLOv12 in terms of precision, recall, mean Average Precision (mAP), and inference speed (FPS). The results demonstrate that all four models achieved an accuracy of approximately 90%, with YOLOv12 slightly outperforming the others in precision and detection stability in complex scenes. These findings confirm that modern YOLO models, especially when fine- tuned for small object detection, provide a reliable and scalable solution for automatic firearm
recognition in surveillance footage.

Keywords: weapon detection, firearm recognition, YOLOv8, YOLOv10, YOLOv11, YOLOv12, object detection, small object detection, video surveillance, deep learning, real-time detection, public safety, Roboflow dataset, image tiling, multi-scale training.

ADVANCING COGNITIVE CAPABILITIES IN LARGE LANGUAGE MODELS WITH IDEA EMBEDDINGS

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Abstract:

Large Language Models (LLMs) have demonstrated remarkable capabilities in generating fluent and semantically appropriate text across a wide range of Natural Language Processing tasks. Despite this, current models largely depend on token-based statistical modeling, a methodology that inherently limits their ability to perform higher-level cognitive functions. Specifically, these models often struggle with tasks that require abstract reasoning and the reliable interpretation of nuanced ideas, leading to problems such as inconsistent outputs and hallucinations. In this paper, we provide a comprehensive survey of state-of-the-art approaches designed to extract essential conceptual information, or the "quintessence", from text corpora. We argue that creating a robust text-to-thought mechanism is critical for advancing LLM cognition from Level 0 to Level 1. Level 0 cognition is characterized by auto-regressive token generation, which relies heavily on learned patterns without clearly distinguishing between simple and complex cognitive tasks. Conversely, Level 1 cognition reflects a more structured and deliberate cognitive process analogous to human thought. It begins with abstract concepts or ideas, followed by the identification of appropriate representative words and phrases capable of accurately conveying these abstract thoughts. Finally, the cognitive mechanism identifies the necessary linking or filler words to ensure grammatical correctness and overall coherence in the generated text. For this, we advocate for methods capable of translating text into conceptual representations of abstract thought, supporting downstream reasoning and subsequently converting these abstract units back into coherent text. Our review covers foundational techniques, including text summarization, topic modeling, keyphrase and concept extraction, named entity recognition, relation and event extraction, semantic role labeling, semantic parsing, topology learning, text simplification and content distillation. We evaluate the relevance of these techniques for implementing bidirectional text-to-thought transformation, identify promising methodologies, and outline challenges related to evaluation and practical deployment. Our findings indicate that transitioning toward idea-centric embeddings could address prevalent shortcomings in LLMs, such as hallucinations and inconsistent reasoning.

Keywords: text-to-thought mechanism, idea embeddings, large language models, abstract representation, information extraction

IMPROVING POWER QUALITY INDICES VIA SMART DEPLOYMENT OF REMOTE-CONTROLLED SWITCHES IN DISTRIBUTION NETWORKS

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Abstract:

This paper presents an optimization model for the strategic placement of remote-controlled switches in medium voltage distribution networks, aiming to improve service quality and reliability. The proposed approach minimizes a multi-objective cost function that integrates key reliability indices: SAIDI (System Average Interruption Duration Index), SAIFI (System Average Interruption Frequency Index), MAIFI (Momentary Average Interruption Frequency Index), ENS (Energy Not Supplied), and ASAI (Average Service Availability Index). The optimization problem is formulated as a constrained mixed-integer programming model, where the decision variables represent the installation status of automated switches at candidate nodes. The objective function minimizes the weighted sum of reliability indices, reflecting both technical performance and customer impact. Constraints include limits on the maximum number of switches, network topology (maintaining radial structure), feeder and line capacity limits, and mandatory supply to critical loads. Each reliability index is modeled as a function of the network's reconfiguration capabilities and restoration time, which are directly influenced by the presence of automated switches. For instance, the installation of remote-controlled switches significantly reduces the average restoration time after a fault, thereby lowering SAIDI and ENS values. The model also considers the improvement in MAIFI and ASAI through faster fault isolation and service restoration. Numerical simulations conducted on a representative medium voltage distribution feeder demonstrate the effectiveness of the proposed method in enhancing reliability metrics with a limited number of installations. The results confirm that targeted deployment of automated switches can substantially improve network resilience and service continuity with optimized investment. This optimization framework can support distribution system operators in making informed decisions for reliability-centered planning in the context of increasing grid automation and smart grid development.

Keywords: remote-controlled switch, distribution network, SAIDI, SAIFI, ENS, optimization, smart grid.

REAL-TIME VISION-BASED CONTROL SYSTEM FOR LAB-SCALE AUTONOMOUS VEHICLES

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Abstract:

The continuous progress of advanced driver assistance systems (ADAS) has intesified the requirement for computationally efficient computer vision algorithms, specifically designed for real-time performance in embedded environments. This paper presents a classical image processing method integrating lane detection and traffic sign recognition functionalities, which has been implemented and experimentally validated on asmall-scale autonomous vehicle prototype. The lane detection algorithm is based on the Hough transform applied to grayscale video frames. Preceding line detection, the frames are processed through a Gaussian smoothing filter to reduce image noise, followed by Canny edge detection. A region of interest (ROI) is isolated to remove irrelevant areas and optimize processing time. The system uses line grouping and slope filtering to detect both continuous and discontinuous lane markings under different illumination conditions. Despite the simplicity of the approach, it shows robustness to common environmental challenges such as shadows and perspective distortion. In parallel, the traffic sign recognition module uses trained Haar cascade classifiers to recognize several traffic signs, such as stop, pedestrian crossing, and speed limits. This approach enables detection with sufficiently high accuracy while ensuring computational efficiency suitable for implementation on low computing power platforms. The two developed modules have been developed in Python using the OpenCV library, integrated on a single embedded processing unit, and tested on a prototype autonomous vehicle designed at a reduced scale. In addition to perception, a basic proportional-integral-derivative (PID) control algorithm was implemented to adjust the direction of the vehicle based on the position and angle of the detected traffic lines. The system was tested under various lighting conditions and lane configurations on an indoor track with printed signs representing common road symbols. The system achieved a high lane detection accuracy in good lighting conditions and successfully recognized traffic signs. The entire perception-control loop worked in real time on an integrated platform, confirming the performance and practicality of the system and the reliability of classical image processing methods for implementing basic ADAS functionalities in controlled environments.

Keywords: Image processing, lane detection, lane following, traffic sign recognition, Hough transform, Haar classifier

INTERFERENCE MANAGEMENT IN 5G AND BEYOND NETWORKS

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Abstract:

Wireless data services had a great impact on people's life due to the exponential grow of number of mobile terminals and of the data traffic they sustain. 5G networks are designed to answer to the increasing demand regarding the data rates, latency, connectivity, reliability, and power efficiency. The key technologies involved are using millimeter waves, massive MIMO, network densification, dynamic TDD, and new waveforms with mixed numerologies. By introducing these new technologies, the heterogeneous structure and the flexibility of 5G networks make possible significant interference, asking for a careful management. This interference may be divided into two main categories: inter-cellular interference and intra-cellular interference.

The inter-cellular interference refers to co-tier and cross-tier interference, adjacent channel interference, intra-mode and inter-mode interference, and remote interference. They are generated by using identical resources in neighboring cells and may limit the 5G network performance, but also, can downgrade the communication service for edge users.

The intra-cellular interference refers to self-interference and multi-user interference. Multiplexing different numerologies in 5G networks and using the same time/frequency resources to serve multiple users may destroy the channels' orthogonality and generate intra-system interference.

Minimizing interference power means using complex schemes to avoid, cancel, and exploit the interference signals, by managing the transmission, the reception or the network. Interference management techniques may be static or dynamic, and are with centralized, distributed, semi-distributed or autonomously distributed control. They are applied in time, frequency, power, space or code domain. The applied techniques ask for resource coordination, filtering, code-spreading, power management, and beamforming. Efficient interference management is essential for the 5G network optimal performance in offering high-quality communication services to the users.

This paper analyzes the interference management in modern 5G networks and includes a detailed taxonomy and methods to tackle it, including solutions based on artificial intelligence.

Keywords: 5G Network, inter-cell interference, intra-cell interference, remote interference, interference management

A POLYNOMIAL-BASED MODELING APPROACH FOR SWITCHING ENERGY LOSS IN SIC MOSFETS USING NON-INTEGER EXPONENTS AND THREE KEY VARIABLES

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Abstract:
The power loss in a SiC MOSFET is primarily determined by two key mechanisms: switching loss and conduction loss. To estimate switching losses, various modeling approaches have been proposed in the literature (e.g. [1], [2]). In industrial applications, switching loss calculations are typically based on energy loss characteristics provided in datasheets of individual MOSFETs.
This paper presents the methodological framework for curve fitting of the switched energy loss of the SiC MOSFET's deriving a parametric model that will express the essential future of the dependency of the function on three key operational variables as drain to source voltage (VDS), drain current (ID) and gate resistor value (Rg), using a product of three polynomial equation with non-integer exponents, which formally, the model will be defined as:
$Esw.loss(VDS, ID, Rg) = F(VDS) \cdot G(ID) \cdot H(Rg)$
Each function F(VDS), G(ID) and H(Rg) are polynomial equations and each is described by an equation with a shape as $\alpha 1 \cdot x + \alpha 2 \cdot x\alpha 1 + \alpha 3 \cdot x\alpha 2 + \alpha 4 \cdot x\alpha 3$, where α1, α2 and α3 are the non-integer exponents of the polynomial equations.
Due to the Eloss is a product of three polynomial equations and the existence of a common root component, the system can be solved using separable non-linear regression (e.g. [4]). This involves the decomposition of the initial system, into a system of three equations, where two variables stay constant and solve for one.

$Esw.loss(VDS) = F(VDS) \cdot G(ID.ct) \cdot H(Rg.ct)$
$Esw.loss(ID) = F(VDS.ct) \cdot G(ID) \cdot H(Rg.ct)$
$Esw.loss(Rg) = F(VDS.ct) \cdot G(ID.ct) \cdot H(Rg)$
Equation 1 System of three equations for separable nonlinear regression

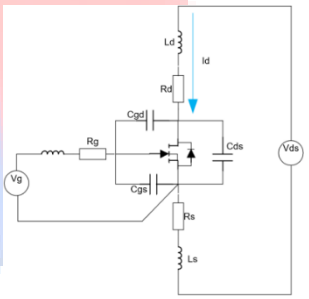

Figure 1 Simplified SiC MOSFET model including parasitics (e.g. [3])

The criterion used for optimization system model of identification is the minimization of root mean square error. This is the difference between the observed or measured values and predicted ones.
The proposed modelling approach by expression the switching loss energy in SiC MOSFET's, as a product of three polynomial function based on key operational variables, improve the predictive capabilities of the losses in designing and optimization of a power converter. The non integer exponents polynomial equation provide an increased precision and efficiency of fitting function compared with normal polynomial equations.

Keywords: switching energy loss, curve fitting, operational variables, polynomial equation, non-integer exponents

NIGHT VISION TECHNOLOGIES IN AUTOMOTIVE SAFETY – INTEGRATION AND POTENTIAL

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Abstract:

As intelligent transportation systems continue to evolve, integrating night vision technologies in the automotive industry represents a significant step toward reducing accidents in low-visibility conditions. This paper explores the implementation of night vision systems—especially infrared-based sensors—in modern vehicles. It focuses on their capabilities, limitations, and interactions with other advanced driver assistance systems (ADAS).

The study positions night vision technologies within the broader context of automotive safety, alongside LiDAR, radar, and optical cameras. Unlike traditional light-based solutions, thermal night vision sensors enable detection of pedestrians, animals, or obstacles at distances beyond the reach of headlights, improving driving safety during nighttime or adverse weather conditions such as fog and heavy rain. Moreover, these technologies are continually evolving, with advancements enhancing both their range and accuracy, offering more reliable assistance.

The methodology includes a comparative analysis of real-world applications from major automotive manufacturers and a technical overview of sensor fusion strategies. The goal is to demonstrate how night vision data can be layered with input from other systems (e.g., LiDAR or radar) to generate more accurate driver alerts. This approach aims to create a synergistic effect, where each system compensates for the other's limitations, resulting in a safer driving experience.

Preliminary findings highlight the added value of combining night vision technology with real-time processing algorithms and AI-based object recognition. Furthermore, the study considers the potential role of night vision systems in semi-autonomous and fully autonomous driving platforms, where complete visibility in all conditions is essential. Additionally, the user experience may be enhanced through more intuitive integration of visual feedback into the vehicle's interface, making these systems more user-friendly for a broader audience.

In conclusion, night vision technology holds strong potential for reducing accident rates, especially in rural or poorly lit environments. Combined with other safety systems, it provides a more comprehensive and context-aware understanding of the vehicle's surroundings. As technology continues to improve, integrating night vision could become a standard feature in vehicles, transforming road safety for all drivers.

Keywords: night vision, automotive safety, sensor fusion, ADAS, thermal imaging, autonomous vehicles

THE INFLUENCE OF RC SNUBBER IN THE PATH OF THE GATE DRIVER CIRCUIT OF SiC DEVICE OF A HALF BRIDGE CONFIGURATION

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Abstract:

Since the market availability has increased and technology has become affordable for big industries like automotive, devices such as GaN and SiC are found in every product related to voltages higher than 100V. Compared to classical silicon, wide band gap devices have advantages such as lower Rds ON, low output capacitance, ultra-low feedback capacitance, and high switching speed. These advantages lead to high-frequency oscillations during ON/OFF events, potentially disturbing the gate supply, gate driver IC, and increasing the risk of false turn ON due to the Miller capacitance. This paper presents a simple solution, like an RC snubber, calibrated to the layout parameters of the gate circuit, to limit the parasitic turn-on effect and attenuate gate oscillations, without significantly affecting the switching performance or increasing the driver gate RMS current.

The snubber is calibrated through experimental tests conducted on a 3.7kW dual-phase DC-DC step-down converter, featuring a wide input voltage range of 800V to 400V and an output voltage of 12V. Main primary side switches are SiC devices of 750V

The current, determined by the complementary FET's positive or negative value of DV/dt, creates a spike on the gate voltage that might open the FET during the OFF period. In addition to the voltage transition, the damped resonances between the switching cells propagate voltage oscillations across gate circuits at frequencies up to 100MHz.

The switching cell's complexity increases even more if we consider the standard auxiliary supply parasitic couplings and the routing of the power traces. So, for the sake of the study, the snubber is calibrated on the oscillations seen in the measurements. The snubber's main task is to keep the oscillations in a safe area, underneath the threshold level of the FET.

The test results below were obtained using a Rhode&Schwarz oscilloscope with an acquisition rate of 5Gsa/s, three differential voltage probes, and one Rogowski coil for current transition measurement. Only the worst result is presented in comparison with the effect of the RC snubber chosen.

Keywords: RC Snubber, half-bridge, SiC device

VIBRATIONS IN HYBRID SOFT ACTUATORS: AN EXPERIMENTAL STABILITY ANALYSIS

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Abstract:

When contemplating robots, especially those in direct contact with humans, precision and repeatability are widely regarded as fundamental performance metrics. However, in the realm of soft robotics, flexibility and inherent safety take precedence without compromising or diminishing the importance of precision and reliability. The development of soft actuators necessitates a careful balance between these factors, ensuring optimal performance regardless of the selected actuation method.

In this study, a custom-designed hybrid soft actuator is examined to assess the combined effects of multiple actuation methods. The actuator under investigation consists of a soft silicone PneuNet structure actuated through a shape memory alloy (SMA) component, effectively integrating the mechanical advantages of both systems. This dual-actuation approach facilitates enhanced stability and mitigates undesired oscillatory behavior, ultimately leading to a superior actuation response compared to traditional soft actuation techniques.

A key objective of this research is to analyze the vibrational behavior of the hybrid actuator under various actuation scenarios. By employing a piezoelectric vibrational sensor, precise measurements of oscillations are obtained, allowing for a comprehensive statistical analysis of vibration attenuation. The results indicate that the hybrid actuation mechanism significantly reduces unwanted oscillations when compared to single-mode actuation systems, thereby enhancing operational stability and functional reliability.

Moreover, the synergistic interaction between the elastic bending of the PneuNet and the controlled deformation of the SMA results in a more predictable and controlled actuation sequence. Unlike purely pneumatic or shape memory actuators, which often suffer from slow response times or excessive deformation, the hybrid system optimally leverages the strengths of both methodologies. This results in improved force output, faster response, and a more consistent dynamic performance.

The findings presented in this research underscore the advantages of hybrid actuation strategies over conventional soft actuators. The increased stability, vibration reduction, and enhanced functional adaptability make hybrid actuators a promising alternative for future robotic applications requiring precise yet compliant movement.

Keywords: soft robotics, statistics, soft actuation, robotics,

AN EVALUATION OF BIDIRECTIONAL INVARIANT DESCRIPTORS USING A DUAL LIE ALGEBRA FRAMEWORK

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Abstract:

Tracking and recognizing human gestures represent a key element for a valuable and effective human-robot interaction as nowadays' technology involves a strong collaboration between them. The comprehension of human intentions leads to an efficient generalization and adaptation of the robot's motions when it comes to replicating the human actions. We aim to build a motion model, employing an invariant representation of motion by the means of invariant trajectory descriptors. In this way, the rigid body motions are described independently of the context in which they were executed. Among the advantages of this representation, we highlight its coordinate-free characteristic and not being affected by Euclidean transformations. In our research we approach the Denavit-Hartenberg Bidirectional Invariants for the purpose of describing a rigid body's trajectory. The DHB invariants are built on a mathematical framework that encapsulate the rotational and translational information, while being invariant to contextual dependencies, to changes in the initial pose or to different reference frames. They consist of three position-based and three velocity-based invariants which are constructed considering the linear and angular frames attached to the rigid body along with the frames' spatial motion. The DHB invariants are similar to the Extended Frenet-Serret invariant trajectory descriptors, requiring the computation of the twist which characterizes the instantaneous rigid-body motion, defining its velocity field. The novelty of our approach lies in the computation of the twist by leveraging the advantages of the dual Lie algebra, namely of the dual numbers, dual vectors and dual tensors calculus. The isomorphism between the Special Euclidean group $S\mathbb{E}_3$ and the orthogonal dual tensors group $\underline{S\mathbb{O}_3}$ facilitates the twist's computation. Our experimental results consist in evaluating the Denavit-Hartenberg Invariants using a real dataset acquired using the Vicon Motion Capture System while performing various activities such as pouring a cup of water or assembling Lego blocks. We compare the DHB-based results with existing representations of motion via invariant trajectory descriptors such as Extended Frenet-Serret invariants.

Keywords: invariant trajectory descriptors, DHB, bidirectional, dual vectors, twist, rigid-body

THERMAL DRIFT OF TEMPERATURE SENSORS – A SHORT REVIEW

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Abstract:

Thermal drift is a real and frequently encountered issue for the temperature sensors, with an important impact on the long-term accuracy and reliability of measurements. This drift occurs gradually over time, being influenced by factors such as temperature variations, component aging, frequent changes in voltage or current or harsh environmental conditions. In critical applications from environmental monitoring or civil infrastructure to IoT systems and the automotive industry these deviations can compromise data quality and lead to poor decision-making. Recent researches propose sophisticated solutions for identifying and compensating sensor drifts.

Artificial intelligence models, neural networks, and big data analysis methods are already being used to detect anomaly patterns and estimate deviations in real time. In the medical field, where accuracy is essential (especially in non-invasive applications), such solutions play a key role for keeping their reliability. Applied studies in structural health monitoring (SHM) of civil infrastructure, such as bridges, have shown that temperature sensor drift that can introduce errors into thermal compensation models, affecting the accuracy of structural integrity assessments. Thus, probabilistic data-driven methods offer effective solutions for detecting anomalies and estimating drift. Additionally, Hall sensors show sensitivity drift with temperature, but it can be corrected using simple resistance-based techniques, eliminating the need for additional temperature sensors.

Moreover, the integration of advanced sensors, such as piezoelectric and magnetostrictive types, offers promising perspective for reducing thermal drift and improving measurement performance. However, high production costs and technological complexity remain significant challenges for this problem. For long term, research is focusing on the integration of smart calibration techniques, self-learning algorithms, or adaptive systems capable of error free operating under variable environmental conditions. This paper provides an overview of current state of the art on temperature sensor drift, highlighting the performances and the implications across various fields and the need for continuous innovation. Despite significant technological progress, accurate compensation of drift in various environments remains an important challenge. Future studies should aim at optimizing calibration protocols, implementing advanced AI algorithms and establishing international standards for drift compensation across industries. Ultimately, understanding and correcting sensor drift will lead, not only to improved sensor performance, but also to better error management and longer operability of monitoring systems.

Keywords: thermal drift, Big Data, IoT, temperature sensors, artificial intelligence

SCENARIO GENERATION USING TRANSFORMERS FOR RETAIL DATA

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Abstract:

What-if scenarios have an important role in the decision-making process for dynamic environments, such as e-commerce, where pricing strategies influence product demand and revenue outcomes. Traditional methods of scenario analysis include statistical forecasting, sensitivity analysis, or different simulations, which have difficulty in determining the linear relationships and the causality between price and demand. To improve the results, a framework that integrates the structural causal model, transformer-based forecasting, and optimal profit window optimization is proposed. Creating scenarios involves adjusting the price and demand time series to reflect the price change percentages. The process starts with transforming the price time series using the change percentage. The causality between price and demand is determined using a log-log regression model and counterfactual simulation. The prediction of future demand is performed using an encoder-only transformer model that captures complex temporal dependencies. Determining the optimal profit window is treated as an optimization problem. A grid search algorithm is used to determine the optimal window from the generated time series that maximizes profit, while accounting for demand pressure and penalizing long windows. Experiments are performed to determine the performance of scenarios compared to the baseline and identify the best scenario. A retail dataset with price and demand for each month is used. Beyond choosing the best scenario, the optimal window that is less than the forecast length is calculated to determine the best period for making a promotion. The results on e-commerce datasets demonstrate the effectiveness of the proposed method and its ability to support decision-makers in choosing the optimal pricing strategies. The framework can be improved to include a multi-variable causal model that uses additional factors, such as marketing campaigns and macroeconomic indicators. A generalisation of the method can be done to create what-if scenarios in multiple domains, such as finance, healthcare, energy, education, supply chain, and transportation.

Keywords: what-if scenarios, machine learning, transformers, causal model

PROTECTING DATA PRIVACY IN ARTIFICIAL INTELLIGENCE MODELS

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Abstract:

The proliferation of digital technologies has led to an exponential increase in the volume of data generated and stored. This growth introduces the need to ensure a secure environment for data processing and storage, considering that every dataset has an owner who determines its level of accessibility.
In the context of the rapid development of artificial intelligence and the widespread use of data processing models, ensuring data privacy becomes a major challenge. It is essential to guarantee that data processing is carried out without information leakage, thus respecting users' right to privacy.
A promising solution for confidential data processing is homomorphic encryption. This cryptographic technique allows mathematical operations (such as addition and multiplication) to be performed directly on encrypted data, without the need for prior decryption. The resulting output is also encrypted, and its decryption yields the same result as if the operations had been performed on plaintext data.
This research aims to explore the possibility of using homomorphic encryption to enable large language models to operate on encrypted data, thus ensuring its confidentiality.
The use of homomorphic encryption in the context of artificial intelligence models presents a series of limitations and challenges. A major issue is that these models, in addition to simple mathematical operations (addition, multiplication), also use complex nonlinear functions, such as exponential, logarithmic, or trigonometric functions. These functions are not directly compatible with homomorphic encryption.
To overcome these limitations, the research explores various methods for approximating nonlinear functions using operations compatible with homomorphic encrypted computation. As a preliminary step, an experiment was conducted on a simpler convolutional neural network to evaluate the practical implications of applying homomorphic encryption. This experiment revealed the main limitations and highlighted the extent of performance and accuracy degradation.
The use of homomorphic encryption for confidential data processing in the context of large language models is a promising field of research. Overcoming current limitations and developing efficient solutions could revolutionize the way we interact with artificial intelligence technologies, ensuring a higher level of data privacy and security.

Keywords: privacy, data security, homomorphic encryption, encrypted data, secure computation, artificial intelligence

INTEGRATION OF FORMAL PATH PLANNING SOLUTIONS BASED ON DISCRETE-EVENT-SYSTEMS INTO MATLAB TOOLBOX RMTOOL

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Abstract:

This work addresses the integration of advanced path planning strategies based on Discrete Event System (DES) formalism into RMTool, a MATLAB-based open-source toolbox designed for modeling and simulating multi-robot scenarios. RMTool provides a flexible environment where teams of robots operate in a predefined workspace consisting of regions of interest that can be designated for visitation or avoidance. The high-level mission requirements for these robotic teams are expressed using formal specification languages, such as Boolean formulae and Linear Temporal Logic (LTL), which enable sequencing and/or synchronization of actions based on the spatial constraints related to these regions of interest.

Two DES-inspired methods have been developed and implemented. Firstly, a planning algorithm enables parallel movement of robotic agents, inspired by resource allocation strategies in Petri net models. This approach ensures efficient task execution by avoiding sequential bottlenecks and enabling dynamic path adjustment, considering also rerouting of the paths when necessary. The second method builds on a Composed Petri Net (CPN) framework, where the entire robotic team is represented by a single Petri net capturing their movement and state transitions. This model is then composed with a mission-level Petri net that encodes the global specification given in LTL. This approach supports formal analysis and ensures that the overall system behavior satisfies the high-level mission constraints, based on solving two Metric Interval Temporal Logic (MILP) problems.

The integration of these two planning methods into RMTool significantly extends its capabilities for multi-robot coordination and mission planning under high-level missions incorporating logical constraints. The toolbox enables users to define various planning scenarios, simulate robot behavior, and evaluate algorithm performance in controlled environments. A comparative study between the newly added methods and other existing planning approaches within RMTool is provided, supported by illustrative examples. This comparison highlights the effectiveness and potential improvements of the DES-based approaches, guiding further development and optimization within the tool.

Keywords: discrete event systems, path planning, multi-robot systems, Matlab-integration

SOFTWARE-IN-THE-LOOP FRAMEWORK FOR LOGISTIC ENVIRONMENTS USING AUTONOMOUS MOBILE ROBOTS

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Abstract:

Facilitating current automation means is required to enhance the Industry 4.0 paradigm in its current state of rapid development. Many companies and academic institutions desire to create facile and universal frameworks that optimize production chains and enhance their robustness and adaptability using robotic entities that increase the production and precision of current labour.

Such systems are achieved by a thorough stage of development and simulation, where the physical modelling of the underlying systems and their interoperability logic are determined. However, constructing a Software-in-the-Loop framework enhances not only the development stage that is tasked with visualising the process modelling but also the deployment, supervision and real-time modifications for the executing tasks.

In this paper, the concept is demonstrated for the equipment of a logistic environment that contains both static and mobile conveyor belts. These conveyors have their corresponding simulation models for the components of perception and motion. The static conveyor has integrated limit switches as perception components and a roller motor for the motion components. The mobile conveyor is composed of an omnidirectional mobile robot and a conveyor belt attached to interact with the static conveyors for the transfer of packages. Likewise, its perception equipment is composed of encoders for the motor wheels, LiDAR systems, and an end-stop limit switch for the conveyor. The motion components are the four motors used to drive the robot wheels and another motor for the attached conveyor.

The study uses the trajectories generated by the path planner layer on a predefined set of waypoints, which is validated on the simulation medium and compared with the real physical evolution. The software architecture is defined by the Robot Operating System (ROS) framework to create a system-agnostic layer that facilitates deployment. The results show the high fidelity of the simulation medium referenced to the real world and the ease of deployment on the real system using a well-thought-out architecture and modelling.

In conclusion, the use of accurate modelling of sensors and system dynamics and the appropriate software tools lead to an increase in development efficiency and the ability to cycle thorough testing scenarios fast and efficiently.

Keywords: path-planning, mobile robots, logistic systems, robot operating system, software-in-the-loop

GLARE ASSESSMENT IN LIGHTING ENGINEERING – LITERATURE REVIEW

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Abstract:

The article is a review of current knowledge in the increasingly analyzed field of glare, which is defined as "difficulty in vision in the presence of strong light, such as direct or reflected sunlight, or artificial light, such as car headlights at night", which has multiple implications. The large number of articles related to glare, presented by researchers from various fields, denotes the increased interest in human safety and comfort. The use of artificial light has a major potential in current activities, as an environmental factor, but it also has negative effects, already recognized, due to the quantity and quality of light. The issue of the two effects of glare: "disability glare" and "discomfort glare", was reiterated in the 10th edition (2011) of Lighting Handbook of the Illuminating Engineering Society (IES). In support of researchers studying glare and its effects one mentioned: the Stiles-Holladay equation for physiological glare (Holladay, 1927, Stiles, 1929), "Borderline between Comfort and Discomfort" (BCD – Guth, 1963), "Cumulative Brightness Evaluation" (CBE – Bennett), the de Boer rating scale (9-point scale) for discomfort glare, etc. In 2002, the International Commission on Illumination (CIE) defined three equations for physiological glare. Taking into account Sørensen's proposal from 1987, the CIE recommends, however, the Unified Glare Rating (UGR) as a quantitative measure of glare. The subject is quite controversial, leading to multiple discussions and studies, because the UGR method has multiple limitations, including: it is not applicable in industrial halls, it only captures the subjective disturbance, not the objective one of visual performance, and, the most acute problem, it does not cover the evaluation of physiological blindness, not being developed for this purpose. With the development of technology, electronic products, light pollution, the problem of glare and its effects has become increasingly important. The authors analyze how to evaluate the phenomenon of glare through established calculation relationships, this being usually reserved only for specialized simulation programs as DIALux EVO.

Keywords: discomfort, parasitic light, flickering, psychophysics, peripheral vision

USING BAG-OF-WORDS CLASSIFICATION MODELS AND ELECTROMYOGRAM SIGNALS FOR MULTIDAY PERSONAL IDENTIFICATION AND AUTHENTICATION

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Abstract:

To overcome the limitations of conventional biometrics such as voice identifiers, facial recognition, and fingerprints, surface electromyograms (sEMG) have emerged as a ground-breaking solution for biometric authentication and identification. EMG signals offer a promising approach to biometric password generation and decryption, as they capture unique muscle activity patterns produced during specific gestures. This article analyses the efficiency of combining fast Fourier transform (FFT)-based features extracted from multichannel sEMG signals with a bag-of-words (BoW) classification model for both authentication and identification tasks. The sEMG data were acquired from a group of 43 healthy subjects performing 16 distinct hand gestures over three different days, using eight electrodes evenly placed on the forearm. Robust evaluation and analysis were facilitated by the open-access, multi-session, multi-channel Gesture Recognition and Biometrics Electromyogram (GrabMyo) database.

BoW classifiers, which have previously demonstrated success in ECG-based biometrics, offer several advantageous characteristics: flexibility in setup parameters, compatibility with various input feature types, robustness to variable-length recordings, and ease of integrating sensory or feature data fusion methods. In this study, FFT-based features were extracted from six non-overlapping frequency bands and encoded using BoW histograms. The encoding process and codebook design allow the system to handle variable-length gesture sequences effectively due to histogram normalization.

A systematic ablation study was carried out to examine the influence of key design choices, including the encoding strategy, codebook size, and length of the gesture-based password, on system performance. Metrics such as area under the curve (AUC), equal error rate (EER), and cumulative match characteristics (CMCs) were used to assess performance in both within-day (WD) and cross-day testing scenarios. Results show near-perfect operation for passwords composed of three successive gestures in the WD case, with Rank-5 identification rates exceeding 99%. In the cross-day scenario, only minor degradations of 1.1% in AUC, 3.1% in EER, and 3.2% in Rank-5 CMC were observed, underscoring the robustness and long-term stability of the proposed approach, and its potential to outperform traditional physiological biometrics.

Keywords: biometrics authentification, EMG, bag-of-words, gesture, open-access data set

A MARKET OVERVIEW OF GAN, SIC AND SUPERJUNCTION POWER DEVICES

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Abstract:

In the race for best performances with smallest power loss, industries - such as the ones related to EV transition - shift from silicon made power devices to other materials with a higher power density, improving their competitiveness in a fast shaped global market.
To assess the current state of new materials usage, a market analysis was conducted to understand where GaN, SiC and Superjunction power devices are used in terms of VDSS, ID, QG and RDS_ON.
As experimentation methodology, the component database Digikey was filtered by material or technology and a list of transistors with key parameters was featured. A classification of components has been done considering several intervals: <30V, 30-100V, 100-600V, >600V for VDSS; <1A, 1-10A, 10-100A, >100A for ID; <10nC, 10- 50nC, 50-200nC, >200nC for QG; and <1mΩ, 1-10mΩ, 10-100mΩ, >100mΩ for RDS_ON.
Components filtered by VDSS show that more than 98% of SiC and Superjunction devices are used over 600V, while GaN devices are marketed with all types of voltages. If ID is considered, most components are placed within 10-100A range. Components sorted by QG show that most of the GaN devices come with gate charges between 10-50nC, while SiC and Superjunction devices are to be found in the ranges of 10-200nC in proportion of 90%. RDS_ON classifies most of the components in both the 10-100mΩ and >100mΩ ranges, with only the GaN device being present in the 1-10mΩ range.
From the results gathered, all technologies available in the open market can be used at high voltage, with only GaN devices being used at lower voltages. SiC devices come with the highest current capability, with Superjunction and eGaN devices not far behind. GaN performs better if the gate charge is compared, leaving SiC and Superjunction devices behind. In terms of ON resistance, it seems that GaN performs better, but there is no clear winner based on present data.
The open market data show clear benefits for each material. Future work should evaluate the performance of each device considering figures of merit.

Keywords: comparative analysis, market overview, eGaN, SiC, superjunction

3D SYSTEM FOR LEARNING TO OPERATE INTRAORAL X-RAY DEVICE

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Abstract:

Simulator for learning intraoral radiography positioning using Webots.
This article presents an interactive simulator designed for training dental radiology technicians. Usually, the process of learning the correct positioning of such a device involves the use of real equipment and a mannequin or human subject. This method has some limitations, such as high costs, limited access to equipment, and risks of radiation exposure. Training a large number of students is difficult due to the limited availability of devices and the need to supervise each user.
The proposed simulator uses the Webots simulation environment to create a 3D model of a robotic intraoral radiography device. In the current version, this model can be controlled by using the keyboard and mouse, offering two positioning options. First option - the user can manually control the device with the mouse and keyboard, adjusting its position to practice different angles and orientations necessary in obtaining accurate radiographic images. Second option - the device can be automatically positioned by simply pressing keys corresponding to preset positions, which facilitates quick and correct learning of the technique, ensuring standardized and repeatable placement of the device.
The simulator offers the possibility of repeated practice in a controlled environment, without risks and the need for physical equipment, eliminating the additional costs associated with the wear of real devices. It provides flexibility and accessibility by allowing the training of many students simultaneously without limitations imposed by the availability of equipment and can also be used for individual study on any compatible computer.
Also, the integration of automatic positioning helps users learn more effectively by directly observing the correct positions used in practice, thus reducing the time required for training.
The simulator was realized by creating the 3D model in Python programming language, using Webots functionalities to ensure a realistic interaction between the device and the human anatomical model. This simulator is an innovative tool for training dental radiography specialists, improving practical training and safety. It can also be used in research by testing new X-ray machine positioning techniques.

Keywords: X-ray simulator, Webots, medical education

ADVANCED APPROACHES IN ECG SIGNAL ACQUISITION AND PROCESSING FOR BIOMEDICAL APPLICATIONS

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Abstract:

Electrocardiography (ECG) remains one of the most reliable and widely used methods for non-invasive cardiac assessment. In recent years, both the miniaturization of biomedical devices and the increasing demand for remote patient monitoring have led to significant progress in ECG signal acquisition and analysis. This research explores recent developments in electrode technologies—including dry, flexible, and textile-based designs—as well as the integration of advanced signal processing techniques aimed at improving noise reduction, feature extraction, and the identification of pathological patterns. Special attention is given to the challenges posed by motion artifacts, skin-electrode interface variability, and the need for real-time processing in wearable systems. The study provides a structured overview of current methodologies, highlighting innovative solutions proposed in recent scientific literature and outlining potential directions for future research. The objective is to support the development of more efficient and accurate ECG monitoring systems, with practical applications in preventive medicine and long-term cardiovascular care.

Keywords: ECG signal, biomedical applicacations, wearable devices, signal processing, ECG electrodes

PANOPTIC SEGMENTATION TECHNIQUES

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Abstract:

A crucial aspect of numerous computer vision applications, such as autonomous vehicles, mobile robots, and assistive systems is the ability to understand the environment. Humans are able to do this effortlessly perceiving and interpreting their surroundings through their visual system. Scene understanding remains a significant challenge in the field of artificial intelligence. Panoptic segmentation has emerged as a concept aiming to address this challenge, striving to enable artificial systems to understand scenes effectively through the analysis of visual information. Unlike traditional semantic and instance segmentation approaches which address these tasks independently, panoptic segmentation aims to jointly predict 'stuff' classes, such as background objects or amorphous regions, and 'thing' classes, which represent distinct foreground objects.
This study presents a comparative analysis of two prominent panoptic segmentation models used in the automotive domain: EfficientPS, trained on the Cityscapes dataset, and Detectron2, trained on the COCO dataset. EfficientPS employs a two-stream architecture, concurrently processing image data for both semantic and instance segmentation tasks. This architecture prioritizes real-time performance without trading accuracy, making it well-suited for applications such as autonomous driving.
Developed by Meta Platforms Inc., Detectron2 builds upon the architecture of its predecessor, Detectron. It possesses the capability to perform a variety of tasks, including object detection and recognition, pose estimation, semantic segmentation, instance segmentation, and panoptic segmentation. To achieve this, Detectron2 leverages multiple networks, such as TensorMask, TridentNet, RetinaNet, Mask R-CNN, and Fast R-CNN. Currently, the training of these models is exclusively conducted using the COCO dataset.
The comparison between EfficientPS and Detectron2 is based on their performance on Cityscapes dataset and on a custom dataset, SoVLite. Using SoVLite dataset allows to analyse the networks' performances on novel images. Furthermore, given the increased luminosity present in the SoVLite dataset, the study also investigates the impact of external factors, such as luminosity, reflection, and object viewing angle, on the results produced by both networks. Finally, the study discusses the advantages and disadvantages of each neural network and explores potential future directions for development in the field of panoptic segmentation.

Keywords: panoptic segmentation, efficientPS, detectron2, cityscapes dataset, SoVLite dataset

PREVENTING COGNITIVE DECLINE WITH THE HELP OF SOCIAL ROBOTS

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Abstract:

Socially assistive robots (SARs) are increasingly explored as tools to support older adults with mild cognitive impairment (MCI), aiming to maintain independence, provide cognitive stimulation, and reduce caregiver burden. Given the increasing proportion of older adults and neurodegenerative conditions on the rise, innovative approaches are urgently needed to address cognitive decline at an early stage. This study presents an intervention using the humanoid social robot Pepper, designed to help prevent or delay cognitive deterioration through personalized memory training, emotional support and assistance with daily routines and mental activities. Our approach is grounded in a user-centered design methodology, emphasizing individual preferences, adaptive interaction, and sustained engagement. Building on findings from the literature and preliminary trials, we developed a system of cognitive stimulation exercises that leverage Pepper's integrated natural language processing (NLP), speech recognition, and multimodal interaction capabilities. The intervention framework incorporates storytelling, theater-inspired scenarios, and memory games—interactive elements known to enhance focus, emotional well-being, and user motivation. Two interactive memory games were prototyped and tested, demonstrating how Pepper can deliver personalized and dynamic cognitive training sessions using its speech, gestures, touch sensors, and visual interface. These features not only support memory retention and cognitive agility but also foster companionship, helping to reduce feelings of isolation—a well-documented contributor to accelerated cognitive decline. Additionally, Pepper enables ongoing monitoring of user responses and behavior, providing valuable feedback to caregivers or healthcare professionals regarding cognitive progression. The proposed system demonstrates potential as a flexible, home-based cognitive support tool for older adults living independently or in assisted care. It aligns with the growing interest in affective robotics and intelligent assistive technologies as scalable solutions to support ageing populations. By integrating socially intelligent robots into everyday life, we can address both cognitive and emotional aspects of aging. Ultimately, this project contributes to a broader effort to integrate robotics into proactive dementia prevention strategies, improving quality of life and reducing strain on traditional caregiving systems.

Keywords: social robots, ageing, mild cognitive impairment, Pepper robot, cognitive stimulation, assistive technology

ENGINEERING APPROACHES IN EXOSOME-BASED THERAPIES

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Abstract:

The paper synthesizes the main approaches from an engineering perspective to using exosomes in medical treatments and research.
The advent of exosome engineering has redefined the landscape of targeted therapeutics, offering a natural, biocompatible, and versatile platform for drug delivery, diagnostics, and regenerative medicine. Engineered exosomes—biologically derived extracellular vesicles (EVs)—can be functionally enhanced through genetic, chemical, and physical modifications to improve specificity, stability, and therapeutic efficacy. Genetic engineering of donor cells, particularly using CRISPR-Cas9 (a gene-editing tool used in genetic engineering) or plasmid transfection, enables exosomes to encapsulate therapeutic nucleic acids or surface ligands. Additionally, chemical strategies such as PEGylation and click chemistry augment their circulation time and targeting capabilities.
Cargo loading methodologies, including passive diffusion, electroporation, and sonication, further tailor exosomes for precision therapy. Despite promising outcomes in delivering siRNA (a short, double-stranded RNA molecule that plays a key role in the RNA interference pathway), CRISPR components, or anticancer drugs, these techniques might compromise exosomal integrity or loading efficiency. Hybrid and exosome-mimetic nanovesicle systems offer scalable alternatives with enhanced cargo capacity and production yields.
Surface engineering strategies, such as fusion with synthetic liposomes or receptor-mediated ligand attachment, have shown significant promise in targeting hard-to-reach sites like the brain via transferrin and ApoB conjugation. Integration with microfluidics and nanoelectronics further accelerates their clinical translation by refining exosome isolation, characterization, and real-time tracking using impedance spectroscopy, photonic biosensors, and plasmonic nanomaterials.
Furthermore, engineered exosomes are central to developing bioactive scaffolds and hybrid delivery systems combining liposomes, nanoparticles, and synthetic polymers for enhanced regenerative and oncologic applications. ICT integration via AI, machine learning, and cloud platforms has enabled large-scale exosome biomarker discovery and telemedicine-based diagnostics. Despite challenges in standardization and scale-up, exosome engineering continues to catalyze next-generation nanomedicine, with significant translational potential for personalized, non-invasive, and multifaceted clinical interventions.
The paper concludes with concrete ways in which ICT can support the development of research in genetic engineering in general and in exosome-based therapies in particular.

Keywords: exosome, therapy, genetic engineering, ICT

MAPPING SCIENTIFIC PROGRESS IN NEUROSURGICAL EQUIPMENT FROM THE PERSPECTIVE OF ELECTROMAGNETIC INTERFERENCE IN OPERATING THEATRES

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Abstract:

In order to assess the scientific impact of research on medical devices used in neurosurgery operating rooms, bibliometric methods have become indispensable. By providing a methodical approach to the analysis of large volumes of scientific literature, these approaches make it possible to identify important research trends, significant publications, and well-known authors in the field. A thorough grasp of the creation, dissemination, and evolution of information about neurosurgical technology is supported by bibliometric analysis, which looks at huge datasets. With an emphasis on their use in evaluating scholarly output pertaining to neurosurgical devices, this paper investigates the theoretical foundations of bibliometric approaches. To reveal the structural and intellectual landscape of the field, methods including keyword co-occurrence analysis, co-authorship mapping, and citation analysis are used.

By using these techniques, the study finds high-impact papers, new research topics, and unexplored fields that can profit from more research. Additionally, bibliometric analyses shed light on the contributions of top universities, writers, and funding organizations, providing insightful information for promoting scholarly cooperation and influencing research policy. In a time when neurosurgery technology is advancing at a breakneck pace and includes robotic-assisted systems, intraoperative imaging, and real-time monitoring tools, these insights are especially important. Clinicians, researchers, and policymakers can better remain up to date on revolutionary advancements and their therapeutic implications by comprehending how these breakthroughs are represented in academic literature. Notwithstanding several drawbacks, including biases based on citations and challenges in evaluating transdisciplinary outputs, this study emphasizes the continued usefulness of bibliometric techniques in capturing the dynamics of scientific advancement. The study intends to facilitate evidence-based decision-making and improve the conversion of technology developments into better neurosurgical procedures and patient outcomes by combining quantitative analysis and conceptual viewpoints.

Such insights are instrumental for fostering research collaborations, guiding strategic investments, and shaping science policy. In the context of neurosurgery, where technological breakthroughs such as robotic-assisted surgical systems, intraoperative imaging modalities, and real-time physiological monitoring tools are increasingly prevalent, bibliometric analyses serve as a vital tool for tracking how these innovations are reflected in the academic landscape and their potential impact on clinical practices.

Keywords: bibliometry, neurosurgery, operating theatres, devices

ENHANCED VALIDATION OF RAY TRACING SIMULATIONS USING MULTI-INTERSECTION 5G MEASUREMENTS IN URBAN ENVIRONMENTS

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Abstract:

Accurate modeling of radio wave propagation is essential for effective 5G network planning, particularly in dense and complex urban environments. The study evaluates the performance of ray tracing simulations against real-world 5G measurements collected at multiple urban intersections. The locations vary in terms of street geometry, building height, density, and line-of-sight conditions, offering a diverse set of propagation environments for analysis.

Measurements were performed using the Quectel RM500Q 5G module as user equipment (UE), capturing key parameters such as Signal-to-Interference-plus-Noise Ratio (SINR), Reference Signal Received Power (RSRP), and Reference Signal Received Quality (RSRQ). Data collection was performed along predefined routes using walk tests to ensure coverage of both line-of-sight (LOS) and non-line-of-sight (NLOS) scenarios. All measurements were geo-tagged to allow for accurate comparison with simulated results.

Ray tracing simulations were conducted using a MATLAB-based platform, based on high-resolution 3D maps and modeling major propagation mechanisms including reflection, diffraction through multiple environment types. The simulated results were compared with the real-world data across a range of urban morphologies to assess the accuracy and generalizability of the simulation tool.

Results show a high level of agreement between measured and simulated data, with minor discrepancies attributed to small-scale fading, dynamic obstacles, and unmodeled material properties. The consistent performance of the simulation across multiple intersection types demonstrates its robustness and reliability for urban 5G scenario analysis.

This work supports the use of ray tracing as a reliable method for evaluating and optimizing 5G network performance in complex environments. By validating simulation results against measurements from varied real-world scenarios, the study provides a stronger foundation for simulation-based design, analysis, and deployment of 5G systems in urban areas.

Keywords: 5G technology, signal propagation, urban scenarios, real-world measurements, ray tracing simulation, received signal power

DESIGN AND INTEGRATION OF A PNEUMATICALLY-ACTUATED GLOVE WITH MICROSOFT HOLOLENS FOR NEUROREHABILITATION

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Abstract:

Rehabilitation robotics continues to evolve, incorporating emerging technologies that improve motor recovery for individuals with neurological or musculoskeletal impairments. One of the most promising innovations in this field is the integration of augmented reality (AR) with pneumatic glove systems to assist in upper limb rehabilitation. AR technology enhances the user's interaction with their environment by overlaying holographic elements onto the real world, creating an engaging and intuitive rehabilitation experience. In light of the increasing number of individuals with motor impairments in Europe, including Romania—mainly due to population aging—there is a clear need for effective, accessible, and motivating therapeutic tools. To address this, we developed a pneumatic glove-based mechatronic system combined with Microsoft HoloLens 2 smart glasses. The pneumatic glove assists hand and finger movement through air-actuated components, offering controlled support or resistance during therapy sessions. The AR interface projects interactive 3D holograms into the user's environment, which can be manipulated through natural hand gestures and eye tracking, all synchronized with the movements facilitated by the pneumatic glove. This real-time biomechanical interaction enhances motor control and helps compensate for deficits caused by stroke or other motor disorders. A major focus of the system design is ease of use. Algorithms detect user intent, enabling intuitive interaction without the need for complex commands or prolonged training. This approach significantly increases patient engagement and therapy effectiveness. As a potential future improvement, the glove system could be equipped with integrated sensors to objectively assess hand function and monitor therapy progress in real time. All collected data could be stored in a cloud-based Oracle database, providing clinicians with valuable tools for long-term tracking, performance analysis, and personalized treatment adjustments. By combining the tactile support of pneumatic actuation with the immersive experience of AR, this innovative solution offers a motivating, adaptive, and data-driven approach to upper limb rehabilitation.

Keywords: augmented reality (AR), pneumatic glove systems, interactive 3D holograms, rehabilitation robotics, HoloLens 2

LEVERAGING ELECTRIC VEHICLE INTEGRATION FOR OPTIMIZING DISTRIBUTION NETWORKS

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Abstract:

The concept of sustainability and the transition of an energy system towards it involves the modernization of electrical distribution networks and the integration of flexible solutions for managing energy consumption and production. As the demand for energy increases and the need for cleaner, more efficient energy systems grow, the role of electric vehicles (EVs) becomes crucial. This paper explores the potential of integrating electric vehicles into the energy system and their role in optimizing the operational regimes of low and medium voltage networks.

Specifically, it examines how EVs can contribute to balancing energy demand and supply, improving the efficiency of the grid, and enhancing overall system stability. The primary objective is to investigate the concepts of Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), and Vehicle-to-Everything (V2X), as well as participation in Demand Response (DR) mechanisms. These strategies aim to optimize load profiles, reduce power losses, and increase grid resilience during peak consumption periods. By utilizing EVs as flexible assets within the grid, their integration can lead to a more stable and efficient energy network, which is vital for future smart grids. This paper also presents the development of a mathematical model designed to analyze the impact of coordinated charging and discharging of electric vehicles on key network parameters, such as voltage, load currents, and conductor losses. The model is implemented in MATLAB, allowing for the simulation of various operating scenarios based on the level of EV penetration and the applied control strategy. The model provides valuable insights into how different penetration levels and strategies can affect network performance. The results of this study highlights the benefits of the intelligent integration of electric vehicles into distribution networks. Additionally, the paper identifies the balance conditions necessary to prevent network overload and ensures smooth operation. The study emphasizes the critical role of electric vehicles in shaping the future of smart grids and offers a solid foundation for the development of supportive policies, technologies, and regulatory frameworks.

Keywords: vehicle-to-grid, electrical vehicles , demand response, grid optimization, smart grids

INTEGRATED VELOCITY OPTIMIZATION IN NONLINEAR MODEL PREDICTIVE VEHICLE CONTROL

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Abstract:

In the field of technological development, the automotive industry plays an important role, especially in shaping how we think about the vehicles of the future. Its impact can be seen not only in the cars we use today but also in the growing expectations for what future mobility should look like. These advances are made possible by ongoing progress in both academic research and industrial innovation. A major reason for the strong interest in autonomous vehicles is the wide range of potential benefits they offer. These include better traffic flow, lower carbon emissions, reduced use of fossil fuels, and the opportunity to explore and develop new research areas and technologies. At the center of this progress, the automotive field successfully brings together vehicle dynamics modeling with advanced control algorithms and driver-assistance systems (ADAS). This study presents a control approach designed to better capture the nonlinear behavior of vehicles, using predictive control techniques, specifically, Nonlinear Model Predictive Control (NMPC). Nonlinear models have a clear advantage over linear ones because they are better able to reflect the true physical behavior of a vehicle. Linear models simplify the system by focusing on a fixed point of operation, which can lead to errors or reduced performance. In contrast, nonlinear models avoid these problems and give a more accurate description of how a vehicle behaves in real situations. This makes NMPC especially useful in complex driving situations where nonlinear effects are more noticeable, such as when the vehicle follows paths that lead to behaviors that don't match linear predictions. Model Predictive Control (MPC), in general, is considered one of the most powerful modern control methods, known for its accuracy and its ability to deal with system limits in a structured way. In addition to handling nonlinear vehicle behavior, this study also focuses on the use of intelligent features, such as estimating the vehicle's maximum velocity profile and tracking its desired path. These functions help improve the system's reliability and make it more adaptable to the challenges of autonomous driving.

Keywords: nonlinear predictive control, vehicle dynamic systems, autonomous vehicles, trajectory tracking, path following

THE EUROPEAN ENERGY TRANSITION: CURRENT CONTEXT AND INDEPENDENCE

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Abstract:

The present study analyzes the relationship between the Gross Domestic Product (GDP) and the energy structure, focusing on the ratio between total available energy and energy from renewable sources at the level of the member states of the European Union (EU). The research utilizes official statistical data provided by Eurostat, including total available energy and energy from renewable sources and biofuels, to evaluate how economic dynamics influence the adoption of renewable energy. This approach aligns with the European Union's objectives regarding climate neutrality, which aim for the transition to a sustainable economy and the reduction of net greenhouse gas emissions by 2050.

In this context, promoting renewable energy represents a strategic priority of the Union's energy policies, being a key tool for reducing dependence on fossil fuels, increasing energy efficiency, and protecting the environment. Renewable energy sources, such as wind, solar, hydro, and biofuels, play a fundamental role in transitioning to a sustainable energy system. Not only do they reduce carbon emissions, but they also contribute to diversifying energy sources, thus minimizing risks associated with the volatility of fossil fuel prices and dependence on external resources. Additionally, the development of the renewable energy sector generates significant economic opportunities by creating jobs and stimulating technological innovation.

The methodology of Structural Equation Modeling (SEM), implemented through the SMART PLS 4 software, allows for a detailed analysis of the complex relationships among the analyzed variables. It facilitates the identification of GDP's influence on the proportion of renewable energy within total consumption and the interdependencies between economic growth and the energy transition. Preliminary results indicate significant links between GDP and the use of renewable energy, showing that more developed economies exhibit a higher degree of integration of renewable sources within their energy mix. This suggests that GDP can act as a catalytic factor in the adoption process of renewable energy, offering important perspectives for energy policy strategies.

Keywords: GDP, renewable energy, European Union, energy transition, sustainability, energy policies.

HARMONIZING COST-EFFICIENCY AND RENEWABLE INTEGRATION IN NEARLY ZERO-ENERGY BUILDINGS: A COMPARATIVE AND PRACTICAL INSIGHT

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Abstract:

The transition towards sustainable and energy-efficient buildings is at the heart of the European Union's energy and climate policies, supported by initiatives such as the promotion of Nearly Zero-Energy Buildings (NZEB). These buildings combine high energy performance with the integration of renewable energy and have the potential to make a significant contribution to reducing environmental impacts and achieving sustainability goals. In this context, the study explores the diversity of legislative approaches at the European level and provides an applied perspective through a case study from Romania, analyzing the economic and sustainability implications of NZEB implementation. The research focuses on assessing the differences in national requirements for renewable energy integration in NZEB buildings and analyzes the economic and energy performance of a specific residential project. The methodology involves, on the one hand, a comparative analysis of European regulations, focusing on the diversity of renewable requirements, and on the other hand, a simulation-based assessment applied to distinct building scenarios: one conventionally built and one designed according to the specific Romanian NZEB standard. The results of the study indicate that Nearly Zero-Energy Buildings (NZEB) have the capacity to considerably reduce the energy required for heating, contributing to significant savings by optimizing thermal performance and minimizing heat losses. At the same time, the financial analysis indicates that the investment required for such retrofits can be amortized within a reasonable timeframe, contributing to the economic feasibility of the projects. From an implementation perspective, matching EU legislative requirements with national specificities is a challenge, but the technical and economic viability of NZEB offers a sustainable solution in the medium and long term. Nearly Zero-Energy Buildings (NZEB) not only support environmental protection, but also stimulate technological innovation, creating significant economic opportunities for the development of the sustainable construction sector. The research findings underline the importance of optimizing future strategies for legislative compliance and increasing energy efficiency.

Keywords: nearly zero-energy buildings, energy efficiency, renewable energy share, cost-effectiveness, EU legislation, sustainable construction

EFFICIENCY OF USING NOISE CORRELATORS IN DIAGNOSING AND REDUCING LOSSES IN DRINKING WATER NETWORKS

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Abstract:

Water leak detection in distribution networks is a critical activity for the efficiency and safety of supply systems. One of the most accurate and efficient methods is the use of acoustic correlators, such as the “Touch Pro" equipment produced by HWM-Water. Correlators identify the exact location of a leak using highly sensitive acoustic sensors strategically placed on the pipe under investigation.
The operating principle consists in capturing the sound generated by the water leak, Which propagates through the pipe wall in the form of vibrations and through the water column in the form of a pressure wave. These sensors transmit the acoustic signals to a central unit that using advanced algorithms, analyzes the time differences between the signals received from each sensor. The correlator determines the exact position of the leak by relating the time difference between the arrival of the signals to the known speed of sound propagation and the distance between the sensors. The "Touch Pro" equipment is equipped with highly sensitive accelerometer sensors and can additionally use hydrophones for detection in difficult conditions or in plastic pipes. The system features an intuitive LCD touch screen interface, Which allows for quick and precise configuration of parameters such as pipe material and diameter. "Touch Pro" also integrates advanced automatic noise filtering technology, applying multiple filter combinations to obtain clear and precise results even in Conditions of high ambient noise. The correlator is portable, completely autonomous and communicates Wirelessly with extemal units located in the field, facilitating fast and safe operations. Its prominent Performances allow for the accurate identification of leaks at distances of up to several hundred meters between Sensors ‘even in dense urban networks or in plastic networks, thus ensuring prompt intervention and significant reduction of water losses. This paper provides a comprehensive technical presentation of the Touch Pro correlator, detailing its design, functionality and application. Also, several case studies are presented that demonstrate its effectiveness in a real-world scenario.

Keywords: acoustic correlation, accelerometric sensors, hydrophones, leak detection, automatic filters, water networks

DESIGN AND SIMULATION OF DIGITIZATION METHODS USED IN CONTROL OF POWER CONVERTERS

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Abstract:

Amid the accelerating shift toward digitalization in power electronics, this paper presents a comprehensive analysis of digitization methods used in the control of power converters, with a strong emphasis on software-based implementations, focusing on the transition from analog to digital systems in modern high-frequency applications. The study begins with the observation that while digital platforms offer advantages such as flexibility and easy reconfiguration of controllers, they also come with constraints imposed by sampling frequency and control loop execution time. Point-of-load (POL) converters, commonly used in telecommunications and computing systems, impose strict dynamic performance and stability requirements, making the selection of digitization techniques critical.

The study is based on the design and simulation of a Buck converter with a digitally implemented control loop using MATLAB® and validated in SIMULINK®. A PI controller is considered, and four digitization techniques are compared: Tustin (bilinear transform), Zero-Order Hold, Matched Pole-Zero, and Least Squares. Each method is evaluated under dynamic conditions, including step changes in voltage reference and load current, to highlight their impact on system response. Simulation results show that all four methods provide similar transient behavior, with minimal differences in terms of rise time, overshoot, and steady-state performance. However, the choice of digitization method influences the fidelity with which the continuous-time behavior is replicated in a discrete- time system.

Additionally, the study investigates the impact of the control loop sampling frequency relative to the converter switching frequency, analyzing the differences in dynamic performance for different sampling frequency of 1/1, 1/10, 1/20 of the switching frequency. The findings highlight the importance of optimizing the sampling rate to the switching frequency, especially when using software-based digital control on microcontroller platforms.

The paper thus provides a guide for the design of digital control in power converters, emphasizing the importance of choosing the digitization method and sampling frequency in the context of dynamic performance and system stability.

Keywords: buck converter, digitization methods, digital control, PI digitization, sampling frequency, MATLAB®

APPLYING PETRI NETS FOR CYBERATTACK ANALYSIS IN POWER SYSTEMS

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Abstract:

Modern power systems, heavily relying on digital communication and automation, have become increasingly vulnerable to cyberattacks. These systems—comprising SCADA, PLCs, RTUs, and other critical infrastructure components—are targeted by sophisticated threats such as Denial of Service (DoS), command spoofing, and logic manipulation attacks. Given the essential nature of power infrastructures, ensuring their cyber-resilience is paramount. Formal methods are thus crucial in accurately modeling and evaluating system behavior under potential attack scenarios.

This paper investigates the application of Petri nets as a formal tool for modeling and analyzing cyberattacks on power systems. Petri nets provide a robust framework to describe the asynchronous and concurrent behavior of system components. Their graphical and mathematical structure allows for clear representation of process flows and system state transitions, making them well-suited for cybersecurity analysis. A concrete example is presented in which a SCADA system subjected to a Denial of Service attack is modeled using a Petri net. The model highlights the transition from normal operation to a communication breakdown, emphasizing how specific tokens and transitions are affected by the attack. Through simulation, the Petri net allows the identification of blocked states and loss of control propagation, revealing vulnerabilities that could compromise grid reliability.

The results show that Petri nets offer a powerful means to visualize and simulate cyberattack impact in a structured and traceable way. Moreover, they can serve as a foundation for proactive detection mechanisms and automated incident response systems. The study discusses both the strengths and limitations of using Petri nets, including challenges in scaling to large systems and the expertise required to develop accurate models.

Finally, the paper outlines future research directions, such as integrating Petri net-based models with machine learning algorithms and intrusion detection systems (IDS). This integration can enhance situational awareness and contribute to building more resilient and secure power infrastructures.

Keywords: petri nets, cyberattacks, scada, dos, malware, modeling

USING PDE FOR SEGMENTING AUDIO STREAMS INTO INDIVIDUAL NEWS ITEMS

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Abstract:

In the field of audio signal processing, the task of segmenting continuous audio streams into consistent, semantically distinct units remains a central challenge, special in the context of broadcast news. Segmenting long-form audio into individual news stories facilitates efficient indexing, retrieval, summarization, and analysis-critical components for both automated media monitoring systems and digital journalism. Traditional segmentation approaches have largely relied on supervised learning techniques, acoustic feature thresholds, or statistical change detection models. While these methods have demonstrated varying degrees of success, they often suffer from limitations related to data dependency, lack of interpretability, and sensitivity to noise or domain variability.

Recent developments in physics-inspired signal processing have introduced PDEs (Partial Differential Equations) as a promising tool for feature-preserving smoothing, boundary detection, and structure extraction in one-dimensional signals. PDEs have seen considerable success in image and video processing, yet their application to temporal audio segmentation—particularly for detecting boundaries between distinct news items—remains relatively unexplored. This study addresses this gap by investigating the viability of PDE-based models for unsupervised segmentation of broadcast news streams.

The main objective of this research is to develop and evaluate a PDE-based framework that models the audio signal as a dynamic function that evolves over time, where local changes in signal characteristics (e.g., energy, spectral entropy) can be accentuated by anisotropic diffusion techniques. The central hypothesis is that PDEs can highlight discontinuities corresponding to subject changes or speaker changes without relying on large labeled datasets or complex feature engineering. The study evaluates the method's performance against standard baselines in terms of segmentation accuracy, robustness to background noise, and computational efficiency.

By extending the application of PDEs to audio segmentation, this paper offers a new, interpretable and potentially more generalizable approach to structuring audio content. His contributions lie at the intersection of applied mathematics, signal processing, computer science and media, and have particular relevance for scalable content analysis in low-resource or multilingual broadcast environments.

Keywords: audio segmentation; partial differential equations; broadcast news processing; unsupervised signal analysis; topic boundary detection; acoustic discontinuity modeling

CELLULAR IOT-BASED ENERGY MONITORING FOR ISO 50001 COMPLIANCE: SYSTEM DEVELOPMENT AND IMPLEMENTATION

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Abstract:

The integration of Cellular IoT into energy monitoring has emerged as a transformative approach to optimizing energy efficiency, ensuring regulatory compliance, and improving resource management. In the context of ISO 50001, real-time energy data collection is critical for identifying consumption patterns, detecting inefficiencies, and supporting data-driven decision-making. This study focuses on the development and deployment of a Cellular IoT-based energy monitoring system, laying the foundation for future integration with Machine Learning (ML) algorithms.

The primary objective of this research is to design an efficient and scalable system that leverages IoT connectivity for continuous energy monitoring. A sensor network, consisting of current transformers, IoT nodes and a gateway based on the Telit ME910G1 chipset, was implemented to enable reliable and secure energy data transmission over cellular networks and the lightweight machine-to-machine (LwM2M) protocol. The system architecture was designed to support real-time data acquisition and processing, ensuring compatibility with future ML-based analytics.

The experimentation methodology involved deploying IoT nodes across multiple industrial sites to collect real-time energy consumption data. The setup was validated in terms of network stability, data integrity, and system reliability, ensuring robust operation under real-world conditions. Data preprocessing techniques, including noise filtering and data structuring, were applied to prepare high-quality datasets for future ML analysis. While ML models have not yet been implemented, the system is designed to support advanced analytics, including anomaly detection, trend forecasting, and energy optimization, in subsequent phases.

The results demonstrated that the Cellular IoT-based setup successfully enables real-time energy monitoring while addressing challenges related to connectivity, data transmission, and system scalability. The system establishes a solid foundation for integrating ML algorithms in future work to enhance predictive capabilities and optimization strategies.

In conclusion, this study highlights the potential of Cellular IoT for energy monitoring in compliance with ISO 50001. The developed infrastructure provides key insights for the deployment of scalable, intelligent energy management solutions, ensuring operational efficiency while addressing challenges related to data security, network reliability, and data processing.

Keywords: Internet of Things; cellular IoT; sensor networks; smart energy monitoring; real-time data transmission

TAMPER-EVIDENT MEDIA: A TAXONOMY OF SELF-DESCRIBING TRUST SIGNALS IN DIGITAL CONTENT

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Abstract:

The increasing ubiquity of digital media across domains such as journalism, forensics, autonomous sensing, and digital archiving has intensified the need for mechanisms that can ensure the authenticity and integrity of content without reliance on external infrastructures. Traditional approaches based on detached cryptographic signatures, hash registries, or blockchain anchors have proven effective in controlled environments but face significant limitations when metadata persistence, centralized services, or sidecar files cannot be guaranteed. In this context, self-describing trust signals—mechanisms that embed verifiable integrity information directly within the content—have emerged as a compelling alternative, providing tamper-evident properties as an intrinsic feature of media objects.

Despite their growing relevance, the landscape of self-describing mechanisms remains conceptually fragmented, hindering systematic evaluation, interoperability, and integration into emerging trust frameworks. This paper addresses the gap by proposing a unified taxonomy of self-describing trust signals in digital content. Six major classes are identified and analyzed: embedded watermarking, perceptual hash-in-header structures, self-signing containers, secure hash-in-header architectures, encoded provenance layers, and redundant signaling through data-carrying channels. Each class is characterized in terms of its embedding strategies, verification models, resilience against transformations, degree of infrastructure independence, and application suitability. A comparative framework is developed along six critical axes, enabling multi-dimensional evaluation and design trade-off analysis.

The study reveals that no single approach dominates across all operational contexts. Instead, different classes offer distinct balances between transformation resilience, cryptographic assurance, semantic expressiveness, and deployment complexity. Embedded watermarks and redundant signaling provide high resilience in lossy environments, while self-signing containers and encoded provenance layers support formal verifiability and rich provenance but require stricter format preservation and key management. Furthermore, the paper discusses the challenges of standardizing self-describing structures, addressing adversarial robustness, enabling machine-verifiable semantic claims, and balancing integrity with privacy considerations.

By structuring this diverse design space, the paper offers system architects, researchers, and standardization bodies a conceptual foundation for advancing content-intrinsic trust mechanisms. It underscores the necessity of moving beyond externalized validation infrastructures toward architectures where the content itself becomes a self-verifying and tamper-evident entity, resilient to fragmentation, re-encoding, and distribution across decentralized or adversarial ecosystems.

Keywords: self-describing trust signals, tamper-evident media, in-content verification, digital provenance, embedded integrity mechanisms.

SECTION 3.

Chemistry;

Chemical engineering;

Environmental engineering

ADSORPTION OF OFLOXACIN FROM WASTEWATER: A COMPARATIVE STUDY

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Abstract:

The presence of organic compounds in wastewater has become an increasing issue, particularly with pharmaceutical substances present in concentrations ranging from micrograms to milligrams per liter. Antibiotics have toxic effects on the environment including hepatotoxic effects, hormonal imbalances, metabolic dysregulation, bacterial resistance, impacting aquatic life as well as human organisms. Ofloxacin belongs to the fluoroquinolone class, which inhibits bacterial DNA synthesis by targeting topoisomerase II. It is indicated in the treatment of pulmonary infections, gastrointestinal, ORL, bones infections, and the drug is eliminated from the human body 80% unmodified. Due to its frequent use and environmental persistence, ofloxacin was added to the European Union's watch list of substances for monitoring in 2022 under Directive 2008/105/EC.

This paper aims to provide a clear image of the adsorption importance in ofloxacin removal. Materials used include activated carbon, copper- doped ZIF8, chitosen, molecular imprinted geopolymers, reduced graphen oxide-copper oxide nanocomposites, lignin-based adsorbents, N doped activated carbon. The N-doped activated carbon, in particular, demonstrated a removal rate higher than 90%. Most of the experiments measure the initial and equilibrium concentrations using spectrophotometric methods. The maximum absorbance wavelength for ofloxacin is typically between 285-295 nm. The mechanism of ofloxacin adsorption includes hydrogen bonding, hydrophobic interactions, active pore adsorption, electrostatic attractions, electron donor interactions, surface complexation. These interactions depend on the functional groups of both ofloxacin and the adsorbent material. The effect of different parameters such as pH, adsorbent dose, and contact time on the adsorption efficiency are also disscused. The advantages such as its simple equipment and high efficience and disadvantages (being a non-selective method with high cost of regeneration) of the adsorption process are discussed, alongside a detailed description of the materials used and their specific characteristics.

The correlation between functional groups of ofloxacin (including the carboxyl group, ketone group, fluorine atom, piperazine ring, quinolone core responsible for π-π interactions) and the adsorbent materials provides a better comparison between the experiments.

Keywords: adsoption, antibiotics, ofloxacin, pharmaceutical substances, wastewater removal

EQUILIBRIUM AND KINETIC STUDIES OF HG(II) ION ADSORPTION FROM AQUEOUS SOLUTIONS BY CLAY ADSORBENT

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Abstract:

In recent decades, a significant challenge for researchers has been identifying a new generation of adsorbent materials for wastewater treatment, as these systems are primary sources of contamination with heavy metal ions. Due to their toxic effects and tendency to accumulate, heavy metals are regarded as persistent environmental pollutants, posing serious risks to both ecosystems and human health. While methods like precipitation, ion exchange, and flocculation have demonstrated effectiveness in laboratory settings for removing heavy metal ions, they come with notable drawbacks, including high costs, the need for complex equipment and low removal efficiency. In contrast, adsorption offers a promising alternative for mercury ion removal from aqueous environments due to its high selectivity, low cost, and operational simplicity. Over the years, various adsorbent materials, including those derived from natural sources (such as clay, yeasts, and peat) and industrial waste (like fly ash and plastics), have been explored for remediation efforts. Among these, clay materials have garnered particular attention due to their low cost, widespread availability across the globe, and minimal preparation requirements. Furthermore, clay materials possess a variety of functional groups on their surfaces, which serve as binding sites in adsorption processes. Clays are a crucial category of materials with ion-exchange properties, originating from minerals in the alumino-silicate family. In this study, a local clay material was examined as an affordable, natural adsorbent alternative for removing Hg(II) ions from aqueous solutions. The adsorption performance of the clay was assessed in relation to various factors such as the initial solution pH, adsorbent dose, initial concentration of Hg(II) ions, contact time, and temperature. Experimental data were analyzed using several isotherm models (Langmuir, Freundlich, and Dubinin-Radushkevich) as well as three kinetic models (pseudo-first order, pseudo-second order, and intra-particle diffusion), with specific parameters calculated for each. The findings from this study emphasize the practical applicability and enhanced potential of this clay material as an adsorbent for the removal of toxic Hg(II) ions from aqueous media.

Keywords: clay material, Hg(II) ions, adsorption, aqueous media

SOLAR-LIGHT RESPONSIVE COPPER NANOPARTICLES/LAYERED DOUBLE HYDROXIDES HETEROSTRUCTURES AS ACTIVE ENVIRONMENTAL CATALYSIS

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Abstract:

The growing environmental concerns and stringent EU regulations have driven research toward advanced nanocomposite systems as efficient photocatalysts for pollutants degradation. A key challenge in this field is optimizing photocatalytic properties through controlled nanoarchitecture assembly. Layered double hydroxides (LDHs), a class of anionic clays, have gained significant attention due to their tunable catalytic performance and unique self-repairing "memory effect," which enables them to reconstruct their layered structure after calcination. This property enhances their catalytic efficiency, making them promising candidates for environmental applications.

The objective of this study was to synthesize and characterize heterostructured assemblies of copper nanoparticles (CuNPs) with LDHs with specific compositions and to evaluate their photocatalytic performance in degrading p- nitrophenol from aqueous solutions. Phenol, is a hazardous pollutant with serious environmental and health implications, requires effective removal strategies.

The LDH-based nanocomposites were synthesized via a co-precipitation method, utilizing the reconstruction procedure by "memory effect" to give rise to Cu/LDHs heterostructures. The fabricated Cu/LDHs were extensively characterized using X-ray diffraction (XRD), thermogravimetric analysis (TG/DTG), X-ray photoelectron spectroscopy (XPS), UV-VIS spectroscopy, and high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM). Photocatalytic degradation experiments were performed by irradiation with simulated solar light, with reaction progress monitored via UV-VIS spectroscopy.

The results confirmed the successful formation of CuNPs, uniformly distributed on LDH large nanoparticles (~120 nm). UV-VIS analysis revealed strong absorbance under both UV and solar light, indicating the formation of Cu-LDH heterojunctions. XRD analysis further demonstrated that the LDH structure was fully restored after four hours of reconstruction. Among the tested catalysts, CuNP/ZnLDH exhibited the highest photocatalytic efficiency, achieving 97% p-nitrophenol degradation under solar irradiation, compared to 57% for CuO/ZnO/ZnAl2O4. The presence of highly hydroxylated LDH sheets played a key role in enhancing photodegradation.

Keywords: layered double hydroxides, photocatalysis, copper nanoparticles, phenol degradation, nanocomposites

MANAGERIAL SUSTAINABLE BEHAVIOR DEVELOPMENT TOWARDS ECOLOGICAL WORKING ENVIRONMENT IN THE CONTEXT OF OCCUPATIONAL HEALTH AND SAFETY

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Abstract:

An ecological environment in the workplace is a set of activities aimed at ensuring optimal conditions in the work process, defending the health, bodily integrity, and life of workers and other people involved in the work process. The legislation, procedures, and standards of quality of work define a unitary system of measures and rules applicable to all participants in the work process. The prevention and protection activity aims to ensure optimal working conditions, prevent accidents and occupational diseases among people engaged in gainful activities, and adapt to the progress of science and technology. Organizational psychology is the science whose sphere of concern is the human condition of work. It is closely related to several areas of interest in psychology such as experimental and social. Organizational and work psychology is responsible for the scientific application of psychological principles in organizations and at the level of workplaces.

The expected quantitative and qualitative achievements within this work, which will be reflected in a set of activities aimed at identifying the optimal human interactions needed in the workplace, aiming at the protection of human rights and psychological well-being in specific work processes, are analyzed and presented. Adapting to the progress of science and technology in the field of environmental protection requires a valid system of measures and rules applicable in the work process and the continuous updating of procedures and standards. Measures to prevent and protect well-being at work are aimed at ensuring better work interactions and preventing injuries and occupational diseases among employees.

The innovative strategies applied to green workplaces and scheduled workshops on environmental protection management that educate employees about the climate/ecological environment in the workplace and about the effects on their health. Providing a professional ecological environment is an important aspect of the main objective – that of promoting good health at work, and organizations are engaged in tailored actions to reduce the so-called psychosocial hazards and factors responsible for causing stress. Workplace safety is a multidisciplinary field related to safety, health, and organizational psychology, and it is understood as the well-being of people at work or providing employees with an ecological climate/environment at work.

Keywords: ecological climate/environment, organizational psychology

EVOLUTION OF CAR FLEET IN IAȘI CITY AND THE IMPACT ON LIFE QUALITY

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Abstract:

Reducing the emissions from fossil fuel combustion has become a priority at global level, as road transport is one of the major contributors to pollution. Over the past two decades, the automotive industry has made significant progress in reducing environmental impact by optimizing conventional engines (Euro 1-6), adopting hybrid technologies (MILD, PLUG-IN, range extender), and transitioning to electric propulsion. Assessing the impact of the vehicle fleet on the urban environment is crucial for sustainable development. In Iași, the accelerated increase in the number of vehicles has led to major traffic, air, and noise pollution issues, causing discomfort and negatively affecting residents' quality of life. The analysis of the composition and evolution of the vehicle fleet in Iași reveals an annual increase of approximately 7%, with a predominance of vehicles older than 10 years, which are the main sources of high emissions of CO_2, NOx, and particulate matter (PM10, PM2.5).

This study uses specific methods to assess the impact, including the analysis of European emission standards, air quality monitoring, and the effects on public health, along with the application of the RIAM method for environmental impact quantification. The results indicate high pollutant levels in areas with heavy traffic, correlated with a decline in quality of life and an increased risk of respiratory diseases. The analysis also highlights the excessive ageing of the vehicle fleet in Iași, with 40% of vehicles being over 20 years old. To mitigate these negative effects, the paper proposes sustainable measures, such as modernizing public transport with electric buses, developing infrastructure for non-polluting vehicles, and promoting alternative mobility (bicycle lanes, electric scooters). Additionally, the implementation of local policies, such as congestion charges and the expansion of low-emission zones (pedestrian areas), could significantly improve air quality in sensitive areas.

A comparative analysis with cities like London, Stockholm, and Copenhagen demonstrates the effectiveness of sustainable mobility strategies and provides applicable solutions for Iași. In conclusion, effective management of the vehicle fleet and the integration of ecological policies are essential for creating a healthier and more sustainable urban environment.

Keywords: environmental impact, air pollution, urban quality of life, car fleet evolution, sustainable mobility

COMPOSITE HYDROGELS BASED ON CALCIUM PHOSPHATES WITH APPLICATIONS IN MEDICINE

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Abstract:

Currently, a large number of scientific studies are focusing on the applications of calcium phosphates in regenerative medicine, in particular for bone tissue restoration. This is due to special characteristics of these phosphates: a very good biocompatibility and bioactivity, osteoinductive and osteoconductive capacities, favouring cell adhesion and cell growth due their interaction with extracellular matrix proteins. Of the calcium phosphates, hydroxyapatite is considered to be very important because it is the most abundant mineral component in the bone structure (about 70 % of the dry weight of bone tissue). Unfortunately, hydroxyapatite is brittle, which greatly limits its wide applications in medical field. For this reason, many studies have been directed towards creating biocomposites in which apatite is coupled with a polymer (exhibiting elasticity). In our study, new hydrogel-hydroxyapatite biocomposites were obtained using several types of biopolymers (gelatine and chitosan). The biocomposites were characterized by XRD, SEM, EDX, FTIR and Raman methods. FTIR and Raman results indicate the formation of strong interactions between the polymer chains and the hydroxyapatite crystals, which explains an enhancement of the mechanical properties of these composites. The hydrogel-hydroxyapatite biocomposites may have various applications in restorative medicine, in particular for the regeneration of bone defects and bone tissue healing.

Keywords: calcium phosphates, hydroxyapatite, hydrogels, biocomposites, gelatine, chitosan

HETEROSTRUCTURES BASED ON LAYERED DOUBLE HYDROXIDES AS NOVEL ENVIRONMENTAL ACTIVE PHOTOCATALYSTS

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Abstract:

Photocatalysis based on semiconductor technology is highly expected to offer cost-effective solutions for effective utilization of solar energy in water purification, hydrogen generation, carbon dioxide reduction or air detoxification. In a semiconductor heterostructure, designed as ensembles of specific cojoined units, the heterojunction interface of the components is able to facilitate the interfacial charge transfer thus, to enhance the separation of photoinduced charges. Layered double hydroxides (LDH) are layered porous matrices belonging to the class of anionic clays. A highly versatile chemical composition of LDHs can be obtained by tailoring the reconstruction process of the LDH in aqueous solutions of specific metal salts. By this experimental procedure we designed AuNP/LDH as novel heterostructured catalysts. The LDHs precursors, with a M^{2+}/M^{3+} ratio equal of 2 or 3 (where M^{2+} = Zn^{2+}/Mg^{2+} and M^{3+} = Al^{3+}), were obtained by a standard co-precipitation method at a constant pH. Further, AuNP self-supported on ZnAlLDH and MgAlLDH were obtained via exploiting the structural memory effect of LDH matrices in $Au(C_2H_3O_2)_3$, aqueous solutions and were denoted here as AuNP/LDH. The novel materials were tested in the photocatalytic degradation of p-nitrophenol (p-NPh) from aqueous solutions, under simulated solar light. The photocatalytic tests to study the degradation of p-nitrophenol (p-NPh) were carried out in a glass-reactor with a cooling system with 0.1 g of the catalyst dispersed in 100 mL (25 mg ·L-1) aqueous solution of p-NPh.
Results point good photocatalytic performances for AuNP/LDH for removing phenol pollutant from water. AuNP/ZnAl(2/1)LDH was the most performant photocatalyst that removed almost 95% of p-NPh from aqueous solution, at room temperature, under irradiation by solar light.

Keywords: heterostructured catalysts; environmental catalysis, layered double hydroxide, phenol

EXPERIMENTAL RESEARCH ON MOISTURE REMOVAL FROM SPENT COFFEE GROUNDS

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Abstract:

Spent coffee grounds are an organic residue with high potential for reuse in various fields, such as agriculture, the cosmetics industry, biofuel production, and composite materials. However, the high moisture content of fresh spent coffee grounds promotes the growth of microorganisms, accelerating their degradation and limiting their valorization possibilities. Safe storage of spent coffee grounds can be achieved if the final product's moisture content is below 10%. In this context, the drying process plays a crucial role in preserving and expanding the applicability of this byproduct.

This study explores different drying methods for spent coffee grounds, analyzing their efficiency based on factors such as temperature, duration, energy consumption, and impact on chemical composition. The comparison between halogen heating, which emits infrared radiation to ensure rapid and uniform heating of the sample, and the dehydration technique through electroosmosis highlights the advantages and disadvantages of each method, considering aspects such as energy costs, preservation of bioactive compounds, and the possibility of further utilization of the dried material.

Infrared drying is a technique that involves using infrared radiation to directly heat the coffee grounds during the drying process. Unlike traditional drying methods that rely on hot air or high temperatures, infrared technology uses electromagnetic radiation to penetrate directly into the wet material.

Electroosmosis, on the other hand, is a more energy-efficient method. Instead of depending on heating an entire medium (e.g., air), electroosmosis uses an electric field to transport water from the coffee grounds, leading to significant energy savings. Additionally, electroosmosis provides a more uniform moisture distribution within the material, preventing the formation of excessively wet or dry areas that could affect the final product’s quality. Unlike drying at high temperatures, which can destroy certain components of spent coffee grounds (e.g., volatile compounds or nutrients), electroosmosis minimizes the risks of thermal and chemical degradation.

The results obtained highlight the importance of selecting an optimal drying method to maintain the quality of coffee grounds and maximize their benefits in sustainable applications.

Keywords: spent coffee grounds, drying, infrared radiation, electroosmosis

MULTIFUNCTIONAL HYBRID BIOMATERIALS BASED ON HYDROXYAPATITE LOADED WITH ANTIBIOTIC

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Abstract:

A problem that can arise after the implantation of a biomaterial in a bone structure is the appearance of bacterial infections. Therefore, it is extremely important that the bioceramic implant also has an antibacterial function to prevent or treat a possible infection associated with the bone implant. In recent years, a series of studies have been carried out regarding the creation of bioceramics that incorporate antibiotic-type active principles, precisely to induce antibacterial activity of the implant. In our study, an antibiotic was introduced into the apatitic bioceramic to act quickly on pathogenic bacteria that could develop on the implant. The hydroxyapatite-based biomaterials were obtained in the form of porous matrix (scaffolds) for tissue engineering applications. These biomaterials allow improving the functioning of the conventional bone implants by overcoming the limitations of the individual materials and imitating the structure of the calcified tissues, while preventing the microbial infections that may occur. The porous scaffolds were obtained by the phase inversion process and were characterized by XRD, SEM and EDX methods. *In vitro* drug release of antibiotic indicated that these hybrid biomaterials can provide a prolonged release of bioactive agents in physiological conditions. The results suggested that these biomaterials with antibacterial function may be of use for the regeneration of bone defects and bone tissue healing.

Keywords: biomaterials, bioceramics, hydroxyapatite, scaffolds, antibiotic

ANALYSIS OF WASTE VALORIZATION INTO BIOGAS PLANTS

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Abstract:

The production of biogas from organic waste has gained attention as a promising alternative energy technology with high potential use. Transforming biowaste into bioenergy represents a promising approach to sustainable waste management, supporting renewable energy production. In this context, the primary objective of this research is to demonstrate that utilizing biodegradable organic waste for biogas production represents a solution for mitigating environmental pollution, primarily by reducing greenhouse gas emissions. This study examines various strategies for converting biowaste into bioenergy, including anaerobic digestion, combustion, gasification, fermentation, and pyrolysis. Research has found that, from an economic perspective, it is most cost-effective to incinerate mixed waste, utilizing the gaseous components of the fuel obtained from the waste and organic waste as a raw material for anaerobic digestion. It also highlights the challenges of developing an integrated biowaste management strategy that improves the quality of life in rural and urban communities. The production of biogas for energy generation through anaerobic digestion is considered an effective way to harness local renewable resources as a substitute for fossil fuels. Biomass valorisation stands as a pivotal strategy in the pursuit of carbon neutrality and the establishment of a circular economy. This work approaches the biodegradable aspects of organic waste from an innovative and up-to-date perspective, offering solutions to prevent and reduce the generation of organic waste and encourage the energy recovery of waste to produce biogas. Stimulating the application of these courses of action would have the effect of improving the quality of the environment, particularly by reducing greenhouse gas emissions and pollution of water resources. It also presents innovative approaches to understanding and subsequently addressing the generation of biodegradable and municipal organic waste. It validates multi-criteria models that describe, in an integrated manner, the techno-economic, environmental, and social impacts of these types of waste and their management scenarios.

Keywords: biogas, biodegradable organic waste, anaerobic digestion, renewable resources, biomass

HETEROSTRUCTURES BASED ON LAYERED DOUBLE HYDROXIDES FOR SOLAR - DRIVEN CATALYSIS

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Abstract:

Addressing global climate change driven largely by the rapid increase in atmospheric carbon dioxide (CO_2) levels is one of the most urgent challenges we face today. In this context, we present heterostructures consisting of layered double hydroxides (LDHs) and nickel nanoparticles, which are directly synthesized on LDH matrices. These photocatalysts demonstrate strong potential for CO_2 reduction under solar light exposure, representing a valuable step toward sustainable energy solutions.

Leveraging the structural "memory effect" of LDHs, we have recently developed a straightforward method for fabricating metal or metal oxide nanoparticles/LDH as self-assembled heterostructures. According to this procedure the LDH matrix is able to reconstruct its structure, based on its structural memory, by using the anions of the solution as interlayer anions and further to adsorb the metal cations of the aqueous solution and organizing them as nanoparticles of metals or metals oxides on its surface-denoted as Me/LDHs. In this study, plasmonic Ni/ZnSnLDH catalysts were synthesized "in situ" through the structural reconstruction of LDHs in an aqueous solution of $Ni(CH_3CO_2)_2$ at room temperature. The corresponding mixed oxides were subsequently obtained via calcination. The size of the Ni nanoparticles formed on ZnSnLDH surface affects the catalysts efficiency for CO_2 reduction. Additionally, the nanostructural features of the evolved heterostructured catalysts and the optimized Zn/Sn ratio within the LDHs composition are important factors establishing the catalytic performances of these materials. The results show that mixed oxides obtained through calcination exhibit the highest catalytic efficiency under UV irradiation, while Ni/ZnSnLDH catalysts perform better under solar irradiation. This emphasizes the beneficial role of surface hydroxyl (OH) groups of the LDH in enhancing the photocatalytic process under solar light irradiation.

The nanoarchitecture of the catalysts, identified here as Ni/ZnSnLDHsand the derived mixed oxides obtained after calcination could pave the way for new approaches in developing advanced catalytic systems for CO_2 reduction under light irradiation.

Keywords: layered double hydroxides, structural memory, heterostructures, catalysts, mixed oxides

VALORIZATION OF PRUNUS SPINOSA EXTRACT AS SUSTAINABLE COLORING AGENTS IN TEXTILE FINISHING: A GREEN CHEMISTRY APPROACH

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Abstract:

In the context of the need to develop sustainable textile technologies, this research investigates the application of *Prunus spinosa* extracts as environmentally friendly coloring agents. The fruits and bark of this species are rich sources of bioactive compounds, including tannins, flavonoids, and anthocyanins, characterized by antioxidant, antimicrobial, and dyeing properties, thus providing a viable alternative to synthetic dyes.

Pigment extraction from *Prunus spinosa* fruits can be conducted through various methods such as maceration, boiling, and pressing. The chemical composition of the extracts can be characterized using advanced analytical techniques, including High-Performance Liquid Chromatography (HPLC), Proton Nuclear Magnetic Resonance (^{1}H-NMR), and Fourier Transform Infrared Spectroscopy (FTIR). Employing these extracts in environmentally friendly textile dyeing processes significantly contributes to the reduction of environmental pollution by eliminating the necessity of harmful chemical agents.

The stability and fixation properties of these natural dyes can be evaluated using spectroscopic analyses, wash, light, and rub fastness tests, as well as colorimetric measurements. Literature studies have indicated a high affinity of these natural dyes towards natural textile fibers, such as cotton and wool, ensuring strong adherence and enhanced color durability.

In addition to ecological advantages, this method supports the development of a more sustainable textile industry by providing products with additional functional properties, such as ultraviolet (UV) protection and antimicrobial activity. Therefore, the valorization of *Prunus spinosa* extracts in textile dyeing aligns with green chemistry principles, promoting innovative and eco-friendly alternatives to conventional dyes.

This approach represents a significant step towards reducing the ecological impact of the textile industry by demonstrating the feasibility of utilizing natural resources in sustainable processes. Future studies will focus on extending the applicability of these natural dyes to synthetic fibers, optimizing extraction procedures, and maximizing pigment fixation efficiency.

Thus, the application of *Prunus spinosa* extracts as natural coloring agents not only offers a viable and environmentally friendly alternative to synthetic dyes, thereby reducing the negative environmental impact of the textile industry but also opens new perspectives for the development of functional textiles with antimicrobial and UV-protective properties, contributing to the transition towards more sustainable production processes aligned with circular economy and green chemistry principles.

Keywords: natural dyes, Prunus spinose, textile dyeing, green chemistry, sustainability, bioactivity

INTEGRATING QUALITY AND ENVIRONMENTAL SYSTEMS IN HEALTHCARE: A STRATEGIC FRAMEWORK FOR SUSTAINABLE INSTITUTIONAL TRANSFORMATION

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Abstract:

The convergence of healthcare quality improvement and environmental responsibility represents a critical opportunity for system-wide transformation in modern hospitals. As healthcare institutions face mounting pressures to enhance service delivery while mitigating their ecological footprint, integrated management systems offer a strategic response. This review explores the concept and practice of Integrated Quality and Environmental Management (IQEM), which merges Quality Management Systems (QMS) and Environmental Management Systems (EMS) into a unified framework. Drawing from international standards such as ISO 9001 and ISO 14001, as well as case studies from Europe and Asia, the study synthesizes current knowledge on implementation strategies, institutional benefits, and systemic barriers. A narrative review methodology was used to analyze peer-reviewed literature, policy documents, and sectoral benchmarks published between 2000 and 2024. The results reveal that IQEM fosters shared governance, enhances audit efficiency, aligns institutional policies, and strengthens stakeholder engagement. Institutions that adopted IQEM, particularly those with dual ISO certifications reported improved compliance, cost savings, higher patient satisfaction, and increased resilience during crises. Despite its benefits, IQEM implementation remains limited by organizational silos, staff resistance, lack of integrated metrics, and regulatory fragmentation. The review highlights enabling factors such as leadership commitment, interdisciplinary collaboration, and digital infrastructure, which are critical to sustained adoption. IQEM is positioned not merely as an operational upgrade but as a redefinition of healthcare excellence—where patient-centered care and environmental stewardship are integrated at all levels of governance and practice.

The study concludes by proposing IQEM as a viable pathway toward aligning healthcare operations with the Sustainable Development Goals (SDGs), especially SDG 3 (Health), SDG 12 (Sustainable Consumption), and SDG 13 (Climate Action). This integration offers a forward-looking model for institutions seeking sustainable, resilient, and ethically aligned healthcare delivery in the 21st century.

Keywords: environmental stewardship, healthcare sustainability, integrated management, iso standards, quality improvement

REVIEW - CHEMICAL FUNCTIONALIZATION OF COTTON CELLULOSIC TEXTILES BY SELECTIVE OXIDATION

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Abstract:

Chemical functionalization by selective oxidation reactions mediated by sodium or potassium periodate and/or 2,2,6,6-tetramethylpiperidin-1-oxyl (TEMPO) has attracted the attention of many researchers in the last decade. Their studies aim to determine the yield and degree of substitution of the primary/secondary hydroxyl groups of the anhydroglucosidic unit (AGU), the reaction conditions in aqueous medium and the subsequent possibility of modifying the structure and functional properties. Selectively oxidized cellulose depending on the oxidation method applied is called oxycellulose, aldehyde functionalized cellulose, dialdehyde cellulose or carboxycellulose.

In the case of cellulosic textile materials, it is essential to control the degree of oxidation, the degree of polymerization and the mechanical resistance, so that the conduct of selective oxidation achieves a compromise between functionality (expressed by the content of aldehyde and/or carboxylic groups) and moderate degradation of the molecular, supramolecular and morphological structure of cotton cellulose.

This documentary study systematically presents the possibilities of selective oxidation of cotton textiles, the reaction mechanisms, the assessment and the analytical and instrumental determination of the degree of oxidation of the hydroxyl groups in the C_2, C_3 and C_6 positions of the AGU unit with aldehyde/carboxylic groups. The effects of selective oxidation on the molecular and morphological structure of cellulose are also briefly presented, since oxidation depending on the reaction conditions can significantly affect both the amorphous and crystalline areas of cellulose, at the microfibril level, which leads to a decrease in mechanical resistance, which is undesirable in the case of textiles with long-term use or even single-use.

Textile materials functionalized by selective oxidation, by modifying the surface morphology of the fibers, microfibrils and by increasing the reactivity of the intrinsic fibrous matrix, certainly lead to the improvement of chemical, physical and biological properties, such as: reactivity/affinity towards other chemical compounds, bioresorbability, biodegradability, sorption capacity, the degree of adsorption of heavy metal ions, or organic molecules/dyes from wastewater and the conferring of antibacterial and hemostatic effects.

Keywords: oxidized cellulose, sodium or potasium periodate, TEMPO, aldehyde and carboxyl groups, degree of oxidation

INTEGRATING CIRCULAR DESIGN PRINCIPLES INTO PLASTIC WASTE REDUCTION AND RECOVERY STRATEGIES

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Abstract:

In the context of escalating the environmental crisis stemming from the accumulation of plastic waste, circular economy represents a concept for the transition towards a sustainable model of production and consumption. A central tenet of this paradigm is the circular design, which entails the engineering of plastic products in a manner that facilitates their reuse, repair, recycling, and reintegration into closed-loop production cycles. This approach enables a reduction in the reliance on virgin resources, a decrease in greenhouse gas emissions, and a decrease in the volume of waste reaching landfills or the natural environment.

This study analyzes the contribution of circular design to the sustainable management of plastic waste, with a focus on its applicability in the early stage of the product lifecycle. It highlights design principles such as: the utilization of monocomponent plastic materials, the avoidance of non-recyclable additives, the form optimization for logistical efficiency, and the direct integration of recycling codes into the product. The challenges encountered in the implementation of these principles are discussed, including technological limitations, the costs associated with redesign, and the behavioral barriers of consumers and producers.

Furthermore, the paper explicitly addresses the sustainability dimension of plastic waste, analyzing the interaction between product design and recycling performances, carbon footprint, energy consumption associated with processing, and the material's regeneration potential. Through the integration of industry case studies and data from specialized literature, it is demonstrated that circular design can significantly enhance the efficiency of collection, sorting, and recycling processes, contributing to attainment of high-quality recycling streams and the reduction of microplastic pollution.

In conclusion, the circular design applied to plastic products is not merely a tool for waste reduction, but also a determining factor for the waste management system sustainability. Its integration into the plastic value chain necessitates cross-sectoral collaboration, legislative support, and investments in research and innovation. The present study underscores the potential of circular design to transform plastic waste from a major ecological problem into a valuable resource within a functional circular economy.

Keywords: circular design, plastic waste, sustainability, circular economy, recycling, eco-design

CRITICAL ANALYSIS OF DRINKING WATER QUALITY POLICIES AND REGULATIONS IN ROMANIA

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Abstract:

The quality of drinking water is an essential condition for maintaining human health and ecological balance. The degradation of drinking water quality, depletion of resources, and pollution are attributed to human activities, industrialization, climate change, and the disposal of municipal wastewater and industrial effluents. As a result, the harmonization of drinking water regulations and legislation and their implementation according to international protocols, are critical components in the management of health risks associated with drinking water consumption, and an important aspect in protecting human health.

Although significant progress has been made in the implementation of drinking water quality standards and legislation, EU Member States continue to face outbreaks of waterborne infections, organic and inorganic contamination of water resources, demonstrating that the regulatory systems are not always functional.

Extensive EU legislation has been put in place to protect drinking water resources from pollution; however, meeting water quality targets remains an ongoing challenge across Europe. In this situation, constant updates of standards are needed in view of emerging contaminants, technological challenges, and systemic vulnerabilities. This study presents the main problems related to the implementation of water quality legislation and standards in Romania. Thus, two fundamental dimensions of the existing vulnerability have been highlighted, which are traced by identifying the structural deficiencies of the current drinking water quality standards, characterized by the absence of potential toxic contaminants with significant health impacts or limit values set based on questionable or outdated scientific criteria. The shortcomings in the implementation and monitoring of water quality standards due to limitations of available analytical methods defined by inadequate testing protocols for real risk assessment, discrepancies between regulatory frameworks, and current technological capabilities are also presented.

The results indicate that difficulties and inconsistencies in drinking water quality legislation against pollution with the main categories of contaminants, that is, synthetic chemicals and biological species, occur most frequently at the urban level where cross-sectoral measures need to be taken and effects monitored.

Authorities must prioritize the regular monitoring and assessment of water quality to address the identified challenges. Restoring water to an acceptable level is becoming increasingly difficult without proactive measures.

Keywords: drinking water quality, monitoring, EU Directive, resources management, policies

NATURAL DEEP EUTECTIC SOLVENTS (NADES): SUSTAINABLE SOLVENTS FOR ENHANCED BIOACTIVE PHYTOEXTRACTS WITH POTENTIAL IN DERMATO-COSMETIC APPLICATIONS

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Abstract:

The increasing interest in natural and sustainable alternatives in the cosmetic and pharmaceutical industries has encouraged the development of innovative green extraction approaches. This study explores the application of Natural Deep Eutectic Solvents (NADES), composed of betaine and 1,3-propanediol, for the extraction of bioactive phytocompounds from *Acmella oleracea* and *Artemisia annua*, two plant species recognized for their antioxidant, anti-inflammatory, and skin-soothing potential. Both plants contain a wide range of secondary metabolites, including flavonoids, polyphenols, spilanthol, and artemisinin, with proven dermatocosmetic relevance. NADES were prepared in various molar ratios (1:3, 1:4, 1:6) and tested under two environmentally friendly extraction techniques: vibrational maceration and ultrasound-assisted extraction (UAE). The impact of key process parameters such as solid-to-liquid (S/L) ratio, extraction temperature, time, and water content in NADES was systematically investigated to identify optimal conditions for maximizing total phenolic content (TPC) and total flavonoid content (TFC). The results show that the extraction method yielding the highest concentrations of polyphenols and flavonoids (6.48 mg GAE/mL and 14.5 mg QE/g for Acmella oleracea and for Artemisia annua (22.63 mg GAE/mL; 5.54 mg QE/g) was UAE. The optimal extraction conditions were: NADES 1:3, 25 °C, and 60 minutes of extraction time. The study demonstrated that extraction efficiency is highly influenced by both solvent composition and method. UAE outperformed maceration in most cases, particularly when combined with diluted NADES, which reduced viscosity and enhanced ultrasonic propagation and mass transfer. Water addition had a dual role—improving extraction of flavonoids while reducing polyphenol solubility in certain conditions. Spectrophotometric analyses (using Folin–Ciocalteu reactive for TPC and $AlCl_3$ for TFC) confirmed the high antioxidant content of the extracts, while previous studies indicated their biocompatibility and local retention in Cell Franz test, extracts proved to be stable, safe, and directly suitable for incorporation into topical dermato-cosmetic products.

NADES-based extraction represents a sustainable and effective strategy for obtaining "ready-to-use" phytoextracts with strong potential in natural skincare applications. This research supports the integration of green solvents and extraction technologies into circular economy models and opens new perspectives for applying NADES in the recovery of diverse bioactive molecules from botanical sources.

Keywords: NADES, Acmella oleracea, Artemisia annua, phytoextracts, green extraction techniques, dermato-cosmetic applications

TOURISM AND FREE MOVEMENT IN THE EUROPEAN UNION: ENVIRONMENTAL CHALLENGES AND PATHWAYS TO SUSTAINABLE DEVELOPMENT

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Abstract:

This research addresses the complex and growing interrelation between tourism and the free movement of people in the European Union (EU), with a focus on their combined impact on environmental sustainability and regional development. As one of leading tourist destinations of the world, the EU faces increasing pressures on its natural resources, ecosystems, and infrastructure due to the intensification of both intra- and extra-European mobility. The study is structured around two major thematic pillars: (i) the environmental impact of tourism, particularly greenhouse gas emissions, water and energy consumption, and waste generation; and (ii) the socio-economic implications for sustainable development, including employment creation, local economic stimulation, and cultural integration.

In this preliminary phase of the PhD research, emphasis is placed on an extensive literature review, synthesis of current findings, and identification of research gaps. The project also explores public perceptions, governance frameworks, and existing sustainable tourism practices across various EU member states, aiming to build a comparative understanding of challenges and policy responses. The research methodology to be applied in the following phases includes spatial analysis using GIS tools, qualitative interviews, field surveys, statistical modeling, and SWOT analysis. The outcomes are expected to provide actionable knowledge for designing more balanced tourism strategies, aligned with the European Green Deal and Agenda 2030.

By integrating environmental engineering approaches with sustainability science and policy evaluation, the research aims to contribute to the transition towards responsible tourism and equitable mobility. The insights will support the development of adaptive, region-specific strategies for mitigating environmental impacts while fostering socio-economic benefits within the EU context.

Keywords: environmental impact, European Union, free movement, sustainability policy, sustainable tourism

PATHWAYS TO CIRCULARITY: SUSTAINABLE APPROACHES IN WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT MANAGEMENT

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Abstract:

The rapid growth of electronic equipment production and the decreasing product lifespans have led to the accelerated generation of Waste Electrical and Electronic Equipment (WEEE), now recognised as one of the fastest-growing waste streams globally. In this context, the shift towards a circular economy has gained traction as a sustainable solution for alleviating environmental pressure and improving resource efficiency.
This research explores how circular economy principles—particularly reuse, repair, and recycling—can be effectively integrated into WEEE management systems. The study focuses on both the European framework and national-level implementation in Romania. The research objectives include assessing the regulatory landscape, analyzing collection systems, and applying environmental evaluation tools to identify areas for improvement and long-term sustainability. The methodology combines a critical review of EU and Romanian legislation, an examination of practical collection models (e.g., municipal collection centers, buy-back incentives, and public awareness campaigns), and the application of Life Cycle Assessment (LCA) and Material Flow Analysis (MFA) to assess environmental impacts and resource flows. These tools provide a clearer picture of the environmental burden at different stages of the product life cycle. Key findings show that although the European Union has established comprehensive regulations and made measurable progress, implementation varies significantly among member states. In Romania, low collection rates and limited infrastructure remain major barriers. The LCA results reveal that strategies focused on reuse and refurbishment significantly reduce the carbon footprint compared to traditional recycling, especially when applied early in the product lifecycle.
The discussion emphasises the importance of consumer behavior in shaping the effectiveness of WEEE management, highlighting the need for policies that encourage responsible purchasing, extended usage, and proper disposal. Analytical tools such as LCA and MFA are essential for identifying inefficiencies and informing improved environmental policies. In conclusion, transitioning to a circular model for WEEE management requires coordinated efforts involving legislation, innovation, and citizen participation. Incorporating environmental impact assessments into policy and practice can promote systemic change towards a sustainable and resilient electronic waste system.

Keywords: WEEE, circular economy, life cycle assessment, consumer behavior, Romania, sustainable waste management, environmental impact, e-waste

CIRCULAR BIOECONOMY IN ACTION: CASE STUDIES ON FOOD WASTE VALORIZATION FOR NUTRACEUTICAL AND COSMETIC PRODUCTS

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Abstract:

Food waste represents a critical sustainability challenge, with approximately one-third of global food production lost or discarded annually. This study presents a series of case studies illustrating how food waste can be transformed into high-value products through innovative and sustainable valorization strategies. The research focuses on real applications where bioactive compounds and essential nutrients are extracted from food processing by-products and redirected into commercial value chains.

Three representative case studies are analyzed to demonstrate the feasibility and impact of such approaches. In the first, orange peel waste from citrus juice manufacturing is valorized through eco-friendly extraction of hesperidin and other flavonoids, which are now used in antioxidant-rich cosmetic and nutraceutical formulations. The second case examines grape pomace, a by-product of winemaking, processed to recover polyphenols such as resveratrol, with applications in functional foods and anti-aging skin care products. The third case investigates the large-scale recovery of whey proteins from dairy waste, particularly cheese whey, yielding high-purity isolates widely used in clinical nutrition and sports supplements.

Each case study details the extraction methods employed, ranging from enzyme-assisted and ultrasound-assisted extraction to membrane filtration and supercritical CO_2 extraction, alongside an assessment of economic viability, environmental benefits, and product quality. Collectively, the cases highlight how food waste valorization supports circular economy principles, reduces greenhouse gas emissions, and replaces synthetic additives with natural bioactives.

The study concludes that targeted food waste valorization, when integrated into industrial systems and supported by green technologies, can generate scalable, economically viable solutions. These case studies exemplify how waste streams can be reconceptualized as resource flows, driving both sustainability and innovation across food, cosmetic, and nutraceutical sectors.

Keywords: bioactive compounds, circular economy, food industry, food waste, nutraceuticals, valorization

PHOSPHORUS RECOVERY FROM SEWAGE SLUDGE ASH: CHEMICAL PROCESSING AND GRANULATION FOR SUSTAINABLE FERTILISER PRODUCTION

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Abstract:

Phosphorus is essential for plant growth, but its availability is limited due to finite reserves, environmental impacts and geopolitical risks. Recycling phosphorus is becoming increasingly important due to rising demands for resource efficiency and a circular economy. EU policy classifies phosphorus as a strategic raw material and requires its future recovery from most municipal sewage sludge, which plays a crucial role in achieving sustainability goals.

This work focuses on the recovery of phosphorus from sewage sludge ash after mono-incineration. This process concentrates phosphorus while removing microplastics, hormones, pharmaceutical residues and pathogens. The research centres on the chemical processing of the ash using acids to convert phosphorus into a plant-available form and the granulation stage, which is essential for agricultural use. Granulation enables even distribution, transportability and effective application in the field.

In the experiments, the particle size distribution of the ash was examined as a function of reaction time. A laser particle size analysis showed a decrease in particle size during chemical treatment. This reduction indicates that the phosphorus becomes water-soluble. The ash particles disintegrate due to the breakdown of water-insoluble phosphate, which had previously acted as a binder. This chemical reaction was analysed in detail to optimise the conversion process and ensure efficient phosphorus recovery. The chemical analysis focused on quantifying the different phosphorus fractions in the ash, particularly water-soluble, neutral-ammonium citrate-soluble and mineral acid-soluble phosphate. Various methods were tested for granulating the processed ash, including fluidised bed granulation, mixers and granulating discs. These methods were evaluated regarding their efficiency and the mechanical stability of the granules. For practical agricultural use, granules must be transportable, storable and evenly spreadable, with mechanical structural integrity being a key factor. Scale-up experiments were conducted to further optimise the granulation process and improve its industrial applicability.

The results show that both efficient chemical conversion and the production of mechanically stable granules are feasible, offering a promising route to high-quality recycled phosphate fertiliser from sewage sludge ash, which can contribute to sustainable agriculture.

Keywords: ash treatment, chemical sewage sludge, circular economy, granulation, phosphorus recovery, recycled phosphate fertiliser

TRENDS FOR ENERGY EFFICIENCY AND COST REDUCTION OF THE BRINE ELECTROLYSIS FOR CHLOR-ALKALI MEMBRANE CELL PROCESSES

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Abstract:

The brine electrolysis in chlor-alkali membrane cell is one of the basic electrochemical processes, producing chlorine (Cl_2), sodium hydroxide (NaOH) and hydrogen (H_2). The chlor-alkali production process is energy-intensive industrial sector, requiring industrial manufacturers to find sustainable technological solutions to minimize the environmental pollution resulting from electricity consumption. Chlorine and sodium hydroxide can be used in a variety of applications, including the production of polyvinyl chloride, organic synthesis, detergents, herbicides, pesticides, pharmaceuticals, plastics, and soaps, metallurgy, bulding materials, water treatment etc. The energy efficiency of the chlor-alkali sector can be improved by developing integrated systems for utilizing the co-product hydrogen (cogeneration systems and steam production, hydrogen fuel cell technology for the construction of hydrogen power plants etc.), and the integration of hydrogen as a raw material in chemical processes (for the production of ammonia, hydrocracking and other petroleum processing industries, chemical and organic fine chemical synthesis, production of high-purity compressed hydrogen for direct sale in electronics, metallurgy, glass, and other industries etc.).
In this paper, the research directions and prospects in the chlor-alkali industry are proposed for its further improvement at the industrial romanian companies. The technological evolution from the chlor-alkali industry has marked the upgrade and transition of brine electrolysis processes given the evaluation of factors influencing energy efficiency (such as: type of ion exchange membrane, materials of electrodes, types of electrodes configuration and activation, current density, operating flow rates, the level of impurities in the initial brine solution, and the purity of the demineralized water product processing, product processing). Sustainable technology can implement best practices, such as enhancing the energy efficiency of the electrolysis process, introducing advanced cell technologies (zero gape), minimizing waste and CO_2 emissions using unconventional energy sources (such as solar energy and wind energy). The energy savings from the green hydrogen can be converted into a reduction in CO_2 emissions, and the larger part of this potential is found to be cost effective from a chlor-alkali industry perspective.

Keywords: ultrapure brine, chlor-alkali industry, green hydrogen, ion exchange membrane processes

PERFORMANCE OF NEW CHELATING RESIN IN BRINE HARDNESS REMOVAL TO FEED THE CHLOR-ALKALI MEMBRANE CELL PROCESS

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Abstract:

The brine electrolysis based on the ion exchange membrane process produce sodium hydroxide, chlorine and hydrogen, and plays a particularly important role for chlor-alkali products with a low carbon footprint. The efficient performance of the present technology (membranes zero-gape) is influenced by brine purity. Using the ultrapure brine in the membrane cells improves current efficiency and reduce electricity consumption. It also, using an ultrapure brine solution allows for a longer operating life for the membrane. The brine hardness content is lowered to less than 20 ppb (ultrapure brine conditions) by ion exchange using polymer resins that must have a good exchange capacity and a special affinity for retaining of Ca^{2+} and Mg^{2+} ions.
Lewatit® MonoPlus TP 208 resin by Lanxess is a weakly acidic cation exchange resin with chelating iminidiacetic acid groups designed for the selective removal of alkaline eart cations. According to the manufacturers, they resin offer of economic benefits fot the brine prurification and cost saving energy. These materials’ data sheets from the producers inform about the total capacity of min. 2,5 eq/L for the resin delivery form (H^+) used at 60 to 75 ^{0}C and pH 8.5 to 10.5. The literature lacks sufficient experimental research that scientifically explains the behaviour and the performance of the new commercial resins and also investigations on the kinetics and thermodynamics of the brine hardness purification process.
In thise paper, the practical ion exchange capacity of Lewatit® MonoPlus TP 208 resin for Ca^{2+} and Mg^{2+} ions removal from real brine was investigated. In the experiments industrial brine solution (by Chimcomplex Borzesti, Romania) was used. Preliminary batch ion-exchange experiments were conducted to determine the effect of resin dose, pH of the solution, initial brine hardness concentration, temperature, contact time solid – liquid. This preliminary study allows for the termodinamic and kinetics analysis and subsequent implementation of the ion-exchange brine purification process in dynamic mode. The final objective of the study is the transposition to an industrial scale, so that the secondary brine purification process can be exploited industrially in optimal conditions with maximum efficiency.

Keywords: calcium and magnesium removal, ion exchange resin, secondary brine purification

ATMOSPHERIC EMISSIONS AND EFFECTS ON URBAN AREA ENVIRONMENT GENERATED BY CONSTRUCTION INDUSTRY

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Abstract:

The construction industry is one of the most important indicators of economic development in a country, but at the same time, it is also responsible for significant environmental effects (direct and indirect). Thus, civil construction becomes one of the barriers to sustainable development, with interferences from the local to the global scale. One of the major environmental impacts caused by construction is the generation of atmospheric pollution. The massive urban development in recent human history has inevitably led to major pollution of all components of the environment: water, air and soil. Air pollution is achieved by the presence in high concentrations in urban air of carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_2), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOCs), and methane (CH_4). Sustainability in construction and urban development can only be implemented gradually by applying strategic actions to priority items, that is, to its most impactful activities.

Within the scope of pollution emitted by construction site activities, particulate matter (PM) in the atmosphere consists of the mixture of solid and/or liquid particles (except pure water) found in the air, with distinct chemical and physical characteristics, emitted by polluting sources or formed in the atmosphere and which can be responsible for a series of respiratory and cardiac problems, in addition to damage to flora and fauna, inconvenience to neighborhoods, damage to soil, water and air quality, among other aspects. Particulate matter consists of particles with a diameter that can vary from 0.001 µm to 100 µm that are divided into three groups:

- $PM_{2.5}$ - Respirable particles, particles with an aerodynamic diameter of 1 to 2.5 µm;
- PM_{10} - Inhalable particles, particles with an aerodynamic diameter between 2.5 µm - 10 µm;
- Total Suspended Particles - TSP, particles with aerodynamic diameter up to 100 µm.

When these particles enter into respiratory system, they cause various diseases, such as silicosis, asthma, bronchitis, allergies, cardiac arrhythmia and heart attacks.

In conclusion, construction site activities require commitment from construction companies to ensure control of their PM emissions, in order to identify the risks involved, the emitting activities and the prevention, control and monitoring tools, as well as the need for continuous monitoring.

Keywords: urban development, sustainability, atmosferic emissions, particulate matter, environmental certification systems

SUSTAINABLE ELECTRORHEOLOGICAL LUBRICANTS. EFFECT OF ELECTRIC FIELD ON FILM THICKNESS IN ROLLING CONDITIONS

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Abstract:

Electrorheological fluids alter their rheological properties instantaneously and reversibly upon the application of an external electric field. This ability positions them as highly promising smart lubricants, given that they can be dynamically adapted to varying operational parameters (speeds, loads, etc.), resulting in an optimized performance. Despite their potential, the application of these fluids in lubrication remains relatively unexplored, presenting multiple variables that require further investigation.

This study aims to examine the effect of an electric field on the thickness of the lubricant film in a ball-on-disc contact working in rolling conditions, using custom-formulated electrorheological lubricants. In this regard, improved biodegradability and sustainability of the formulations with respect to traditional lubricants was pursued. The bio-based lubricants selected for the investigation consisted of dispersions of organo-modified nanoclay Cloisite 15A within castor oil (at concentrations ranging from 1 to 6 wt.%), whose rheological behaviour has been characterised in previous studies. By means of optical interferometry, the variation in lubricant film thickness when increasing the voltage between the ball and the disc from 0 V to 30 V disc was measured, at entrainment speeds comprised between 10.5 and 148 mm/s. Thus, the resulting effects on film thickness from the joint action of the parameters considered (nanoparticle concentration, entrainment speed and electric potential difference) was explored, with a focus on the central and minimum values. A major outcome from such study corresponds to the confirmation of the effective electro-modulation of the film thickness. The results show that, when electric potential was applied, film thickness increased for every nanoparticle concentration studied, which became mostly relevant at lower speeds. As a direct consequence of those results, this type of lubricants acquires utmost relevancy from both its reduced environmental impact and improved efficiency. From an experimental perspective, the conditions applied in the present study set the path for further research on the influence that electric field exerts on friction, as well as its comprehensive understanding in relation to film thickness behavior. A wider knowledge of these aspects is crucial for the development of practical applications in smart lubrication.

Keywords: smart lubricant, electro-rheological fluid, film thickness, rolling

MODERN APPROACHES TO VEGETABLE OIL FRACTIONATION

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Abstract:

This study analyzes the fractionation of vegetable oils using the methods known up to this point and examined the use of these fractions in various industries. Emphasis was placed on sunflower oil due to its high-oleic acid content, which has health benefits. As a new fractionation method, the work focuses on molecular distillation.
Vegetable oils mainly consist of complex lipids, mainlytriacylglycerols, whose composition determines their physicochemical properties. Sunflower oil, for instance, is rich in linoleic acid, and its high-oleic variant is highly valued for both its health benefits, such as reducing cholesterol and protecting against arteriosclerosisand its technological applications. Fractionation represents a fundamental technological process within the vegetable oil industry, enabling the separation of oils into targeted fractions for specialized applications. These fractions are extensively utilized in the food, cosmetic, pharmaceutical, and industrial sectors, contributing to enhanced product quality and functionality. There are three main fractionation methods: dry, solvent, and detergent-assisted. Dry fractionation is the most widely used due to its eco-friendliness and cost-effectiveness. Solvent fractionation provides a more precise separation, but raises environmental concerns. Detergent fractionation yields high-purity fractions but involves complex waste management. In the case of fractionation of methanol-transesterified oil is a process used to separate the components formed during transesterification, mainly to obtain biodiesel and glycerol. The biodiesel fraction can be obtained by decanting the glycerol or by simple washing with acids and the use of absorbents.
Molecular distillation is a technique used to fractionate vegetable oils by removing free fatty acids and recovering volatile compounds like squalene and tocopherols. It minimizes oil losses, is effective for oils with various acidity and reduces wastewater treatment requirement. Our experimental attempts at fractionation of sunflower oil by molecular distillation have shown that the light phase and the heavy phase have their own physicochemical properties and compositions. At the same time, attempts to create a model that can couple molecular distillation to process simulators are presented. Vegetable oil fractionation is a key process that enhances oil functionality across food, pharmaceutical, cosmetic, and industrial applications. Various techniques, including dry fractionation, solvent-based methods, and molecular distillation, enable the production of high-purity fractions with improved properties.

Keywords: vegetable oils, oil fractionation, sunflower oil, molecular distillation, methanol transesterified oil fractionation

A CRITICAL SURVEY ON SUSTAINABLE APPROACH FOR AGRICULTURAL SOIL RESILIENCE

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Abstract:

Polluted agricultural soils represent a critical threat to global environmental quality and food security. Recent studies have been pointed a sharp increase in the concentrations of heavy metals as well as harmful levels of pesticides, plasticizers and other hazardous pollutants in agricultural soils all over the world.
Several possibilities (chemical techniques, physical treatments and biological methods) have been studied to minimize the soil pollution and/or increase the capacity of soils to support agricultural practices. Among them, the use of bio-based amendments has emerged as an innovative and sustainable approach not only to improve soil properties but also to reduce soil degradation.
The goal of this study is to highlight some research-innovative pathways to strengthen the soil's ability to resist, adapt, and recover after exposure to risk factors, stress, or disturbances such as pollution, climate change, erosion, or intensive agriculture, through the use of bio-based amendments.
In order to conduct this study, recent research and review articles have been thoroughly analyzed. Following the literature analysis, it was found that bio-based amendments have multiple applications in agriculture, and environmental protection, due to their structure, chemical composition and physical properties.
Bio-based amendments could be obtained following some processes that convert biomass wastes into a natural carbon rich porous matrix.
This matrix improves soil fertility by increasing organic matter content, water retention, and the absorption of essential nutrients and reduces the salinity of affected soils, making it a valuable amendment for the restoration of degraded lands. Due to its adsorption capacity, it is effective in removing contaminants from soil, serving as a support for beneficial microorganisms involved in the degradation of organic pollutants.
Design of new functional amendments represents a sustainable approach for agricultural soil resilience. Depending on applications, functional matrices could provide an even greater contribution to solving issues related to polluted agricultural soils.

Keywords: soil pollution, soil properties, biomass waste, bio-based products, amendment

HYDROGENATION OF LEVULINIC ACID TO γ-VALEROLACTONE OVER HIGHLY DISPERSED AND STABLE COPPER NANOCATALYSTS SYNTHESIZED ON MESOPOROUS SILICA BY DEPOSITION - PRECIPITATION

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Abstract:

Fossil-based resources currently dominate the production of chemicals and fuels. However, their extensive use has led to critical challenges such as greenhouse gas emissions and environmental pollution, necessitating the search for sustainable alternatives. Biomass conversion has emerged as a promising approach, with levulinic acid (LA) recognized as a key platform molecule for catalytic hydrogenation into γ-valerolactone (GVL), a valuable chemical. Among the transition metal-based catalysts investigated for LA hydrogenation, supported copper nanoparticles (Cu NPs) have attracted attention due to their promising catalytic activity and selectivity toward GVL. Nevertheless, Cu nanocatalysts require high metal loadings and operate under harsh conditions, making the stabilization of Cu NPs particularly challenging. This study addresses these limitations by synthesizing Cu NPs on a mesoporous SBA-15 support using the deposition-precipitation (DP) method at hight metal loadings of 10 and 20 wt.%, (sampels 10Cu/Si_DP and 20Cu/Si_DP). A reference sample (10Cu/Si_IWI) prepared *via* incipient wetness impregnation (IWI). The textural properties of the synthesized catalysts were analyzed by nitrogen physisorption. The DP method resulted in a partial degradation of the SBA-15 support, leading to a reduction in the BET surface area and pore volume. For 10Cu/Si_DP, these values decreased by 50.7 % and 2 % respectively, while for 20Cu/Si_DP, the reductions were 38.6 % and 2 %. X-ray diffraction (XRD) patterns indicated that the Cu species in DP-derived samples were highly dispersed, in contrast to the poorly dispersed CuO particles observed in the reference IWI sample. Transmission electron microscopy (TEM) provided direct visualization of Cu NPs, revealing small particles in the reduced forms of DP-derived samples (sizes of ~ 4.5 nm), whereas the IWI sample exhibited large agglomerates. The catalytic performance in LA hydrogenation (150 °C, 30 bar H_2, 3 h), evaluated in terms of GVL yield, showed a good correlation with the Cu surface area. Accordingly, the following performance trend was observed: 10Cu/Si_IWI (4 mol%, 5 m^2Cu/gcat) < 10Cu/Si_DP (41 mol%, 45 m^2Cu/gcat) < 20Cu/Si_DP (100 mol%, 82 m^2Cu/gcat). These results highlight the superior performance of copper nanocatalysts synthesized via DP, demonstrating that higher metal loadings combined with enhanced Cu dispersion improve catalytic efficiency in LA hydrogenation.

Keywords: hydrogenation, levulinic acid, γ-valerolactone, SBA-15, copper nanoparticles

CALCULATION OF SEASONALITY INDICATORS OF MINIMUM RUNOFF IN THE CONTEXT OF CURRENT CLIMATE CHANGES

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Abstract:

Water resources in the context of the current climate changes are an indispensable factor for human activities, having a renewable character but also a high degree of vulnerability and limitation in time due to the increasing level of living standards and concentrated urbanization. Given that the main water supply needed by the economic and social sectors of Vaslui municipality and adjacent areas is the one stored in the Solesti reservoir, the satisfaction of drinking and industrial water requirements is paramount and in order to avoid supply dysfunctions, it is necessary to assess the occurrence of minimum flow leakage and seasonal variability on the rivers upstream of it, by calculating some seasonality indicators, such as the cyclic seasonality index and the seasonality rate. The calculation of the cyclic seasonality index and the seasonality rate quantifies the mean daily flows extracted, over a period of 19 years, from the hydrometric stations upstream of the Solesti reservoir by using the LFSTAT application package, developed in the RStudio software, based on the methodology included in the “Manual of Low-flow Estimation and Prediction” published by the World Meteorological Organization in 2008, analyzing the specific Q95 flows (95th percentile of the duration curve of the mean daily flows). The availability of information on the evolution of the minimum river discharge in the upper catchment of the Vaslui river, with an area of 429 km2, helps to outline decisions on ensuring sustainability in water supply and prudent planning on how to exploit the Solesti reservoir and directing decisions to other water resources in order to ensure the necessary water resources. The analysis of the cyclic seasonality index and the seasonality rate based on the calculations performed at the 3 hydrometic stations in the analyzed watershed revealed a strong seasonality of occurrence of minimum runoff towards the end of the warm season.

Keywords: seasonality rates, seasonality index, climate change, water resources management, minimum runoff

OPTIMIZED EXTRACTION OF PRECIOUS AND RARE MATERIALS FROM E-WASTE

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Abstract:

The rapid expansion of the electrical and electronic equipment industry has resulted in a significant increase in the generation of electronic waste (e-waste) worldwide. This growth is closely linked to accelerated technological advancement, which shortens the lifespan of devices due to the constant need for upgrades and product replacement. As a result, vast quantities of e-waste are produced daily, posing both environmental and health risks due to the presence of hazardous substances, particularly heavy metals. Among the key components of e-waste are printed circuit boards (PCBs), which are estimated to contain approximately 40% metals, 30% plastics, and 30% ceramic materials. Metals commonly found in PCBs include lead (Pb), mercury (Hg), copper (Cu), nickel (Ni), iron (Fe), and silver (Ag). These elements are not only toxic but also of high economic value, making their recovery a strategic objective.

The effective recovery of valuable metals from PCBs is essential for reducing environmental pollution and supporting sustainable resource management. This study reviews and critically analyzes the main methods used for material separation and recovery from e-waste, particularly from PCBs. The methodologies investigated include physical, chemical, and thermochemical processes, as well as pyrometallurgical, hydrometallurgical, and biometallurgical techniques. Specific methods evaluated include solvent extraction, ion exchange, membrane separation, adsorption, coprecipitation, compaction, precipitation, and sequential distillation. Each method presents specific advantages and limitations in terms of efficiency, selectivity, environmental impact, and scalability.

The analysis reveals that while individual techniques may perform well under specific conditions, the most promising results are achieved through hybrid approaches that combine multiple recovery methods into a single, integrated technological flow. These hybrid systems demonstrate superior adaptability to the complex and heterogeneous composition of e-waste and significantly enhance metal recovery rates. Furthermore, the implementation of such advanced technologies contributes to the development of circular economy models by enabling the reintegration of critical raw materials into the production cycle.

This comprehensive overview provides a foundation for further innovation in e-waste recycling and highlights the importance of adopting sustainable and efficient recovery strategies at industrial scale.

Keywords: E-waste, printed circuit boards, metal recovery, hydrometallurgy, hybrid methods, sustainable technologies

NON-THERMAL PLASMA TREATMENT OF ACETONE-POLLUTED WASTEWATER FROM CHEMICAL INDUSTRY PROCESSES

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Abstract:

The increasing presence of volatile organic compounds (VOCs) in industrial wastewater poses a significant environmental challenge, with acetone being one of the most commonly encountered pollutants, particularly in effluents from the chemical industry. Due to its high volatility, toxicity, and persistence in the environment, acetone must be efficiently removed to prevent harmful impacts on both ecosystems and human health. Traditional treatment methods often involve high energy consumption and can lead to the generation of secondary pollutants, limiting their sustainability. As an alternative, non-thermal plasma (NTP) technology has emerged as a promising solution, offering the ability to generate reactive oxygen and nitrogen species at low temperatures, without requiring chemical additives.

This study explores the degradation of acetone in water using a T-shaped NTP reactor specifically designed with two inlets—for the liquid and the carrier gas—and a single outlet for plasma-activated water (PAW). The water samples used in the experiments contained acetone at concentrations of 30%, 50%, and 90% (v/v), diluted in deionized water. The reactor operates using pulsed high-voltage discharges, a configuration that enhances plasma-liquid interactions while minimizing energy usage. Key parameters such as acetone concentration, pH, and electrical conductivity were monitored at four different liquid flow rates (5, 10, 15, and 20 mL/min), with argon serving as the carrier gas at a constant rate of 2.5 L/min.

The results demonstrated that lower flow rates improved acetone degradation efficiency due to longer residence times within the plasma zone. Variations in pH and conductivity indicated the formation of acidic intermediates and ionized species during the treatment process. Overall, the findings support the potential of non-thermal plasma as an effective, energy-efficient, and environmentally friendly method for the treatment of VOCs in industrial wastewater streams.

Keywords: NTP, PAW, acetone wastewater, average power

EXPERIMENTAL RESULTS ASSOCIATED WITH THE PHYSICAL-CHEMICAL ANALYSIS METHODS USED FOR WASTEWATER CHARACTERIZATION IN A CATTLE ZOOTECHNICAL FARM

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Abstract:

Livestock farming practices have largely shifted to intensive animal farming with a fast grown up in Romania, which has been accompanied by a significant increase in waste production, and places a heavy burden on the environment. Emissions/discharges (liquid, gaseous, solid) from the livestock industry have become one of the main sources of pollution. Environmental pollution has become an important limiting factor for the sustainable and efficient development of industries all over the country.

In this study, a large-scale farm and its facilities were studied. Therefore, a traditional cattle farm is assessed. The dairy farm has an average area of 20 ha with 7 animal production sheds (stalls) (3,130 animals at the time of the permit). The water consumed on the farm site comes from three controlled underground sources (4 boreholes) and from the local centralized water supply system. The livestock farm has an internal sewage system, i.e. six separate collectors in each farm building that are drained periodically (every 3 months) and two aerated lagoons for the entire urine produced.

This research work highlights the main activities in the studied livestock farm, which produce waste of different types, and which can be recovered in different processing stages, including on-site wastewater treatment processes. The main sources of pollution in the studied livestock farm can be caused by semi-liquid and liquid animal excrements; solid manure; effluent from silos where animal feed is stored, respectively untreated or insufficiently treated uncollected wastewater. Moreover, constant control of the collected wastewater characteristics is obviously necessary and reported to environmental authorized regulator, and directions for the recovery of possible on-site treated wastewater and other solid wastes must be updated and implemented for a sustainable environmental management of the livestock farm.

Keywords: livestock, wastewater, quality indicators, waste management, treatment processes, environmental protection

SUSTAINABILITY INDICATORS FOR WATER MANAGEMENT: ENERGY CONSUMPTION IN TREATMENT PROCESSES

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Abstract:

An important aspect of sustainable water and wastewater treatment is the need to transform the corresponding infrastructure into energy-efficient and intelligent systems. Sustainability indicators are tools used to measure progress towards sustainable development and reflect the balance between human needs and the ecosystem's ability to sustain life. They assess environmental impacts (e.g., carbon emissions, water consumption, biodiversity loss), economic performance (e.g., energy efficiency, sustainable production costs), and social aspects. Thus, in the context of rapid urbanisation, pollution, and climate change, the proposed solutions in sustainable water treatment focus primarily on technological modernisation through AI and ML (Artificial Intelligence and Machine Learning). Another proposed solution is intermittent electrocoagulation and UV photoelectrochemical oxidation combined with boiling – effective methods for eliminating emerging pollutants (drugs, pesticides). Decentralised and circular systems, including artificial wetlands and bioremediation, efficiently treat small volumes of water at multiple points and present unique challenges. The energy efficiency of treatment plants correlates with the reduction of carbon emissions, as water treatment generates significant energy consumption and greenhouse gas emissions, particularly N_2O and CH_4. Models from literature indicate that sludge recirculation and biogas cogeneration significantly contribute to energy neutrality. Process efficiency is influenced by operational parameters such as dissolved oxygen, which is crucial for nitrification and denitrification. At the same time, GPS-X simulations assist in choosing optimal scenarios between performance and sustainability. Furthermore, it has been shown that pumping drinking water accounts for more than 80% of energy consumption, and energy efficiency scenarios (by upgrading pumps and reducing per capita demand) offer viable solutions to cut emissions by up to 4.7%. In the context of the water-energy nexus, the valorisation of biomass serves as another critical factor and represents a carbon-neutral, versatile resource with multiple applications ranging from biofuels (bioethanol, biogas, biodiesel) to high-value products (bioplastics, platform chemicals). Valorisation processes include pyrolysis, gasification, anaerobic digestion, and fermentation, which are increasingly supported by nanotechnology and AI for optimisation, opening new economic and ecological opportunities. Current studies emphasise the need for integrated approaches that combine technological innovation (AI, catalysis, advanced sensors) with the optimisation of existing processes (modelling, simulation), resource recovery (energy, nutrients), and the reduction of environmental pressure (GHG reduction, toxicity).

Keywords: water-energy nexus, sustainability indicators, treatment processes, environment

EXPERIMENTAL MODELING STUDY OF COAGULATION-FLOCCULATION TREATMENT PROCESS APPLIED FOR TEXTILE EFFLUENTS CONTAINING REACTIVE REMAZOL ROSSO RB DYE USING COMMERCIAL HYBRID COMPOSITE MATERIALS

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Abstract:

The research work proposes a modeling study of the coagulation-flocculation process applied in the case of textile effluents treated with commercial hybrid materials as eco-coagulant/eco-flocculant at laboratory scale setup, i.e. VTA BIOSOLIT 6124 with varying added concentrations and CETTA CLEAR (5 mg/L). The tested textile effluents contain different molecular and ionic species which confer specific characteristics and/or properties, between its, of significant interest, being turbidity (fine solids) and color (due to different colored species, including residual dyes such as reactive Remazol Rosso RB dye). The laboratory coagulation-flocculation experiments are based on Jar tests with an initial varying agitation step followed by a settlement step of at least 30 min. All experiments were performed according to an experimental planning design which considered the influences of three independent variables such as X_1 - the varying hybrid material concentration (20-80 mg/L), X_2 - pH (2-12) and X_3 - stirring time (3-40 min) against the dependent process variable (optimization criterion) which is the removal of turbidity (Y_1) and color (Y_2). All experiments were performend with textile effluents containing residual Remazol Rosso RB concentration (50 mg/L) in association with other additives and auxiliaries according with the preparation and/or dyeing formulation scheme. For experimental modeling was used a central active compositional rotatable 2^3 design which consists of twenty experiments operated at specific values of each tested independent variables (X_1-X_3) according with the experimental planning design. The optimum values were proposed considering the classical/conventional mathematical optimization methodology. The optimum removals were of 89.52 % for turbidity and 48.22% for color, working in specific conditions of 46.30 mg/L of VTA BIOSOLIT 6124 hybrid material, pH 10.28 and 28 min of stirring period (mean deviation value of -3.842%), and further research works will be performed for additional details and experimental improvements.

Keywords: coagulation-flocculation, color removal, hybrid composite materials, textile effluent, turbidity removal

EXPERIMENTAL ADSORPTION MODELING AND OPTIMIZATION STUDY OF REMAZOL ROSSO RB DYE REMOVAL FROM AQUEOUS SYSTEMS USING ALGAL BIOMASS-BASED ADSORBENT

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Abstract:

The research work proposes the presentation of laboratory experimental adsorption results performed in the case of a textile reactive dye (Remazol Rosso RB) removal from aqueous systems (around 50 mg/L of residual dye, pH 3-4) onto algal dried biomass (preliminary mechanically prepared) as adsorbent in association with the experimental data modeling using an empirical design. The tested adsorbent is included in the category of 'non-conventional' and 'low cost' adsorptive material, being only mechanically processed, and consisting mainly in dried *Spirogyra* freshwater algal biomass, fraction of < 2 mm. The principal three independent influencing variables of the reactive dye adsorption process were considered to be X_1 - the algal biochar-based adsorbent concentration (0.50-30.00 g/L), X_2 - the operating temperature (6.50°-33.50° C) and X_3 – the adsorption contact time (0.50-22 h). The modeling study was based on an experimental planning consisting in 20 experiments, each one performed at specific value of each independent variable according with an experimental matrice, i.e. a central active compositional rotatable experimental 2^3 design, for which the dye removal efficiency (%) reffering to Remazol Rosso RB dye was considered as optimization criterion. The optimum dye removal in static working regime was of 86.35%, good enough for the specific optimum operating conditions of 16.22 g/L of algal biomass-based adsorbent, around 20° C and 6 h of adsorption time (having a value of -4.143% for the mean experimental deviation, in the agreed deviation limit of ±10%). This tested adsorbent can be applied as an alternative material in the adsorption treatment step of textile dye-containing effluents or aqueous solutions, especially for recycling and/or reuse facilities being a cheap and ease to use material at laboratory/pilot or industrial scale.

Keywords: adsorption/sorption/biosorption, dye removal, dried algal biomass-based adsorbent, Remazol Rosso RB dye

DEVELOPMENT AND CHARACTERIZATION OF TREE TROPICAL WOOD SPECIES (AYOUS, AZOBE AND IROKO) AND A NATURAL BINDER

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Abstract:

Firewood and charcoal are the main sources of energy in Cameroon and one of the factors of deforestation; However, the accumulation of wood residues in processing industries is a source of energy that can be capitalized to meet society's needs. In order to contribute to the reduction of pressures on the natural forest, this study proposes to recover the associated waste from the wood processing industries by manufacturing compressed pellets. The process used consists of a mixture of three by-products of wood processing with a natural binder, which is then compacted via an electric granulator. The main objective of the study is to formulate the pellets densified by such a process in order to characterize them energetically. To achieve this, three wood species (azobé, iroko and ayous) were chosen on the basis of two criteria, the first of which consisted of experimenting with heavy, medium-heavy and light wood; Then the second criterion was based on the choice of the most exploited species for the availability of the raw material. The effects of particle size, moisture content and the proportions of mixtures per sample were studied. The optimal conditions chosen are a grain size of 2 mm and moisture levels of 24%, 16.5%, 19.32% and 18% respectively for mixtures of ayous, iroko, azobé and hybrid from these three species. The formulation conditions varied from one species to another, each composed of sawdust, binder and water; respectively for Ayous pellets (77%, 3.85% and 19.23%); iroko (81%, 2.5% and 14.2%); Azobé (81%, 2.83% and 16.2%); and hybrid (81%, 24% and 15.79%). Once compressed, we obtained pellets with a diameter of 4 mm and a length of 12 mm for the azobe and an average of 10.5 mm for the other samples. The results obtained after characterization show that these pellets from azobe, ayous, iroko and hybrid woods have respectively a higher calorific value of 18561; 19250 ; 20419 ; 20284J/g and an ash content of 8.5; 4,3 ; 3.2 and 6.6%. A respective humidity level of 12.8; 14,7 ; 14 ; 14.5% and a volatile matter content of 29.5; 29 ; 18.6 and 26.9%. These results agree with some authors who estimate that the SCC of softwoods varies from 19.12 to 21.10 MJ/kg while for hardwoods, the average is between 18.40 and 20.09 MJ/kg. A thermogravimetric analysis of the resulting pellets was performed to assess the variation in the masses of the samples used as a function of time, for a given temperature profile. First of all, to promote the variation of the rolls on the die, it is necessary to ensure that the particle size of the sawdust is large enough.

Keywords: wood residues, pellet, binder, granulation, densification, characterization

ASSESSING ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG) INTEGRATION IN TOURISM AND HOSPITALITY: A COMPARATIVE ANALYSIS OF GLOBAL STANDARDS AND INDUSTRY PRACTICES

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Abstract:

Being one of the major engines driving international economic growth, the tourism and hospitality sector is under immense pressure to reduce environmental impact and adopt sustainable practices to align with environmental, social and governance (ESG) criteria. While ESG frameworks are widely adopted in other sectors, their implementation in tourism and hospitality remains fragmented due to different standards and implementation constraints. This study assesses ESG frameworks for tourism and hospitality, evaluating their alignment with sector-related goals and global sustainability objectives. This study examines the effectiveness of current ESG standards and best practices in the industry, based on an extensive literature review, industry reports, and ESG guidelines from organizations like the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), and the World Travel & Tourism Council (WTTC). It critically examines the applicability, strengths and limitations of these frameworks for addressing major sustainability problems in tourism and hospitality, such as for carbon emissions, resource management, labour practices and community engagement. The findings of the study reveal that environmental and governance dimensions emphasize in many ESG frameworks, while community impact and employee well-being are less analyzed. Case studies of sector leaders illustrate best practices, integrating ESG principles into core operations, demonstrating that the benefits provided by this framework can be measurable, adding to operational efficiency, brand reputation and increasing stakeholder confidence. However, inconsistencies in reporting standards and the scarcity of sector-specific metrics prevent widespread implementation. This review emphasizes the need for an ESG framework responsive to the dynamics of the hospitality sector, emphasizing measurable outcomes, transparency and stakeholder engagement. In conclusion, the study highlights the critical role of ESG integration in achieving long-term sustainability in the industry and encourages collaborative efforts among stakeholders, corporations and certification bodies to establish unified standards. By addressing existing challenges, the sector can increase its resilience, competitiveness and contribution to global sustainable development goals.

Keywords: best practices, ESG frameworks, global standards, hospitality industry, sustainable tourism

SECTION 4.
Civil engineering and installations

FIRE HAZARDS IN SOLAR PHOTOVOLTAIC INSTALLATIONS: A MULTIDISCIPLINARY APPROACH TO RISK MITIGATION

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Abstract:

The increasing adoption of photovoltaic (PV) systems, driven by the global transition toward sustainable energy, has introduced new challenges for emergency response teams, particularly in the context of fire safety and risk mitigation. This paper provides a comprehensive framework for understanding and managing the risks associated with PV installations during emergency situations. It emphasizes the dual nature of photovoltaic systems both as power generators and potential hazards highlighting their continuous power generation capabilities even under low-light conditions, which is considered one of the main risks regarding first responder safety. The document systematically classifies PV systems based on location (open-space vs. building-mounted) and grid connectivity (on-grid vs. off grid), outlining specific risks inherent to each configuration. Particular attention is given to the operational risks firefighters face during interventions, such as electric shock, roof collapse, and toxic smoke inhalation. Detailed procedural steps are provided for safe disconnection, fire suppression techniques, and post-incident equipment assessment, particularly in relation to energy storage systems (ESS) like lithium-ion batteries. Furthermore, the article explores the technical and design-related causes of PV fires, including poor component quality, inadequate maintenance, improper system sizing, and environmental stressors like lightening or hail. The risk of electrical arcing in direct current (DC) circuits is analyzed in depth, as it represents one of the primary ignition source in PV-related fires.
This document addresses fire safety challenges posed by photovoltaic (PV) systems, focusing on emergency response, system classification, and operational risks. It outlines safe disconnection, fire suppression methods, and causes of PV fires. Emphasizing a multidisciplinary approach, it aims to enhance safety and resilience in PV system design and intervention. It could also serve as a resource for both fire intervention personnel and engineers involved in the design and maintenance of PV systems. By applying these best practices, stakeholders can significantly reduce the likelihood of fire incidents and improve the resilience of photovoltaic infrastructure.

Keywords: photovoltaic system, fire safety, risk management, emergency response, electrical hazards

INTEGRATING 3D PRINTING INTO CONSTRUCTION MANAGEMENT: TOWARDS A NEW PARADIGM OF DIGITALIZED PROJECT DELIVERY

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Abstract:

The contemporary construction industry is increasingly shaped by rapid technological innovation, digitization, and the growing demand for efficient, cost-effective, and sustainable building practices. Among the most transformative developments in recent years is 3D printing, also known as additive manufacturing, which offers the potential to fundamentally reshape how buildings and infrastructure are designed, managed, and constructed. This paper examines the role of 3D printing as a disruptive force within the discipline of construction management, focusing on how its integration can enhance the five core managerial functions: planning, organizing, staffing, directing, and controlling.

While traditional construction workflows rely heavily on linear processes, 3D printing introduces opportunities for automation, customization, and accelerated timelines, particularly in conjunction with digital design tools. The paper explores the interoperability between 3D printing and other modern digital technologies such as Building Information Modeling (BIM), 3D laser scanning, and digital twins, emphasizing the need for a holistic, data-rich approach to project delivery. Case studies involving printed structural elements, architectural components, and emergency housing solutions are analyzed to illustrate the practical implications for scheduling, cost estimation, risk assessment, and quality control.

In addition, the research highlights the changing nature of managerial responsibilities in projects utilizing 3D printing, where real-time decision-making, cross-disciplinary collaboration, and continuous data integration become essential. The adoption of such technologies demands a reconfiguration of management systems to accommodate new production methods, regulatory considerations, and sustainability metrics.

Ultimately, this study argues that 3D printing should be viewed not solely as a technological advancement, but as a strategic component within the future of construction management. Its successful implementation relies on its alignment with project objectives, regulatory compliance, and digital workflows, requiring construction managers to adapt their methodologies to embrace innovation at every phase of the project lifecycle. This shift marks a transition toward a digitally integrated, performance-driven model of construction management, in which technology is both an enabler and a catalyst for systemic change.

Keywords: project delivery innovation; construction management; 3D printing; Building Information Modeling (BIM); digital technologies

CRITICAL PARAMETERS FOR OPTIMIZING THE TERTIARY TREATMENT STAGE

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Abstract:

The main goal of the work consists in the optimization from the point of view of energy efficiency and the reduction of the implementation and operation costs of the advanced (tertiary) treatment stage of urban and industrial treatment plants, through the correct choice of the staged sequence of calculation of the still used primary parameters from the design phase of the tertiary stage component equipment.
In the evaluation of the biological treatment stage within a wastewater treatment plant, several critical operational and design parameters must be rigorously analyzed. Primarily, the focus is on quantifying the concentration of organic pollutants (CBO_5) in the influent to the biological reactor, alongside the total pollutant load, which includes both organic and inorganic constituents. These concentrations are essential for dimensioning the reactor and determining the oxygen demand. Furthermore, a detailed mass balance is performed for nutrients, particularly nitrogen and phosphorus. The nitrogen balance defines the total load of nitrogen compounds that must be biologically removed through nitrification and subsequent denitrification. In parallel, the phosphorus balance quantifies the amount of phosphorus that needs to be chemically precipitated, typically using iron or aluminum-based coagulants. The denitrification potential of the system is assessed through the ratio between the total nitrogen load requiring denitrification and the biodegradable organic load available, expressed as CBO_5, at the inlet of the biological stage. This ratio is a key indicator of the carbon availability for effective denitrification processes. Sludge age, or solids retention time (SRT), is another critical operational parameter. This parameter influences both the stability of nitrification and the efficiency of biomass production and degradation. Lastly, recirculation flows play a vital role in nutrient removal strategies.
In conclusion, in order to obtain the correct results from the point of view of efficiency regarding the dimensioning of the parameters used in the design of the tertiary treatment stage, it is necessary to take into account: the correct evaluation of the wastewater characteristics, the treatment capacity related to the wastewater loads, the efficiency energy and implementation and operation costs during the exploitation period.

Keywords: energy efficiency, improvement and dimensioning of the parameters

ASPHALT PRODUCED WITH A WASTE. DETERMINING THE SWELLING OF ASPHALT MIXTURE WITH STEEL SLAG

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Abstract:

Roads have always been an indicator of the level of development of a region. In Romania, it is expected that in 2025 approximately 240 km of highway will be built, to which is added the construction of national, county, communal and village roads as well as the modernization and rehabilitation of existing ones. However, a single kilometer of road consumes a lot of raw materials and the exploitation of nature to obtain these limited resources produces a lot of pollution. In terms of pollution, the biggest polluter today is industry, contaminating the environment both through the processes of manufacturing raw materials and through the production of waste. It is known that industry has developed greatly in the last century. Trying to keep up with the demand of the population that has grown, it has produced much more raw materials but also a greater amount of waste, which has come to occupy ever larger areas of land.

The present work represents a solution that solves two major problems of modern society: building roads using fewer natural resources and freeing up storage space for industrial waste. More precisely, the natural aggregates in asphalt mixtures used on roads are replaced with a metallurgical waste, steel slag. However, in order to validate this unconventional type of asphalt, it must be subjected to some determinations.

The purpose of this work is to determine the swelling of samples made from several recipes of asphalt mixtures with steel slag and to observe their volume variation. Swelling is an important characteristic of asphalt mixtures, large volume variations can lead to road degradation. The results obtained were encouraging, the swelling of the samples being below 2%. In the work, it will be possible to observe how the swelling varies during the 28 days of testing, which of the 4 asphalt mixture recipes is more sensitive to the action of water, as well as how the percentage of bitumen influences the increase in volume of the samples. After this study, we can say that the asphalt mixtures with steel slag tested had good swelling behavior, not posing the problem of large volume variations.

Keywords: steel slag, road construction, asphalt, recycling, secondary product, swelling.

INTERINSTITUTIONAL RESPONSIBILITIES IN MANAGING ATERCOURSE INTERVENTIONS AND THE NEED FOR UNIFIED MANAGEMENT

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Abstract:

This paper addresses the interinstitutional responsibilities involved in managing interventions on watercourses,
emphasizing the necessity for a unified management approach to ensure effective and sustainable water resource management. Watercourses play a vital role in environmental health, economic development, and public safety, but their management often involves multiple institutions with overlapping or fragmented responsibilities. This can lead to inefficiencies, conflicts, and missed opportunities for better protection and use of water resources. The report outlines the key institutions involved in watercourse interventions, including national environmental agencies, local authorities, and various regulatory bodies, detailing their specific roles in areas such as water quality, flood management, infrastructure development, and conservation. It highlights the importance of clear delineation of responsibilities and the need for effective communication and collaboration among these entities to address the challenges of watercourse management in a coordinated way.
A central theme of the report is the critical need for integrated management systems that combine the expertise and resources of various stakeholders. Unified management structures would facilitate more streamlined decision-making processes, reduce bureaucracy, and ensure that interventions are both timely and effective. Such a system would also improve the implementation of policies that support the sustainable use of water resources while safeguarding ecosystems and communities.
The report further explores the benefits of creating collaborative platforms for sharing data, resources, and best practices across institutions. It suggests that the development of joint action plans and clear guidelines would enhance the efficiency of interventions and strengthen institutional cooperation. The report also stresses the importance of aligning these management efforts with both national and European water management policies to ensure compliance with environmental regulations and contribute to broader sustainability goals.
In conclusion, the report calls for the establishment of a unified, collaborative framework for managing interventions on watercourses, aimed at improving the overall efficiency, transparency, and sustainability of water resource governance.

Keywords: managing watercourse interventions, unified management

OPTIMIZED MORTAR COMPOSITIONS WITH STEEL FIBERS AND TREATED RECYCLED RUBBER: PRELIMINARY ASSESSMENT OF STRUCTURAL AND ENVIRONMENTAL PERFORMANCE

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Abstract:

The preliminary research aims to identify innovative and sustainable solutions in the field of construction materials by investigating the influence of short steel fibers, in combination with recycled rubber additives, on the mechanical and environmental behavior of cement-based mixtures. The main objective is to develop an optimized composite with increased fracture resistance, capable of meeting the structural requirements of buildings while also contributing to the reduction of CO_2 emissions and pollution resulting from industrial waste management. Laboratory tests conducted so far on various mortar samples have highlighted the positive role of steel fibers in maintaining the structural integrity of elements under stress. Mixtures that included steel fibers and rubber demonstrated significantly greater elasticity, with visible cracking but without total failure. These results underscore the real potential of such compositions to be used in diverse applications where crack resistance and load redistribution capacity are essential. To improve the compatibility of recycled rubber with the cement matrix, chemical treatment is proposed using various agents such as $KMnO_4$ and NaOH, as well as immersion in a cement paste prior to incorporation. These treatments serve to increase the surface roughness of rubber particles and reduce organic impurities, thereby enhancing adhesion and contributing to a more chemically and mechanically stable composite. Another important aspect of the study is monitoring the secondary effects of rubber treatment on the compositional matrix of the final hardened element. By extending the preliminary research toward concrete mixtures with structural applicability, the aim is to formulate a sustainable, elastic, and durable blend with the potential for use in a wide range of structural elements. Thus, this work outlines an applied contribution to the field of low-carbon construction, while simultaneously targeting enhanced technical performance.

Keywords: steel fibers, carbon emissions, crumb rubber, sustainable construction, material optimization

MODERNIZATION OF THE MONITORING SYSTEM OF EARTH DAM DISPLACEMENTS

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Abstract:

The safety of dams depends on the ability to monitor the deformations and displacements of these structures over time. Movements occurring in the dam body (settlements, horizontal displacements, rotations) can indicate phenomena such as foundation settlement, backfill relaxation, thermal variations or effects of hydraulic loads. Monitoring the behavior of dams over time is mandatory according to regulations in the field, with the aim of detecting potential stability problems in time. Traditional methods of tracking over time, such as periodic geometric levelling or classic topographic measurements, provide highly accurate data, but at relatively long intervals (weeks, months or years).

Upgrading monitoring systems at old dams involves both installing new technologies and integrating them with existing ones. A dam initially equipped with only topographic landmarks can be brought up to current standards by adding GPS/GNSS sensors, robotic total stations to perform automatic measurements, and remote sensing sensors. The use of GNSS (Global Navigation Satellite Systems) for dam monitoring represents a stage of modernization at a high technical level. The GNSS system can be used in periodic measurements at dams by performing static differential measurements on landmarks on the dam and reference landmarks outside the area of influence. GNSS technologies have advanced towards continuous applications, in permanent mode by using networks of GNSS receivers located on the dam.

The advantages of the GNSS monitoring system are the independence of the direct visibility of the receivers. In these systems, there is no need for a straight line of sight between the landmarks and the reference station, as required by optical methods and the absolute reference of measurements in the global system.

Another advantage of GNSS is the high acquisition frequency: the receivers can record positions every second if necessary, allowing the identification of vibrations or short cyclic displacements.

Keywords: dams, displacements, elevations, geodetic equipment, GNSS

INNOVATIVE APPLICATIONS OF RECYCLED PET IN ROAD ENGINEERING: A REVIEW OF METHODS AND IMPACTS

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Abstract:

This paper addresses the growing global issue of plastic waste, with a specific focus on polyethylene terephthalate (PET), one of the most commonly used plastics, especially in the packaging of beverages and food products. PET's widespread use, combined with its high resistance to decomposition, has led to a significant accumulation in the environment, posing long-term ecological threats. Despite the increasing emphasis on recycling, current rates remain low: approximately half of PET bottles are not recycled, and only a small fraction of those collected are reprocessed into new bottles. These challenges highlight the urgent need for innovative recycling solutions.

Among emerging strategies, the incorporation of PET waste into asphalt mixtures stands out as a promising approach to both reduce environmental pollution and enhance road infrastructure performance. Recycled PET can be added to asphalt mixtures through various processes—either as a partial aggregate replacement or as a reinforcing fiber—to improve the mechanical properties of the pavement. Studies cited in this work demonstrate

that the use of PET can increase resistance to deformation and fatigue, improve durability, and contribute to resource conservation by reducing the demand for virgin aggregates and bitumen.

The paper provides an overview of the mechanical behaviour of asphalt mixtures modified with PET, drawing on experimental data from international research and highlighting the benefits and limitations of this approach. One key finding is that while moderate amounts of PET (e.g., 0.7% by weight) can improve certain performance indicators, excessive content may negatively affect mixture stability. Therefore, optimizing dosage is critical.

In conclusion, the integration of recycled PET into asphalt mixtures represents a viable and sustainable method of waste management with dual benefits: mitigating plastic pollution and contributing to the development of more durable and eco-friendly road infrastructures. Further research and regulatory support are necessary to standardize methodologies and promote wider adoption at both national and international levels

Keywords: plastic waste, pet recycling, asphalt mixture, road durability, sustainable infrastructure

SUSTAINABILITY GOALS AND THE ROLE OF CONSTRUCTION SECTOR. PRELIMINARY RESULTS ON THE IMPACT OF USING HEMP AND WOOL FIBERS IN A MORTAR MIX

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Abstract:

The construction sector is one of the key pillars of the global economy that can benefit from implementing various measures leading the transition to a greener and decarbonised economy. At the global level, the built environment is responsible for 39% of gross annual carbon emissions which includes both embodied carbon and operational carbon. In addition, the world economy is constantly changing and is affected by various crises and natural disasters, including climate change, natural resource shortages, earthquakes, floods, wildfires, increased taxes, and wars. Therefore, it is necessary to adapt and redefine the long-term priorities as we develop and implement a vision to reshape the building environment from the extraction phase through the end use of the buildings. There are several actions taken by the policy makers at the European level and ambitious targets transposed via various EU Directives as a result of the Green Deal and Circular Economy Plan. Those actions are targeting the decarbonization and energy performance of the construction sector and compliance of construction products. It also aims to demonstrate the potential of using recycled and bio-based materials thus reducing the waste. Furthermore, digitalization is essential with the new policies updates. While the European building stock is outdated, those policies serve as an opportunity for deep renovation actions. There is also a need for new innovative materials and technical solutions for strengthening and increasing the resilience of the construction sector. Based on the European policies and sustainability goals, the presented research study investigates the possibility of integrating the „renewable” materials like hemp and wool in the current construction market. Also, highlights the advantages of hemp as an absorbing and retaining carbon solution and of wool for diminishing the waste and creating a new market for the local wool production. After the preliminary material trials, it has been observed an increase of flexural strength and a decrease of compression strength for the samples with hemp and wool fibers compared with those without fibers. Also, the fiber samples showed an increase in thermal resistance, closely related to their content in the analysed compositions.

Keywords: sustainability, decarbonization, Green Deal, circular economy, energy performance, resilience, fibers

EARTHQUAKE RESISTANT REINFORCED CONCRETE STRUCTURAL SYSTEMS FOR HIGH-RISE RESIDENTIAL BUILDINGS

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Abstract:

The construction of reinforced concrete high-rise residential buildings is a remarkable engineering achievement that has made a decisive contribution to urban development. Projects erected in Romania during the industrialization period (1970s-1980s) that have experienced major earthquakes provide valuable information for the engineering approach to the design of such buildings. The paper presents the structural systems used in the past, the various non-conformities found following the March 1977 and August 1986 earthquakes and the rehabilitation solutions adopted. The paper also presents the evolution of the structural systems to the present day in terms of seismic design codes.

For the main types of structural systems – reinforced concrete moment resisting frames, structural walls, dual systems (with predominant walls or with predominant frames), with central core, with thick slab or with frames and wide rectangular columns – both, advantages and disadvantages are highlighted for each of the proposed structural systems. The degree of prefabrication permitted and the savings made in terms of labor and materials used are also taken into account in this comparative proposal. The behavior of these types of building is also centralized and presented with respect to major seismic event.

Considering the existing built environment, various damage mechanism are observed as a result of seismic action due to design and execution causes or as a result of subsequent intervention by the beneficiaries on the buildings. In relation to these damages the existing intervention methods are centralized and brief comments on the technical challenges, material consumption and financial resources required are presented.

In the end, a series of recommendations are made regarding the choice of an optimal structural system leading to significant savings (both financially and in terms of resources) and oriented towards environmental protection and sustainability for both the existing built stock and future construction. Following the conclusions, possible research directions are proposed.

Keywords: high-rise residential, RC structural system, wide rectangular column, earthquake, structural intervention

CALCULATION OF SEASONALITY INDICATORS OF MINIMUM RUNOFF IN THE CONTEXT OF CURRENT CLIMATE CHANGES

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Abstract:

Water resources in the context of the current climate changes are an indispensable factor for human activities, having a renewable character but also a high degree of vulnerability and limitation in time due to the increasing level of living standards and concentrated urbanization. Given that the main water supply needed by the economic and social sectors of Vaslui municipality and adjacent areas is the one stored in the Solesti reservoir, the satisfaction of drinking and industrial water requirements is paramount and in order to avoid supply dysfunctions, it is necessary to assess the occurrence of minimum flow leakage and seasonal variability on the rivers upstream of it, by calculating some seasonality indicators, such as the cyclic seasonality index and the seasonality rate. The calculation of the cyclic seasonality index and the seasonality rate quantifies the mean daily flows extracted, over a period of 19 years, from the hydrometric stations upstream of the Solesti reservoir by using the LFSTAT application package, developed in the RStudio software, based on the methodology included in the "Manual of Low-flow Estimation and Prediction" published by the World Meteorological Organization in 2008, analyzing the specific Q95 flows (95th percentile of the duration curve of the mean daily flows). The availability of information on the evolution of the minimum river discharge in the upper catchment of the Vaslui river, with an area of 429 km2, helps to outline decisions on ensuring sustainability in water supply and prudent planning on how to exploit the Solesti reservoir and directing decisions to other water resources in order to ensure the necessary water resources. The analysis of the cyclic seasonality index and the seasonality rate based on the calculations performed at the 3 hydrometric stations in the analyzed watershed revealed a strong seasonality of occurrence of minimum runoff towards the end of the warm season.

Keywords: seasonality rates, seasonality index, climate change, water resources management, minimum runoff

CONCEPT OF SPECIAL CONSTRUCTIVE STRUCTURE TO CONSOLIDATE THE BLACK SEA CLIFFS ALONG TO THE ROMANIAN COASTLINE

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Abstract:

The Black Sea cliffs along the Romanian coastline have been, and continue to be, affected by a series of natural land instability phenomena. However, due to the development of human settlements and the expansion of built-up areas, land instability phenomena have intensified.

The basic concept considered so far for the consolidation and combating of instability phenomena of the Black Sea cliffs started from the hypothesis of the possibility of stabilizing the terrain. The analysis of the long-term behaviour of these constructive approaches implemented has demonstrated that the adopted technical solutions did not produce the expected results - neither in the short term nor in the long term. In fact, in many cases, the instability phenomena of the terrain in the consolidated areas reactivated immediately after the works were completed.

In other cases, due to financial constraints, adequate long-term maintenance of these complex structures could not be ensured, leading to their gradual degradation, which no longer fulfilled the role for which they were carried out. As a result, in many cases, not only complete degradation of these structures was achieved, but also an increase in the danger related to the reactivation of the phenomena of ground instability in the consolidated areas.

The concept we propose today is based on the hypothesis of the technical impossibility of combating terrain instability phenomena. And starting from this hypothesis, the constructive approach is to eliminate the soil/rock affected by instability phenomena and replace it with a constructive structure with the role of supporting and reinforce the cliff unaffected by instability phenomena. In fact, the proposed constructive model has two components which will be presented in the study.

In fact, through the multiple functionalities that the proposed construction concept can have, they can generate an economic capitalization of the construction through activities that produce income. Thus, over time, not only can the construction costs be amortized, but the project may also generate profit. But from the income generated from the exploitation of the construction structure, the necessary costs for the adequate maintenance of the drainage structure can be ensured in time and on time.

Keywords: Black Sea, costal area, seacliffs, concept, constructive structure

THE ASSESSMENT OF NATURAL INSTABILITY PHENOMENA OF THE BLACK SEA CLIFFS. STUDY CASE: 23 AUGUST AREA (CONSTANTA COUNTY – ROMANIA)

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Abstract:

The Black Sea cliffs along the Romanian coastline have been affected by a series of natural land instability phenomena. However, the natural land instability phenomena is a phenomenon that is practically disappearing, being replaced by land instability phenomena generated by human activity due to the development of human settlements and the expansion of built-up areas.

Even under these circumstances, there are limited areas along the Romanian coastline where these natural phenomena can still be observed today and can be scientific analyzed. One of these perimeters is located on the administrative territory of the 23 August Commune (Constanța county).

For the temporal evaluation of the natural instability phenomena of the Black Sea cliffs in this area, a multitude of cartographic sources (maps), but also aerial photographs and satellite images, covering an interval of approximately 80 years, were available.

The study aims to present a series of aspects of interest regarding the instability phenomena captured in the analyzed images. Based on these identified aspects that will be presented, a series of conclusions can be drawn on the characterization and understanding of the evolution over time of this portion of the Romanian coastline.

The central element of the analysis that will be presented in this study is a military casemate, a defensive structure built during the Second World War. This structure can be identified in all aerial photographs taken after its construction, and even more clearly in satellite images captured after the year 2000.

Thus, correlating elements related to the casemate with a series of other features concerning the positioning of the Black Sea shoreline, identifiable in these images, allows for a detailed analysis over a significant time interval. And the conclusions come to emphasize the fact that the particular aspects specific to this perimeter have a determined role in the evolution of instability phenomena.

Keywords: Black Sea, costal area, natural land instability phenomena, 23 August area

EVALUATION OF THE CAUSES THAT LED TO THE DEGRADATION OF THE STRUCTURAL WORKS IMPLEMENTED FOR THE CONSOLIDATION OF THE BLACK SEA CLIFFS. CASE STUDY: NORTHERN SEA CLIFF - CONSTANȚA (ROMANIA)

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Abstract:

The development of human settlement and habitat within the coastal area of the Black Sea along the Romanian required the development of the coastal area so that to be in agreement with the social and economic needs of the population.
This study is, in fact, a continuation of the one presented last year (2024) at the 7th International Conference of the Doctoral School, under the title Long-term behaviour of the structures built within the 1950s-1960s to consolidate the shores and cliffs of the Black Sea coast in Constanța City, Romania (Book of abstracts, page 139). This time, it proposes a detailed analysis of the behavior over time of the complex structures built to consolidate the cliffs, focusing on the North Sea Cliff sector from Constanta.
The evaluation and analysis of the situation based on aerial photographs and satellite images allows us to present both the behavior over time of the structures built in this area, as well as a detailed analysis of the causes that caused the deterioration of the structures built and the reactivation of the phenomena of ground instability.
As part of the presentation, we will provide a detailed analysis of the evolution of land instability phenomena within this area, with an additional focus on their dynamics. The elements identified through aerial photographs and satellite images, along with their manifestation and evolution over time, allow for an accurate interpretation of the long-term behavior of the constructive structures built in this area for the purpose of soil stabilization.
First of all, our analysis will primarily emphasize the role and importance of carrying out maintenance works to fulfill the role for which the cliff reinforcement structures were built. Because in fact, the current situation of degradation of these constructive structures and reactivation of the instability phenomena were caused by the cessation of their maintenance works.

Keywords: Black Sea, costal area, seacliffs, consolidation, degradation, structural works

PERFORMANCE OF GREEN CONCRETE INCORPORATING MARBLE WASTE AND FIBER REINFORCEMENT

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Abstract:

This study investigates the mechanical properties of fiber-reinforced concrete incorporating marble waste as a replacement for natural aggregate. The research aims to evaluate the influence of steel and polypropylene fibers, in different dosages, on the compressive, flexural, and split tensile strengths of concrete containing recycled marble waste. The motivation for this study lies in the need to develop sustainable construction materials by integrating waste by-products into concrete mixtures, thereby reducing environmental impact and natural resource depletion. Two series of concrete mixes were prepared, replacing natural aggregates with marble waste in proportions of 20% and 80%, respectively. Additionally, steel fibers were introduced at dosages of 75 kg/m³ and 150 kg/m³, while polypropylene fibers were added at 4.8 kg/m³ and 9.6 kg/m³. The experimental program included tests on density, compressive strength, flexural strength, and split tensile strength conducted on specimens cured for 28 days. Results indicated that the inclusion of steel fibers led to an increase in flexural and split tensile strengths compared to control mixes, with the highest values recorded for the mix containing 150 kg/m³ steel fibers and 20% marble waste. However, steel fibers negatively impacted compressive strength, with reductions of up to 39% compared to control mixes. On the other hand, polypropylene fibers resulted in a general decrease in all mechanical properties, particularly compressive strength, which dropped by up to 46%. The most favorable mix in terms of compressive strength was observed in concrete with both size II and III aggregates replaced by 80% marble waste and reinforced with 75 kg/m³ steel fibers. The findings suggest that while steel fibers enhance flexural and split tensile strength, polypropylene fibers contribute to a significant reduction in mechanical performance. The optimal dosage and combination of fibers depend on the desired properties of the final concrete mix. The use of marble waste and fibers in concrete production represents a viable approach toward sustainable construction while maintaining acceptable mechanical properties.

Keywords: fiber-reinforced concrete, marble waste aggregate, mechanical properties, sustainable construction, steel fibers

SUSTAINABLE USE OF SOILS IN AGRICULTURE

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Abstract:

Ensuring the sustainable use of soil is essential for the health of agricultural ecosystems and global food security. Soil degradation, primarily driven by unsustainable agricultural practices, leads to decreased fertility and reduced water retention, negatively impacting agricultural productivity. Recent research highlights the importance of sustainable practices such as conservation agriculture, crop rotation, cover cropping, integrated nutrient management, irrigation, and reducing pesticide use while creating habitats for beneficial microorganisms as effective strategies for improving soil quality and productivity. This paper places the research within the broader context of addressing these issues amidst global challenges like climate change and population growth.

The purpose of this research is to explore methodologies and findings related to sustainable soil practices in agriculture, focusing on their technical application and impact on soil quality. Key methodologies include periodic soil analysis for precise nutrient application, the integration of organic fertilizers, and the use of efficient irrigation systems like drip irrigation, which promote optimal water use. These techniques are essential in various agricultural contexts to combat climate change impacts, increase crop resilience, and ensure sustainable production with a reduced ecological footprint.

The research methodology involves a comprehensive review of literature, analyzing scientific articles, reports, and guidelines from international organizations such as the FAO. The analysis highlights the adaptation of management practices to specific agricultural contexts, such as soil type and climate, detailing the technical conditions necessary for their successful implementation. For example, sandy soils require biodegradable mulch and frequent organic fertilization, while clay soils benefit from cover crops and periodic aeration.

Results indicate that practices like crop rotation and integrated nutrient management significantly enhance soil fertility and reduce dependency on chemical inputs, fostering biodiversity and ecological balance. Efficient irrigation systems, such as drip irrigation, have been shown to improve water use efficiency and soil health, crucial for regions facing drought.

In conclusion, sustainable soil management practices are necessary for improving soil health and ensuring agricultural profitability. This holistic approach is necessary for achieving long-term agricultural sustainability and addressing global challenges in food security and environmental conservation.

Keywords: soil degradation, conservation agriculture, crop rotation, water retention, environmental impact

THE POTENTIAL OF LOW-COST SENSOR USE IN STUDY OF OPTIMIZED NATURAL VENTILATION IN BUILDINGS

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Abstract:

The use of accessible sensors, such as the Bosch BME680/280, ENS160, AHT21, has the potential to provide easy to use indoor environmental monitoring, particularly in naturally ventilated buildings. These sensors integrate multiple functionalities, including air quality, pressure, humidity and temperature sensing, into a compact and energy-efficient design. Their affordability and versatility make them an ideal choice for widespread deployment in common spaces. Naturally ventilated buildings rely on passive airflow mechanisms to regulate indoor air quality and thermal comfort. Monitoring environmental parameters in such scenario is crucial for optimizing ventilation strategies and ensuring occupant well-being. The BME, ENS and AHT sensors, provide the ability to detect volatile organic compounds (VOCs) and other air quality indicators such as eCO2 providing real-time insights into indoor environmental conditions. This are high accuracy and low power consumption devices that can further enhance suitability for continuous monitoring applications. This study explores the application of the BME680 sensor in an office building, focusing on its performance, data reliability and integration with a database. By deploying these sensors in various indoor environments, the research highlights their potential to identify patterns in air quality fluctuations and correlate them with external factors such as weather conditions and occupant behaviour. The findings underscore the importance of low-cost sensing technologies in promoting sustainable building practices and improving indoor comfort. The aim is to demonstrate that the BME680 sensor is a cost-effective solution for comprehensive indoor environmental monitoring. Its deployment in naturally ventilated buildings not only supports energy-efficient ventilation strategies but also contributes to healthier indoor environments. The integration of the BME680 sensor with an ESP32 microcontroller, MQTT server, Node-RED, and InfluxDB enables efficient and scalable indoor environmental monitoring. The ESP32 collects sensor data and transmits it to the MQTT server using its robust Wi-Fi connectivity. Node-RED processes and visualizes the data, offering a user-friendly interface for real-time monitoring and analysis. Meanwhile, InfluxDB serves as a time-series database, storing data for long-term trends and insights. This ecosystem ensures seamless communication and comprehensive management of environmental parameters, enhancing the capabilities of naturally ventilated buildings to optimize air quality, occupant comfort and energy efficiency.

Keywords: natural ventilation, sensors monitoring, data logging, energy efficiency

THE EVOLUTION, PERFORMANCE AND APPLICATION OF HEMP-LIME CONCRETE FOR SUSTAINABLE CONSTRUCTIONS

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Abstract:

The construction sector is among the largest contributors to global environmental impact, accounting for approximately 36% of greenhouse gas (GHG) emissions and 40% of final energy consumption. As global climate objectives push the industry toward more sustainable and energy-efficient practices, the demand for renewable, low-carbon construction materials has grown significantly. Hemp-lime concrete, or hempcrete, has emerged as a viable alternative due to its carbon-negative profile, low embodied energy, and effective moisture and temperature control.

Hempcrete is a bio-based, non-load-bearing composite made from the inner woody core of the hemp plant (shiv or hurd) mixed with a lime-based binder. Historically used as early as the 6th century, hempcrete is now recognized for both its performance and environmental benefits, including its capacity to sequester up to 300 kg of CO_2 per cubic meter over its life cycle.

This state-of-the-art review synthesizes current research on hempcrete's historical evolution, material properties, production techniques, and potential in sustainable building applications. The methodology is based on a comprehensive literature review of experimental studies and technical data, focusing on mechanical and hygrothermal properties across various construction methods including casting, spraying, and prefabrication.

The reviewed data indicate that hempcrete can reach compressive strengths up to 5.75 MPa under optimized formulations, densities can rise to 920 kg/m³ in compacted systems, while thermal conductivity values as low as 0.05 W/m·K have been recorded. These characteristics depend on factors such as the binder-to-shiv ratio, particle size, compaction method, and moisture content.

The discussion explores the optimization of binder compositions - especially pozzolanic and hydraulic types such as metakaolin and ground granulated blast-furnace slag (GGBS) - to improve mechanical strength without compromising thermal efficiency. Despite its limited load-bearing capacity, hempcrete's sustainability, breathability, and long-term energy-saving potential position it as an ideal solution for non-structural applications in green building.

In conclusion, hempcrete represents a viable and scalable alternative for sustainable construction, aligning with the sector's shift toward low-carbon, high-performance materials that meet both ecological and functional demands.

Keywords: sustainable buildings, thermal performance, compressive strength, binders

WATER LOSSES IN SUPPLY NETWORKS: ANALYSIS OF EVALUATION METHODS AND OPTIMIZATION STRATEGIES

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Abstract:

Water scarcity is a critical problem affecting many countries, including Romania. Urban water-supply systems are of paramount importance for socioeconomic development. Given the scarcity of resources and the need to accommodate urban growth, the issue of water loss has garnered significant attention from researchers and policymakers. Recent studies have indicated that the global water scarcity in 2022 was 1.2 billion cubic metres, and by 2025 it is expected to increase to between 1.7 and 2.4 billion cubic metres.

The present study constitutes a systematic review of water loss assessment tools and methods in water supply systems applied to assess, monitor, and control water loss. The development of tools and methods to reduce these losses and enhance the efficiency of water distribution systems has been a continuous endeavor over the years. The objective of this study is to identify the methods that have been applied, gaps, and future research needs. Three main methods are used globally: night flow analysis, water balance, and Burst and Background Estimates (BABE). Night flow analysis provides real measurements, whose accuracy can be evaluated, and the limitations of this method are given by the average pressure, which is not always accurate, and night consumption estimates. The BABE method is considered as an additional tool through which the volume of real losses is broken down into its subcomponents.

The water balance is not contingent on water pressure, and its apparent loss assumptions are not universally applicable to all utilities. However, the application of these methods in global water distribution systems is limited. The present study demonstrated that current assessment methods, including water balance, night flow analysis, and the BABE method, are valuable tools. However, their practical application remains limited owing to outdated infrastructure, lack of accurate data, and unauthorized consumption.

Consequently, the primary optimization strategies that have emerged from this study are focused on investments in infrastructure, pressure management, and the implementation of advanced technologies for early fault detection. Additionally, the harmonization of policies at the European level is identified as a crucial aspect for enhancing the effectiveness of water distribution systems.

Keywords: water losses, distribution networks, optimization, methods, sustainability

BÂRNOVA TERRITORIAL ADMINISTRATIVE UNIT, IASI COUNTY - EVALUATION OF THE DYNAMICS OF BUILT-UP LAND

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Abstract:

The development of urban or rural settlements, the continuous updating of the technical and material base of all branches of the national economy, materialized by the re-technologizing of existing ones and the creation of new branches, involves the execution of complex works in the fields of geomatics. Urban or rural landscaping, general and particular architecture of localities are supported by topography, cadastre and territorial organization activities. Due to the phenomenon of expansion of large urban centers, the neighboring areas also experience a development materialized through a complex process of increasing well-being, through actions aimed at environmental protection, social development, economy, territorial planning, education and training, science and research, all of which have as a starting point the potential of that territory. Urbanization (the current phenomenon with the most profound implications for the scale and consumption patterns), with the always unresolved problem of living space and the aspects generated by pollution are the most direct consequences of demographic and economic growth. Among the basic natural resources is also included territory, understood both as space and as the surface available for the location of human settlements. The limitation of areas suitable for the construction of cities leads to the idea that the protection and management of the territory must constitute one of the major concerns on the path to sustainable development. This being the current context in which the issue of the expansion of human settlements can be analyzed, I proposed in this article to highlight the territorial changes that took place following the acceleration of the construction process in the rural area bordering the city of Iași, studying the dynamics between urban and nonurban areas, the evolution of the number of buildings, the impact of the reduction of agricultural area and the evolution of the land fund in the locality of Bârnova. For this purpose, we used graphic and alphanumeric information from the Database of the Iași Cadastre and Real Estate Advertising Office, the Bârnova General Urban Plan, Google Earth images and statistical data from the Iași National Institute of Statistics. Following the processing of graphic and numerical data using the AutoCAD Map program, maps were produced that highlight the territorial transformation of the Bârnova locality, Iași county. I hope that this result will help in the application of appropriate management by local and municipal authorities in terms of taking measures and finding solutions to solve new urban challenges.

Keywords: evolution of the number of the constructions, graphic information, dynamics, urban planning, territorial changes

SECTION 5.
Mechanical engineering;
Industrial engineering;
Materials engineering;
Engineering and management

OBTAINING AND ANALYSIS OF HIGH YTTRIA – YSZ COATINGS ON METALLIC SUBSTRATE

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Abstract:

Ceramic thermal barriers are designed to protect underlying materials from extreme heat by providing insulation and reducing thermal conductivity, thereby enhancing the durability and efficiency of high-temperature components. YSZ coatings are widely used as thermal barrier coatings in gas turbines and aerospace engines due to their excellent thermal insulation, high-temperature stability, and resistance to thermal shock and oxidation. Enhancing Yttria-Stabilized Zirconia (YSZ) thermal barrier coatings (TBCs) involves several strategies to improve their performance in high-temperature applications: microstructural optimization: implementing segmented microstructures in YSZ coatings has been shown to enhance thermal cycling behavior and erosion resistance compared to conventional coatings; material modifications: alumina incorporation: adding alumina to YSZ can improve oxidation and corrosion resistance, as well as hardness and bond strength, without significantly altering the elastic modulus or toughness; rare-earth zirconates: materials like $La_2Zr_2O_7$ (LZ) offer potential as alternative TBC materials due to their phase stability at high temperatures and low thermal conductivity, although they may have lower fracture toughness compared to YSZ or other solutions like: advanced deposition techniques, multilayer coating systems, or thermal conductivity reduction through porosity control.Using Metco powders of YSZ (Yttria-stabilized zirconia) with a higher percentage of Yttria (38wt% Y2O3) than those presented in the literature (7-8%), ceramic layers were obtained by thermal jet spraying. Ceramic layers were made on metallic substrates with and without an adhesion layer of Ni and Al oxide powders (Ni-20% Al—410NS). The coatings have the role of forming a thermal barrier for metallic materials operating in high and very high temperature environments. The structure of the obtained layer on the surface and in section was investigated using scanning electron microscopy. The chemical composition of the deposited layer (several passes were made during the deposition process leading to the formation of a ceramic layer of 120-150 micrometers) on the surface was determined by energy dispersive spectroscopy (EDS). The same technique was used to characterize the chemical composition in section identifying the metallic substrate, the adhesion layer area (Ni and Al oxides) and that of the ceramic layer. By implementing these improvements, YSZ-based TBCs can achieve enhanced thermal stability, increased resistance to sintering, and better overall performance in high-temperature environments.

Keywords: ceramic thermal barriers, YSZ coatings, EDS, thermal barrier coatings

EFFECTS OF CUTTING PARAMETERS ON THE FLANK WEAR OF CUTTING TOOLS WITH A CUTTING EDGE

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Abstract:

Metal machining represents an important place in mechanical engineering. The purpose of this processing is to obtain the desired shape, dimensions and surface quality of the product. Turning is one of the most widespread cutting operations in the production of new components. This operation is performed with single-edged cutting tools called turning tools. During a machining operation using a single-point cutting tool, the main edge of the cutting tool performs most of the cutting, being susceptible to the following types of wear: corner wear, flank wear, and notch wear. Flank wear is one of the greatest interest because it is the most widely used criterion in determining cutting tool durability. The objective of the work is to monitor and evaluate flank wear by performing measurements based on off-line methods using different parameters for the turning cutting regime. The experimental strategy consists of performing orthogonal turning on the surface of a semi-finished product made of steel, 40Cr10, a material selected for its industrial significance in manufacturing drive wheels, shafts, piston rods, brake discs, and intake valves. using different parameters for the cutting regime. The choice of material was due to its industrial relevance, being intended for the production of drive wheels, shafts, piston rods, brake discs, intake valves. After each experiment, flank wear is determined, according to the ISO 3685:1993 standard, for each lathe tool. The thermal regime in the cutting zone was monitored using a thermal imaging camera to assess the relationship between temperature distribution and tool wear. The generated chips were collected, analysed, and documented to provide further insights into the cutting process. The findings reveal that flank wear is predominantly influenced by thermo-mechanical interactions at the tool-workpiece interface. Higher temperatures accelerate diffusion and adhesion wear mechanisms, while mechanical forces contribute to abrasive wear along the tool flank. These insights contribute to improving industrial machining processes, reducing tool replacement costs, and ensuring higher precision in component manufacturing.

Keywords: tool, wear, flank, temperature, chip

MOBILE ROBOTS FOR LIFTING AND TRANSPORTING OBJECTS OF ANY SHAPE – A REVIEW

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Abstract:

In recent years, the integration of robotic systems in industrial, logistics, and service environments has progressed rapidly, driven by the increasing demand for automation, precision, and operational efficiency. Robotic technologies have significantly improved productivity in tasks involving object manipulation, transportation, and repetitive operations. However, traditional industrial robots, although efficient, are generally confined to static environments and face major limitations when dealing with irregularly shaped items or dynamically changing conditions. These constraints have led to the emergence of collaborative mobile robots as a promising and interdisciplinary research direction. This paper proposes a review on the development of multi-agent robotic systems composed of mobile robots designed to collaborate in the co-manipulation and transportation of objects with various shapes, sizes, and weights. These robots can operate independently or connect to form structures known as p-bots, allowing them to dynamically adapt to different object geometries and task requirements. The system is intended to be highly flexible, scalable, and suitable for real-world applications in logistics, manufacturing, rehabilitation, and rescue operations in unstructured or hazardous environments. The research methodology focuses on the modular design of mechanical and electronic components, the development of adaptive gripping mechanisms, and the creation of a hybrid control architecture that combines centralized coordination with distributed systems. Each robot is equipped with sensors and algorithms for real-time decision-making and collective behavior. Preliminary simulation environments are being used to assess the system's performance, including stability, motion planning, obstacle avoidance, and robot-to-robot communication. This study addresses a significant gap in the current literature regarding collaborative mobile robots capable of transporting irregular loads. It lays the groundwork for next-generation robotic systems that interact seamlessly with both humans and their environment, providing substantial benefits to industries that require automation, precision, and safety.

Keywords: mobile robots, cooperative manipulation, object transportation, multi-robot system

OPTIMIZATION OF PARAMETRIZED HEAT FINS DESIGN BASED ON THERMAL SIMULATION

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Abstract:

Heat fins are widely used today to improve thermal solutions in Electronic Control Units as being the most common and cost-effective way to enable heat transfer and protect electronics side of the unit. Heat fins have always some limitations to be considered, the most important ones being component material, design manufacturability, fins position on the component and available area size. Some research is done to reveal existing solutions and their usability as the most important conditions in choosing any of the solutions is manufacturability time and cost. Existing literature presents a lot of studied solutions which promise a strong effect in heat transfer, but this paper has the scope of introducing solutions designed to be easily manufactured and cost-effective. Most the solutions proposed by the literature which present high thermal improvement are mostly fitting on prototypes and not for mass production. The case study proposed in the paper consists in a parametrized heat fins design based on a Skeleton used to choose design solutions and parameters values (size, number of fins, thickness, etc). The different design solutions are introduced in a thermal simulation which has the objective of highlighting the efficiency of the heat transfer considering the most used material in such applications (aluminum). The design provides possibility of material, thickness, number and fins shape change, but the simulations contain only fixed properties considered best fitting on Electronic Control Units applications. The studied cases include straight / shaped fins, thicker / thinner fins, higher / lower fins. Fins number, thickness and shape prove to be the most effective when using a given material however the choose of material is also important. However, fins thickness and shape is important, these two factors could affect the distance between fins (automatically calculated by parameters) and direction of air flow, which are also important factors in cooling efficiency.

Keywords: heat fins; heat transfer; cooling; electronic control unit; thermal

WORK ENVIRONMENT: A FACTOR THAT INFLUENCES EMPLOYEE PERFORMANCE

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Abstract:

The work environment consists of all the factors that surround employees and the space in which they perform their tasks. It includes both external and internal elements that can impact morale and, consequently, influence productivity. A productive workplace must provide an environment in which employees can perform their work in a way that achieves the expected results. Conversely, a poor and inadequate work environment can significantly contribute to work-related stress, ultimately leading to the underutilization of employees' valuable skills and talents, and the results obtained will not be what the employer expects. There is a significant relationship between employee productivity and the physical work environment. As the work landscape evolves, employees' preferences for their workspaces are also changing. It is important to recognize that no single work environment can satisfy everyone; what works well for one employee may not be suitable for another. Additionally, a workspace that is ideal for one task on a particular day may not be effective for a different task on the same day or even on a different day. Today's workers seek more than just a well-paying job; they desire a meaningful workplace with a positive culture that promotes a balance between their professional and personal lives. They also value opportunities for personal and professional growth, along with a sense of appreciation and respect. A healthy work environment is essential in any organization, as it brings advantages that directly and indirectly benefit both the company and its employees. Work environments are more than just a place where people work; they shape company culture, promote employee well-being, and lead to better organizational outcomes. This paper aims to provide a thorough examination of the various work environments present in different organizations. By utilizing an exploratory research approach, the study seeks to identify the work environments that employees prefer and those that companies adopt, which have resulted in enhanced human resource performance and positively impacted organizational outcomes.

Keywords: work environment, working conditions, productive work, job satisfaction, professional life

SOME EXPERIMENTAL APPROACHES TO THE EVOLUTION OF RADIAL RUNOUT MEASURED ON A CYLINDRICAL WORKPIECE PLACED IN A LATHE JAW CHUCK

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Abstract:

This paper presents several methods for the computerized experimental study of radial runout measured on a theoretically cylindrical workpiece clamped in a lathe jaw chuck rotating at constant speed prior to any machining. An experimental technique is used to obtain a signal describing the radial runout (as a runout signal). In this technique, a non-contact optical sensor is used to measure the radial runout. This non-contact technique allows accurate data to be collected as a numerically sampled signal without affecting the mechanical behavior of the part being tested. The runout signal is then processed using appropriate methods that have been experimentally tested. A synthetic model of the radial runout is mathematically constructed by signal processing of the runout signal. This model is found by averaging of some periodically selected sample of the runout signal and provides data about the part shape, the chuck clamping mode, and the accuracy of the rotary motion. The proposed model provides a detailed description of the radial deviations and highlights the main sources of mechanical errors present in the rotary kinematics and in the clamping system. The analysis of this model includes both analytical methods and the use of the Fast Fourier Transform (FFT). Finally, a detailed analytical description of the model (as a sum of harmonically correlated sinusoidal components) is obtained. This analytical description reveals important features such as the dominant sinusoidal component associated with clamping errors, geometric imperfections of the workpiece, or deviations from ideal rotation. The experimental results validate the proposed model and show that the information extracted from the signal can be used for fast and accurate assessment of the initial workpiece condition and clamping mode quality before the machining process starts. Therefore, this work contributes significantly to the development of efficient automatic radial runout control techniques. Increasing the accuracy of machining operations, optimizing clamping processes, and improving the quality of industrial products are all direct results of applying these research results. These techniques and methods reduce inspection time, increase the reliability of modern processes, and reduce losses due to defects or incorrect assembly.

Keywords: radial runout; lathe; cylindrical workpiece; runout signal, numerical processing; runout model

SMART SAFETY SOLUTIONS FOR PASSENGER TRANSPORT: WEARABLE HEALTH MONITORING AND VEHICLE AUTOMATION

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Abstract:

Passenger transport is a vital part of modern infrastructure, facilitating economic and social activities worldwide. However, drivers face significant occupational risks, including fatigue, stress, exposure to pollutants, and the potential for medical emergencies such as heart attacks while operating vehicles. Recent advancements in automotive engineering and wearable health technology present promising solutions to mitigate these risks. Real-time health monitoring systems, such as Apple watch and other wearable devices, can detect early signs of cardiac distress, while modern vehicle automation technologies enable intelligent response mechanisms to prevent accidents.This paper explores the occupational hazards faced by passenger transport drivers, the role of health monitoring devices, and the integration of advanced automotive safety systems, such as autonomous emergency braking (AEB), adaptive cruise control (ACC), and lane-keeping assist (LKA), in mitigating health-related accidents. Furthermore, we propose a novel automated emergency response system that connects wearable health devices with a vehicle's onboard diagnostics and control systems. In the event of a detected medical emergency, this system can automatically decelerate and safely bring the vehicle to a stop while alerting emergency responders. By leveraging the synergy between biomedical technology and intelligent automotive systems, this approach enhances road safety and minimizes fatal incidents caused by medical emergencies in passenger transport. Future research should focus on refining real-time health data integration with autonomous vehicle safety protocols, ensuring a seamless and effective intervention process.

Keywords: passenger transport, driver safety, health monitoring, wearable technology, emergency response systems (ERS), automotive engineering

BEYOND THE HUMAN RESOURCE MANAGEMENT RISK

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Abstract:

Risk management in Human Resource describes the process of determining and evaluating risk based on human characteristics, then creating strategies for strategic human resource management. The relevance of risk management in human resources has increased significantly in the modern period; according to some experts, it is a necessary skill and function for every HR professional. Even at this stage of technological development, when artificial intelligence is practically embedded in business culture, human aspects are still essential to the majority of tasks and activities carried out by businesses or organizations. The purpose of this research is to explore the framework for risk management of human resources in the public sector (customs) and the various variables that influence it. By reviewing the literature, collecting information, and applying descriptive statistics, we managed to define the study using the system approach, analysis, and synthesis as methods of research. As the framework's primary results, we described the primary challenges for the public sector in terms of continuous, professionally focused training program, or the potential for growth in the form of advancement to professional levels in the customs field: the lack of a special curriculum in colleges and universities for the administration - customs field, also we have compared with the state's other national security agencies in the European Union; the incompatibility of previous experience with the demands of the customs officer's current job description. We agree that the point is proper to begin developing some improvements to the current human resources management system, that can handle a broad spectrum of needs in the customs activity field. For example, our opinion is that the recruitment process for staff members should be developed based on the real-world requirements of the departments. This will give the public customs sector a modern approach to managing its human resources and could even establish a new standard for competence in human resource management.

Keywords: training program, public sector, risk administration

OVERVIEW OF METHODS FOR ANALYZING MECHANICAL VIBRATIONS IN PCBS

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Abstract:

Mechanical vibrations significantly affect the performance and durability of electronic systems, particularly printed circuit boards (PCBs) used in demanding operational and environmental conditions. This paper provides an overview of existing research on the fatigue damage and remaining useful life (RUL) estimation of PCBs subjected to random and sinusoidal vibrations. The study focuses on synthesizing insights from literature previous research to understand how mechanical stress impacts solder joints and other critical PCB components over time. The objective is to evaluate the methodologies and analytical approaches used in existing studies, with a particular focus on vibration testing and finite element analysis (FEA) as key tools for assessing the dynamic behavior of PCBs under vibrational loads. The paper examines the application of random vibration tests to identify natural frequencies and participation factors, which are very important for detecting vulnerabilities in PCB design. It also discusses how stress power spectral density (PSD) analysis is used to assess the effects of random vibrations on solder joints and predict fatigue life. Studies on this topic have demonstrated a strong correlation between numerical simulations and experimental data, reinforcing the reliability of these methods for evaluating the durability and lifespan of PCB components under vibrational stress. This paper also reviews predictive models such as the Oh-Park method, Steinberg's model, the modal assurance criterion (MAC), and Kirchhoff plate theory, which have been employed to enhance the accuracy of PCB design and improve resistance to mechanical vibrations. The analysis underscores the importance of aligning PCB design with established industry standards such as ISO-16750-3 and IPC-2221A, which provide guidelines for factors like creepage and clearance distances, keep-out areas, and manufacturing tolerances. These standards, when integrated with advanced testing and predictive modeling techniques, contribute to improved mechanical durability and electrical performance of PCBs. By examining the interplay between mechanical stress analysis, predictive modeling, and design standards, our paper aims to provide a structured understanding of the current state of research and identify potential gaps that could inform future investigations into PCB reliability under vibrational stress.

Keywords: printed circuit board, mechanical vibrations, fatigue life, power spectral density, finite element analysis

ENHANCING SUBSTATION FOULING DETECTION IN DISTRICT HEATING SYSTEMS

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Abstract:

District Heating and Cooling (DHC) systems are the key infrastructure element for urban decarbonization, yet their operational efficiency is often compromised by undetected faults. The data-driven fault detection methods became an important topic for researchers lately, but the lack of labeled real-world data represents still a huge bottleneck for developing robust models. This study addresses this gap by experimenting on a synthetic dataset, made publicly by IEA DHC (Annex XIII project 3), which simulates substation fouling scenarios in a DHC network. The main goal is to propose an interpretable and robust machine learning solution for early and accurate fault detection of heat exchangers in substations. The research focuses on developing a model based on Extreme Gradient Boosting (XGBoost) algorithm to distinguish between normal and faulty operational states using sensor-derived features, such as primary/secondary side temperatures, valve positions, demand profiles, etc. The paper also explores the utility of domain-specific feature engineering, namely by creating new inputs from existing data e.g., logarithmic mean temperature difference (LMTD), heat transfer ratio, etc. Furthermore, a rigorous tuning of algorithm’s hyperparameters has been conducted and optimal parameters are provided. The model performance is benchmarked against the published results and evaluated using metrics such as Accuracy and Matthew’s Correlation Coefficient (MCC). To enhance model interpretability, SHapley Additive exPlanations (SHAP) were conducted to analyze parameter’s contributions and corelate the predictions to the thermodynamic principles. The XGBoost model developed in this paper demonstrated a high performance, achieving 95% Accuracy and 90% MCC on test data, outperforming baseline model by ~13%. SHAP analysis reveals that primary outlet temperature, control valve position and engineered feature LMTD are the most important fouling predictors. This work underscores the potential of machine learning and the utility of synthetic data for fault prediction and modeling in DHC systems. The paper may also be useful for predictive maintenance strategies, since it provides a better understanding of how operators can use data trends for proactive maintenance. Future efforts may focus on validating the model against real-world data and integrating transfer learning to adapt to heterogeneous DHC networks.

Keywords: district heating and cooling, substations, fault detection, heat exchanger, machine learning

AN OVERVIEW OF THE STATE OF THE ART OF THERMOCHEMICAL TREATMENT OF GEARS

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Abstract:

Gears are machine parts that generally transmit rotation motions from a power source to at least one executive element. During the transmission process, the gear's teeth are subjected to high contact pressures and wear while the gear's body has to overcome high torsion stresses and eventual chocks. These localized and strongly differentiated loads require highly different properties for the teeth' surface and the gear's body. The common practice is manufacturing the gear, including the teeth, from hypoeutectoid steel (typically below 0.2 % C) and subjecting it to a complex thermomechanical treatment. The gear is firstly cemented by exposing the teeth to a carbon-rich environment, such as methane. In this way, the outer layer would strongly enrich in carbon (exceeding 0.77 % C) which would generate cementite thus strongly enhancing its hardness. The cemented gear is subsequently subjected to a complex heat treatment consisting of quenching and temperating. The former would enhance strength, due to the formation of hard martensite and the latter would increase toughness and elasticity by transforming the quenching martensite into intermediate compounds such as bainite and troostite. In this way, the outer layer of the teeth would gain hardness, by cementation, thus providing enough resistance to contact pressure and wear. On the other hand, the gear's body would gain strength and toughness to support high torsion stresses and chocks. After describing this industrial technology, the paper provides an overview of the state of the art of the thermomechanical treatment of gears. The most common hypoeutectoid steel grades (both plain carbon and alloy), used for cemented gears manufacturing, are inventoried. The most frequently manufactured gears are summarized, from the point of view of teeth geometry and orientation, external diameter and width, teeth profile and direction. Finally, a summary of the most frequently used parameters for cementation, quenching and tempering is performed and some possible new research directions are outlined.

Keywords: cementation, quenching, tempering, carbides, steel

AN APPLICATION TO DUAL ALGEBRA FOR PROPOSING A NOVEL METHOD FOR QUALITY INDICATORS OF SURFACES: EVALUATING ROAD REPAIRS WITH SMARTPHONE ACCELEROMETER DATA

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Abstract:

The use of mobile technology in infrastructure assessment demands innovative methods for evaluating surface quality. This paper introduces a novel dual algebra-based approach to obtain precise quality indicators for surfaces using smartphone accelerometer data. Acceleration measurements are first integrated numerically to obtain velocity and displacement, which are then represented as dual vectors. By applying dual algebra, variations between consecutive dual vectors $\underline{x_i}$ are analyzed to yield an exact measure of surface uniformity and, consequently, repair quality. This method provides a computationally efficient method capable of determining higher-order variations in the road surface profile. Moreover, the proposed method is highly cost-effective, making it particularly advantageous for local authorities responsible for verifying that public roads remain in proper condition following utility-related interventions. Its minimal implementation costs and reliance on standard smartphone sensors enable rapid and transparent results. Utilizing timestamped accelerometer data (X, Y, Z) sampled regularly from smartphones, this paper introduces an innovative dual-algebra-based method to determine precise surface quality indicators. First, these accelerations are integrated numerically to obtain velocity and position. We then represent each measurement as a dual vector defined as:

$$\underline{x} = x + \varepsilon_0 \cdot x_1, \varepsilon_0 \neq 0, \varepsilon_0^2 = 0$$

where $x, x_1 \in \mathbb{R}$, x is the real part, derived from the integrated displacement, and x_1 is the dual part, obtained by normalizing the acceleration vector as a proxy for local surface inclination. In this setup, $\varepsilon_0 \cdot x_1$ captures the orientation variability of the surface while x encodes the displacement of the smartphone. The next plot illustrates the variation in road surface quality based on dual algebra analysis applied to smartphone accelerometer data. Real part curve increases steadily over time, as expected, since the phone is moving along a road and accumulates displacement. Dual part curve that fluctuates around zero and is the key indicator of surface quality. Small, smooth fluctuations indicate uniform surfaces. Large spikes or rapid changes suggest bumps, cracks, or irregularities in the road.

Keywords: dual algebra, road surface irregularity, road surface quality

CHARACTERIZATION OF LASER-TEXTURED SURFACES – A REVIEW

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Abstract:

Laser surface texturing (LST) represents an advanced and highly versatile technique for modifying the properties of biopolymer surfaces, with applications in biomedical, automotive, and industrial fields. The present study explores the effects of LST on the mechanical, tribological, thermal, and wettability properties of polymeric and biopolymer surfaces, aiming to enhance their functionality and durability. The methodology involves the use of laser ablation to create microstructures with various geometries, optimizing processing parameters such as fluence, scanning speed, and pulse duration. The research examines how different polymeric and biopolymeric materials, including PLA, PHA, PEEK, HDPE and PET, respond to laser-induced modifications. The experiments include mechanical testing (microhardness, tensile strength), tribological evaluations (friction coefficient, wear resistance), thermal analysis (DSC, TGA), and wettability assessments (contact angle measurements). Additional studies focus on the impact of texturing patterns such as linear, hexagonal, and circular structures, evaluating their specific effects on material properties. The results demonstrate that laser texturing significantly influences the mechanical behavior of biopolymers.. In tribological applications, laser-induced surface texturing reduces friction and wear by approximately 30%, making biopolymers more suitable for high-performance applications.

Thermal analysis reveals that LST can slightly alter crystallinity and thermal degradation behavior, with HDPE and PET showing minor structural modifications post-irradiation. The ability to precisely control the heat-affected zone ensures the preservation of polymer integrity while enhancing functional properties. Additionally, wettability studies indicate that LST can tailor surface properties to be superhydrophobic or superhydrophilic, depending on texture design. This control over surface energy has implications for biomedical implants, self-cleaning surfaces, and anti-bacterial coatings. LST proves to be an efficient technique for improving biopolymer surface properties, making them more suitable for applications in medical implants, automotive components, and protective coatings. By optimizing laser parameters, this method enhances durability, adhesion, and wear resistance. Future research will focus on refining the process for large-scale industrial production and assessing its long-term stability in practical applications.

Keywords: biodegradable polymer; surface texturing, wettability, degradadation, friction coefficient, wear resistance

COMPARATIVE ANALYSIS OF RCM AND FMEA IN THE CONTEXT OF ECO-MAINTENANCE SUSTAINABILITY AND CIRCULAR ECONOMY

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Abstract:

Environmental problems are growing, and industrial waste is one of the most important problems. Eco-maintenance is a method employing sustainable practices to maintain machines and reduce waste. Through saving resources and prolonging machine life, it supports both sustainability and the circular economy. The aim of this study is to compare two maintenance approaches—Reliability Centered Maintenance (RCM) and Failure Mode, Effects, and Criticality Analysis (FMECA)—within the framework of eco-maintenance, sustainability, and the circular economy. The objective is to examine how the strategies can be adapted to minimize environmental impact, increase equipment lifecycles, and facilitate the reuse of materials and, in the process, build a responsible circular industrial model. The study examines in detail how the use of FMECA, through the initial identification of likely failure modes, their effects assessment, and criticality analysis with risk metrics like the Risk Priority Number, can be used to avoid failures which were unexpected and save unplanned repair costs. Whereas FMECA is appreciated for its careful process and its ability to rank risks by thorough analysis, this added complexity of approach makes it more challenging and time-consuming to implement. RCM, by contrast, depends on comprehensive examination of the equipment operation and on creating preventive and predictive maintenance practices to reduce the utilization of resources and enhance asset life. Although the strongest aspect of RCM is its systems approach, it is typically more complex and costlier in terms of front-end costs. The proposed method includes considering the top performance measures such as operational cost, effectiveness of maintenance, and environmental impact to examine the technical sustainability of both the methods. By applying eco-maintenance principles, the study seeks to create a model for an integral maintenance strategy in favor of circular economy by minimizing wastes and preserving resources and providing a solid platform for managerial decision-making towards sustainable industrialized conduct. The research is based on literature review of professional sources, and it provides a current view of the evolution of such techniques and identifying opportunities to integrate them into one maintenance model that can cater to the industrial requirements of today.

Keywords: eco-maintenance, sustainability, circular economy, reliability centered maintenance (RCM), failure mode, effects, and criticality analysis (FMECA)

ASSESSING LEADERSHIP AND MANAGEMENT BEHAVIORS IN A TECHNICAL HIGH SCHOOL

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Abstract:

In the context of ongoing efforts to improve organizational effectiveness in educational institutions, the behavior and competencies of school managers have come under increasing scrutiny. This research contributes to the field of educational management by examining the frequency and consistency of key managerial behaviors as perceived by staff in a technical high school setting. The purpose of the study was to analyze how often school managers demonstrate behaviors that are considered essential for effective leadership and administration. The research employed a quantitative methodology based on a structured questionnaire distributed to 30 respondents, including both teaching staff and administrative employees. The instrument assessed a range of managerial behaviors such as leadership, communication, fairness, organizational skills, decision-making, orientation toward innovation, loyalty, risk-taking, and moral integrity. Respondents evaluated their direct managers using a five-point scale reflecting the frequency of observed behaviors: always, usually, sometimes, never, and don’t know. The results reveal a diverse spectrum of perceptions regarding managerial conduct. While certain behaviors—such as moral integrity, communication, and fairness—were frequently rated as consistently demonstrated, others—such as risk-taking and innovation—were perceived as less commonly exhibited. Additionally, variations in responses suggest perceptual differences between teaching and administrative staff, highlighting the importance of context and role-based expectations in management assessment. These findings indicate that while some aspects of effective management are well-represented in current practice, others may require targeted development or training. The results underscore the value of regular feedback and reflective practice in fostering managerial growth, and they provide a useful foundation for designing professional development programs tailored to the needs of educational leaders. In conclusion, the study emphasizes the necessity of ongoing evaluation of managerial behavior within educational institutions, as such assessments can serve as catalysts for improving leadership effectiveness and enhancing institutional performance.

Keywords: management behaviour, leadership, technical education

KINETIC RECOVERY OF FINGER JOINTS USING 3D PRINTING TECHNOLOGY AND INERTIAL SENSORS

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Abstract:

The accelerated evolution of advanced engineering has led to significant progress in the field of personalized medical devices, particularly through additive manufacturing technology, represented by 3D printing, which offers innovative solutions for motor rehabilitation. This work introduces an advanced kinetic recovery system for finger joints, a personalized mechanical exoskeleton crafted using 3D printing and incorporating inertial sensors for accurate motion tracking. The primary aim is to support patients with hand impairments in their intricate journey of functional restoration. The core of the proposed system is a 3D-printed exoskeleton, meticulously designed to conform to each patient's unique hand anatomy. This individualized fit enhances user comfort and ensures optimal biomechanical interaction between the device and the affected area. A crucial aspect of the exoskeleton is its capacity to measure various essential biomechanical parameters, facilitating continuous and objective monitoring of the patient's rehabilitation progress. The device is engineered to provide precise control over finger joint flexion and extension, fundamental movements for hand mobility and dexterity. The exoskeleton's modular and adaptable design presents a significant advantage, enabling precise adjustments to meet the specific needs of each patient throughout different phases of their rehabilitation. This adaptability offers a practical and accessible alternative to conventional rehabilitation equipment, which often lacks such a high degree of personalization. Regarding hardware integration, the system incorporates high-performance inertial sensors (MPU6050) connected to an ESP32 microcontroller. This setup allows for real-time capture and recording of kinetic signals from finger movements. The collected data is transmitted in real-time to a dedicated processing unit for analysis, evaluating the patient's progress within the rehabilitation plan. This continuous and objective monitoring provides valuable insights for tailoring and refining rehabilitation protocols. This approach underscores the significance of customized mechanical design in optimizing hand functional recovery. By harnessing the benefits of 3D printing, a support system precisely tailored to each patient's individual functional characteristics is created, offering an accessible, accurate, and efficient rehabilitation method. The proposed system holds the potential to substantially enhance the quality of life for patients with hand dysfunctions by providing a more personalized and effective pathway toward regaining functional independence.

Keywords: 3D printing, mechanical exoskeleton, inertial sensors, biomechanical parameters, motor rehabilitation, functional recovery

A SYSTEMATIC REVIEW OF THE PRINCIPLES OF INDUSTRY 4.0

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Abstract:

Since the early days of industrialization, the field of industrial engineering has proposed technologies that have led to a paradigm shift, later known as "Industrial Revolution". In this context, the terms "Industry 1.0", "Industry 2.0", "Industry 3.0" and "Industry 4.0" describe the segment of an economy responsible for the production of material goods, characterised by a high degree of mechanisation and automation. The term "Industrie 4.0" was introduced by the German government in 2011, signifying an approach to the fourth industrial revolution as the subsequent phase in the organisation and control of the entire value stream throughout a product's life cycle. The aim of this paper is to identify the principles that correspond to all organisations (smart factories) that have adopted the “Industry 4.0” concept or how these principles influence the interrelationships that exist between technologies and the main pillars of this concept. The study will also identify the effects of these principles in terms of the factors that prepare new smart factories and how they should operate in view of the long-term challenges of restructuring labour markets, their environmental consequences, the risks associated with cyber security and the risks associated with creating highly customized products that are considerably less costly and that truly meet the individual needs of each customer. Therefore, Industry 4.0, through its principles and pillars, represents an effort to extend the strategy of improving the technology created by Europeans and to bring it up to the standards of the Fourth Industrial Revolution. This objective is realised through the integration of machine technologies, characterised by their speed, reliability and performance, with human ingenuity and talent. Regardless the comprehensibility of the concept of Industry 4.0, it is imperative to acknowledge that the principles, pillars and technologies that correspond to this concept will define organisations in terms of new administrative, managerial and control.

Keywords: industry 4.0, principles, pillars, advanced technologies, technological transformation

REAL-TIME MONITORING AND EFFICIENCY ANALYSIS OF PHOTOVOLTAIC SYSTEMS FOR HYBRID ENERGY APPLICATIONS USING A MULTI-MICROCONTROLLER EXPERIMENTAL PLATFORM

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Abstract:

This study presents a comprehensive real-time monitoring and data acquisition platform designed to evaluate the performance of photovoltaic (PV) technologies in the context of hybrid energy systems. The system integrates three PV panel types – amorphous, polycrystalline, and monocrystalline – within a modular experimental setup built around multiple microcontrollers (ESP32, Arduino Mega R3, and Arduino Uno R3). Each panel is equipped with dedicated voltage, current, and temperature sensors, while solar irradiance is monitored using a pyranometer. To ensure accurate tracking and storage of performance data, the platform incorporates three independent software modules: one for irradiance logging, one for panel electrical and thermal monitoring, and one for dynamic control of battery charging and discharging. The software ensures synchronized acquisition, real-time data logging on SD cards, and intelligent energy management through DC relay activation and load control. The experimental data is processed using a custom-developed computational framework – PV-EEC (Photovoltaic Efficiency-Energy-Cost) – implemented in C++. This model calculates real-world PV efficiencies, estimates energy production under varying irradiance and temperature conditions, and performs an economic analysis including cost per unit energy and system payback period. The use of real-world measurements ensures high accuracy and relevance, especially for assessing the suitability of each PV technology under winter and diffuse-light conditions. The study directly supports the design and optimization of hybrid solar-CHP systems, where accurate efficiency data and dynamic performance evaluation are essential for system scaling, component selection, and off-grid viability. By linking experimental observations with computational modeling, the platform creates a practical bridge between hardware implementation and hybrid system simulation. It highlights the critical role of real-time monitoring and experimental validation in ensuring that hybrid systems are not only theoretically feasible but also operationally reliable under site-specific conditions. This methodology offers a scalable, flexible, and cost-effective solution for researchers and designers aiming to validate PV technologies in hybrid energy systems for residential applications, particularly in cold climates with variable solar availability.

Keywords: hybrid solar, PV performance monitoring, real-world efficiency, data acquisition, experimental PV analysis

THE INFLUENCE OF FDM PRINTING PARAMETERS ON PRINTING ONTO TEXTILE SUBSTRATES

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Abstract:

The integration of 3D printing in fashion and textile design has opened new pathways for material innovation and hybrid fabrication techniques. Among the various additive manufacturing technologies, Fused Deposition Modeling (FDM) remains one of the most accessible and adaptable solutions, particularly due to its compatibility with a wide range of materials and ease of parameter adjustment. Traditionally, FDM printing parameters—such as temperature, speed, layer height, and flow rate—have been optimized to ensure adhesion to the build plate or between filament layers, focusing primarily on achieving strong interlayer bonding and structural integrity.

However, when applied to textile substrates the goals shift significantly. Here, adhesion to a flexible, porous, or textured fabric becomes the priority, and mechanical rigidity may be less desirable than tactile softness or aesthetic quality. In this context, 3D printing parameters must be reconsidered and continuously adjusted based on the intended function—be it durability, comfort, flexibility, or visual effect. The strength of FDM lies in this very versatility, offering endless combinations of print settings and material interactions. While the literature extensively covers the influence of textile substrates on adhesion and print quality, fewer studies investigate how variations in FDM parameters can enhance or control the bonding process. The majority of existing research emphasizes fabric characteristics such as weave, texture, and porosity. Yet, a number of studies have explored the impact of altered print settings, such as extrusion temperature, build plate temperature, first layer infill direction, nozzle-fabric distance, flow rate, and speed, offering valuable insights into how parameter tuning can optimize adhesion without relying solely on substrate modifications. Through this paper, we aim to review the research conducted thus far where FDM printing parameters were intentionally varied to achieve improved adhesion or material behavior, with the goal of identifying potential directions for future investigation and development in the field of 3D printing applications onto textile substrates

Keywords: 3D printing, FDM, textile substrate, printing parameters, adhesion

THE CURRENT STATE OF DENTAL IMPLANT TYPES WITH DIFFERENT DESIGNS AND HIGH BIOCOMPATIBILITY

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Abstract:

The therapeutic success of dental implants is decisively influenced by the design and biocompatibility of the materials used, thus the superiority of conical implants over cylindrical ones in ensuring primary stability, essential for rapid and efficient osseointegration, especially in low-quality bone. Active-threaded implants have demonstrated clear advantages in initial stability, while passive-threaded implants remain recommended in situations of increased bone density. The platform switching concept has proven effective in reducing marginal bone loss and maintaining the integrity of peri-implant tissues, and monobloc implants, by reducing biological complications, offer procedural simplicity. However, two-piece implants remain essential for high prosthetic flexibility, especially in complex aesthetic restorations. The use of titanium and its alloys remains prevalent due to their excellent biocompatibility and mechanical strength properties. However, innovative titanium-zirconium (Ti-Zr) alloys represent an emerging alternative, promising faster and more stable osseointegration. Zirconium ceramic materials have seen a significant increase in use due to their superior esthetic appearance and low risk of peri-implant adverse reactions. The application of zirconium oxide to the surface of titanium dental implants combines the mechanical advantages of titanium with the excellent biocompatibility, aesthetic and antimicrobial properties of zirconium oxide. Coating titanium implants with zirconium oxide substantially improves the interaction with bone and gingival tissues, accelerating osseointegration and reducing the incidence of peri-implantitis.

Keywords: Zirconium oxide , titanium, biocompatibility, osseointegration.

OPEN INNOVATION IN THE AUTOMOTIVE INDUSTRY: ADVANCING AUTONOMOUS DRIVING THROUGH AI

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Abstract:

Generative Artificial Intelligence and Large Language Models have seen widespread adoption in various fields in recent years. However, as AI moves into the physical world, especially in areas like autonomous driving, it faces a very different set of challenges. Unlike applications which rely on text, self-driving systems must take decisions in dynamic, uncertain and safety-critical conditions. They must integrate data from multiple sensors, while accounting for the physical dynamics of motion, space and interaction with unpredictable environments. This paper explores how Open Innovation can help bridge that gap, focusing on the potential of World Foundation Model, which are a new category of generative AI models trained to simulate and predict physical interactions and the NVIDIA Cosmos platform, an open and modular framework that offers an extensive set of collaborative tools for training and validating models in the development of autonomous vehicles. The research follows a qualitative methodology, reviewing academic and industry literature, conducting interviews with AI experts and automotive engineers and analyzing company reports, licensing and governance documents related to open AI models. This approach allows to map both the promises and challenges of Open Innovation in this context. The results highlight a clear tension. On the one hand, companies remain cautious about sharing intelectual property and face high infrastructure costs when working with advanced AI models. On the other hand, open collaboration has the potential to significantly speed up development, lower barriers to entry for smaller players, and improve transparency and safety through shared validation practices. The lack of standardized governance frameworks also introduces regulatory uncertainty. In terms of contribution, this study extends existing Open Innovation theory by showing how it applies in cyber-physical systems like autonomous vehicles. Practically, the research outlines how stakeholders, starting from startups to established automotive firms, can leverage open platforms like NVIDIA Cosmos to build better AI for real-world use.

Keywords: open innovation, autonomous vehicles, artificial intelligence ,world foundation models, NVIDIA cosmos

IMPROVING THERMAL SHIELDS TO PROTECT THERMOELECTRIC GENERATORS (TEGS) IN AUTOMOTIVE ENERGY RECOVERY SYSTEMS

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Abstract:

Reclaiming the energy found in waste heat from various sources is crucial for boosting energy efficiency. A thermoelectric generator (TEG) is a device that transforms thermal energy into electricity using an arrangement of semiconductor components. This idea was initially demonstrated by the German physicist Thomas Seebeck in the 1920s, the way a TEG works is based on an electric current occurring in semiconductor n- and p-type elements, connected in a series, and sandwiched between two ceramic plates. When one ceramic plate is cooled and the other is heated, a thermoelectric current emerges, producing an electrical voltage. Although TEG technology can convert heat directly into electricity, the conversion effectiveness is relatively low. To cut down on pollution from waste heat and improve energy recovery, efforts are underway to refine these systems (number, size, shape, arrangement, etc.). This research is centered on processes in internal combustion engines and recovery techniques that use TEGs. The experimental setup utilized a TEC1-12706 SR, a 12V 60W Peltier TEG, with dimensions of 40 x 40 x 3.8mm, that withstands temperature differences (for cooling or heating) up to 138 degrees Celsius. Because the exhaust gases from internal combustion engines are much hotter and might damage the TEGs, the latter need to be protected by a shielding material. This material should transfer thermal energy partially from the exhaust system to the TEGs. The main goal of this research is to test various protective (yet conductive) materials to safeguard the TEG in the proposed device. The hot side is exposed to different temperatures from an open flame, while the cool side is considered at ambient temperature. During experiments, current and voltage output from the device were continuously measured, at set time intervals using two different meters that recorded all the values in real time. The temperature difference was measured using thermocouples mounted on ceramic sides of the TEG, and the readings were obtained using a thermocouple scanner. While a stainless steel plate would offer more thermal protection, the greatest conductivity and TEG energy output were achieved when a copper protective plate was used. Furthermore, it was observed that the spatial placement of the TEG on the thermally conductive interface plays a critical role in maximizing the overall energy conversion efficiency.

Keywords: thermoelectric generator; thermal management; waste energy; automotive; seebeck effect

TITANIUM ALLOYS AND THE ROLE OF ALLOYING ELEMENTS IN MATERIAL PERFORMANCE

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Abstract:

Titanium and its alloys occupy a important place in numerous industrial, biomedical and aerospace fields due to their excellent strength-to-weight ratio, biocompatibility and corrosion resistance. The properties of titanium alloys are strongly influenced by the alloying elements, which determine their phase structure, mechanical characteristics and behavior in specific environments. This paper provides a detailed review of titanium alloys, focusing on their classification, the influence of alloying elements and relevant applications. Titanium alloys are classified into three main categories: α alloys, β alloys and α+β alloys. α alloys, which contain α phase stabilizers such as Al and O, are characterized by good corrosion resistance and weldability, but are not heat treatable. α+β alloys, such as Ti-6Al-4V, combine the advantages of both phases and can be heat treated to improve mechanical properties. On the other hand, β alloys, stabilized by elements such as Mo, Nb and Ta, offer high ductility and can be processed more easily. Alloying elements have a major impact on the mechanical properties of titanium alloys. Al stabilizes the α phase and increases mechanical strength, while V improves ductility and machinability. Elements such as Mo, Nb and Ta act as stabilizers of the β phase, contributing to improved biocompatibility and corrosion resistance. Also, elements such as Zr and Sn provide solid solution strengthening and corrosion protection, while Fe, Cr and Mn contribute to the development of more economically accessible titanium alloys. The mechanical properties of titanium alloys are directly influenced by the chemical composition and the heat treatments applied. Hardness and tensile strength can be improved by adding Al and O, while beta-stabilizing elements such as Nb and Ta improve ductility and fatigue resistance. In biomedical applications, the biocompatibility of titanium alloys is a key factor. Ti-6Al-4V is widely used in orthopedic and dental implants, but recent research is focusing on vanadium-free alloys such as Ti-6Al-7Nb to eliminate the risk of cytotoxicity. In recent years, technological developments have enabled the use of titanium alloys in advanced manufacturing processes such as additive manufacturing (3D printing), opening new perspectives for the customized design of implants and complex components. Future research is focused on low-cost alloys and high-entropy alloys (HEAs), which combine several elements to achieve superior mechanical properties. In conclusion, titanium alloys are essential materials for numerous applications due to their unique combination of mechanical and chemical properties. Studying the influence of alloying elements and optimizing manufacturing processes will continue to open new directions of research and development in the field of these high-performance materials.

Keywords: titanium alloys, alloying elements, biocompatibility, corrosion resistance, additive manufacturing

PLASTIC MANUFACTURING PROCESSES FOR AUTOMOTIVE APPLICATIONS

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Abstract:

The automotive industry has used plastics almost since the beginning. Plastics are employed in a variety of automotive parts, ranging from exterior components like bumpers and body panels to interior elements such as dashboards, seating materials, and trim. Plastic materials have become integral to the automotive industry due to their lightweight, with the average car containing between 150-200 kilograms of plastics (around 15% of its total weight) durable, and cost-effective nature. They play a crucial role in enhancing fuel efficiency, safety, reduced emissions, and design flexibility, while also reducing manufacturing costs.The manufacturing of these parts involves advanced plastic processing techniques, including injection molding, blow molding, thermoforming, rotational molding, compression molding, and extrusion.Each technique offers a variety of benefits and challenges, so it's important to consider the specific application and desired outcome when selecting the right manufacturing technology. Plastics also provide design flexibility, durability, lightweight properties and allowing for complex shapes and aesthetic features that metal parts cannot easily achieve. These materials, often synthetic, are engineered to meet specific needs such as resistance to heat, chemicals, and physical stress. There is no one-size-fits-all approach to plastics parts manufacturing, but the tools and techniques available make it possible to create quality parts and products. However, there are also disadvantages to the widespread use of plastics in automotive manufacturing. One of the main concerns is their limited strength and impact resistance compared to metals, which may affect the overall safety of vehicles. Plastics can also be prone to degradation over time due to exposure to UV rays, heat, and chemicals, potentially leading to material failure. Furthermore, while plastics offer cost benefits, their manufacturing processes can be energy-intensive, and some types of plastic can be difficult to recycle, contributing to waste create a big problem for poluation with the annual accumulation of millions of tons of plastic waste in our oceans and landfills.

Keywords: plastic materials, automotive, manufacturing technologies, molding, cost-effective vehicles.

APPLICATION OF TECHNICAL CREATIVITY TECHNIQUES AND METHODS FOR OPTIMIZING THE PENDULUM-TYPE OSCILLATOR MODEL

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Abstract:

Mechanics is not exclusively a branch of mathematics but also a fundamental part of physics, as highlighted by Mach. Scientific inquiry generally follows the scheme: hypothesis – prediction – negation – rejection. The rejection of hypotheses is based on direct observational data and experimental results. When analyzing pendulum-based oscillator experiments within the Newtonian interaction paradigm, unexpected results (anomalies) have been observed. These anomalies reveal a limited viability of the pendulum-type measurement system, due to a lack of control, causality observation, and other systemic properties, pointing to a weak physical consistency of the experimental paradigm used for data collection and analysis. The aim of this research is to optimize the physical consistency of the experimental paradigm by developing a more viable pendulum-type oscillator model. The methodology involves a thorough analysis of heuristic approaches, technical creation methods, and creative processes historically applied in designing pendulum systems. The study uses sequential-selective morphological analysis to identify valuable solutions by combining existing technologies. Additionally, the Altshuller algorithm (ARIZ) is applied to systematically eliminate contradictions in the model and to synthesize optimal solutions. The main results of the research include the creation of a new mechano-electric paradigm for the construction, data collection, and analysis of measurement results, along with the development of a new complex mechano-electric pendulum oscillator system. The transition from the physical solution to a technical system was carefully managed by considering three subsystems: the pendulum (S1), the gravito-electric environment (S2), and perturbations from celestial bodies (S3). In short, the study demonstrates that by optimizing the physical consistency of the mechano-electric interaction paradigm, only expected (controlled) perturbations occur in measurements conducted with the newly designed complex pendulum system. These findings not only enhance the reliability of pendulum-based experimental setups but also contribute a robust methodological framework for future experimental mechanics research.

Keywords: pendulum experiment, anomaly, technical creativity methods, Altshuller algorithm, model optimization, system, perturbation, viable model

ATMOSPHERIC PLASMA SPRAYING OF WEAR-RESISTANT COATINGS ON CARDAN JOINT TRUNNIONS: MATERIALS AND MORPHOLOGICAL EVALUATION

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Abstract:

Cardan joints are used on large in longitudinal transmissions of transportation vehicles (cars and trains). The use of a simple cardan joint results in nonuniform speed of the end spindle, but the correct coupling of two cardan joints will provide a homokinetic transmission, offering a constant speed and a stable torque. Cardan joints are subjected to intense wear due to severe operating conditions: heavy loads, unfavorable lubrication kinematics, and abrasive contamination between sliding surfaces. If an excessively large angle occurs between the transmission shafts, it leads to a significant power loss and wear of all its mechanisms. Consequently, the trunnions of the universal joint cross also wear out. A solution to avoid de premature wear out of the trunnnions is the deposition of coatings resistant to wear. To obtain wear-resistant coatings, we used atmospheric plasma thermal spraying (APS), which today is one of the most effective methods, recommended due to the superior quality of the resulting layers and the wide range of materials that can be employed. The study presents some aspects on APS method, the deposition powders chosen for antiwear coatings of caradn joints trunnions, and a morphological analysis of the realized coatings. The selected material, suitable for forged universal joint crosses, was 40Cr10 and RUL2 according to Romanian standards. Test specimens were manufactured from these materials in the form of plates for microscopic analysis and rings for tribological studies. The surface coatings of the specimens were applied using two powders from the Metco family: Metco 32 and Metco 72. The coatings exhibit good adhesion to the substrate, with the presence of some small micropores at the substrate–coating interface.

Keywords: cardan joints; coatings; trunnions; wear; 40Cr10; RUL2; Metco 32; Metco 72

THE INFLUENCE OF EMPLOYEE-MANAGER RELATIONSHIP ON WELLBEING IN AN ORGANISATION

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Abstract:

The quality of workplace relationships significantly influences the psychosocial work environment and may serve as protective factors that promote employee wellbeing. One of the elements that influence employee job performance and productivity is the working relationship between employees and their managers. Although employee wellbeing remains a key focus in organizational research, significant gaps persist in understanding its mediating role in the relationship between human resources management practices and organizational performance. The manager-employee relationship constitutes a fundamental element of the psychosocial work environment. Building upon this foundation, the current study specifically examines how these relationships influence workplace wellbeing. In this way, drawing on theories of psychosocial work environments and leadership, the aim of this article is to examine how managerial relationships impact employee wellbeing, considering both positive and negative dynamics. In addition, the article explores the influence of the employee-employer relationship on employee wellbeing by comparing three theoretical models: the Job Demands-Resources Model (JD-R), the Self-Determination Theory (SDT) and the PERMA Model. A comparative analysis highlights key factors, such as employee autonomy, employer feedback and emotional support provided to the employee, that could be taken into account by the employer in order to improve his professional relationship with the employee. Moreover, through a Systematic Literature Review Approach, we highlight key mechanisms—such as social support, trust and communication—that mediate this relationship. The findings suggest that positive manager-employee interactions enhance job satisfaction, reduce stress and contribute to overall psychological wellbeing, while poor relationships can lead to burnout and disengagement. However, deeper insights into leaders’ implementation of human resources management are needed, as existing research tends to examine leadership and human resources management in isolation, with limited exploration of their combined influence on employee wellbeing and performance. Further research is also needed to elucidate the key determinants of positive workplace relationships and to create a model of wellbeing that considers the employee-employer relationship.

Keywords: employee-manager relationships, organizational wellbeing, leadership development, workplace psychology, communication

BARRIERS IN THE ADOPTION OF METAVERSE FOR BUSINESS MODEL INNOVATION

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Abstract:

The business model is a conceptual description of the way in which a company creates value for targeted markets, delivers it and captures revenue from customers. In a rapidly evolving business landscape, companies have only one solution for remaing competitive and thriving: to continuously innovate their business model. Digital technologies have the potential to foster such innovations. Comprising of multiple digital technologies, the metaverse is an immersive digital world, in which people and companies interact with each other as avatars. Although the metaverse has high potential for business model innovation, there are also important barriers for its adoption. The concerns regarding the privacy and the security of personal data may discourage customers from using the metaverse. The new digital products must be exclusive and retain their value in time, which might be a challenge in a digital world. The lack of standards and interoperability of metaverse might hinder collaborations between companies, or the customer's transition from one metaverse to another. Cryptocurrencies and other financial innovations might also threat established revenue streams. High initial investments, without a clear return on investment timeframe, might also discourage managers to adopt the metaverse. Upskilling employees for the new ways of working and for the new technology becomes a must. A rather traditional organizational culture might oppose the change, leading to the insuccess of the adoption of the metaverse. Ensuring the right technological infrastructure and its integration with the existing one might also result in technical adversities. The metaverse has a disruptive potential for the economical and social landscape, but its success depends highly on the adoption by companies and people. Thus, it is crucial to understand the barriers in its adoption, to proactively address and overcome them. Using a literature review, this article investigates what are the barriers in the metaverse adoption by companies, with a particular emphasis on the most impacted component of their business model.

Keywords: Metaverse, digital business model, innovation, barriers, adoption

STUDY OF CARBON CAPTURE IN INTERNAL COMBUSTION ENGINES

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Abstract:

The concentration of carbon dioxide in the atmosphere has increased significantly over the past century, largely due to human activities such as the burning of fossil fuels, deforestation and industrial processes. This increase in CO_2 levels is a major contributor to climate change, as it enhances the greenhouse effect, trapping more heat in the Earth's atmosphere. Thus, carbon capture is becoming an increasingly important solution in efforts to reduce greenhouse gas emissions. The aim of this paper is to present the current state of carbon capture and storage technologies and practices in internal combustion engines. The advantages and limitations of each technology, its impact on the environment and development prospects in the context of global greenhouse gas emission reduction goals are also highlighted. Current technologies aim to extract CO_2 from the gases emitted from the combustion of fossil fuels, either by treating the resulting gases or by modifying the combustion process itself. In parallel, the focus is also on more advanced solutions that allow the extraction of carbon dioxide directly from the atmosphere, thus contributing not only to the reduction of future emissions, but also to the elimination of part of the existing pollution. At the same time, the article also focuses on different materials used in carbon capture, which are studied for their efficiency in this process, such as zeolites, activated carbon, and silicon-based materials. Based on the information obtained, we propose to analyze in detail the current methods of carbon capture, focusing on their efficiency, associated costs and environmental effects. The analysis focuses not only on how these technologies work separately, but also on the possibility of combining them in an integrated solution. Such a mixed approach could capitalize on the strengths of each method, being adapted depending on the source of emissions, the scope of application or the available resources. In this way, more efficient and customized solutions can be outlined, necessary for the transition to a low-carbon economy.

Keywords: carbon dioxide emissions, carbon capture, internal combustion engine, carbon storage technologies, greenhouse

STUDY ON THE OPTIMIZATION OF MACHINING PROCESSES WITH COMBINED TOOLS

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Abstract:

Combined machining tools, which combine multiple functions in a single tool, represent a breakthrough in the machining industry, fundamentally changing traditional methods. The implementation of these advanced tools not only significantly reduces the time required to complete machining tasks, but also improves the efficient use of available resources while raising the caliber of surface finishes achieved in manufacturing processes. This comprehensive study shows us the myriad advantages offered by state-of-the-art materials, meticulously optimized geometric configurations and innovative cooling mechanisms, all of which play a critical role in evaluating the overall effectiveness of these advanced tools in terms of wear resistance, accuracy and technological cost implications. Empirical data convincingly demonstrates that the strategic incorporation of such tools into technological workflows can enable a remarkable reduction in manufacturing cycle times of up to 40%, as well as a significant reduction in operating costs of up to 30%. In critical sectors such as aerospace, automotive and energy, the need for these breakthrough innovations is underscored by the increasingly stringent regulatory requirements placed on manufacturers. The results of this research underscore the critical importance of the use of combined cutting tools as a means of increasing overall productivity, while encouraging the development of sustainable methodologies capable of addressing and meeting the complex demands of today's industrial practices. As the industry continues to evolve, the adoption of these advanced tools will undoubtedly play a critical role in shaping future manufacturing processes to ensure they remain competitive and efficient in a rapidly changing marketplace. Consequently, it is imperative that industry stakeholders recognize and embrace these innovations, as they represent not only a path to increased efficiency, but also a commitment to sustainable operational practices that align with the overall goals of modern industry. Ultimately, the integration of composite cutting tools will serve to redefine the manufacturing landscape and position companies to thrive in an increasingly challenging economic environment.

Keywords: accuracy; productivity; efficiency; area; cost

STRUCTURAL AND MECHANICAL BEHAVIOR OF 316L STAINLESS STEEL UNDER COMBINED TENSILE AND TORSIONAL LOADING

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Abstract:

Stainless steels, particularly 316L stainless steel, are widely used in industrial applications due to their high corrosion resistance and mechanical performance, especially in marine environments with high salinity. However, under combined mechanical stresses—tensile and torsional—these materials can exhibit complex fracture behaviors. The present study investigates the structural, chemical, and mechanical responses of 316L stainless steel subjected to combined loading conditions, aiming to better understand its behavior in elasto-plastic regimes. Cylindrical samples were first preloaded in tension within the elastic range (6%) and subsequently twisted simultaneously from both ends using a patented device, with torsional angles reaching up to 772°, at various loading rates (5, 10, and 20 mm/min). Two reference tests—pure tensile and pure torsion—were also performed to establish baseline mechanical parameters. Structural evaluations were carried out using scanning electron microscopy (2D and 3D SEM), light optical microscopy (LOM), and energy-dispersive spectroscopy (EDS). These analyses revealed fracture surfaces composed of two or three distinct zones, each with varying grain orientations and occasional extraction voids. Microstructural observations indicated the presence of Cr and Mn carbides, which contributed to microcrack initiation in otherwise chemically homogeneous regions. Microhardness measurements demonstrated significant strain-induced hardening, with notable variation from the center to the edge of the torsion zone. Grain refinement and increased boundary misorientation were observed in regions affected by torsional and compressive stresses. Additionally, a marked reduction in Young's modulus—up to four times lower than the initial value—was detected under medium and high stress rates, highlighting the material's sensitivity to complex loading conditions. The results confirm that 316L stainless steel, despite its susceptibility to localized microstructural changes, retains a high degree of mechanical adaptability, making it suitable for components operating under combined tensile and torsional loads in demanding environments.

Keywords: structural analysis of 316L, tensile and tortion forces, fractures of steel, corrosive saline environment, corrosion resistance

A REVIEW OF THE CURRENT STATUS OF WIRE DRAWING RESEARCH

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Abstract:

Wire drawing is one of the most widely used technologies for producing finished products, which are subsequently employed across all sectors of industrial manufacturing—including household appliances, automotive, food, construction, and aerospace industries. Alongside the development of new wire drawing techniques, both numerical and empirical approaches are being explored to enhance existing processes and to create new wire drawing technologies. In recent years, numerous innovative numerical algorithms, experimental techniques, and theoretical contributions have been proposed by researchers and industrial R&D centers. These methods primarily aim to improve material formability, achieve wires with higher mechanical strength, enhance surface quality, minimize residual stresses, accelerate production cycles, reduce the number of required operations, and improve the environmental sustainability of production processes. The objective of this review is to summarize recent advancements in both numerical and experimental research within the domain of conventional wire drawing methods (e.g., those using steel or carbide dies), computer-controlled drawing systems, as well as emerging severe plastic deformation (SPD) techniques. SPD is a promising approach for enhancing both the plasticity and strength of wire materials by producing ultrafine-grained microstructures. These methods involve simple shear mechanisms under high-cycle loading conditions and are currently under active development. The formation of ultrafine-grained structures contributes to significant improvements in the mechanical strength and formability of metallic materials. This review specifically focuses on developments from the last decade (2015–2025), with an emphasis on trends and breakthroughs in SPD technologies, tribological performance, sustainable processing, and the processing of hard-to-draw materials used in automotive and aerospace applications.

Keywords: wire drawing, wires, review, severe plastic deformation, mechanical properties, microstructure

THERMOELECTRIC GENERATORS IN AUTOMOTIVE APPLICATIONS: A COMPREHENSIVE REVIEW OF CONCEPTS, MATERIALS, AND INTEGRATION STRATEGIES

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Abstract:

Thermoelectric generators (TEG) represent an innovative technology with high potential for harnessing waste heat. In the context of the growing interest in energy efficiency and the reduction of pollutant emissions, thermoelectric generators (TEG) stand out as a promising solution, capable of transforming residual thermal energy-especially that from the exhaust gases of internal combustion engines-into electrical energy, which can significantly reduce fuel consumption, without moving parts, in a silent and reliable manner. The use of TEGs in automobiles is attracting increased interest from the industrial and scientific communities. The paper offers an extensive examination of current developments in the field of thermoelectric generator (TEG) application research in the automotive industry, focusing both the theoretical basis and applicable problems associated with implementation. The principle of operation of the Seebeck effect is explained, the fundamental mechanism underlying the conversion of thermal energy into electrical energy, as well as the conditions necessary to achieve optimal efficiency. Advanced materials used in the construction of TEGs are examined, with an emphasis on thermoelectric characteristics of nanostructured-based materials, which promise to improve system performance at high temperatures. Different constructive architectures and integration strategies of these systems into vehicles are also presented, either in the exhaust system area or in combination with other sources of waste heat. The paper critically analyzes the advantages of using TEGs, such as mechanical simplicity, reduced maintenance, efficient conversion of waste thermal energy into electrical energy, reduction of CO_2 emissions, and improvement of the overall efficiency of vehicles, as well as current limitations, such as relatively low conversion efficiency, difficulty in managing thermal flows, and the high cost of high-performance materials. These aspects are discussed in correlation with the integration requirements in modern vehicle systems and the prospects for medium- and long-term improvements. This analysis contributes to a better understanding of the potential of TEGs in automotive applications and outlines future directions for research and development. In addition, the development of more thermally efficient architectures and the combination of TEGs with energy storage systems could lead to more viable solutions for electric and hybrid vehicles.

Keywords: thermoelectric generator; waste energy; automotive; seebeck effect; heat recovery systems

DIGITAL USE IN THE PHARMACEUTICAL INDUSTRY TO IMPROVE ENVIRONMENTAL PERFORMANCE: A REVIEW OF RECENT LITERATURE

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Abstract:

The global situation, marked by increasing ecological pressure, is forcing the pharmaceutical industry to reevaluate its operational strategies in terms of their environmental impact. Although valuable for human health, the process of obtaining medicines is quite harmful to the environment, the pharmaceutical industry being among the most polluting industries globally or perhaps even in the top of the most polluting industries. Therefore, this paper explores how digital transformation could influence the environmental performance of the pharmaceutical industry through a systematic analysis of the academic literature published in the last decade. The study focuses on technologies such as process automation and artificial intelligence, analyzing how they support objectives such as reducing energy consumption and reducing waste while at the same time making the use of natural resources more efficient. The research methodology involves a selection and analysis of relevant academic literature, taking into account articles published in well-known databases such as Web of Science, Scopus, and ScienceDirect, based on significant keywords for the research topic addressed: environmental sustainability in the pharmaceutical industry, green pharmaceutical production, and digitalization of the pharmaceutical industry. The selected period is 2014-2024, thus aiming to analyze the most recent data but over a longer period for a broader vision of the research. The paper aims to present an integrated perspective on how digitalization can contribute to the ecological dimension of sustainability in the pharmaceutical industry and to pave the way for future applied research. Of the three dimensions of sustainability, the environmental dimension is often addressed by researchers, being perhaps the most significant in terms of assessing sustainability in pharmaceutical companies.In conclusion, it can be seen that the adoption of digitalization in the pharmaceutical industry could have important potential in supporting the ecological transition, but there are also some challenges, such as high costs and difficult management of errors that can lead to significant losses. On the other hand, the consumption of natural resources could be reduced, which would mean a great gain.

Keywords: environmental, sustainability, digitalization, pharmaceutical industry, pollution

THE FASHION INDUSTRY BETWEEN ENVIRONMENTAL IMPACT AND CIRCULAR SOLUTIONS

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Abstract:

Environmental degradation caused by the fashion industry is no longer just a topic of activism but a concern increasingly supported by scientific evidence and policy frameworks. Amid growing awareness regarding water overuse, carbon emissions, textile waste, and chemical pollution, this study examines how sustainability in the fashion sector can be improved through the use of assessment tools and alternative production strategies. Specifically, it offers a structured literature review focused on current academic findings about environmental impacts and highlights the role of Life Cycle Assessment (LCA) and upcycling as complementary strategies to mitigate this footprint. The research methodology is based on a qualitative literature review, including academic sources, policy reports and environmental studies relevant to fashion sustainability. Within this framework, the paper explores how LCA is used to assess environmental indicators such as water use, carbon emissions, and energy consumption across the entire lifecycle of garments, from raw material extraction to end-of-life disposal. In parallel, the review explores the potential of upcycling, defined as the creative reuse of textile waste, whether pre- or post-consumer, as a more sustainable alternative to traditional recycling and downcycling, without degrading material quality. The findings reveal that although LCA offers valuable insights and guidance for sustainable decision-making, its adoption in fashion remains limited due to data inconsistency and implementation challenges. At the same time, upcycling is increasingly mentioned in the literature as having a potential high-impact but under-exploited solution that can make a significant contribution to reducing greenhouse gas emissions and limiting the use of water and chemicals. The study concludes that the combined use of LCA methodologies and circular strategies such as upcycling holds strong potential for system-level change. While challenges remain, particularly in terms of scalability and industrial integration, emerging research suggests that these tools can play a central role in redefining how production, consumption, and environmental responsibility intersect within the fashion industry.

Keywords: sustainable fashion, life cycle assessment, upcycling, textile waste, circular economy, carbon emissions

ASSEMBLY STRATEGIES FOR THREADED FASTENERS

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Abstract:

Bolts are essential components designed to securely join two or more separate parts while maintaining a minimum required clamping force. At the same time, design constraints such as space limitations and material efficiency necessitate the optimization of fastening techniques to achieve both mechanical performance and cost-effectiveness. The control of friction in a screw-nut-socket assembly is of paramount importance, as friction influences the efficiency, reliability, and longevity of automotive components. Friction affects both the torque applied during tightening and the resulting clamping force, making it a key factor in ensuring the structural integrity of the assembly. The most common method of bolt tightening is torque-controlled tightening, which relies on an accurate estimation of friction coefficients to achieve the desired preload. However, variations in surface conditions, lubrication, and manufacturing tolerances can lead to deviations in the expected clamping force, potentially compromising the reliability of the connection. This paper focuses on assembly strategies recommended for threaded fasteners, examining the advantages and limitations of different tightening methods. It emphasizes the importance of accurately determining friction coefficients—both at the thread interface and under the bolt head—through experimental measurements. The study presents results on the achieved clamping force and the required tightening torque, highlighting the need for precise control of friction to ensure reliable and reproducible bolt connections. By understanding and mitigating frictional variability, engineers can improve the safety and durability of bolted joints in automotive applications, ultimately enhancing vehicle performance and longevity.

Keywords: automotive; threaded bolts; clamping force; thread friction; underhead bolt friction

TECH-DRIVEN APPROACHES TO MAXIMIZE WORK EFFICIENCY

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Abstract:

In a highly competitive industry with increasing pressure to reduce production costs, optimizing operational processes in clothing factories is a strategic necessity. This paper explores effective approaches and strategies to enhance productivity in garment factories, with the goal of improving operational performance and labor efficiency. This research focuses on improving work efficiency by stimulating the operators in real time through data collection, efficiency calculation, and visual feedback via screen displays. Data collection will occur either at preset time intervals (e.g., every 2 hours) and at the end of the workday or in real time. The research is centered on establishing a reliable method for data collection and implementing an algorithm to evaluate work efficiency and productivity. Additionally, when the data is displayed on the operator's screen, every time he or she exceeds the preset target, the bonus they could receive will also appear on the screen, further stimulating them. The data can be collected either through an app installed on the worker's phone, a counter that is pressed after each phase completion, or by scanning a barcode of the specific product. A mathematical algorithm will process the collected data either in real time or at scheduled intervals, calculating operator efficiency and displaying the output on a mobile device or a dedicated screen at the workstation. When production is lower than the target for the analyzed time interval, the output will be displayed in red, and when it exceeds the target, the output will be displayed in green. At certain thresholds that can be set, along with the display of output, the bonus that can be earned by exceeding the target will also be shown. Given the substantial pressure to boost labor efficiency and lower production costs, the clothing industry must explore new motivational strategies, including financial and non-financial incentives, to enhance workforce performance.

Keywords: clothing industry, productivity, motivation, labor efficiency, worker stimulation

NVH INVESTIGATION OF VEHICLE CHASSIS

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Abstract:

Vehicle design has evolved significantly over time in multiple aspects. Beginning with computer-aided design (CAD) and design validation using finite element analysis (FEA), and extending to the adoption of 3D printing technologies and modern manufacturing methods, fundamental changes have been introduced in the approach to design processes. Additionally, increased attention has been devoted to reducing research and development (R&D) costs in the design phase—an essential aspect, given its direct influence on the costs associated with design, manufacturing, and ultimately, the final price of the vehicle. This study presents a method for enhancing vehicle design through the integration of CAD-based topology optimization and finite element analysis (FEA) simulation. Specifically, the vehicle chassis is refined by incorporating design elements inspired by biomimicry, which are integrated to improve the vehicle's NVH (Noise, Vibration, Harshness) performance. Noise and vibration have consistently played a critical role in vehicle design; as such, automakers devote substantial attention to minimizing the transfer of road and engine-induced disturbances into the cabin. This reduction is crucial, as excessive noise and vibration can lead to an unpleasant driving experience and may accelerate driver fatigue. Moreover, if the chassis does not effectively absorb these disturbances, the resulting stress on vehicle components can be significantly increased. In this study, FEA is employed to establish a baseline chassis model, with simulations conducted to analyze its natural vibrational modal response. Once the initial performance thresholds are established, identical constraints are applied to assess the vibrational response of the modified chassis featuring the optimized structure. The results underscore the critical value of integrating CAD and FEA methodologies in vehicle design, demonstrating a substantial positive impact by reducing development time and enhancing the overall quality of the resulting prototypes.

Keywords: topology optimisation, NVH, FEA, vehicle, structure, chassis

CORPORATE SUSTAINABILITY PERFORMANCE: EVALUATION METHODOLOGICAL FRAMEWORK

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Abstract:

The issue of sustainability is a real coordinate both in the business environment and in the literature, and nowadays the level of clarification and awareness of the associated importance has increased considerably. If in the past there was a majority focus only on environmental issues, over time the social and economic dimensions have significantly balanced the synergistic couple associated with real and predictable sustainable development. The change in the approach to the concept of sustainability from that of the past to that of the present has taken place as a result of the increase in the number of human population, in the past terrestrial or aquatic ecosystems were not threatened by human actions, thus they provided enough food for the number of living beings. Sustainability as a process therefore needs to be explored in detail on all three dimensions: environmental, social and economic. Companies in all industries are integrating sustainable development as an integrative approach to current needs and requirements that will actively facilitate the possibility for future generations to develop at least at the same level as today. The transition towards a sustainable development of companies can only materialize through an effective approach to sustainability. Therefore, it is necessary to be acquainted with the methodologies, ways, methods, techniques of assessing corporate sustainability. Thus the aim of this paper aims to improve the process of assessing and analyzing corporate sustainability. The main objective associated with this research is to develop a theoretical framework that synthesizes the methodologies associated with assessing and analyzing the performance of corporate sustainability. In order to identify these methodologies for sustainability assessment, a systematic literature review will be carried out, which will identify and present the most effective tools and methods that make it possible to assess corporate sustainability. The broadest possible knowledge of the models and tools underlying the assessment and analysis of sustainability performance helps us to identify the most effective methodologies, methods and techniques with which to improve the process of assessing corporate sustainability.

Keywords: sustainability, corporate sustainability, assesing corporate sustainability, methodologies assessing sustainability

RAW MATERIALS AND STRUCTURAL INNOVATIONS IN THE DESIGN OF BALLISTIC PANELS MADE FROM TEXTILE COMPOSITE MATERIALS

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Abstract:

Ballistic plates are specialized protective devices, designed to absorb and dissipate the kinetic energy of projectiles, thereby preventing penetration and reducing the impact of ammunition (trauma). These plates are usually used in personal body armor and protective systems for special vehicles. They can be built in various material variants and configurations to improve their protective capabilities against various types of ammunition, including piercing bullets and artillery skids. Traditionally, they were made of steel, often used in monolithic and multi-layered plates due to its strength and durability, and aluminum, in monolithic-type structures. In view of technological advances in the field of polymers, but also the need to reduce mass while improving performance, modern ballistic protection predominantly uses high-performance fiber-reinforced composite structures, such as those made of aromatic polyamides - or para-aramid (known by commercial names such as Kevlar® DuPont or Twaron® Teijin Aramid) and High Tenacity Polyethylene (UHMWPE-with commercial names such as Dyneema® Avient or Spectra® Honeywell). These two types of fibers are in a process of synergy, managing to reinforce each other's weaknesses. In addition to these, high-tenacity polypropylene yarns are beginning to play an increasingly important role in the market, and ceramic fibers should not be neglected either. The general presentation of these polymers is in the form of filamentary yarns, which are not imprinted with any kind of texturing, so as not to interfere with ballistic performance. Structurally, the reinforcements used for ballistic panels can be divided into two main categories, represented by non-woven and woven materials. Those of the first category involve mechanical or chemical reinforcement of layers of continuous filaments arranged in planes with different orientations, in order to achieve isotropy, and those of the second category involve the interweaving of two or more systems of threads positioned at 90 degrees, with two-dimensional and three-dimensional weave structures, respectively. The present paper presents a synthesis of recent advances in materials science and techniques for making textile composite materials intended for ballistic plates, highlighting the critical role these elements play in improving performance.

Keywords: ballistic plates, personal protective devices, textile composite materials, high-performance fibres, 3D woven fabrics

GAPS AND OPPORTUNITIES AT THE INTERSECTION OF LEAN SIX SIGMA, EMERGING TECHNOLOGIES AND SUSTAINABILITY IN MANUFACTURING

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Abstract:

This study examines the amalgamation of Lean Six Sigma methodologies, emerging technologies, and sustainability within the manufacturing sector, emphasising the imperative of reconciling operational excellence with environmental accountability. In an era marked by swift technological progress and escalating environmental challenges, integrating process optimisation strategies with sustainable practices is essential for manufacturers, both strategically and operationally. Despite the extensive use of Lean Six Sigma for quality enhancement and process optimisation, its traditional applications have insufficiently incorporated sustainability metrics and have not leveraged modern digital technologies, such as Industry 4.0, the Internet of Things (IoT), and advanced data analytics. A systematic literature review and case study analyses have revealed numerous significant gaps. Existing frameworks significantly lack the robustness required to integrate Lean Six Sigma methodologies with sustainability and environmental performance metrics. Traditional metrics, such as defect rates and cycle times, inadequately represent the overall impact of manufacturing processes on energy consumption and waste reduction. This study encourages creating new composite key performance indicators (KPIs) that fully show how well operations perform and how they support sustainability. This research promotes the development of advanced change management strategies that effectively address both cultural and operational challenges. This study demonstrates that successfully managed integrated approaches, supported by documented and analysed case studies from diverse manufacturing settings, enhance quality and efficiency while offering significant environmental benefits. The findings suggest that a hybrid approach, integrating Lean Six Sigma, advanced digital technologies, and sustainability considerations, can foster innovations that are both economically and environmentally sustainable. This study promotes the creation of integrated models that align quality management with sustainability goals, offering practical insights for practitioners and policymakers tackling the complexities of modern manufacturing environments. This integration is suggested as an important way to achieve lasting competitive advantage while addressing the pressing global need for sustainable industrial practices.

Keywords: industry 4.0 tools, environmental practices, sustainability metrics, energy efficiency, process optimization

MECHANISMS WITH INTERNAL-EXTERNAL GEAR PAIRS HAVING SMALL DIFFERENCE IN NUMBERS OF TEETH

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Abstract:

Internal-external gear pairs with a small difference between the numbers of teeth are frequently encountered in the construction of planetary or differential reducers with high transmission ratios, as well as in the construction of compact gearboxes. They have a number of advantages, when used in such mechanisms, such as: they are very compact, ensuring high transmission ratios at small overall dimensions, both gears rotate in the same direction, etc. This has led to numerous researches in recent years. By appropriately selecting the distance between the axes of the two gears, as well as the addendum modification coefficients, it is possible to reduce the difference between the number of teeth on the internal and external gears to one, and even zero. In this way, mechanisms formed with such gear pairs can achieve high transmission ratios, with small dimensions, using simple and compact design solutions. Despite these significant advantages, internal-externl gear-pairs with a small difference between the numbers of teeth also have some drawbacks. Among these, the following can be mentioned: the occurrence of interference phenomena and a reduced contact ratio. If the value of the contact ratio falls below 1, there will be a brief loss of contact between the teeth, leading to improper gear pair operation. If this contact ratio is close to 1, assembly errors, as well as wear, can also cause a loss of teeth contact. Therefore, it is recommended that the value of the contact ratio should be at least 1,2. As for the interference, next phenomena could appear: involute interference, trochoid interference and trimming interference. Some theoretical aspects regarding internal cylindrical gears with a small difference between the numbers of teeth, a series of numerical results, as well as examples of the use of these gears in the construction of geared mechanisms, will be presented in this paper.

Keywords: internal gear, small difference, teeth numbers, cycloidal gear mechanism

REVIEW OF MAGNESIUM ALLOYS FOR BONE IMPLANTS – BIODEGRADABILITY, BIOCOMPATIBILITY, AND MECHANICAL PROPERTIES

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Abstract:

Magnesium (Mg) alloys have garnered significant attention in biomedical applications, particularly for orthopedic implants, due to their favorable properties such as biodegradability, biocompatibility, and mechanical similarity to natural bone. These alloys degrade over time in the human body, eliminating the need for secondary surgeries to remove implants, which is a major advantage in clinical applications. One of the most significant benefits of Mg alloys is their elastic modulus, which closely resembles that of human bone, reducing stress shielding effects. This characteristic prevents implant loosening and promotes bone regeneration. Additionally, Mg ions released during degradation stimulate osteogenesis and angiogenesis, further accelerating the healing process. Despite their advantages, Mg alloys face challenges, primarily due to their rapid degradation rate in physiological environments. Excessive degradation can lead to premature implant failure, loss of mechanical integrity, and accumulation of hydrogen gas, which may cause adverse reactions in surrounding tissues. Various strategies have been explored to improve the corrosion resistance of Mg alloys, including alloying with elements such as aluminum (Al), zinc (Zn), and rare earth metals, as well as surface modification techniques like polymer coatings and ceramic coatings. Surface modification plays a crucial role in enhancing the corrosion resistance and biocompatibility of Mg alloys. Techniques such as hydroxyapatite coatings, polymer coatings, and composite coatings have been employed to control the degradation rate and enhance bioactivity. Furthermore, in vitro and in vivo studies are necessary to assess the cytocompatibility, histocompatibility, and hemocompatibility of these materials to ensure their safe clinical use. In conclusion, Mg-based alloys hold great promise for orthopedic applications due to their biodegradability and biocompatibility. However, challenges related to rapid corrosion must be addressed through innovative alloying and surface modification strategies to improve their long-term performance. Ongoing research aims to optimize these materials for widespread medical applications, ensuring their safety and effectiveness in bone regeneration and implant technology.

Keywords: magnesium alloy, biodegradability, biocompatibility, surface modification, orthopedic implants

TECHNIQUES FOR RECONSTRUCTING OLD EMBROIDERIES THROUGH DIGITIZATION

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Abstract:

Textile cultural heritage objects, due to the raw material they are made of (cotton, linen, hemp, silk), show an advanced degree of aging or destruction compared to heritage objects made of wood, metal, stone, etc. Therefore, the need for preventive restoration-conservation of this type of heritage objects, but also for studying the possibilities of transposing textile decorative elements onto new supports, as well as creating replicas for archiving. Among the objects of Romanian textile cultural heritage, clothing items specific to traditional wear represent a significant share of museum collections. The conservation of both textile objects from the heritage of specialized museums, as well as their restoration techniques, is a current issue which requires the combined efforts of specialists from multidisciplinary fields. This paper contains a study on the analysis of the decorative elements and the original technique of making embroidery on a Romanian shirt "camasa cu altita" from the Moldavian area, approximately 80 years old, located in the patrimony of the "Moldova National Museum Complex Iasi", followed by proposals on the techniques of making replicas with modern technology. The analysis of the structural characteristics of the base material and yarns for embroidery, the establishment of the size of decorative unit area/decorative lines, was followed by the reconstruction of the hand-embroidery technique. Detailed information is provided on the original embroidery technique, with indications regarding the optimal path for creating the decorative lines, so that the reconstructed product is identical to the original product on both sides. The study also presents the analysis of the digitalization options for the decorated areas, proposing a method that would not only preserve the appearance of the decorative elements, but also allow their transposition with modern industrial technologies, into replicas as close as possible to the originals. Digitization, as a preservation method, represents a current practice of creating digital versions, with the aim of ensuring accessibility and long-term use of old decorative patterns. The digital transposition process with the DB-Weave and Wilcom EmbroideryStudio software resulted in replicas executed on the Barudan Triple Combination Embroidery Machine with 4 heads and 12 needles.

Keywords: magnesium alloy, biodegradability, biocompatibility, surface modification, orthopedic implants

TEXTILE MATERIALS FOR PROTECTION AGAINST VIBRATIONS

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Abstract:

Mechanical vibrations can affect the human body, whether in everyday activities or in the workplace, where the particular nature of the work requires the use of various electrical or pneumatic tools. The energy emitted in the form of vibration from these sources is absorbed by workers and can have a negative impact on their health and productivity at work and, with prolonged exposure, can even lead to permanent occupational diseases. Vibration exposure can cause clinical symptoms that endanger the worker's health, such as kinetosis, dizziness, tendon and muscle inflammation, which in some cases can lead to joint swelling, reduced mobility and gangrene of the fingers. Vibrations can enter the body via the hands (hand-arm vibration, HAV), the feet (foot-transmitted vibration, FTV) or the buttocks and back (whole-body vibration, WBV). These negative effects can be mitigated by the use of personal protective equipment (PPE) made from textile materials, as they offer a number of advantages, such as high flexibility, superior comfort, an optimal mass-to-volume ratio and environmental friendliness. Textile materials can be produced using advanced technologies such as knitting and weaving, in a variety of raw materials, structures, shapes and functional finishes depending on the specific use. To mitigate the effects of vibrations on the human body, anti-vibration materials such as rubber and polyurethane foam have been used to make car cushions, anti-vibration gloves, etc. However, these conventional anti-vibration materials are not very comfortable due to their poor air and moisture management. Knitted spacer fabrics could be an alternative for vibration isolation as they can provide better thermophysiological comfort for the human body. The research confirmed that knitted spacer fabrics can also be effective to reduce vibrations during occupational activities due to their versatility and good mechanical properties. This article provides a critical overview of the classes of textile materials used in protective equipment against mechanical vibrations, mainly knitted fabrics, focusing on the technology used, the structures produced and their specific performances, such as transmissibility, the level of natural frequencies and comfort.

Keywords: mechanical vibrations, textiles, knitted fabrics, protective equipments

LEVERAGING INFORMATION SYSTEM TO DRIVE ORGANIZATIONAL SUSTAINABILITY: CHALLENGES AND OPPORTUNITIES

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Abstract:

This article investigates the pivotal role of information systems (IS) in advancing organizational sustainability, emphasizing both the challenges and opportunities that arise in their implementation. As organizations increasingly recognize the importance of sustainable practices, the integration of IS becomes essential for driving efficiency, transparency, and accountability. This study begins by outlining the theoretical framework connecting information systems to sustainability goals, highlighting how data management, analytics, and communication technologies can facilitate sustainable decision-making. We delve into the challenges organizations face when leveraging IS for sustainability, including resistance to change, data security concerns, and the complexities of aligning technological solutions with sustainable objectives. Additionally, the article examines resource constraints, lack of expertise, and the need for organizational culture shifts that embrace sustainability as a core value. Conversely, the article also explores the myriad opportunities that arise from effectively utilizing IS to enhance sustainability efforts. By showcasing successful case studies across various industries, we illustrate how organizations can harness IS to optimize resource use, reduce waste, and improve stakeholder engagement. The role of emerging technologies, such as artificial intelligence and the Internet of Things, is highlighted as a means to provide real-time insights and foster innovation in sustainable practices. Ultimately, this article contributes to the growing body of literature on the intersection of information systems and sustainability, offering practical recommendations for organizations seeking to navigate the complexities of this dynamic landscape. By understanding and addressing the challenges while capitalizing on the opportunities presented by information systems, organizations can not only achieve their sustainability goals but also enhance their competitive advantage in a rapidly evolving market.

Keywords: information system, organizational sustainability, challenges of information system, opportunities of information system

STUDY AND ANALYSIS OF THE INTEGRATION OF ENERGY RECOVERY SYSTEMS IN HYBRID VEHICLES

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Abstract:

The recovery of thermal and kinetic energy dissipated during the operation of a vehicle is a current approach to increase energy efficiency and reduce environmental impact impact in the automotive sector. In the case of hybrid vehicles, where both the electric and thermal engines are used, the recovery of these lost energies can significantly contribute to improving autonomy and overall efficiency. This paper presents a study on the development of an energy recovery system for hybrid vehicles, by recovering the energies otherwise lost during operation. The proposed system integrates three distinct mechanisms, the recovery of thermal energy from brake discs and exhaust gases using thermoelectric generators (TEG), as well as the transformation of kinetic energy from the damping system into electrical energy through a recovery mechanism, which involves the use of the pressure generated during operation and its transformation into electrical energy, as the damper compresses and rebounds during vehicle motion, its internal pressure variations drive a linear or rotary generator mechanism. For thermal energy recovery, the system uses thermoelectric generators, which convert temperature gradients directly into electrical energy through the Seebeck effect. When installed on brake discs and exhaust pipes, these devices capture waste heat that would otherwise dissipate into the environment. The study examines optimal TEG placement, temperature values obtained, and cooling strategies to maximize energy conversion efficiency while maintaining component reliability under varying operating conditions. The generated energy will be stored in the vehicle's batteries and used to power auxiliary systems, such as lighting, the infotainment system or other equipment that uses electrical energy. The study evaluates the efficiency potential of these systems, the impact on the vehicle's autonomy with their integration into the existing vehicle system, with the aim of expanding the research area to other systems where there are energy losses in the future and also explore scaling possibilities for electric vehicles and heavy-duty transportation, where energy recovery could yield even greater benefits.

Keywords: energy recovery, hybrid vehicle, thermoelectric generator, energy efficiency, kinetic energy

ADVANCED TITANIUM ALLOYS FOR MEDICAL AND INDUSTRIAL USE

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Abstract:

The enhancement of titanium alloys' properties is vital for improving their performance in a wide range of medical applications, including medical devices, targeted drug delivery systems, and durable implants. The main focus of this paper is on titanium and its alloys, but it also looks at the development, optimization, and characterization of biomaterials particularly for medical uses. A big part of the study is about titanium and its alloys, which are popular in the biomedical field because they are very strong mechanically, very light, really resistant to corrosion, and really good at working with human tissue. Titanium alloys can be broken down into three main groups: alpha, beta, and alpha-beta. Each group has its own unique structure, which is affected by the alloying elements that are used, such as Al and V. The paper speaks about the influence of alloying elements and their role in modifying mechanical and chemical properties for medical applications. Furthermore, the study details the methods employed in the extraction, purification, and fabrication of titanium and its alloys. It goes into more detail about the different ways that biomaterials are described and evaluated, such as microstructural analysis using optical and electron microscopy. The paper also talks about how to make sure that materials will work and be reliable in the long term by testing them mechanically and checking their resistance to corrosion using both chemical and electrochemical methods. While retaining a primary focus on medical applications—such as orthopedic and dental implants—this paper also touches upon the versatility of titanium alloys in various other industries, including aerospace and automotive. Lastly, the paper discusses the future directions of biomaterials research. The paper includes discussions on innovative surface modifications aimed at enhancing osseointegration, the exciting potential of 3D engineering for customized implants, and the development of biodegradable metallic biomaterials. We anticipate that these advancements will revolutionize the field of medical implants, ultimately leading to significantly improved patient outcomes and a higher quality of life.

Keywords: titanium alloys, biomaterials, medical devices, alloy characterization, biocompatibility, mechanical testing, alloying elements

BIOMECHANICS-DRIVEN DEVELOPMENT OF PROSTHETIC FINGERS: A TWO PHALANX APPROACH

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Abstract:

This study presents a biomechanics-driven approach to the development of prosthetic fingers, focusing on a two-phalanx configuration designed to replicate the essential motion characteristics of the human finger. The foundation of the design process is a detailed biomechanical analysis of natural finger movement, which includes joint trajectories, anatomical constraints, and the coordination required for functional tasks such as grasping and manipulation. By examining these parameters, key motion features are identified and used to inform the development of mechanically efficient prosthetic alternatives. Based on this foundation, two prosthetic finger designs are proposed: both underactuated mechanisms intended to balance anatomical realism with structural simplicity. Each model utilizes mechanical couplings and passive elements to produce coordinated phalanx movement using minimal actuation. The designs aim to capture the primary motions of the human finger—particularly flexion and extension—while simplifying the mechanical structure to enhance manufacturability and integration into upper limb prostheses. To validate the designs, kinematic modeling and simulation are conducted using both Denavit-Hartenberg (D-H) parameters. These models are implemented in MATLAB to generate motion trajectories and assess fingertip path accuracy under various actuation conditions. Biomechanical constraints from the initial analysis are integrated into the kinematic models to ensure realistic motion ranges and joint coordination. Prosthetic models are evaluated against natural finger behavior by comparing their range of motion and fingertip trajectories. Results indicate that both underactuated mechanisms closely approximate the intended motion patterns, achieving satisfactory trajectory fidelity, smoothness, and repeatability. The two-phalanx structure, despite its simplicity, successfully captures the fundamental dynamics of finger movement in a mechanically efficient form. This work demonstrates the value of a biomechanics-informed design approach and shows how hybrid kinematic modeling can support the creation of anatomically relevant yet practical prosthetic fingers. The proposed models contribute to the broader field of upper limb prosthetics by offering compact, adaptable solutions grounded in the natural function of the human hand.

Keywords: prosthetic finger, biomechanical analysis, underactuated mechanism, workspace analysis, motion trajectories

PUBLIC PROCUREMENT AND SUSTAINABLE INVESTMENTS IN RIVER BASIN ADMINISTRATIONS

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Abstract:

This paper presents a detailed literature review on the integration of sustainability principles into public procurement, with a specific focus on the water resource management sector. The main objective is to analyze how legal frameworks, institutional strategies, and public procurement practices support or hinder sustainable investments in water infrastructure and services. By examining both national and European legislative frameworks, the paper aims to uncover key factors that influence the development of sustainable water management projects and their successful implementation. The review focuses on Romania's Water Law, the Public Procurement Law, and relevant European Union directives, all of which emphasize sustainability goals such as environmental protection, resource efficiency, and climate change mitigation. These legal instruments are designed to guide public authorities in selecting projects that align with sustainability objectives and contribute to long-term improvements in water quality, resource conservation, and community resilience, thereby ensuring that public investments support future generations. Public procurement is recognized as a powerful tool for promoting sustainability. The literature suggests that when procurement processes incorporate environmental, social, and economic criteria, they can lead to better outcomes in water management, reduced environmental impact, and enhanced cost-efficiency. However, the review also identifies significant challenges, such as unclear procurement procedures, a lack of professional expertise, and insufficient institutional cooperation, all of which can hinder the effective implementation of sustainable procurement practices. The paper further discusses the crucial role of local authorities and water basin administrations in applying sustainability principles. Case studies from countries such as Germany, Sweden, and the Netherlands demonstrate how effective legal frameworks, staff training, and cooperation between public institutions lead to successful implementation of sustainable procurement practices. This literature review provides valuable insights for researchers, policymakers, and public managers who seek to use public procurement as an instrument for achieving sustainability goals in water management, thereby improving overall policy implementation, efficiency, and decision-making in the field.

Keywords: sustainability, investments, water, efficiency, legislation

OPTIMIZATION OF AIR CONDITIONING AIRFLOW IN ROAD VEHICLES FOR ENHANCED ENERGY EFFICIENCY AND THERMAL COMFORT

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Abstract:

In the context of increasing thermal demands and the transition toward sustainable mobility, optimizing automotive air conditioning systems (HVAC) has become a research priority. This paper addresses the crucial balance between energy efficiency and thermal comfort in road vehicles, with a focus on airflow rate control as a core component of HVAC performance. The study begins by analyzing the current HVAC system architecture, its main components (compressor, condenser, evaporator, cabin fan, and sensors), and common inefficiencies, including delayed response, high energy consumption, and static airflow distribution. The methodology encompasses theoretical modeling based on the fundamental conservation equations (mass, momentum, and energy), as well as simulation using Computational Fluid Dynamics (CFD). Various scenarios were tested to evaluate air velocity distribution, temperature gradients, and estimated energy consumption under different airflow configurations. Adaptive control strategies, including PID, fuzzy logic, and Artificial Intelligence (AI), were explored to dynamically regulate airflow based on real-time sensor inputs such as temperature, humidity, and CO_2 concentration. A sample simulation of a compact car cabin demonstrated that optimized airflow distribution can reduce energy consumption by approximately 21%, while enhancing passenger thermal comfort. The results validate the feasibility of intelligent airflow control strategies in reducing HVAC energy demand, particularly in electric vehicles where power efficiency is critical. This research presents a model that integrates physical design improvements, such as low-resistance ducts and adaptive vents, with intelligent control algorithms, thereby creating a holistic approach to HVAC optimization. Future developments may involve real-time onboard implementation and user-personalized comfort profiling through AI learning.

Keywords: HVAC, airflow optimization, thermal comfort, CFD simulation, energy efficiency, intelligent control

DEVELOPMENT OF A PID-CONTROLLED WATER HEATING SYSTEM FOR RELIABLE SME ANALYSIS IN THERMOFORMED R-PET CUPS

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Abstract:

Most thermoplastics undergo shape memory effect (SME), when rapidly cooled in a deformed shape and reheated. Such is the case of thermoformed cups which were hot deep drawn, from recycled polyethylene terephthalate (r-PET) foils and air-blown. When heated, they tend to recover the permanent planar shape of the raw foil. Moreover, they are able to perform this shape recovery while acting against an opposing force, thus developing work. Prior attempts to quantify work-generating (WG) SME in r-PET thermoformed cups faced challenges due to the inconsistent heat distribution caused by the use of convection ovens and air guns. This uneven thermal activation caused undesired deformation of tested material which, in turn, led to unreliable displacement measurements and limited load-lifting capacity during SME activation. To address this shortcoming, an iterative experimental rig was developed being optimized for precision thermal control. The new approach replaced air with water, as a heating medium, considering that water resistive 7heating is able to provide uniform thermal exposure across cup surfaces. For this purpose, a proportional integral derivative (PID) controller was used, with a solid-state relay, achieving temperature stability within ±1°C at five test points (65–97°C). Cups were produced via hot deep drawing, ensuring anisotropic behavior through a depth-to-width ratio >1:1. The experiments aimed to measure the volumetric SME variation by tracking water displacement in the case of variable loads (140–220 ml water to simulate real-world lifting demands of 1.4–2.2 N), avoiding subjective assessments by measuring initial and final water displacement. Using the PID controller, the cups lifted 220 ml (2.2 N load) with 1 cm displacement, yielding 2.646 J/kg specific work, at recovery rates up to 0.7%/°C. The results proved that the optimized device enabled reproducible SME analysis, advancing r-PET's applicability in sustainable actuators. This study emphasized the importance of thermal control in exploiting-PET's potential for eco-friendly applications.

Keywords: work-generating shape memory effect, resistive heating, temperature control, shape memory thermoformed cups

THE EASY-IN-SHAPE-DEFINITION GAMMA-RAY SHIELDS – AN INTRODUCTION OF PARAFFIN-BASED COMPOSITES FILLED WITH HIGH DENSITY PARTICLES

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Abstract:

The ionizing radiation (gamma and X radiation) is commonly utilized in various sectors, beginning with medicine, through industry, ending with the scientific sector. Despite the many benefits of its utilization, it should be emphasized that gamma and X-rays are harmful to living organisms. Therefore, in order to minimize the dose below the maximum allowed, factors such as exposure time, distance from the source and shields should be applied. Referring to the last-mentioned, utilization of heavy metals as gamma radiation shields is a common practice, with lead being the most popular. However, it should be noted, that traditional lead-based covers are toxic, and not always convenient to use. Consequently, the scientific efforts have been directed toward the development of superior options – nano- and microcomposites. The following study describes composites characterized by susceptibility to shape alterations under the influence of heat and hand force at the average room temperature. Such a feature eliminates the need to repeat the production process in order to provide desired morphology simultaneously saving time and materials, and reducing the use of utilized devices. More importantly, it paves the way to composite's mobility outside laboratory conditions. The samples were manufactured via noncomplex process (considering the ability to carry it out regardless of staff qualifications) where the selected materials were commercially 'off-the-shelf' purchased. As a main component, a plastic paraffin was selected, while the additions were bismuth and lead (along with their oxides) particles in various mass fractions (10 and 50 wt.%). The experimental study in terms of gamma-ray attenuation was conducted with 60Co and Geiger-Müller counter as a detector, while the samples' thickness varied from 0 to 26 centimeters. According to the collected results, the amount of filler significantly enhanced the attenuating ability – the half value layers (the thickness of a material that attenuates intensity of radiation beam by 50%) were estimated approximately of 13–14 cm and ca. 9 cm for 10 wt% and 50 wt% filler concentration, accordingly.

Keywords: paraffin, bismuth, lead, gamma-ray, shielding, composite

MODERN AND SUSTAINABLE EMBELLISHMENT TECHNIQUE FOR FASHION DESIGN USING 3DP TECHNOLOGY

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Abstract:

Current research investigates textile surface embellishment techniques with application in fashion design that can be achieved in a fast, creative and sustainable way using 3D printing technology. Throughout history, embellishment proved to be much more than a decorative adornment; it is used to express cultural identity, social status and artistic innovation among others. The technique of embellishing textile surfaces has different variants of transposing patterns (using beads, sequins, embroidery, ribbons, etc.) and has adorned garments for centuries, transforming simple clothing into symbols of beauty and power through storytelling. The role of embellishment in historical costumes extends beyond aesthetic appeal, it encompasses functionality, it is rich in symbolism and is a reflection of the era's technological advancements. Additive manufacturing, also known as 3D printing, has seen accelerated expansion in industries around the world in recent years. Rapid technological progresses in this industry are also revolutionizing the global fashion industry, increasing its creative and sustainable potential. If the beautification of textiles in the traditional version started from the use of needle and thread, in the version proposed by the present research are created digital variants that can be transposed into physical format with the help of 3D printing. Thus, in order to demonstrate the ease of transposition of the model and the potential for scalability, new design models are proposed as well as some reproductions of traditional and contemporary textile embellishment models using modern 3D printing technology. Using FDM 3D printers, fashion items are proposed that incorporate ornaments on different parts of the garments or all over. Were used different design approaches, two different types of filaments (PLA – polylactic acid and TPU – thermoplastic polyurethane), a combination of 3D printed structures (different patterns of prints on different types of fabrics) and single or multiple elements in the same pattern. The research concludes that by using the right filament, the right fabric substrate, and with the right design process (taking into account the properties of the filament), 3D printing has tremendous potential in designing new patterns or recreating existing ornament patterns on the way to achieving a more sustainable fashion industry.

Keywords: 3D printing, fashion design, sustainability, embellishment

ENHANCING THE MECHANICAL PROPERTIES OF BIODEGRADABLE ZINC ALLOOYS THROUGH SEVERE PLASTIC DEFORMATION TECHNIQUES

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Abstract:

Biodegradable zinc-based alloys, particularly those with magnesium additions (Zn-Mg), have garnered increasing interest in the field of medical implants due to their superior biocompatibility and controlled degradation rates. However, limited mechanical properties, such as low strength and reduced ductility, represent a significant barrier to their practical application. In this study, we focused on enhancing the mechanical properties of a Zn-1%Mg alloy by applying severe plastic deformation (SPD) techniques, namely hydrostatic extrusion (HE) and equal channel angular pressing (ECAP). The primary aim was to investigate the impact of these techniques on the microstructure, dislocation density, and tensile properties of the alloy, with a particular emphasis on correlating microstructure with mechanical performance. The experiments demonstrated that both HE and ECAP led to a significant refinement of the microstructure, resulting in a substantial reduction in grain size and an increase in dislocation density. Microscopic analysis, utilizing transmission electron microscopy (TEM) and electron backscatter diffraction (EBSD), revealed the formation of an ultrafine structure with well-defined grain boundaries and a homogeneous distribution of dislocations. Tensile tests highlighted a significant increase in both tensile strength and ductility of the SPD-processed alloy. These improvements are attributed to the synergy between grain boundary strengthening and dislocation strengthening mechanisms, as well as the crystallographic texture induced by processing. The obtained results suggest that Zn-Mg alloys processed by HE and ECAP exhibit high potential for diverse biomedical applications, such as biodegradable stents, orthopedic implants, and bone fixation systems. Precise control of the microstructure and mechanical properties achieved through SPD allows for the tailoring of the alloy's performance to the specific requirements of various clinical applications. Furthermore, our study explores the impact of HE and ECAP processing parameters on the microstructure and mechanical properties, providing insight into the optimization of these techniques for specific biomedical applications. Our study underscores the importance of severe plastic deformation techniques in the development of advanced biodegradable materials with enhanced mechanical performance and broad applicability in the medical field.

Keywords: zinc-based alloys, severe plastic deformation (SPD), hydrostatic extrusion (HE), mechanical properties enhancement

THE WEIGHT INFLUENCE OF IN-WHEEL MOTOR ON MACPHERSON SUSPENSION HARD POINTS

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Abstract:

Actual development of electric vehicles (EV) shows some potential and innovative architectural solution. One of which is presented in this paper. Integration of In-Wheel Motor (IWM) on a MacPherson suspension presents the challenge of additional weight on the establishing the hard points (HP) of a suspension and additional the influence of behaviour of the vehicle. The HP of a suspension are the points where the elements of suspension are constrained (trough a cylindrical constrain <bushing> or a spherical constrain) or where suspension is fix to the chassis of the vehicle, established from the design phase. Actual consideration of the additional motor on a classic suspension with IWM are based on the integration of the motor in the confined space of the wheel and not on the impact on the HP of the suspension. A model of a current solution of a MacPherson suspension and a model of an IWM MacPherson suspension are developed and compared within Altair Motion View. The HP from classic suspension is chosen from a known vehicle which can be found available on the market. IWM MacPherson suspension model is developed based on the same HP from classic suspension and added the theoretical weight of the motor. HP of a MacPherson suspension shows the behaviour of the suspension of vehicle trough camber angle, caster angle, longitudinal acceleration, lateral acceleration etc. Adjustments of angles and acceleration deteriorate or improve the ride and handling of the vehicle. Furthermore, from the theoretical camber angle and king pin inclination (KPI) the tread and wear of tire are evaluated. The simulation done through Altair Motion View shows a minimum impact of the weight on the HP of a MacPherson suspension, implicitly on the ride and handling of the vehicle. By means a swap from classic suspension with an IWM will not impact or has a minimal impact on the ride and handling of the vehicle.

Keywords: in-wheel motor, hard points, altair motion view, MacPherson suspension, electric vehicle

APPLICATIONS IN OBTAINING SCAFFOLDS FROM BIOMATERIALS FOR USE IN DENTAL MEDICINE

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Abstract:

Despite some clinical applications, maxillofacial bone augmentation, following trauma or bone deficiencies, is still a challenge due to the irregular shape, complex structure, biological and physical properties. In general bone is constantly going through physiological remodeling that adjust its architecture to meet the mechanical needs. Traumas in the region of maxillofacial bone led to an inadequate functioning, unpleasant appearance and ultimately a decrease in the patient's quality of life. Current treatment that uses autografts, allografts and synthetic graft materials, in many cases are causing, secondary trauma, inflammation, and lack of biocompability. Traditioanal used scaffold fabrication methods such as solvent casting, gas foaming, phase separation and fiber bonding, lack in precision and can’t take control over cell distribution which led to an inadequate tissue repair. The technology of 3D bioprinting has overcome the shortcoming of conventional scaffolds by using the construction of three-dimensional devices with loaded cells, mimicking in vivo environments. This technology due to its high precision, the ability to create custom shapes and capacity to work with a variety of materials can overcome these challenges by creating biomaterial scaffolds. Medical 3D printing technologies can be classified into the following categories: Fused Deposition modeling (FDM), Extrusion-based 3D bioprinting, Selective Laser Sintering (SLS) and Selective laser melting (SLM), Electron Beam Manufacturing (EBM), Stereolithography (SLA) and Digital Light Processing (DLP). Each type of 3D printing technique has its advantages and limitations, and selecting the suitable 3D bioprinting technique and material is dependent on its intended application and future clinical success. Moreover, current trends show that biomaterials and tissue engineering are becoming a preferred alternative in the treatment and healing of various bone trauma. This paper presents a current state of 3D bioprinting methods together with their advantages and limitations, also the suitable materials for each category with focus on metals for the production of customized scaffolds with specific applications in maxillofacial medicine.

Keywords: maxillofacial, 3D, bioprinting, biomaterials, scaffolds

WEARABLE SENSORS IN CLOTHING FOR PEOPLE WITH NEUROLOGICAL DISABILITIES

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Abstract:

In the context of neurological autoimmune diseases, such as multiple sclerosis (MS), clothing plays an essential functional role. These conditions severely affect motor, sensory, and cognitive abilities, making routine activities like dressing increasingly difficult. Common symptoms—fatigue, sensitivity to heat, impaired coordination, and fine motor deficits—create physical barriers that impact the autonomy and comfort of affected individuals. This study aims to explore the potential of functional clothing integrated with wearable technologies as a supportive solution in managing daily challenges associated with MS.

The purpose of the research is to develop a framework for integrating biomedical sensors into garments, tailored to the physiological and functional needs of patients with neuro-immune conditions. The methodology includes identifying critical symptoms and correlating them with appropriate sensor types and optimal placement on the body. Sensors such as heart rate monitors, temperature and humidity detectors, and motion trackers were selected for their ability to capture relevant physiological signals. The proposed garments use existing wearable technology either in attached or embedded formats, depending on usability and comfort requirements.

The results indicate that strategic sensor placement—e.g., pulse sensors on the chest or wrist, motion sensors at the waist or ankles, and temperature/humidity sensors on the upper back or torso—can provide real-time, actionable health data. This data supports both the user and medical staff in early detection of symptom exacerbation, improving decision-making in daily management and therapeutic adjustments. Visual interfaces for these data are designed to be intuitive, accessible even to users without medical training.

The discussion highlights that while wearable technology is widely available, its adaptation into functional clothing for medical use is still emerging. The conclusion emphasizes that integrating wearable monitoring into clothing not only enhances patient comfort and autonomy but also contributes to personalized, predictive healthcare models—particularly valuable in chronic conditions like MS.

Keywords: wearable technology, functional clothing, biomedical sensors, personalized healthcare, monitoring

THE METHOD OF REDUCING DISTORTIONS IN THE RADAR IMAGE OF THE EARTH'S SURFACE CAUSED BY CHANGES IN THE COURSE OF THE MOVEMENT OF THE SYNTHETIC APERTURE RADAR

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Abstract:

The paper addresses the problem of distortions in synthetic aperture radar (SAR) images of the Earth's surface that arise due to non-linear motion of the radar platform. In practical scenarios, the radar's trajectory often deviates from a perfectly straight line because of navigation errors, environmental disturbances, or maneuvering requirements. Such deviations introduce one or more Doppler frequency components into the received signal. As a result, the radar image suffers from a noticeable decrease in intensity and the occurrence of multiple displaced replicas of the same object along the radar's flight path. Analytical analysis and simulation results confirm that these distortions can reduce the intensity of the radar image to as low as 45 percent of its undistorted value. Moreover, the replicas of the object appear at regular intervals, with the distance between them directly related to the Doppler frequency shift and system parameters such as range to target, radar velocity, and signal wavelength. To mitigate these adverse effects, the paper proposes a method for compensating the distortions by estimating the Doppler frequency components in the received signal. Based on this estimation, a time-dependent phase correction is computed through numerical integration. This correction is applied to the received signal before processing it with the standard aperture synthesis algorithm. The proposed method does not require prior knowledge of the exact platform trajectory and is therefore suitable for real-world applications where full trajectory information may be unavailable or imprecise. Simulation results demonstrate the effectiveness of the approach under various conditions. In cases where the Doppler frequency is estimated with an error margin of up to 20 percent, the corrected image retains approximately 85 percent of its original intensity, and the replicated artifacts are effectively suppressed. The method is computationally efficient and adaptable to existing SAR processing pipelines. Overall, the technique offers a practical and robust solution for improving the accuracy and interpretability of SAR imagery affected by non-linear radar motion, ensuring enhanced data quality for remote sensing, reconnaissance, mapping, and scientific observation tasks.

Keywords: radar image, non-linear motion, synthetic aperture, image distortions, phase shift, Doppler frequencies, distortion compensation, correction algorithm, radar

DOES THE CIRCULAR ECONOMY INFLUENCE ECONOMIC DEVELOPMENT? A DATA-DRIVEN ANALYSIS OF RESOURCE MANAGEMENT

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Abstract:

Sustainability and the principles of the circular economy contribute to strengthening sustainable economic growth. The aim is to make resources more efficient and minimize environmental impact. This study examines the relationship between circular economy indicators and Romania's economic performance, with a particular focus on Gross Domestic Product (GDP), within the context of sustainable development. The circular economy model aims to promote long-term prosperity by enhancing resource efficiency and mitigating environmental harm. Drawing on data from Romania's National Institute of Statistics (2008-2022), the research explores various sustainability metrics aligned with the United Nations' Sustainable Development Goals. The study begins with a top-down analysis of correlations between GDP and selected circular economy metrics. This phase identifies significant positive relationships between GDP and the growth of environmental technologies and renewable energy use. However, it also finds that increased economic growth is associated with higher material consumption, underscoring the challenge of balancing economic expansion with resource efficiency. In the next phase, the study delves deeper into the factors influencing these key indicators. It reveals that the import and export of raw and recyclable materials play a major role in determining the GVA share in environmental technologies. Additionally, the research shows that renewable energy is predominantly used in electricity production, while other sectors like transportation and heating are lagging behind. A regression analysis also highlights the importance of resource productivity in reducing material footprints, emphasizing efficiency as a critical factor for sustainability. The study also finds that domestic material consumption is influenced by factors such as employment in green sectors and material productivity, suggesting that a transition to a circular economy can be facilitated by targeted investments and policy interventions. In conclusion, the research underscores that achieving sustainability in Romania's economy requires a comprehensive approach, involving government action, industry cooperation, and public awareness, along with continued innovation and infrastructure investment.

Keywords: sustainability, gross domestic product (GDP), Romania, economic prosperity, sustainable economy

SOME KEY FIGURES:

- 180 papers
- 6 plenary conferences
- participants from 12 countries (authors and co-authors)
- 10 Romanian universities, 11 foreign universities
- 2 branch Romanian Academies
- 3 research and development Romanian institutes and agencies
- 3 foreign research and development institutes and agencies
- 3 companies

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