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CONTENT

Preface to the 9th edition

Dear Reader,

It is our great pleasure to present the Book of Abstracts for the 9th Annual PhD Conference on Engineering and Technology “My First Conference 2025.” The conference is jointly organised by the Faculty of Engineering, the Faculty of Civil Engineering and the Faculty of Maritime Studies of the University of Rijeka, with hosting responsibilities rotating annually among them. This year’s edition was held on 22 September 2025 at the Faculty of Civil Engineering in Rijeka.

My First Conference brings together talented PhD and graduate researchers from various engineering and technological disciplines to share their ongoing work, exchange ideas and forge new collaborations. We believe that early exposure to scientific presentation and discussion is invaluable and we hope that all participants will find the experience rewarding.

This volume contains 23 abstracts, including that of a keynote lecture and a workshop, covering topics such as theory, experimentation, modelling, innovation in materials and structures, environmental engineering and more. Each contribution reflects not only the depth of technical work but also the vigour and creativity of emerging scholars.

We wish to thank all authors for their contributions and participation in the 9th edition of My First Conference, including our Keynote Speaker, Dr Laura Grbac, and our Workshop Organiser, Duje Kalajžić. We also thank the organising institutions and the members of the Scientific and Organising Committees for their support in making this year’s event possible.

May this conference continue to grow and serve as a platform for young researchers to exchange ideas, build collaborations, and advance their research. We wish you an engaging and inspiring experience as you explore the research presented in this Book of Abstracts.

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KEYNOTE LECTURE

Materials with Microstructures Under Investigation: Numerical Modelling, Experiments, and Beyond

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Abstract

Materials with pronounced microstructures, such as foams, lattice structures, or various metamaterials, often exhibit mechanical behaviours that cannot be fully captured by the classical Cauchy's theory of elasticity. For this reason, several generalised continuum theories have been developed, among which the *micropolar (Cosserats') theory* [1] has been extensively investigated by our research group* at the Faculty of Civil Engineering in Rijeka. In addition to the standard displacement field, an independent kinematic field — *the microrotation* — is introduced in the micropolar elasticity, and now, in order to fully describe the behaviour of a linear elastic, isotropic, and centrosymmetric micropolar material, *six material parameters* must be identified. However, due to the lack of a reliable and unique methodology for their determination, the theory is still not widely used in practice. To address this challenge, a set of new finite elements has been developed, with different interpolation functions investigated for static and dynamic analyses of the micropolar continuum [2]. These elements were subsequently used as an additional simulation tool for the interpretation and identification of micropolar parameters in laboratory-tested specimens [3].

Current research is focused on nonlinear analysis, in particular on general Seth–Hill materials, with the ultimate goal of extending the framework to the micropolar continuum. The lecture will summarise the results obtained so far and outline future directions for the application of micropolar theory in analysing complex microstructured materials, which are increasingly used in engineering practice.

Keywords: generalised continuum theories, micropolar continuum, FEM, metamaterials.

Acknowledgments: The presented research has been financially supported by the CSF projects (HRZZ-IP-2018-1732, HRZZ-DOK-2018-09-8806 and HRZZ-IP-2024-05-9904) as well as (uniri-mz-25-19).

*Our research group consists of all collaborators involved in the mentioned projects.

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CONTRIBUTING LECTURES

CFD Analysis of a Double Regulated Water Turbine

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Abstract

Climate change, the continuously increasing demand for electricity, and the European Green Deal, which aims to achieve net-zero greenhouse gas emissions by 2050, are driving Europe towards an energy transition. Through this transition, Europe aspires to become the world's first climate-neutral continent by 2050 [1]. Consequently, the demand for renewable energy sources is steadily growing. To meet these goals, hydropower, alongside other renewable sources, is playing a key role in the European electricity system. In this context, the Republic of Croatia is both reconstructing existing and building new hydroelectric power plants, one of which is the MHE Otočac, currently under construction. This small, low-head, run-of-river hydroelectric power plant will be installed next to the river channel. MHE Otočac will consist of three identical axial-flow turbines, each with a capacity of 0.5 MW. These water turbines are enhanced versions of traditional Kaplan turbines, featuring double regulation through the adjustment of both guide vanes and runner speed. To evaluate the expected performance of the water turbine prior to installation, twelve steady-state Computational Fluid Dynamics (CFD) simulations were conducted for this hydroelectric power plant. Four CFD simulations were conducted by varying the volume flow rate, guide vane opening angle, and runner speed to determine optimal operating conditions with maximum efficiency. Additionally, in the remaining eight CFD simulations, the runner speed was varied to determine operating conditions that achieve maximum efficiency for constant guide vane opening angle and volume flow rate. The CFD simulations include modelling of the water turbine, as well as the water intake and discharge systems. For this purpose, Ansys Fluent was used. The obtained results indicate that turbine efficiency is lower than expected due to losses at the guide vanes, whose position and geometry should be optimized to improve efficiency and increase power output. Furthermore, Volume of Fluid (VOF) simulations should be considered to include the effects such as cavitation and the influence of air above the water surface.

Keywords: renewable energy, hydropower, hydroelectric power plant, CFD

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Numerical Simulation and Analysis of Hydrogen Combustion

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Abstract

With the rise in demand for clean energy, hydrogen is emerging as a promising alternative to fossil fuels due to its favorable properties, such as high heating value, and the possibility of being produced from renewable sources. Combustion is a fundamental and widely applied process in engineering, crucial for systems such as engines, turbines, boilers, and power plants, with hydrogen increasingly being integrated into these systems as a clean energy source [1]. To support the development of safe and efficient hydrogen-based systems, it is essential to optimize combustion processes by accurately predicting temperature fields, flame characteristics, and emissions. As hydrogen has not yet been widely used in conventional combustion systems, there is a growing need to conduct further numerical analyses. Based on the experimental and numerical work of Yang et al. [2], this study investigates the hydrogen–air combustion in a small-scale combustion chamber using *OpenFOAM* software. For this numerical simulation, the solver *chtMultiRegionFoam* was used due to its ability to simulate fluid flow with chemical reactions and heat transfer between fluid and solid regions, as well as heat conduction within the solid domain. Different geometric representations and flow conditions were analyzed to determine their influence on temperature distribution, flow velocities, and hydrogen concentration. The results indicate that the computational domain characteristics significantly impact the behavior of the combustion process, while changes in flow conditions can affect flame formation and the location of the maximum temperature achieved. Due to the reliability of the results and their consistency with the experimental data, the conducted numerical simulation of hydrogen combustion can be used in future design and optimization of combustion systems.

Keywords: *OpenFOAM*, numerical simulation, combustion, hydrogen

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Hydrogen Logistics in Maritime Transport: Challenges and Opportunities in Fuel Supply

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Abstract

The maritime sector is one of the leading contributors to environmental degradation. However, it is also a sector making visible efforts at the global level to implement adopted guidelines and measures for reducing its harmful impact in the shortest possible time. Hydrogen has been identified as a promising solution capable of driving this transition and reshaping the role of alternative fuels in the shipping industry [1, 3]. This paper focuses on the properties of hydrogen and how these influence its transport from the point of production to the point of use. Based on an extensive literature review, this paper explores the logistical aspects of hydrogen in maritime transport with a detailed overview of hydrogen's physical and chemical properties, production methods, and sustainability aspects, critically assessing how these factors affect inventory management and delivery [2, 4]. The paper also discusses methane and ammonia as key hydrogen carriers, evaluating their role in transportation planning. Understanding the production processes, material compatibility, and storage conditions is essential for developing an efficient and safe hydrogen supply chain [5]. This research contributes to the broader discussion on establishing a sustainable logistics chain for hydrogen production, storage, supply, and transport to ports.

Keywords: hydrogen, maritime transport, logistics, alternative fuels, fuel supply

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Optimization of the Household Heating System

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Abstract

As an essential component of residential infrastructure, the heating system fundamentally defines the household's overall energy efficiency and long-term operational sustainability. Household heating systems are usually designed in practice using heuristic methods or generalized assumptions, without any formal cost or component optimization. This frequently results in unbalanced systems that are not tailored to the specific needs or characteristics of individual households. Therefore, in this study, a computational tool was developed to optimize the configuration of a heating system for a specific household, aiming to minimize the total life-cycle cost, encompassing both investment and operating expenses. The optimization process focuses on four key variables: heat pump power, thermal storage tank volume, household insulation thickness, and system activation regime. Other relevant parameters – such as the floor area of the building (120 m²), geographical location (Germany), electricity price [1] for reference year (2024), system lifetime (20 years), heat pump coefficient of performance (COP = 3), and maximum allowable temperature difference in the storage tank (60 K) – are treated as fixed inputs, although they remain user-adjustable for scenario-specific analyses.

To solve the optimization problem, three metaheuristic algorithms were employed: Particle Swarm Optimization (PSO), Fireworks Algorithm (FWA), and Squirrel Search Algorithm (SSA). Each algorithm was executed ten times to mitigate stochastic variability, with the arithmetic mean of the objective function values used for performance evaluation. The objective function and constraints were formulated based on actual market prices for heating system components and historical data on electricity price trends, while annual cost curves for individual components were constructed using manufacturer-supplied data.

The results demonstrate that all three algorithms consistently converge to near-identical, economically efficient configurations, underscoring the robustness and reliability of the proposed methodological framework. Furthermore, the comparative performance of PSO, FWA, and SSA reveals negligible differences in cost savings, thereby providing users with flexibility in algorithm selection based on computational resources and time constraints. The proposed optimization approach offers a transparent, adaptable, and reproducible decision-support tool for strategic planning of residential heating systems under conditions of fluctuating energy markets. In future work, the optimization model should be expanded to include a broader range of heating system components in order to enhance the relevance and applicability of the optimization results.

Keywords: heating system optimization, PSO, FWA, SSA

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Numerical Investigation of the Thermohydraulic Performance of Chevron-Type Plate Heat Exchanger

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Abstract

The objective of the present numerical study is to investigate the thermohydraulic characteristics of a cross-corrugated plate heat exchanger with a sinusoidal chevron-type pattern, using water as the working fluid. For the purpose of this numerical investigation, an unsteady three-dimensional mathematical model was defined, consisting of governing equations for fluid flow and heat transfer, along with appropriate initial and boundary conditions. A periodic domain approach was selected for the simulation, representing the characteristic, smallest physically repeating element. Numerical simulations were performed using the finite volume method and ANSYS Fluent solver. As the flow regime in all considered cases was turbulent, the Large Eddy Simulation (LES) turbulence model was used [1]. A number of cases were analyzed on a geometry with a fixed corrugation angle of 45° relative to the plate length, for Reynolds numbers ranging from 528 to 3864. The results were presented in the form of three diagrams illustrating the dependence of the Darcy friction factor, Nusselt number and Colburn *j*-factor on the Reynolds number. These results were compared with available experimental data and established correlations from the literature [2, 3]. A good agreement between the data was observed, confirming the validity of the proposed mathematical model and numerical procedure. Additionally, temperature and velocity contours were presented for characteristic planes to further illustrate the flow and heat transfer behavior.

Keywords: plate heat exchanger, chevron-type corrugation, Large Eddy Simulation turbulence model

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Development of a Deep Learning Model for Cast Removal on Pediatric Medical X-Ray Images

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Abstract

In radiographic bone imaging, a cast appears as a homogeneous white or light gray structure that, due to its density, impedes the transmission of X-rays, diminishing the visibility of details and intricate bone structures. This research aims to suppress casts from pediatric medical X-ray representations of bones through image-to-image translation. Three deep learning approaches were evaluated: CycleGAN [1], HarmonicGAN [2], and CycleDiffusion [3], with GAN models utilizing either a ResNet [4] or a U-Net [5] generator architecture. The models were trained on a dataset consisting of 93,064 X-ray images (50% with casts and 50% without casts), categorized into 17 different anatomical regions. While all approaches performed comparably according to qualitative metrics, visual assessment of images translated using the CycleDiffusion method uncovered common instances of "hallucinations" (loss or distortion of bone anatomical features). In contrast, GAN models proved to be more effective in preserving image intricacies after cast suppression. Among the tested models, CycleGAN with a U-Net generator architecture performed best, achieving a Fréchet Inception Distance (FID) score of 27.06.

Keywords: diffusion models, GAN, radiography, cast suppression

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Microsimulation-Based Surrogate Safety Analysis of Single-Lane Urban Roundabouts

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Abstract

Modern roundabouts are designed to enhance traffic safety, but traditional evaluations are often limited by insufficient crash data [1]. This study assesses the safety performance of single-lane urban roundabouts using surrogate safety metrics within a microsimulation framework. Field data were collected from nine medium-sized roundabouts (outer radii ranging from 15 to 20 meters) in Rijeka, Croatia, capturing traffic volumes, speeds, and vehicle compositions representative of typical urban conditions.

Microsimulation models were developed in PTV VISSIM, replicating average geometric and operational conditions observed in the field [2]. Thirty distinct scenarios were simulated, varying traffic distribution ratios between major and minor directions (50:50, 60:40, 70:30) and distances to the nearest upstream signalised intersection (ranging from 40 to 120 meters). Each scenario encompassed 24 hours of traffic activity, and the resulting vehicle trajectories were analysed using FHWA's Surrogate Safety Assessment Model (SSAM).

Analysis revealed rear-end conflicts as the most frequent conflict type, aligning with previous findings [3]. Correlation analysis identified a strong negative relationship between the distance to the upstream signalised intersection and conflict frequency. Additionally, a moderate positive correlation was observed between higher major-direction volumes and total conflicts.

A multiple linear regression model validated these findings, exhibiting strong predictive capability. The distance between the roundabout and the signalised intersection was identified as the strongest negative predictor of conflicts, followed by traffic distribution ratios. This study reinforces the value of integrating microsimulation and surrogate safety analysis for proactive traffic safety evaluation and supports the need for adequate spacing between roundabouts and signalized intersections in urban environments.

Keywords: traffic microsimulation, surrogate safety measures, roundabout safety, traffic conflict analysis, intersection spacing

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Mechanical Behaviour of the Additively Manufactured Stainless Steel AISI 316L in the Marine Environment

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Abstract

The maritime industry's expanding interest in additive manufacturing (AM) for ship and offshore infrastructure maintenance has highlighted the need to evaluate the performance of 3D-printed materials in marine conditions [1]. This study investigates the effects of the natural Adriatic Sea environment influence on the mechanical behaviour of additively manufactured AISI 316L stainless steel specimens [2]. The specimens were exposed to marine conditions; one group was fully submerged below the seawater surface, the second group was exposed to the tidal conditions, and an additional group of reference specimens was maintained at room temperature. The exposure time of specimens was one, three, and six months. Retrieved specimens underwent visual inspection, cleaning, mass measurement, and tensile strength test [3]. The obtained results indicated that exposure to the marine environment caused a reduction in tensile strength when compared to the reference material, while in the case of tidal condition exposure impact on tensile strength was stronger than in fully submerged specimens.

Keywords: Stainless steel, AISI 316L, 3D print, corrosion, marine environment

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Environmental Ageing of Structural Materials in Marine Engineering

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Abstract

The mechanical properties of structural materials in shipbuilding and marine engineering are significantly affected by environmental stressors such as corrosive environments, UV radiation, and chemical treatments, all leading to material degradation. These factors are especially critical in the marine environment, where materials are exposed to harsh conditions over extended periods of time. Long-term exposure to such stressors not only reduces mechanical properties, material strength, and durability but also contributes to potential failures that can reduce safety and increase maintenance costs. This work presents an overview of previous studies focused on the environmental ageing of materials, showing that UV-C exposure can considerably accelerate polymer embrittlement and reduce mechanical properties, such as tensile strength [1], while chlorination was shown to cause localized pitting corrosion in austenitic stainless steels, especially AISI 316 [2]. Analysis revealed that only a limited number of studies have investigated the coupled effects of multiple stressors, such as simultaneous UV exposure, salt spray, and mechanical loading, under realistic marine conditions. Furthermore, long-term research conducted in natural marine environments remains relatively untackled, and the performance of novel composites and additively manufactured alloys has not been explored enough [3], [4]. Future research should aim to fill these gaps by bringing together knowledge from different fields and looking at how various forms of degradation affect materials when they act together. This could lead to smarter choices when it comes to materials and protection methods, helping marine engineers to better understand the behavior of such materials when exposed to environmental stressors typical for the maritime industry.

Keywords: marine engineering materials, material degradation, environmental ageing, mechanical properties

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Students' Perceived Immersion in Translating FlexSim Models to Virtual Reality

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Abstract

The paper outlines the design and methodology of a study exploring students' perceived immersion when translating FlexSim discrete-event simulation models into a virtual reality (VR) environment. The research will be conducted at the Faculty of Maritime Studies, University of Rijeka, involving final year graduate students from the Logistics and Management in Maritime Industry and Transport program. The primary aim is to investigate how immersive VR experiences, developed from FlexSim's 3D simulation models, affect students' engagement, sense of presence, and perceived realism in the context of maritime logistics education. FlexSim, known for its powerful and intuitive 3D modelling capabilities and realistic discrete event simulation, enables users to model complex logistical systems using drag-and-drop controls and customizable objects. By integrating these models into a VR setting, the study seeks to assess whether the added interactivity and spatial immersion enhance students' understanding of port operations and supply chain processes. The research will employ structured questionnaires to measure key aspects of immersion, including engagement, presence, and realism, complemented by follow up interviews to capture qualitative insights into students' experiences. Anticipated contributions include identifying the factors that most influence immersion and highlighting potential challenges in adapting simulation software for VR-based educational applications. This study aims to inform future development of VR enhanced curricula in maritime and transport education, supporting the integration of innovative digital tools for competency based learning and improved student outcomes.

Keywords: virtual reality, discrete event simulation models, immersion, maritime education

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Pluvial Flood Hazard and Exposure Assessment: Novi Vinodolski Region

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Abstract

Floods are one of the most prevalent hazards in the world, with approximately 23% of the world's population directly exposed to flooding with a 1% annual exceedance probability (AEP) [1]. Flooding in coastal areas usually occurs due to three main sources: high sea levels (coastal flooding), high river discharges (fluvial flooding), and heavy rainfall (pluvial flooding) [2]. As a result of obligations from the EU Floods Directive (2007/60/EC), Croatian Waters have conducted a preliminary flood risk assessment for the river basins and coastal areas in Croatia and classified most of the Novi Vinodolski region as an area of potentially significant flood risk. Based on this classification, this study had two objectives: (1) to assess the pluvial flood hazard for the Novi Vinodolski region at the local scale and (2) to assess the exposure of transportation infrastructure and buildings to flooding. The flood hazard assessment was conducted for three scenarios: low, medium, and high probability of flooding, corresponding to an AEP of 1%, 4%, and 20%, respectively. The results of this analysis are the pluvial flood hazard maps, which show the spatial distribution of water depths and velocities, as well as severity levels for each of the probability scenarios. In the Novi Vinodolski region characterized by its karst landscape, there is little continuous surface runoff. The exceptions are the Suha Ričina catchment, several torrential streams, and local terrain depressions, where water initially accumulates but then infiltrates rapidly. The exposure assessment was conducted primarily to evaluate the exposure of receptors (roads and buildings) to flooding, which was determined based on the spatial distribution of receptors and the flood extent for each probability scenario. The results of the exposure analysis show a clear increase in exposed assets along the Novi Vinodolski region with decreasing AEP, reflecting the greater spatial extent of lower-probability, high-impact flood events.

Keywords: Novi Vinodolski, pluvial flood, hazard assessment, exposure assessment

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High-Resolution Pluvial Flood Hazard Mapping in Rječina River Basin

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Abstract

This study presents a comprehensive flood hazard assessment for seven settlements within the Rječina River basin in Croatia's Primorje-Gorski Kotar County [1]. Following WMO recommendations [2] and extreme value modeling principles [3], intensity–duration–frequency (IDF) and depth–duration–frequency (DDF) curves were derived for rainfall lasting up to 24 hours, enabling the definition of design storms for return periods of 5, 25, and 100 years [4]. A Geographic Information System (GIS) framework, combined with products from the Copernicus Land Monitoring Service, was used to define land cover, from which infiltration parameters and surface roughness coefficients were determined [5, 6]. These inputs were used together with a rain-on-grid simulation approach implemented in the HEC-RAS 2D model to simulate pluvial flooding across the pilot area [7]. Model results were used to generate flood hazard maps illustrating water depth and flow velocity for each probability scenario. The outcomes identify critical flood-prone zones, particularly in valley bottoms and densely urbanized areas. Aligned with global hydrological and hydraulic standards, this study provides robust and comparable outputs to support evidence-based flood resilience planning.

Keywords: Flood hazard, DDF and IDF analysis, Design storms, SCS–CN runoff modelling, HEC-RAS 2D simulation

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Water Surface Detection Using Multi-Source Sentinel Imagery

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Abstract

Detecting water surfaces is becoming increasingly necessary due to the growing impact of climate change and human activities on aquatic ecosystems. Current studies usually present methods in ideal circumstances, such as in [1], [2]. In contrast, this study presents a computer vision-based methodology evaluated across a broader range of real-world circumstances using multi-source satellite imagery, specifically RGB, Normalized Difference Water Index (NDWI), and Synthetic Aperture Radar (SAR) images obtained from Sentinel-1 and Sentinel-2 constellations [3]. The proposed algorithm is built upon the Shoreline detection algorithm (SDA) presented in [4] and employs a combination of classical image processing techniques, including blurring, binarization, morphological operations, and contour detection using the Suzuki algorithm implemented in the OpenCV library [5]. Using RGB imagery is intuitive, however, its effectiveness is highly dependent on ideal conditions. NDWI enhances water body delineation by emphasizing water-specific spectral characteristics, offering improved detection over RGB. Nevertheless, both RGB and NDWI are limited by cloud cover and low-light conditions. In contrast, SAR imagery, which captures backscatter information using active microwave sensors, is largely unaffected by weather or illumination, making it a robust alternative for consistent water surface monitoring under diverse environmental conditions. The results highlight the impact of different imagery types in the success of detecting water surfaces. This shows the potential of using remote sensing and computer vision in supporting sustainable environment monitoring practices.

Keywords: water surface detection, digital image processing, computer vision

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Advancing Sea State Estimation: Current Techniques and Emerging Methodologies

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Abstract

Accurate estimation of sea state is essential for ship trajectory planning, operational efficiency, and the reduction of fuel consumption and CO_2 emissions. Although ship crews remain responsible for estimating sea state based on their experience, several alternative methods have been introduced. These methods rely on physical and statistical modelling, as well as emerging machine learning-based approaches that approximate sea state using ship motion responses based on the method of wave buoy analogy (WBA) [1, 2]. In model-based approaches, statistical analyses are typically conducted either in the frequency domain, using the vessel's transfer functions, or in the time domain, by directly utilizing time series data of the ship's responses. Among these approaches, the most notable techniques include the Stepwise procedure, Kalman filtering, and the Brute-Force approach [3]. Such methods rely heavily on the ship's transfer functions, which often fail to capture the nonlinear dependencies in ship motion responses. This is where machine learning and deep learning models excel. Over the years, several machine learning-based solutions have been proposed for sea state estimation [4]. These approaches have demonstrated high performance and represent a reliable advancement in sea state estimation for both classification and regression tasks, supported by a variety of model structures. However, a key challenge remains the limited availability of real-world datasets, which leads much of the current research to rely on simulated data. Additionally, the adoption of emerging machine learning and deep learning models remains limited.

Keywords: sea state estimation, machine learning, deep learning, wave buoy analogy

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Silty Sand's Monotonic Behaviour in Simple Shear

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Abstract

The **Simple Shear Test** (SST) is a geotechnical testing method used to evaluate the shear behaviour of soils. Testing in the simple shear apparatus allows for the effective simulation of field loading conditions (such as those during earthquakes or settlements), and the tested soil's shear strength, pore pressure response, and stiffness parameters can be obtained.

The Simple Shear Device (SSD) was used to test fully saturated silty sands. The testing program consisted of monotonic, constant-load, drained tests and monotonic, constant-volume, undrained tests [1], [2]. The research goal was to assess the influence of the changing kaolinite silt content on the soil behaviour of silty sands, reconstituted at different relative densities [3], [4]. The initial consolidation load used was 25 kPa and 100 kPa, simulating relatively shallow soil conditions at approximately 1 and 5 m depth below the surface level.

The SSD was slightly modified to improve the induced straining conditions of the samples [5], [6]. The appropriate calibration test with pure water was performed to evaluate and subtract the influence of the rings and outer membrane on the samples' shear stress readings.

By increasing fines content in the host sand specimen, an initial decrease in peak shear stress was observed at very low fines content, followed by an increase at higher fines content. This characteristic change in peak shear stress appears to be unaffected by the consolidation load or draining conditions. Similarly, the volumetric strain in drained tests initially decreases with increasing fines content, followed by a rapid increase close to the fines threshold [7]. With increasing fines content in undrained tests, the pore water pressure build-up decreases; however, at low consolidation stress and very low fines content, an initial increase in the pore water pressure occurs.

The medium-dense and loose silty sands show similar behaviour to the dense specimens. The individual mixture's shear stress and volumetric strain at drained tests are affected by relative density. The pore pressure increase during undrained tests appears to be unaffected by relative density at lower fines content. In contrast, close to the fines threshold, the pore pressure increase diminishes with increasing relative density.

The present research indicates that the silty sand behaviour is affected by the clay fraction in a complex manner. This probably occurs due to the hydrophilic clay properties and their consequential variable consistency, especially at very low fines content. This is also highly affected by the relative density, which manipulates the amount of pore water in fully saturated specimens.

Keywords: simple shear, silty sand, kaolinite silt, monotonic behaviour

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A Versatile Image Annotation and Masking Tool

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Abstract

We present a comprehensive framework for annotating images [1,2] compatible with various image segmentation and object detection algorithms. The application developed in Python stores opaque masks as images for models such as U-Net [3], or in textual format for YOLO (You Only Look Once) [4] models. Google Firebase Firestore saves the annotations in a cloud infrastructure. Classes are predefined, but their meaning can be altered in postprocessing. Objects can be reclassified, edited, moved, deleted, cloned, merged, or intersected. Points can be sorted, reordered, replaced, and inserted. Contours are filtered, and the convex hull removes defects. Shapes such as rectangles, ellipses, circles, circular segments, and arcs can be added for faster processing. Removing or keeping all points inside a rectangle simplifies changes. Undo and redo make actions reversible. The grabCut [5] or SAM (Segment Anything) [6] models detect objects based on points or bounding boxes, and a greyscale threshold can be applied.

Keywords: image annotation, image segmentation, object detection, masking, computer vision

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Towards Full Laboratory Automation: Identification of Bacteria Using Machine Learning and Hyperspectral Imaging

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Abstract

Skin and soft tissue infections are caused by bacterial, fungal, and viral invasions of the skin and underlying tissue. The infections range from superficial cellulitis to lethal necrotising fasciitis, often complicated by increasing antimicrobial resistance and delays in diagnosis. The current standard of care involves taking clinical histories, performing physical examinations, performing laboratory tests, and undertaking surgical assessments. This diagnostic process can take several weeks to identify the microbial organisms involved, which makes timely treatment difficult. [1] Spectral imaging is a promising optical imaging technique that captures spatial and spectral information, allowing for detailed characterisation of biological tissues [2] and pathogens [3] based on their different spectral signatures. In our study, bacterial cultures of Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, and Staphylococcus epidermidis were captured using a hyperspectral camera within the visible and near-infrared spectrum (400-1000 nm). Various dimensionality reduction methods and pre-processing techniques focused on denoising and scatter correction were applied to the acquired data cubes. Three-dimensional convolutional neural network models were trained using the pre-processed data cube patches, achieving a promising multiclass classification macro average F-1 score of 78%. These findings represent a good first step toward full laboratory automation. This approach could enable more rapid and precise identification of the causative agents in skin and soft tissue infections, facilitating timely and targeted therapeutic interventions.

Keywords: Full Laboratory Automation, Hyperspectral Imaging, Machine Learning, Bacteria

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Explainable Graph-Based Peptide Classification

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Abstract

Cyclic peptides present an increasingly popular asset in drug design, primarily because of their ability to interact with certain targets that pose a significant challenge for conventional drug modalities. Despite their therapeutic potential, the effectiveness of cyclic peptides against intracellular targets is fundamentally limited by their low cell membrane permeability [1]. Thus, it is essential to distinguish viable candidates in the early stages of drug development. Experimental methods of determining the membrane permeability of cyclic peptides are costly and time-consuming, and molecular dynamics simulations require extensive computational power and face various challenges. To assist the selection of cyclic peptides with high membrane permeability, a machine learning model based on graph convolutional networks is proposed.

Graph-based methods have proven themselves as capable tools for modelling the natural structures of peptides [2]. As is the case with most deep-learning architectures, the resulting models act as black boxes, requiring the implementation of explainability methods in order to be interpretable [3]. Here, GradCAM-based explainability is used to produce saliency maps and feature rankings. Selecting the appropriate features for a given task is a key step for developing an accurate model, but traditional feature selection techniques fall short when applied to graphs. Thus, this work utilizes a backward selection method guided by the gradient-based feature ranking. This research aims to set a foundation for developing explainable graph-based machine learning models for various peptide-related problems.

Keywords: cyclic peptides, graph neural networks, model explainability, feature engineering

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A Novel Approach for Machine Learning with Hyperbolic Embeddings and Dynamical Systems

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Abstract

Compared to Euclidean embeddings, hyperbolic space embeddings preserve hierarchical and complicated relationships in fewer dimensions, resulting in more compact and memory-efficient models. However, standard machine learning algorithms developed for Euclidean spaces cannot be directly applied in hyperbolic spaces, so it is necessary to adapt basic mathematical operations to hyperbolic geometry [1]. In this paper, we present original methods that combine hyperbolic representations with dynamical systems for modeling data evolution over time. This approach reduces the number of optimization parameters compared to classical techniques, because data are treated as points in a dynamical system that evolves, thus solving complex optimization problems more efficiently. These methods were applied to three different problems: word embedding [2], predicting protein-drug interactions [3], and path optimization in directional labyrinths [4]. The obtained results confirm that important information can be preserved using significantly lower dimensions than with classical Euclidean methods, while retaining or even improving performance. Furthermore, this approach is universal and applicable to various problems involving temporal or structural dynamics of data, thus expanding the possibilities of applying hyperbolic machine learning.

Keywords: hyperbolic machine learning, dynamical system-based optimization, dimensionality reduction, data embedding

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Causes and Risks of Accidents in the Transport of Combat Equipment: Statistical Analysis, Field Challenges and Digital Transformation of Military Training

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Abstract

The transportation of combat equipment represents a key component of logistical support in modern armed forces [1]. However, the conditions under which such transportation takes place—including unpaved roads, complex terrain, and stressful operational circumstances—result in a high accident rate [2]. Research has shown that rollovers, collisions, and road departures represent the greatest safety risks, especially during military training exercises [3].

This paper analyzes the most common causes of accidents through a statistical model based on simulated data and available literature, identifying critical points in cargo securing procedures and driver operational preparedness [4]. Special attention is given to the potential application of virtual reality (VR) in military driver training, enabling the rehearsal of complex scenarios in a safe environment [5]. The results indicate a potential reduction in accidents and operational costs while maintaining or increasing readiness levels. The integration of VR systems into both basic and advanced military driver training programs is recommended [6].

Keywords: combat vehicle transport, military training, accident risk, virtual reality (VR), cargo securing, operational readiness

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Experimental and Numerical Rate-Dependent Analysis of the End-Notched Flexure Test

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Abstract

End-notched flexure (ENF) test is a standardised test [1] used to determine the fracture toughness in mode-II for adhesive joints and fibre-reinforced polymer matrix composites. In its essence, the test is a three-point bending of a layered beam with a predefined notch at one end, from which the crack in the bonding layer propagates. The simplicity of the test method led to its adoption, in favour of other test methods used to define mode-II fracture toughness, such as the four-point ENF and the end-loaded split test. However, the ENF test exhibits numerous challenges, one of them being the significant amount of scatter between different test specimens. Since the averaging procedure for the resulting load-displacement curves is not straightforward, the numerical and analytical solutions are usually compared with the envelope of the experimental results. A novel averaging procedure, based on the parametrisation of the load-displacement curve is presented and applied to the experimental data. The experimental data were obtained from a series of tests with different loading speeds. Together with the experimental data from [2], where the same adhesive was tested for mode-I fracture toughness using the double cantilever beam (DCB) test setup, these test data form a unified experimental set. Numerical simulations using a beam-based numerical model, as presented in [3], are used to capture the averaged experimental data. A procedure for modelling rate-dependent effects in the adhesive (as presented in [4] for mode-I) is implemented in the ENF model in order to capture the behaviour at varying loading speeds. A 2D numerical simulation performed in ABAQUS is used for verification.

Keywords: end-notched flexure test, adhesive joints, beam finite element model, cohesive-zone model, mode-II fracture toughness, rate-dependent effects

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INTERACTIVE WORKHOPS

3D Scanning - Technology, Workflow, and Demonstration

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Abstract

This workshop will introduce the technology behind 3D scanning, focusing on the workflow and data processing steps. An overview of how 3D scanning systems operate will be given, after which several 3D laser scanners will be used in a hands-on session. There will be a live demonstration of data acquisition and subsequent processing.

Statistics

The first edition of My First Conference took place at the University of Rijeka, Faculty of Engineering, in September of 2017. At the first conference, two keynote lectures and 29 contributed lectures were presented.

The second edition of My First Conference was held at the University of Rijeka, Faculty of Maritime Studies, in September of 2018. During the conference, 34 papers were presented along with two plenary lectures.

The third edition of My First Conference took place at the University of Rijeka, Faculty of Civil Engineering, in September of 2019. During the conference, 27 papers were presented along with one plenary lecture.

The fourth edition of My First Conference was held at the University of Rijeka, Faculty of Engineering, in September of 2020. For the fourth edition, 33 abstracts were presented together with one keynote lecture.

The fifth edition of My First Conference was held at the University of Rijeka, Faculty of Maritime Studies, on September 23, 2021. 30 abstracts were submitted for the conference along with three plenary presentations and one keynote lecture.

The sixth edition of My First Conference was held at the University of Rijeka, Faculty of Civil Engineering, on September 22, 2022. During the conference, 29 papers were presented as well as one plenary and one keynote lecture.

The seventh edition of My First Conference was held at the University of Rijeka, Faculty of Engineering, on September 14, 2023. It included 19 abstracts, one keynote lecture and one plenary lecture.

The eighth edition of My First Conference was held at the University of Rijeka, Faculty of Maritime Studies, on September 19, 2024. It included 24 abstracts, two keynote lectures, along with two interactive workshops.

This year, the conference takes place at the University of Rijeka, Faculty of Civil Engineering, on September 22, 2025. The programme includes 21 abstracts and one keynote lecture, as well as an interactive workshop.