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PREFACE

My First Conference is an annual conference for doctoral students of engineering and technology studying at University of Rijeka. It is a joint initiative of Faculty of Engineering, Faculty of Maritime Studies and Faculty of Civil Engineering of the University of Rijeka. Doctoral students from other institutions and graduate students with ambitions in scientific research are also welcome to participate in this annual event.

The goals for the participants of this conference are:

- To provide the feedback for the ongoing student's research; the presented work should not be only the completed research, but also the research that is still not finished
- Improvement of the presentation skills in English at a scientific conference at no cost
- Development of the possibility for the interdisciplinary research projects between doctoral students from different institutions
- Public presentation of the research results required within the doctoral study obligations (this presentation can serve for this purpose if the person in charge of the institution's doctoral study approves it)

The first edition of My First Conference took place at University of Rijeka, Faculty of Engineering in September 2017. For the first conference, 2 keynote lectures and 29 contributed lectures were presented.

The second edition of My First Conference was held at University of Rijeka, Faculty of Maritime Studies in September 2018. During the conference, 34 papers were presented along with 2 plenary lectures.

The third edition of My First Conference took place at University of Rijeka, Faculty of Civil Engineering in September 2019. During the conference, 27 papers were presented along with 1 plenary lectures.

This year the conference is held at University of Rijeka, Faculty of Engineering on September 24, 2020. For the fourth edition, 33 abstracts were submitted together with a keynote speaker lecture from D.Sc. Marko Perčić from University of Rijeka, Faculty of Engineering.

Finally, the organizers would like to thank to all the authors for participating in the fourth edition of My First Conference, as well as the organizing institutions, Scientific and Organizing Committee members for their contribution in the realization of this year's event.

We hope to see you at the fifth edition of My First Conference in 2021!

Organizing Committee of MFC 2020

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Characterization of parameters influencing friction in the nanometric domain

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Abstract

Friction and wear are one of the most challenging problems in many engineering and manufacturing technologies. In fact, friction is a nonlinear stochastic effect with a marked time, position and temperature variability. While frictional phenomena on the macro- and mesoscales can be considered well described and their effects can be simulated via suitable models as well as generally efficiently compensated by using proper control typologies, the study of the occurrence of friction, the parameters that influence its value and the respective models in the nanometric domain is still in the initial phases. The presented research provides a scientific contribution to the study of dry (unlubricated) friction by characterising the parameters influencing its value at the nanometric scale, and especially the dependence of friction on material properties, loading conditions, the velocity of motion, as well as the temperature. The characterisation of the dependence of friction on the listed parameters is based on experimental measurements performed by employing a Scanning Probe Microscope (SPM), due to the large number of monitored influences, the number and type of measurements is determined by developed Design of Experiment (DoE) method by employing Voronoi tessellations. Furthermore, the measurements are subjected to numerical experiments carried out by comparative analysis of state-of-the-art machine learning methods to obtain the predictive models linking the process variables to the value of nanometric friction. The developed models show prediction accuracy between 72 and 91% depending on the type of the sample

Keywords

Nanometric Friction, Atomic Force Microscopy, Nanotribology, Experimental Measurement, Tribology of Thin Films, Friction Modelling

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CAPACITY PLANING AT THE CONTAINER TERMINAL OF THE PORT OF RIJEKA AS MULTIPHASE SERVICE PROCESS

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Abstract

The Port of Rijeka is the most important national port for international traffic, and an important transit port. In order for the port to develop as a strong intermodal centre, it is necessary to determine its possibilities and limitations. Queueing theory is very important and useful in determination of capacity utilization and detection of possible bottelnecks. The apllication of queueing theory is carried out for the container terminal of the port of Rijeka as multiphase service process that consists of the three main phases: operational shore, stacking area and handover zone. The results indicated that the current bottleneck of the terminal Brajdica is the handover zone where a reconstruction and capacity building project is in progress. In the future, if the traffic increases, the stacking area also should be expanded, since the capacity of the stacking area is the next bottleneck of the terminal. The largest capacity reserves are observed in the operational shore subsystem, but in order to ensure the efficient flow of goods at the terminal, it is important to consider the railway (handover zone) as a bottleneck when planning traffic. It can be concluded that there is still space for handling larger quantities of cargo, but not more than 342,000 TEU/year.

Keywords: queuing theory, multiphase service process, bottleneck, container terminal

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Fault Detection in Robotic Manipulators using Support Vector Machines

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Abstract

The detection of faults during the actions performed by robotic manipulators can be of great importance. A timely detection and appropriate stopping of robotic manipulator can prevent damage to the robotic manipulator itself, as well as surrounding equipment [1]. In the presented research the author uses a publicly available dataset to train a model of fault detection. The dataset consists of 463 datapoints – each containing 15 time series of measurements of directional forces (F_X, F_Y and F_Z) and torques (T_X, T_Y and T_Z); measured on the robot end effector [2]. Each of the measurement has one of fifteen different classes assigned to it. Out of these fifteen classes two represent normal operation, while thirteen represent a failure [3]. As the sort of the failure is not important in the control and stopping of robotic manipulator operation those classes are grouped in a class "0" – normal operation, and "1" – fault [4]. With these a binary classification model can be developed, with the goal of detecting a fault based on force and torque measurement. Machine learning (ML) models can have a fast classification performance [5], which is of great importance in preventing any damage caused and have previously been widely used in robotics. Support Vector Machines (SVM) are ML algorithms, which allow for classification by determining a separation between the instances in the feature space of the given problem, through the creation of support vectors [6]. The idea of support vectors is presenting the shortest possible distance between the hypersurface separating the classes and class instances [7]. Hyperparameters are values which define the properties of the machine learning algorithm, and have large influence on the algorithm performance, which is why the adjustment and testing of values is necessary [8]. The training is performed on a total of 120 hyperparameter combinations, with 10-fold K-fold cross validation being performed [9-11]. The quality of the solution is evaluated using Area Under Receiver Operating Curve (AUC) metric. The best solution achieved reaching mean AUC 0.95718±0.16233 (*N=10*) with hyperparameters {'C': 1.0, 'degree': 3, 'gamma': 'auto', 'kernel': 'poly'}. Mean time of detection is 10.000389±1.031651 [μs] (*N=100*).

Keywords

Machine learning, fault detection, binary classification, industrial robotic manipulator, support vector machine

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Compressible micropolar fluid flow – solvability of the model

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Abstract

Classical fluid flow models are used extensively to analyze fluid behaviour at the macroscopic level. Recently, with the advancement of technology, there is a need for models that will more faithfully describe the behaviour of fluids at the micro level by taking into account local microeffects.
In the micropolar fluid model, additional fields of internal structure, body torque per unit mass and couple stress, are defined. Only microrotations are taken into account, while deformations are neglected. In this case, the law of conservation of total angular momentum applies - in addition to the linear part resulting from external influences, the intrinsic angular momentum must be taken into account.
Here we first present a general 3D model of a homogeneous isotropic compressible heat-conducting micropolar fluid, which is in the thermodynamical sense perfect and polytropic. Then we consider a special case of one-dimensional flow, for which we present the conditions under which the governing system of equations will allow the local existence and uniqueness of the generalized solution. The proof of the existence is constructive as it uses Faedo-Galerkin approximations in the process. This approach enables us to compute a numerical solution and visualize the behaviour of the fluid.

Keywords

micropolar fluid flow, *generalized solution*, *local existence and uniqueness*, *numerical solution*

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Optimization of fin-and-tube heat exchanger by response surface methodology and genetic algorithm

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Abstract

In this study an optimisation of a plain fin-and-tube heat exchanger (FTHE) has been performed. Combination of response surface methodology and genetic algorithm is applied to search for optimal geometry configuration of FTHE [1,2]. The aim of this work was to obtain optimal geometry which yields maximal heat transfer as well as minimal pressure drop. Four geometry parameters have been optimized: longitudinal and transversal tube pitches, fin thickness and fin pitch. Colburn *j*-factor and friction factor *f* are taken as objective functions. The finite volume method, implemented in CFD software Ansys Fluent, was used to solve mathematical model of fluid flow and heat transfer. Central composite design method (CCD), combined with the finite volume method, has been applied to calculate objective functions. Based on obtained numerical results, Colburn and friction factors have been calculated for thirty-one different parameter combinations. Additionally, genetic algorithm is utilized in order to optimize the objective functions obtained by response surface methodology.

Keywords

Fin-and-tube heat exchanger, *response surface methodology, genetic algorithm*

Acknowledgement

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Upper limb mechatronics rehabilitation device

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Abstract

Strokes are one of the major causes of impaired upper limb movements [1]. Patients engaging in rehabilitation sessions within 3 poststroke weeks show better outcomes [2]. To regain motion skills, the patients must reacquire in this frame the ability to perform a series of quick and precise movements [1]. The human motor system is, however, very complex, so that the central nervous system "organizes" it hierarchically, forming functional groups encompassing several muscles with their activation sequences. Such synergies should be stimulated in rehabilitation to enable the recovery of daily activities. A compact upper limb mechatronics rehabilitation device, conceptualized in [3], is hence detailed in this work. The considered design goals are smooth interactions, kinematic compatibility with the human arm, redundant safety features, low cost and robust adaptive control enabled by proper sensors. To assure the functional architecture of the device, the analysis of human-device interactions and interfaces, the modeling of the respective kinematics, and the characterization of the respective specifications are hence to be performed [1]. The modeling starts thus from a simplified 8 degrees of freedom (DOFs) human arm configuration, adding subsequently further complexity layers. The functional and operational specifications are then detailed for the interfaces, the mechanical parts, the actuators and sensors, and the control system. The finally proposed mechatronics device comprises 8 revolute active joints supplemented with one spherical and 5 prismatic passive joints, resulting in a total of 14 joints and 16 DOFs distributed along the shoulder-elbow-wrist-hand interaction chain. The study of the respective ranges of motion is also performed, and verified against the rehabilitation requirements. The analysis of the relation between the device and human kinematics, the respective modeling and the practical execution of the proposed innovative design configuration are planned next.

Keywords

Robotic rehabilitation, *functional recovery*, *engineering design*, *mechatronics device*

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Insight into design and shapes of the fish passages and entrance protection construction at micro hydro power plants

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Abstract

Despite the fact that micro hydro power plants (power from 5 till 100 kW) have minor impact on the environment, there is still a need for protection of the flora (mostly fishes) in water flows. Fishes must have a suitable way for passing the micro hydro power plants during migration. Such is provided by fish passages. Also, fishes must be protected from injuries caused by the impact of blades and similar structures inside the rotating parts of the turbine. There are many constructions of the micro hydro power plants [1]. This research will present insight into the design and shapes of such protective measures, i.e. possible constructions of the fish passages and entrance protection.

Keywords

Micro hydro power plant, *fish passage*, *entrance protection*, *construction*.

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SOLAS 2020 Implementation in Shipbuilding Software

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Abstract

During the ship design, Rules and Regulations must be applied and monitor the whole shipbuilding process. The main reasons are safety at the sea and the vessel sustainability. Therefore, in any ship design process, SOLAS Convention has to be followed before design has been approved. The new SOLAS 2020, making amendments adopted in 2016, 2017 and 2018 effective from January 2020. By that, it highlights the main changes to SOLAS and to the codes made mandatory under the SOLAS Convention. As with improved survivability rules for new passenger ships, the most significant 2020 changes raise the damage stability requirements in the event of flooding that may be caused by collision or grounding. This paper presents the stricter requirements that will have to comply with newbuilds. The objective is to investigate hydrostatics calculation results by previous SOLAS rules, and compare then with results obtained by the new SOLAS 2020 rules, all using the software AVEVA Marine, Hydrostatics Module. Point of interest is to show how these Rules are applied in Shipbuilding software, and especially how will they affect the design of Polar vessels. These changes should have increased attention of shipyards, but moreover shipowners as this can have an impact to the cost of the ship, what can bring new challenges in design and construction.

Keywords

Ship, *SOLAS2020*, *Damage Stability*, *Hydrostatics, AVEVA*

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Steering system for RRC6 parts analysis and testing

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Abstract

In order to develop optimal design of the steering system for the RRC6 race car, the static and dynamic measurements have been performed due to the developed protocol. With the goal to achieve lightweight design, modern materials have been used and therefore their mechanical properties have been investigated. Static measurements were performed by using a simple moment key with the ratchet. The moment key has shown 35Nm torque with the car on a flat floor standing. More demanding task, the dynamic measurements, were performed by using strain gauges [1,2], following the tensometric measurement protocol. The gauges were mounted on the car forks. During driving, the forks of the car were loaded with maximal force of 1500N. The measurements were performed in analysis and testing of the carbon fiber steering column, aluminium cardan joints and aluminium rack and pinion. The testing for the carbon fiber steering column showed that the modelled tubes can endure a moment of aprox. 135Nm.. The stress analysis of the aluminium cardan joints [3] resulted with the allowable 220MPa. Aluminum rack and pinion, after two analysis, has shown in the first analysis the stress value 379MPa and in the second analysis stress value 437MPa. The values of stresses on the aluminium rack and pinion were compared with the values calculated through standard procedure by using KissSoft calculation. The analyses showed that the modelled parts have proven the functionality and safety for the race car design.

Keywords

Carbon fiber steering column, aluminium cardan joints, aluminium rack and pinion

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Checking the limit state of vibrations on two pedestrians bridges in Rijeka

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Abstract

Since large number of scientific papers have been written in the last twenty years on the topic of vibrations on pedestrian bridges, there have been certain changes in the way of checking the limit state of vibrations in European standards and design guides [1]. Since this issue is very common in everyday life when people crossing pedestrian bridges, there is a need for checking the limit state of vibrations on pedestrian bridges which were built before the adoption of applicable standards, and which are still in use today. In this paper, the calculations of limit state of vibrations will be made on two pedestrian bridges over the Rijeka bypass, which were built in the 1980s and have remained in operation to this day. The calculations will be made according to two valid European standards for checking the limit state of vibrations: Annex B to Eurocode EN 1995-2:2013: Design of timber structures [2] and UK National Annex to Eurocode EN 1991-2:2003: Actions on structures [3] using Lusas Bridge 18.0 software for calculation. The results will be explained, and the calculation will show whether these bridges meet the criteria by today's European standards.

Keywords

footbridges, vibration limit state, calculation of vibrations, Lusas Bridge

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Assessment of photoelastic methods on models produced by Additive Manufacturing

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Abstract

Photoelasticity is a whole-field optical technique for experimental stress analysis, which uses the temporary birefringence or double refraction exhibited by some transparent media when subjected to strain. It has comprehensive engineering applications in the study of fracture mechanics, stress concentration and contact mechanics, usually associated with the verification and validation of numerical methods and models [1]. A review of the research published in the field of photoelastic investigations on models produced by additive manufacturing (AM), has shown that further research on Digital Light Processing (DLP) printed parts is justified, as the strength, stability and durability of such parts are known to depend on the process parameters. In DLP an entire layer of material is cured at once using an image projected by a DLP device, however the images are pixelated, creating an anisotropy that can be reduced, or even removed in transparent resins by the post-curing process that has the biggest influence on material behavior [2]. Therefore, to explore the influence of the build orientation and the level of post-curing on material behavior, a two-dimensional digital photoelasticity technique was used with pure bending tests performed on rectangular beam samples manufactured from commercial DentaCLEAR photoreactive resin by means of a special loading device, a Tiedemann circular polariscope, and a high-resolution digital camera. The resulting experimental data is then used for the calibration of finite element method (FEM) based models, where the isotropic material models are used for fully cured samples, and orthotropic models for uncured and partially cured ones. Finally, in order to validate the calibrated FEM models, another separate set of arbitrarily oriented test samples was manufactured and tested under the same loading conditions.

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Keywords

Photoelasticity, Additive Manufacturing, Digital Light Processing (DLP), FEM

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Passengers' seasonal distribution analysis at Croatian airports

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Abstract

Smaller airports with an uneven annual passenger flow are regularly dealing with seasonality issues. Overcoming the issue of seasonality is one of the most significant issues impact airline and airport demand. Due to their limited possibilities for development (in terms of resources, capacity, etc.), it is difficult to achieve constant traffic throughout the year. To stay competitive on the market and make the utmost of their potential, such airports should be managed and planned differently. Significant deviations in the number of passengers during the year impose the need for efficient planning of infrastructure and staff required to provide a high level of service. Through experience airlines and airports have worked hard to find a seasonality balance to try and match demand with capacity in the most profitable way. This paper analyses passengers' seasonal distribution problem at six most significant Croatian airports: Pula, Rijeka, Zagreb, Zadar, Split, and Dubrovnik. In order to provide an efficient methodological approach for analyzing and comparing seasonality, as well as the distribution of passengers at each airport in an efficient manner, seasonality is numerically expressed using the Gini coefficient measure. Comparing the results obtained it is determined where the seasonality is most prominent thus representing the greatest challenge for effective management. Ultimately, the measures for mitigating deviations in passenger flow are proposed.

Keywords

capacity, level of service, management, passenger flow, seasonality

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Deep learning approach for ulna and radius bones fracture segmentation on pediatric X-ray images.

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Abstract

Ulna and radius bone fractures are among the most common bone injuries in pediatric trauma reporting. Although radiologists can usually easily spot the fractures in the X-ray image, due to the overwhelming number of cases requiring their attention each day, reporting on them can be time-consuming. To reduce the time needed for fracture detection, we propose a deep learning method for the automatic segmentation of fractures of the ulna and radius bones on the X-ray images. The proposed method is utilizing two approaches based on state-of-the-art machine learning algorithms. The first approach utilizes the YOLO algorithm [1], while the second one uses the U-net-based approach [2]. The used dataset consisted of 19,500 X-ray images labeled by expert radiologists and was divided into stratified disjoint subsets: training set (15,600 images), validation set (1,950 images), and test set (1,950 images). All images were pre-processed by correctly orienting images using the algorithm proposed by Hrzic et al. [3]. Once trained, model performance is evaluated using the intersect-over-union metric(IoU). The tests emerged a satisfying algorithm's performance, which will be further verified by comparing the radiologist's performance on several tasks with and without the proposed algorithm.

Keywords

Deep learning, *X-ray*, *Medical image processing*, *Fracture detection*

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The role of Electronic transportation management systems in maritime transport sector

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Abstract

Maritime transport represents the main mode of transport in a global trade and includes numerous stakeholders, who have to closely cooperate. In order to enable smoother data exchange between stakeholders and streamline overall business operations, it is necessary to avoid the production and distribution of paper documents. In this respect, Electronic transportation management systems may play an important role since they can simplify and accelerate data exchange and enable continuous monitoring of physical or administrative operations related to transportation and planning. Despite numerous benefits of Electronic transportation management systems, some of the stakeholders still use obsolete methods of data exchange and organize their own transport processes without informing other involved stakeholders, even though the smooth flow of transport depends on communication and data transparency. This consequently leads to increased costs, lost time and inefficient execution of business processes in the maritime transport sector.

Keywords

Electronic transportation management systems, *maritime transport*, *data exchange*

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Repair Principles for Corrosion-Damaged Reinforced Concrete Structures

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Abstract

Concrete structures under different several environmental conditions will lead to the damages of structure. Specific Concrete Structures such are bridge structures are more attacked, focused on corrosion of steel bars, and with damages of structure elements. Corrosion is caused by many factors of the external environment which, through the protective layer of concrete, reaches the reinforced steel bars in the process caused by the degradation of the concrete in general. The presence of permanent humidity is the permanent factor that involves in the process many other factors. Through the soluble process with: chlorine, oxygen, carbon dioxide, sulfates, during the penetration process in concrete. The case study analyzing in this paper is a bridge structure, located in village Drelaj, a region of Rugova, mountains in Kosova. The bridge is at an altitude above 2000m, and is under the constant influence of extreme temperature conditions. The methods to be applied in this case will be analytical and experimental nondestructive testing. Chloride testing, Carbonization testing, Relative Humidity, Steel bars Potentials and Corrosion rate measure with the Corrosion Meter instrument.
Based on the output results and analysis of structure, we will present a model for the repairing of the structure, based on the principles of European Standards EN-1504.

Keywords

Corrosion, environment aggresivity, cracking, concrete, reinforces steel bars, repairing, etc

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Numerical analysis of the influence of baffles on heat transfer and pressure drop in a shell-and-tube heat exchanger

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Abstract

In the paper, influence of segmental baffles on heat transfer and pressure drop in countercurrent water-water shell-and-tube heat exchanger has been numerically investigated by comparing two heat exchanger configurations; with and without baffles, for equivalent operating conditions. Six panels are used as baffles, to divert the shell-side fluid flow and to increase heat transfer [1,2]. Computational domain has been divided into three subdomains; hot water, cold water and wall subdomains and mathematical model has been defined. A standard k-ε turbulent flow model was used since Reynolds numbers are greater than critical values for investigated operating conditions. Four cases with different shell-side flow rates have been analyzed for both heat exchanger configurations. Hot and cold water temperature distributions throughout the domain, as well as velocity vectors, have been presented. Heat fluxes on both hot and cold water side have been calculated for all cases. Additionally, pressure drops have been numerically calculated for analyzed cases and configurations. It is observed that higher heat fluxes, but also the higher pressure drops, are achieved for the configuration with baffles.

Keywords

Shell-and-tube heat exchanger, *numerical research*, *heat transfer and pressure drop analysis.*

Acknowledgement

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Modal Analysis of a Marine Propeller

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Abstract

Modal analysis is a standard procedure to obtain dominant vibration modes in structures that can be performed numerically or experimentally [1]. This paper presents the results of the modal analysis performed on marine propeller with variations in propeller's geometry and material. Two different 3D models of marine propeller were built – a propeller with three and with five blades. For each geometry, three cases were studied according to the material of construction – stainless steel, copper-nickel-aluminium alloy (CuNiAl) and a propeller with CuNiAl hub and composite (fiberglass) blades. Ansys Workbench computer software, based on finite element method, was used to perform modal analysis. Results are presented in the form of the natural mode shapes and frequencies of a propeller during free vibration. Based on the obtained results, conclusions were made about the influence of manufacturing materials on the values of eigenfrequencies. Results prove valuable as the initial step in a process of marine propeller design.

Keywords

Eigenfrequency, Modal analysis, Marine propeller, Vibrations

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Optimization of vessel mooring system at container terminals in circumstances when the length of quay is equal to the length of the vessel

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Abstract
In circumstances when container vessels are growing to until recently unconceivable proportions in length and capacity, there is a problem of accommodating such vessels at existing terminals. Insufficient depth at berth and approach channels, insufficient width of approach waterways and manoeuvring space, insufficient characteristics and bollard pull of tugs and insufficient length of individual quay can be a problem in accepting such vessels. This paper aims to provide guidelines for container vessel mooring system optimization at container terminals in circumstances when the length of the vessel is equal to the length of quay. Mooring system optimization will include the main safety factors affecting vessel berthing, but also the efficiency of cargo handling operations. The paper will analyse technical and technological characteristics of container vessels, characteristics of container terminal quays, potential systems and methods of mooring arrangement and define guidelines for optimizing the mooring system.

Keywords
Technical and technological characteristics of container vessels, characteristics of container terminals quay, safety factors affecting vessel berthing, efficiency of cargo handling operations, optimization of mooring system

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Modelling of the elastoplastic behaviour of additively manufactured titanium alloys

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Abstract

Recent advancement of additive manufacturing (AM) technology has brought attention to the problem of insufficient understanding of the mechanical behaviour of additively manufactured metallic materials with polycrystalline microstructure. Material models within which the material at macroscale is considered as a continuum in this case prove insufficient. Therefore, the application and development of material models that consider the size and shape of the grain, orientation of the crystal lattice, size of the melt pool and characteristic pores within the material represent a step forward in modelling of such materials [1]. Titanium alloys are known for their favorable mechanical properties in various applications, such as medical implants, components for aerospace, automotive and process industry. The knowledge on its behavior is very limited, especially if the focus is directed to modeling of the behavior of titanium alloys produced by selective laser melting (SLM). The microstructure of the most researched Ti6Al4V alloy produced by SLM consists predominantly of martensite (α') within long columnar prior β grains, resulting in a high yield strength of about 1000 MPa and a low elongation of less than 10% [2]. The aim of this study is to develop guidelines and recommendations on the properties for the production of SLM-ed titanium alloy samples, as well as references for the development of appropriate material models.

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Keywords

titanium alloy, *additive manufacturing*, *material models*

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CORROSION BEHAVIOUR OF ANNEALED 42CrMo4 STEEL

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Abstract

This paper aims to investigate the corrosion behaviour of low carbon 42CrMo4 steel after different annealing processes. Steel 42CrMo4 is one of the widely used and investigated steels because of its good mechanical properties. Despite that, corrosion properties of 42CrMo4 steel are poorly investigated. The main purpose of this paper is to extend the knowledge on corrosion behaviour of this alloy. The morphology and mechanical properties of specimens after different annealing processes were determined using optical microscopy, scanning electron microscopy (SEM) and hardness testing. Open circuit potential and potentiodynamic polarization measurements of the heat-treated specimens were carried out using potentiostat with three-electrode set-up in 0.6 M NaCl naturally aerated solution. It was observed that the corrosion rate of soft annealed specimens was higher than that of the spheroidizing and isothermally annealed specimens. It was found that the isothermal annealing yielded a significant improvement of the corrosion resistance in comparison with normalised steel specimens.

Keywords

Heat treatment, Corrosion, 42CrMo4 steel, Microstructure

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Diagnostic of Bladder Cancer Using Hybrid Neural Networks Based on Edge Detectors

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Abstract

Bladder cancer is one of the most common malignant diseases of the urinary tract and is the fourth most common malignant disease in men in Croatia [1]. The diagnostic procedure for bladder cancer usually consists of a biopsy and pathohistological findings. Such an approach can often be invasive and time consuming [2]. For this reason, an endomicroscopic method based on confocal laser endomicroscopy (CLE) supported by artificial intelligence algorithms is being introduced into clinical practice. The application of artificial intelligence in problems of medical image recognition is most often based on the application of artificial neural networks (ANN), most often convolutional neural networks (CNN). The selection of CNN models may require considerable computing resources, which are often unavailable in clinical practice. For this reason, edge detectors-based neural network hybrid models are being introduced. Such approaches offer a stabile classification performance with much simpler neural network architectures [3]. In this paper, a multi-class classification approach that is based on four classes (high-grade carcinoma, low-grade carcinoma, carcinoma in situ and healthy mucosa) is presented. From obtained results it can be noticed that such an approach offers stabile classification performances for multi-class classification as well, achieving macro AUC of 0.98 and micro AUC of 0.97

Keywords

Artificial Neural Network, AUC, Bladder Cancer Diagnosis, Edge detector, Hybrid model

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Bladder Cancer Recognition Using SIFT and SURF Features

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Abstract

Bladder cancer is a heterogeneous disease, which starts when cells that make up the urinary bladder start to grow out of control [1]. The standard procedure for the diagnosis of bladder cancer is called cystoscopy, and it's combined with standard biopsy and histopathological examination of the biopsied tissue. Such a procedure can be invasive, therefore a procedure that involves an optical examination of urinary bladder mucosa is imposed, since it is less invasive approach [2]. Early detection of bladder cancer can increase the chance of survival among people, but new technologies could be expensive and time-consuming. For this reason, image processing techniques with the aid of Artificial Intelligence (AI) tools are widely used in different medical fields for detection of cancer in early stages [3]. The application of AI algorithms in medicine has been receiving much attention lately because of the possibility of automated medical diagnosis with high accuracy. In this research, integration of Multilayer Perceptron (MLP) along with Scale-Invariant Feature Transform (SIFT) and Speeded-Up Robust Features (SURF) algorithm is proposed for bladder cancer classification. The dataset was obtained from the Clinical Hospital Center in Rijeka and consists of 1316 image dataset, where the training set consists of 1200 images while the testing set consists of 116 images. SIFT and SURF were first applied to extract features which were later used as the input vector for MLP. The maximum recognition accuracy of 99.92% has been achieved with a combination of MLP and SIFT algorithm (96x128) while using MLP and SURF algorithm (64x64) maximum recognition accuracy of 96.33% has been achieved.

Keywords

Bladder cancer classification, Multilayer Perceptron, Scale-Invariant Feature Transform, Speeded-Up Robust Features

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Aluminum microstructure inspection using deep learning: a conventional neural network approach toward secondary dendrite arm spacing determination

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Abstract

The present research investigates the determination of secondary dendrite arm spacing (SDAS) using convolutional neural networks (CNN). The goal is to create a deep learning model for the SDAS prediction with industrially acceptable tolerance. SDAS is predicted from the image taken from the polished sample of EN AC 46000 AlSi9Cu3(Fe) cast aluminum alloy. The Sequential CNN model from the Keras library was trained using Python software. Additionally, image preprocessing methods were used to simplify the training dataset from a full RGB color scale to a black and white color scale. A relatively simple CNN structure could predict different SDAS values on a single cross-section with very high accuracy, an R^2 score of 99,2%. However, on an EN AC-42000 AlSi7Mg material cross-section sample which was not used during training, CNN had some lower performances, but still inside the practically acceptable range. Furthermore, a CNN approach towards SDAS determination could be used with industrially acceptable tolerance.

Keywords

Secondary dendrite arm spacing, Convolutional neural network, *Casting microstructure inspection, Deep learning, Aluminum alloys*

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Exploitation of high-speed ships in domestic voyages

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Abstract

The aim of this paper is to present an exploitation of high-speed ships in domestic voyages within Croatian coastal area. High-speed ships differ significantly from other ships not only in their construction and manoeuvring characteristics but also in high sailing speeds. The number of such vessels is growing every day in the world, the same trend exists in the fleet of ship owners in domestic voyages. The regulations and requirements that such ships must meet are stated, their characteristics and the current state of the fleet is briefly presented. Great importance is given to the exploitation of high-speed ships, emphasizing the limitations that the ship encounters as well as the system of support to the master by the home port. Furthermore, the conditions, types and manner of performing high-speed lines, their development, the total number of passengers is being analyzed, and finally the possible trend of further development is predicted.

Keywords

high-speed ships, *high-speed lines, domestic voyages*, *exploitation*

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Analysis and improvement of existing sizing methods of the hybrid system "Mini hydropower plant-solar photovoltaic system"

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Abstract

Electricity production using hybrid systems, consisting of hydropower and solar photovoltaic systems is well applied in the world in various combinations, given the design characteristics and power of hydropower plants.These are small hydro power plants, those with a capacity of less than 10 MW and more than 500 kW, and also mini hydro power plants with a capacity of 100 kW to 500 kW are widely used, as well as micro hydro power plants (of 5 to 100 kW). Regarding the sizing of such systems, the literature review proposes different methods, as a three-part method that improves the operation of the hybrid systems for the purpose of higher electricity production, with emphasis on reducing the stochasticity of solar radiation, i.e. electricity production from PV systems [1]. Also, overlaps in the production of hydropower and solar photovoltaic energy are considered, regarding consumption (consumer demand) with optimization [2]. There can be found several written papers dealing with the topic of sizing hybrid systems [3,4] which leads to the conclusion that in addition to the fact that the mentioned issues are not sufficiently researched, an appropriate methodology for dimensioning the same systems has not been developed yet. This gives the motivation for scientific research and the development of a new method for sizing hybrid systems, which aims to eliminate the identified shortcomings. Also, the goal of planned research is to identify differences in the sizing principles of hybrid systems in which mini and small hydropower plants are used, given the corresponding power ranges.

Keywords

Hybrid systems, hydropower, solar photovoltaic energy, system sizing

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MEASURING OF THE GEOMETRY PARAMETERS OF THE BUTT WELD SURFACE

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Abstract

The stress concentration factor of butt welds depends on five geometrical parameters of weld surface geometry: the thickness of the welded material, weld toe radius, weld toe angle, weld face reinforcement, and weld width. Accurate measurement of the geometry of the butt weld surface is essential to determine the stress concentration factor. Currently, several methods for the analysis of weld surface geometry have been proposed. In the paper, different approaches for measuring geometrical parameters of but weld are discussed and a new approach for measuring weld geometries (weld samples) using a 3D scanner and computational software is presented. An introduction to a non-contact 3D measurement method based on structured light projection and relevant measurement software is given. The influence of the operator on surface measurement results is discussed. A comparison of three methods for measuring the weld toe radius was also presented: direct measuring method, the measurement by GOM Inspect software and measurement by Wolfram Mathematica software. The results of toe radius measurement by three mentioned approaches were analysed and commented.

Keywords

Stress concentration factor, Weld surface geometry, Scanning and measuring, Butt weld geometry

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Estimation of the dynamic reaction coefficients and single-degree-of-freedom factors

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Abstract

The methods for estimating the dynamic reaction coefficients and the single-degree-of-freedom (SDOF) factors were developed by the US Army shortly after World War II NS were used for design of blast resistant structures. These methods have been used in NATO countries since then, while the tabulated coefficients for common geometry and loading are still being used today. However, there is a lack of background information on how these coefficients were derived and there seems to be no clear guidance on the solutions of structural elements with other geometries, loading and boundary conditions. Therefore, the preliminary findings of using alternative methods (linear finite element analysis) to estimate these coefficients for linear and planar structural elements are here presented. Two existing methods were used to obtain the dynamic reaction coefficients of the investigated slabs and one new method was proposed based on the equivalent truss and frame model. Finally, the dynamic coefficients obtained by all methods were compared with the tabulated values from the literature.

Keywords

Blast loading, dynamic effects, dynamic reaction coefficients, single-degree-of-freedom (SDOF) factors, finite element method, beams, plates

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Forearm and Wrist Active Rehabilitation Device

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Abstract

Active mechatronics rehabilitation devices are instrumental in physical rehabilitation of stroke patients [1]. Especially important in this frame is the forearm and wrist rehabilitation that is crucial in assuring regaining the most important everyday activities and functionalities.
Based on initial considerations on human arm anatomy and the respective kinematics, a thorough analysis of the state-of-the-art active mechatronics forearm and wrist rehabilitation devices will hence be presented in this work [2-4]. It will be shown that the available devices, increasingly relying on parallel kinematic configurations, differ considerably in the number and type (active vs. passive) of the considered degrees-of-freedom (DOFs), as well as in the respective ranges of motion (ROMs) and needed actuating torques. Average ROM values of 160° for forearm pronation/supination, of 70° for wrist radial/ulnar deviations and of 120° for wrist flexion/extension can, however, be deduced, with the need torques of, respectively, 3.2, 2.2 and 2 Nm. These torques are commonly attained by using brushed or brushless DC motors, coupled to gear reducers (in some cases all integrated in series elastic actuators (SEA)), as well as encoders for positioning feedback, while the required motion transfer is often based on some form of cable drives. In some instances, stepper motors are used instead. The signals on the motion of the forearm itself are, in turn, obtained via inertial motion or electromyography sensors. Based on this analysis, several design configurations of a forearm and wrist mechatronics rehabilitation device will be proposed and critically evaluated. The most promising one will constitute the basis for the development of a compact, efficient and cost-effective innovative design configuration.

Keywords

Mechanical engineering design, *mechatronics*, *rehabilitation*, *forearm and wrist*

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Forecasting Stock Index Movement Using Stationary Wavelet Transform and Long Short-Term Memory network

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Abstract

Forecasting the stock prices with a satisfying accuracy can be considered a highly challenging task due to non-linearity and non-stationarity of the stock market data [1]. Therefore, movements of financial markets behave, according to previous studies, in a dynamic and non-linear manner [2]. In order to help investors, analyst and traders, movement and future direction of the stock market can be predicted with the help of AI-based system. Such system can provide valuable and supportive information about the future situation of the market, which is important for successful investment and maximizing profits. In this research, authors investigate the predictability of NASDAQ Composite movement direction by integrating the Stationary Wavelet Transform (SWT) with Long Short-Term Memory (LSTM) networks. First, the Unit Root Test is performed in order to examine data stationarity. Afterwards, the time-series data is decomposed by utilizing SWT to obtain low and high frequency components which are then used as input variables for the LSTM network. The performance of the trained model is evaluated using Root Mean Square Error (RMSE) measure. Satisfactory results for intraday stock price forecasting are achieved with a combination of four-level SWT using Haar wavelet and LSTM network.

Keywords

Intraday Stock Data, Stock Market Movement, *Unit Root Test, Wavelet transform*, *Long Short-Term Memory*

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Beam analysis: a geometrically exact static and a linear dynamic three-dimensional case

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Abstract

This paper presents the well-established geometrically exact beam finite element developed by Simo and Vu-Quoc [1, 2] and the Euler-Bernoulli beam element described by Strømmen [3] which are used for a three-dimensional static and dynamic analysis respectively. The beam domain is represented by a line of centroids and a family of cross sections. In a geometrically exact beam theory we allow for finite rotations and strains. In contrast, the Euler-Bernoulli beam theory assumes infinitesimal strains which results in decoupled expressions for deformations. The six independent coordinates required for the description of the beam domain in the absence of shear deformation reduce to four. During the deformation, cross-sections remain normal to the line of centroids. Both elements are theoretically derived and formulated in terms of the finite element method. The resulting elements have been implemented in Fortran and Python computer codes. For the purposes of non-linear static analysis, Newton-Raphson method is employed. A basic force-control algorithm is extended to a displacement-control and arc-length algorithms, which are needed in the presence of instability. In dynamic analysis, natural frequencies are obtained by solving ordinary eigenvalue problem. Solution to the dynamic equilibrium equation is computed in time domain using an explicit time stepping scheme. The static element is tested against the numerical examples provided by Simo and Vu-Quoc [2]. Since the dynamic element is linear, the results are verified against the analytical solutions.

Keywords

Geometrically exact beam theory, *Statics*, *Dynamics*, *Finite element*, *Arc-Length*

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Thermodynamic Analysis of Air Source Compression Heat Pump

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Abstract

The aim of this paper is to evaluate air source heat pump efficiency using energy and exergy analyses for different evaporating temperatures and compressor isentropic efficiencies. For each case of different evaporating temperature and compressor isentropic efficiency, the heat pump coefficient of performance (COP), irreversibility and exergy efficiency are calculated [1]. Studied range of evaporating temperatures was from -12 °C to -4 °C and studied range of isentropic efficiencies was from 0.85 to 0.95. Both energy and exergy analyses showed that higher COP and higher exergy efficiency are obtained when the compressor isentropic efficiency is higher, but concerning the evaporation temperature the two analyses yielded opposite results. The energy analysis showed that for higher evaporation temperature, the heat pump COP i.e. the heat pump energy efficiency will be higher, while the exergy analysis showed that the heat pump exergy efficiency will be lower and the irreversibility of the process will be higher. Within the studied range of different evaporating temperatures, the heat pump COP changed up to 20%, while the exergy efficiency changed up to 2%, so it can be concluded that the COP is a suitable criterion for evaluating thermodynamic efficiency of heat pumps.

Keywords

Heat pump, Thermodynamic analysis, Energy and exergy analyses

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Compressor Pressure Vessel Failure Investigation

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Abstract

Failure investigation of a ruptured pressure vessel that served as a part of an air compressor is presented in this paper. Pressure vessel failed during hydrostatic test when, at a pressure level lower than proof pressure, two cracks occurred on the shell and test fluid leakage was recorded. Experimental investigation methods were employed to determine possible causes of crack occurrence and vessel rupture. Liquid penetrate inspection was performed to check for other surface-breaking defects on the shell and locations of the cracks. Visual examination revealed the condition of the internal surface of the shell. Optical microscopy was used to inspect crack area while scanning electron microscopy examination at suitable magnification was employed to characterize fine microstructure of the fractured surface and to reveal flaws that served as rupture initiation points. Material's chemical composition was determined using optical emission spectrometer with glow discharge source sample stimulation. Hardness test results were used to derive maximum tensile strength of the material. According to obtained results, it was concluded that excessive corrosion at the bottom part of the pressure vessel caused formation of pits that served as initiation points for leakage cracks. Recommendations for avoidance of such scenario are given.

Keywords

pressure vessel, *failure investigation*, *fracture*, *crack*

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Novel methods of describing mechanical behaviour through machine learning

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Abstract

Traditional methods of modelling mechanical behaviour include matrices that contain material constants and provide a link between stress and strain. Such formulations are well established in solid mechanics and are used in real-world problems for centuries. They are often simplified but still provide a good model for engineers. However new engineering challenges have given rise to a need for new materials and these materials are often poorly described by conventional models or a multitude of models are used to describe the same behaviour for different materials. A possible way of describing new material properties is the use of machine learning that could use raw experiment data to describe the behaviour of materials avoiding the need for specific material models and speeding up the implementation in engineering calculations.

Keywords

Machine learning, solid mechanics, nonlinear, materials

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