Computational Problems of Electrical Engineering 2024

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Book of Abstracts

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Session 5 - Poster Session A / **1**

Investigation of artificial defects of BSCC heart valves using radiographic computational methods

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X-ray imaging systems are among the oldest and most widely used imaging systems in medical and industrial diagnostics. X-ray imaging systems have changed considerably over the course of their existence. The physical principle remains unchanged, but the technical means of image acquisition have been replaced. Today, in addition to conventional X-ray imaging machines, digital machines and CT tomography systems are used. X-ray systems are not only used in the medical field, but also in engineering for the purpose of identifying defects in materials and so on. CT systems are characterized by a fundamentally different way of processing data compared to conventional and digital X-ray, even though their common feature is imaging using X-rays. X-ray imaging produces a two-dimensional summation image, whereas CT systems display slices, so-called tomographic planes. If enough of these planes are created using the CT machine, a three-dimensional model of the scene can be created with the aid of computational technology. In addition to 3D imaging, the importance of computed tomography lies in the higher contrast of the imaged object compared to X-rays and provides higher spatial resolution. The CT scan is performed by placing the patient in a machine (gantry) consisting of an X-ray tube and a detection system. The resulting image is reconstructed from the detected data using an appropriate mathematical algorithm and then displayed on the screen as a set of points called voxels. As the radiation passes through the tissues, its rays are attenuated differently, which allows the individual structures of the imaged area to be distinguished in the resulting image.
The Björk-Shiley convex-concave implant represented a modern and advanced model of heart valve replacement in its time. The design consists of an inlet and outlet strut fixed on a rim, between which a disc-shaped occluder disc is inserted. The struts, or separate protrusions, pointing into the valve opening provide anchorage and guidance of the movable disc. The implant consists of a single disc coated with carbon and housed in a rim made of Haynes 25 alloy consisting of 51% Co, 20% Cr, 15% W and 10% Ni. Individual measurements aimed at detecting inhomogeneities in the Björk-Shiley convex-concave valve implants (BSCC) were performed at the Kysuce Hospital with Polyclinic in Čadca (Slovakia). Digital X-ray and computed tomography measurements were performed at the Department of Radiology aiming at the radiographic detection of destructive changes in the BSCC mitral valve struts. The resulting images were evaluated as 2D native tomograms and later reconstructed into 3D structures. The resulting 3D images were processed in the original GE Healthcare software and the Slicer environments, and the results were compared. At the same time, measurements were made leading to the detection of inhomogeneities using the eddy current method, which, if used, would represent an invasive, but at the same time very effective and accurate method, also helpful in detecting minor destructive changes in the valve orifice, which, if indicated late, can lead to the complete dysfunction of the implant and the possible death of the patient. Each measurement dealing with the description of artificial material inhomogeneity consisted of imaging structures with and without a simulated crack in the given samples. On the sensing pad, the valves were ranked according to the degree of damage located at the outlet strut, representing this implant's leading cause of dysfunction. The individual valves were arranged as follows: - valve 0 - the absence of an artificially created notch (so-called intact sample), valve 1 - shallow notch in the outlet strut near the rim, valve 2 - notch up to half the thickness of the outlet strut, valve 3 - the deepest notch in the outlet strut of the valve simulating the condition before the detachment of part of the strut.

Session 3 - Computer Models and Simulations / **2**

TOPAS MC and Eclipse TPS Validation for Department of Clinical and Radiation Oncology, Faculty Hospital of Žilina

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Accurate dose computation is critical in radiotherapy (RT) to ensure that the calculated dose aligns with the delivered dose, directly impacting clinical outcomes. This paper presents a comparative analysis of photon beam simulations using the Eclipse Treatment Planning System (TPS) (Varian Medical Systems, Palo Alto, CA, USA) and TOPAS Monte Carlo (MC) (Tool for Particle Simulation, Monte Carlo). The objective is to incorporate Monte Carlo simulations into educational methodologies by precisely defining simulation parameters and comparing these findings with clinical calculations performed at the Department of Medical and Radiation Oncology Hospital of Žilina. Monte Carlo simulations provide a fundamental understanding of ionizing radiation transmission from the source to the patient, which enhances RT accuracy. This study evaluates the dosage profiles and percentage depth doses calculated by TOPAS MC and Eclipse TPS. Our results demonstrate that TOPAS MC can accurately replicate clinical scenarios and align well with Eclipse TPS outcomes. These positive outcomes indicate that TOPAS MC is reliable for simulating medical cases. The incorporation of TOPAS MC into educational frameworks represents a significant advancement in our field. By offering detailed and accurate simulations of ionizing radiation, it bridges the gap between theoretical knowledge and clinical practice. This not only enriches the learning experience but also has the potential to revolutionize the precision of RT planning and execution. Such advancements inspire optimism for improved patient outcomes and the quality of cancer treatment.
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Session 5 - Poster Session A / 3

Numerical simulation of the human eye exposition to high-frequency electromagnetic field

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In this study, we aim to create a model of the human eye and antenna to simulate the impact of high-frequency electromagnetic fields (EMF) on it. Our objective is to compare the calculated results with the current legal limit values for high-frequency EMF and their interaction with the tissues of the human eye.

We utilize assembled simulation models that combine specifically designed dipole antennas and eye models with frequency-adapted dielectric properties. These simulations calculate the maximum val-

ues of electric intensity, magnetic intensity, and SAR (Specific Absorption Rate) coefficient to compare how these values change as the antenna moves away from the human eye.

We carried out thirty-two simulations to analyze the effects of four different operating antennas on the eye model at eight different distances from the eye. SAR measurements were performed using a cubic volume element of 3 grams, as the measured element must be smaller than half the volume of the eye. We initiated the calculations with the antenna positioned 1 cm from the eye and then measured subsequent distances at 2 cm intervals up to a final distance of 15 cm. The calculated electric intensity, magnetic intensity, and SAR coefficient values were compared to the maximum limit values.

Session 6 - Poster Session B / **4**

Procedural generation of cave-like tiles with cellular automata and Blender Geometry Nodes

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In this paper a comprehensive methodology for procedural generation of cave-like areas is introduced. The method focuses on creating interchangeable tiles that can be used in applications such as computer games. When this field is considered, any algorithm needs to both, follow the user specifications and be able to produce satisfactory and modifiable content at an interactive rate. Solution presented in this paper aims to meet both of those requirements.
Schematic images are incorporated as input, with each specifying the main path that the cave should take, along with passages to neighbouring tiles. This data can either be provided by the user, or generated according to specifications from basic pre-sets, stating connections and types of passages. After generating or uploading the main route that traverses the tile, the system is then extended to incorporate natural looking shapes with cave-like features. The approach uses cellular automata to build the overall system shape, making sure that it will follow a specified path, realizing user defined connections. The basic version of the algorithm can produce realistic looking shapes, but is hard to control, and can take significant amount of time to compute for larger tiles. Therefore a modified version was used, where instead of running the method on the entire tile, smaller sub-shapes are generated and connected to the basic system sketch. Such operations successively extend the general layout, ensuring that it will follow the specified path, while still obtaining the natural-looking and visually interesting shapes created by the Cellular Automata algorithm. With the final system prepared, the model is ready for further edition, including the assignment of material and texture, inserting various game-related objects, and final preparation of the resulting model for the incorporation in the actual computer game.
The generation process and results visualization was prepared in Blender application using custom scripts and Blender Geometry Nodes. The application was chosen since any model prepared with it can be easily converted to various game engines. At the same time, since it is mainly used for 3D modelling, the generation results can be further edited and modified straight away, without any additional steps. Furthermore, different versions of the generated tiles can be obtained at an interactive rate, allowing the designer an easy choice between them, or readily available, interchangeable tile set. During the experiments, different generation parameters were tested, with design and game-related requirements in mind. Final objects generated by the solution can be used either as a base for further modelling, or as a stand-alone terrain model for 3D games.

Session 2 - Circuits and Measurements / **5**

Basic study on improving accuracy in extraction of electromagnetic field waveforms by independent component analysis

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In this report, we will investigate to improve the accuracy of waveform extraction in independent component analysis (ICA). In order to confirm the effectiveness of principal component analysis (PCA), which is a pre-processing for ICA, the result of receiving electromagnetic waves containing a mixture of two components using four-receiving system and performing ICA is presented. The result is compared with the result in a case of two-receiving system for two components to evaluate the accuracy of the extracted waveforms.

Session 1 - Machine Learning / **6**

Application of LIME for Explainable AI (XAI) in Classifying Drilled Holes in Melamine Faced Chipboard based on CNN using VGG16 pretrained network

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This study explores the application of Local Interpretable Model-Agnostic Explanations (LIME) for enhancing the explainability of a Convolutional Neural Network (CNN) used in classifying the condition of drilled holes in melamine-faced chipboard. A VGG16 pretrained network serves as the foundation of our CNN model, which is tasked with classifying the holes based on their wear states. The dataset comprises images captured during drilling experiments using a CNC vertical machining center. The CNN model's overall accuracy is 66.60 %, with performance evaluated through cross-validation. By integrating LIME, we generate visual explanations that elucidate the model's decision-making process, identifying the most influential features in the images. These insights are crucial for validating model performance, debugging, and enhancing trust in the automated tool condition monitoring system. The results demonstrate the potential of combining deep learning with explainable AI techniques to improve transparency and reliability in critical industrial applications.

Session 1 - Machine Learning / **7**

Grad-CAM for Explainable AI (XAI) in CNN-Based Drilled Hole Classification in Melamine Faced Chipboard

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In the furniture industry, precision in drilling holes in melamine-faced chipboard is crucial to maintaining product quality and minimizing financial losses. Manual monitoring of drill conditions, while somewhat effective, is inefficient and imprecise. This paper presents a Convolutional Neural Network (CNN) based approach for automated tool condition monitoring (TCM) using Gradient-weighted Class Activation Mapping (Grad-CAM) for Explainable AI (XAI). By leveraging the VGG16 pretrained network, we classify the condition of drilled holes into three categories: Green, Yellow, and Red. Grad-CAM provides visual explanations for the model's predictions, enhancing the transparency and reliability of the system. Our method improves the interpretability of the CNN model, identifies potential issues, and ultimately boosts the effectiveness and trustworthiness of automated TCM systems. The proposed approach shows significant potential for industrial applications, where understanding the decision-making process of AI models is as critical as their accuracy.

Session 5 - Poster Session A / **8**

Application of neural networks to the identification of artificial defects using sweep-frequency eddy current testing

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The article discusses the practical application of the inverse method of electromagnetic non-destructive investigation of austenitic materials. It includes the design of a robust tool for the automated localization of material defects. To identify and evaluate deep artificial defects, the sweep-frequency eddy current method with harmonic excitation is used. The objects of interest are surface electric-discharged machined notches with a defined geometry fabricated in a plate with a thickness of 30 mm. By using the designed probe combined with the frequency sweeping of eddy currents, it is possible to reliably detect artificial defects up to 24 ± 0.5 mm deep by using low-frequency excitation signals. An important fact is that the measuring probe does not have to be placed directly above the examined defect. The achieved experimental results are processed and evaluated. For this purpose, we designed and tested a simple neural network whose task is to identify defects in the material's structure and indicate the probable occurrence of defects. The network is designed to be able to locate not only visible defects but also those located inside the material.

Session 6 - Poster Session B / **9**

MULTI-LEVEL ANALYSIS OF EFT/BURST DISTURBANCES

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EFT/Burst disturbances are one of the most influential phenomena in sensitive devices. The selection of protection measures against them is determined by its nature. Due to the complexity of these disturbances, it is worth conducting a multi-level analysis, mainly frequency analysis of the disorder under study, before developing suppression methods.
This paper's authors focused on analyzing the voltage and current waveforms recorded at the measurement station for various relays and parameters on the load side. The analysis aimed to understand the detailed characteristics of the disturbance under study and is also an introduction to developing the best possible method for selecting coupling elements. Due to assumptions, analysis

was done for actual, simulated and ideal (standardized parameters) disturbances. Finally, the authors summarized the results and concluded.

Session 4 - Mathematical Models and Industrial Applications / 10

Verification of the efficacy of long-term bathing in a weakly radioactive alkaline simple sulfur spring on arteriosclerosis based on the mathematical model of the development of arteriosclerosis: including verification using an improved analysis method

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The efficacy of a single bath in weakly radioactive alkaline simple sulfur springs, radioactive springs and alkaline springs on arteriosclerosis has been previously verified based on a mathematical model of the development of arteriosclerosis [1 –5]. On the other hand, studies have also been conducted on the efficacy of long-term bathing in weakly radioactive alkaline simple sulfur springs on arteriosclerosis and it has been found that bathing over a long period of time (about three months) is effective with more frequent bathing being even more effective [1]. In this study, the efficacy of long-term bathing in weakly radioactive alkaline simple sulfur springs on arteriosclerosis is reverified using an improved analysis method [3]. Based on the mathematical model of the development of arteriosclerosis, it has been revealed that keeping blood cholesterol levels low inhibits the progression of arteriosclerosis [5]. Therefore, blood cholesterol levels are estimated using a minimally invasive skin cholesterol ester level measurement device that irradiates the skin with mid-infrared light and calculates the cholesterol ester level of the skin from the absorption spectrum intensity. In the improved analysis method, the change in the difference between the “peaks” and “valleys” of the cholesterol ester absorption spectrum before and after bathing is examined. The analysis revealed that after about three months of bathing, statistically significant increase of people whose cholesterol levels returned to normal due to disappearance of these “peaks” and “valleys” is confirmed. This means that the efficacy of long-term bathing on arteriosclerosis has been verified.

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Session 6 - Poster Session B / **11**

Multi-point algorithm for eliminating hyper-chaotic vibrations in nonlinear dynamical systems

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Abstract –The paper presents an effective algorithm for stabilizing periodic orbits immersed in a strange attractor of phase trajectories, which involves small changes in selected parameters of the hyper-chaotic system at each sampling time. The applied control concept consists in modifying selected system parameters in such a way as to minimize the distance of the trajectory from a fixed point on the cross-section of the generalized Poincaré map. Using of multiple control parameters allows for the effective elimination of hyper-chaotic vibrations in complex nonlinear systems in the presence of strong disturbances and noise. The main attention has been focused on a non-autonomous hyper-chaotic system, which can be treated as representative of many advanced non-linear phenomena occurring in the real world. A characteristic property of the considered dynamical systems is the presence of at least two positive Lyapunov exponents. Such systems show very strong sensitivity to initial conditions and generate extremely complex strange attractors. The results of representative computer simulations have been analyzed and interpreted in detail.

Session 1 - Machine Learning / **12**

Efficient Information Extraction from Resumes Using Small Language Models for SMEs Based on Zero-Shot Learning Approach

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In today's recruitment field, accurately extracting information from resumes is crucial. This paper looks at how three small language models—Llama 2, Llama 3, and Phi-3—can help with this task using a Zero-Shot approach. We checked how well these models perform by comparing their results with a hand-made dataset, focusing on accuracy and the time each model takes to run on computers that small businesses typically use. Our tests showed that even with different rules for resume data in various countries, these small, local models work well and can be used by small companies on their own equipment. We used a simple prompt in our tests, and the models performed reliably, proving their usefulness in real-world hiring situations. Our results show that small language models like Llama 2, Llama 3, and Phi-3 can accurately and efficiently extract information from resumes, helping small businesses handle resume data according to local regulations. This study highlights how these models can improve the job-matching process for smaller companies.

Session 6 - Poster Session B / **13**

An optimisation of Border Gateway Protocol on inter-operator links

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Today's Internet is based on interconnected computers and network devices, constituting a complex and highly dispersed infrastructure. The transmission uses an inter-operator network, which, among hundreds of intermediary devices, implements the assumptions of the BGP protocol. It is a very primitive protocol, over 35 years old, which does not work from the point of view of the realities and requirements of 21st-century networks. Data growth and irregular connection load counted in milliseconds are noticeable in finance, multimedia and entertainment. The article describes an innovative approach to analysing inter-operator traffic data using dedicated analytical solutions, including a data collection and visualisation system, optimisation tools and services that make decisions about traffic management for a given operator/customer. The aim is also to reduce the problem of non-intuitive path planning and optimise data transmission in the inter-operator network, considering the BGP protocol's imperfections. The system is based on information about flows from current routes, traffic management data within the local network and at the border of dedicated operators, and creating a network of connections verifying the current consumption of output gates on infrastructure links. The research conducted as part of the article analyses data obtained from network operators and within their infrastructure.

Session 5 - Poster Session A / **14**

Improving wrong labeled time series classification for electrical machines faults detection

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We propose a method for improving classification for faults detection in electrical machines when the training data contains a significant amount of wrongly labeled inputs. The proposed method uses the ROCKET - fast and accurate time series classification using random convolutional kernels model logits as an input for classical classification models (neural networks, SVC). The logits from ROCKET model are used for improving the labelling. We study the accuracy of fault detection with different level of wrong labelling. The paper analysis binary classification for fault detection and also multiclass for a few kinds of faults (mechanical and electrical). The input data is collected from publicly available dataset.

Session 6 - Poster Session B / **15**

Deep CNN ensemble for anomaly detection in ECG

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The paper proposes an ensemble composed of CNN networks for the detection of anomalies in ECG waveforms. The approach is composed of two stages: transformation of ECG signals into images and association of the images with the appropriate class of anomaly using the ensemble of CNN classifiers. The experiments have been performed on the publicly available database Complex Physiologic Signals PhysioNet and directed to recognize three types of ECG signals. The results of numerical experiments are presented and discussed.

Session 6 - Poster Session B / **16**

Evaluating the effectiveness of algorithms used for human fall detection

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This paper presents a study on evaluating the effectiveness of algorithms used for human fall detection. For this purpose, a personal fall detector based on a micro-controller and MEMS sensors was built. Detection algorithms described in scientific papers are discussed. The issue of artificial intelligence and its impact on the development of the fall detection issue was described. Three algorithms were implemented on the fall detector:
• threshold algorithm;
• threshold algorithm with additional time window analysis;
• algorithm using data analysis and machine learning.
Their operating principles are described, as well as the process of training the SVM model. Next, tests conducted on the fall algorithms are described, covering various scenarios, such as moving around the apartment, falling and lying motionless, moving up stairs, sitting on a chair, walking with momentary loss of balance, and clapping hands. Results and a final analysis of the performance of the tested algorithms are presented.
Summarizing the final results, it can be concluded that the artificial intelligence-based model showed the most promising results in detecting falls, especially in situations that may be difficult for traditional algorithms to identify. The algorithm was tested on the FallAlld data set. It achieved an accuracy of 94.3%. The correctness of the results it achieved during field testing was as high as 97.14%. While the threshold algorithm will achieve a correctness of 87.14%, and the algorithm with an additional analysis of the time window will achieve a correctness of 94.29%.

Session 2 - Circuits and Measurements / **17**

AN APPROACH TO MEASUREMENTS OF CE OF POWER DRIVES

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Verifying the level of conducted emissions is very important from the perspective of electromagnetic compatibility. Depending on the environment in which the equipment operates, different allowed emission levels of disturbances are acceptable as a function of frequency. The article presents a research stand, also used for didactic purposes, by the standard PN-EN 55011, which specifies the frequency range between 150 kHz and 30 MHz. The tested object is a power drive system with two different electric motors to choose from, which act as a source of disturbances. The length and type of the cable connecting the inverter with the selected electric motor are verified for their different rotational speeds. The shield is floating at both ends, possibly connecting an unshielded adapter. In addition, the stand is also intended to select and verify filter components. The selection of filter components was carried out using measuring clamps, which are used to measure the common and differential mode.

Session 6 - Poster Session B / 18

Morphological neural network in medical image processing.

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This paper investigates the use of morphological neural networks in medical image processing, demonstrating their ability to capture spatial structures. The goal of the paper is to investigate the potential of morphological neural networks to outperform traditional convolutional neural networks in tasks like segmentation, classification, and anomaly detection by utilizing morphological operations.

Session 6 - Poster Session B / 19

Implementation of EMG Signal for Prosthetic Hand Control

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The paper presents a constructed model of a prosthetic hand controlled by an electromyographic (EMG) signal. The hand model, along with the forearm, was printed using a 3D printer from PETG material. An Arduino Uno microcontroller was chosen as the control system for the servomechanisms, which act as the execution system. A polyester braid is responsible for transferring the movement of the servomechanisms to the fingers. The prosthesis has two power systems. The first one is responsible for the operation of the microcontroller, and the second powers the executive motors. Three surface electrodes, which are attached to the forearm with a strap, are responsible for reading the electromyographic signal. The measured signal is transmitted to an amplifier and then to the microcontroller, where signal processing and filtering occur. Based on the measurements, control signals are generated to operate the servomechanisms.
During the tests, an analysis of the recorded EMG signal was performed, and trials were conducted to control the prosthesis using the electromyographic signal. The proposed solution allows for the clenching and loosening of the hand, enabling actions such as grasping objects and offering a hand to another person. The conducted studies and tests demonstrated the possibility of using the EMG signal to control the prosthetic hand.

Session 4 - Mathematical Models and Industrial Applications / 20

Input parallel output parallel (IPOP) dual active bridge converters

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The research focuses on galvanically isolated, bidirectional DC//DC dual active bridge converters, which are the basic and essential components in electric energy exchange, including energy storage systems and renewable energy sources. They can be the main building component of larger DC structures called DC microgrids. Creating large-scale power systems usually involves connecting the converters in parallel.
The subject of consideration are converters connected in parallel (IPOP configuration). Issues related to modeling and analyzing the converter operation with consideration of parasitic elements, circulating currents and EMC compatibility are one of the fields of interest. Power modules' baseplate parasitic capacitances and transformer parasitic capacitances play a crucial role in generating EMI, providing paths for uncontrolled high-frequency current flow. Some of them close within one converter whereas else flow through both converters. Analysis of the phenomenon is the main part of research.

Session 6 - Poster Session B / 21

Technical and economic analysis and assessment of the possibility of building an agrophotovoltaic installation based on an existing solar power plant

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Abstract. The aim of the paper is to demonstrate the multidimensional benefits resulting from building a photovoltaic system in agricultural areas intended for asparagus cultivation. Energy, agronomic and economic analyzes will be conducted. For the purposes of extensive energy analyses, solar irradiation and energy production data from an existing solar power plant located in western Ukraine will be used. The agronomic analysis, in turn, will include an in-depth analysis of the conditions for growing asparagus in fertile Ukrainian lands, taking into account weather conditions, soil quality and plant irrigation needs. An important part of this paper will also be an economic analysis determining the profitability of the investment in building an agrophotovoltaic farm. Economic calculations will be made based on the analysis of average electricity prices and asparagus purchase prices applicable to the Ukrainian market. Economic calculations will be carried out on the basis of an analysis of average electricity prices and asparagus purchase prices applicable to the Ukrainian market. The summary of the work will also propose possible ways to improve the agrophotovoltaic system and justify such a choice.

Keywords: agrophotovoltaic system, renewable energy, solar power plant, technical-economic analysis.

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Session 6 - Poster Session B / **22**

Evaluation of Computational Performance of PUF Implementation for IoT Device Authentication

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One of the primary challenges in the Internet of Things (IoT) is efficiently authenticating massively deployed devices without relying on user technical expertise. Traditional methods such as certificates and public-private key pairs are impractical on resource-constrained embedded devices due to their computational demands, while read-only unique identifiers incur high implementation costs, vulnerability to circumvention, and require oversight by authoritative entities. In contrast, Physical Unclonnable Functions (PUFs) utilize the inherent physical properties of devices to securely and reliably generate unique identifiers.

This paper presents an analysis of computational performance in processing data streams from a nonlinear oscillator circuit to generate Physical Unclonable Function (PUF)-based identifiers. The investigated computational tasks include signal acquisition, quantization, error correction, and the application of a final hashing function. These tasks are executed and evaluated on an ARM Cortex-M processor, chosen for its suitability in IoT applications.

The significance of this research lies in exploring computational processes that provide cost-effective, reliable, and scalable methods to enhance IoT device authentication, ensuring trust in such systems. By analyzing the performance of PUF-based unique identifier computation, this study contributes important findings to improving IoT device security through modern, robust authentication mechanisms.

Session 1 - Machine Learning / **23**

Methods of classifying voltage surges using deep neural networks

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Insulating systems of high-voltage electrical devices used in the power industry are exposed to various types of exposure during their operation. Overvoltages in the nature of lightning surges, resulting from the direct or indirect impact of atmospheric discharges - lightning, constitute a certain group of these exposures. For this reason, the need to perform tests and design and acceptance tests of insulating systems of devices that may be subject to such impacts is justified. Insulating materials, insulators, insulating systems of switches, transformers, rotating machines, cables, etc. are tested. The aim is to verify the structural correctness of a given type of device or a specific product by checking the electrical strength of its insulating system with a test voltage of the appropriate shape and value according to standards.

The paper focuses on exploring the potential application of neural networks for the classification of voltage surges compliance with the norm. Therefore, the training dataset comprising 269 voltage surges - 134 correct ones and 135 with incorrect parameters was generated. Three potential neural network architectures were considered for the task - a convolutional neural network (further referred to as CNN), a model combining convolutional and LSTM layers (CNN+LSTM) and a transformer model.

Due to the small dataset size, network models have relatively few layers. For the same reason, data were preprocessed using a sub-sampling of series from 40000 to 1000 points. In the next step, z-score normalization was applied to highlight the differences between the individual time series. The data set was randomly split in an 80:20 ratio to training and test datasets, respectively. Twenty per cent of training data created a validation set.

All three network models were trained by 42 epochs with a batch equal to 32, with an early stopping criterion applied if validation loss did not decrease for the following ten epochs. The best results were achieved by the CNN+LSTM model (accuracy of 87% on the test dataset), followed by the simple transformer model (accuracy: 81.5%), and CNN (accuracy: 72%).

The preliminary results described above show that neural networks can be successfully applied to the task of voltage surge validation and allow for a quick assessment of whether the generated impulse meets the appropriate standard.

In future work, the authors aim to expand the dataset by collecting additional time samples and generating extra data through artificial augmentation. They also intend to improve the current model by hyperparameters tuning and considering other types of networks, such as those treating the input as a two-dimensional image.

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Session 6 - Poster Session B / 24

Application of the GAES Fitting Method for Determining Parameter Values of Cauer Multi-Branch Circuits

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Abstract. Fitting methods are based on optimization techniques. These methods find wide application in the process of designing new systems and devices as well as redesigning existing ones. In the publicly available literature, a significant number of matching methods can be found, including both proprietary and widely known and used algorithms, contained in commercial software such as Matlab, Scilab, and CST Studio Suite [1]. Among the commonly used methods, the most popular are those based on genetic algorithms [2, 3] or optimization methods based on the behavior of various species of animals and insects [4, 5, 6, 7, 8]. Unfortunately, most optimization methods are usually applied to solving problems with a small number of decision variables. For more complex optimization problems, an approach combining elements of evolution strategy (ES) with the genetic algorithm (GA) method is much more frequently used [9, 10]. In this work, the authors, due to the consideration of tasks aimed at finding the extremum not only of a multimodal function but also of a function with many variables, utilized a method combining elements of evolution strategy with the genetic algorithm, i.e., the GAES method. The developed method was used to determine the parameters of Cauer multi-branch circuits. The proposed method allows for the search not only for functions of many variables but also for the values of these variables in a complex form. The authors introduced a number of modifications to the basic GAES method, including a proprietary procedure that enables the gradual narrowing of the search area and, to avoid the method getting stuck in a local extremum, deliberately introduced a proprietary operator called " infusion of fresh blood." This operator allowed the authors to "steer" the decision variables of the function out of a local minimum and enabled finding the global minimum. The article presents the proposed method and its implementation in searching for the parameters of Cauer multi-branch circuits. The correctness of the applied method was verified and the obtained results were compared with the results obtained based on the field model.

Keywords: Fitting Method, Genetic Algorithm, Evolutionary strategies, Cauer multi-branch Circuits.

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Session 2 - Circuits and Measurements / **25**

Characterization of Electromagnetic Fields in a GTEM Cell Using a KSQ1000 Comb Generator and Analysis of Comb Generator Technologies

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This paper presents a comprehensive investigation into the characterization of electromagnetic fields within a Gigahertz Transverse Electromagnetic (GTEM) chamber using a commercially available KSQ1000 comb generator. The measurements provide detailed information on the field uniformity and frequency response across the chamber volume. This data is crucial for ensuring the accuracy and reliability of various electromagnetic compatibility (EMC) testing applications conducted within the GTEM chamber.

Furthermore, the paper delves into the underlying technologies employed for comb generator creation, with a specific focus on Step Recovery Diodes (SRDs) and Non-Linear Transmission Lines (NLTLs). We provide a detailed discussion on the fundamental principles of operation for both technologies, highlighting their respective advantages and limitations in the context of comb generation. This analysis offers valuable insights into the selection criteria for comb generators. By understanding the strengths and weaknesses of SRD and NLTL-based comb generators, researchers and engineers can make informed decisions based on desired output characteristics and specific testing requirements within the GTEM chamber.

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GTEM Cell Characterization:
D. M. Kingsbury and G. W. Kant, "GTEM cell characterization for radiated emissions measurements," in IEEE Transactions on Electromagnetic Compatibility, vol. 46, no. 1, pp. 122-134, Feb. 2004. [This paper focuses on the characterization of GTEM cells, providing context for the application of comb generators in this setting]
IEEE Standard 183-2008 (Revision of IEEE Std 183-1996), "IEEE Standard on Electromagnetic Compatibility - EME Measurement Techniques - Electrostatic Discharge (ESD) Immunity Testing," pp. 1-57, doi: 10.1109/IEEESTD.2008.4626222. [This standard provides an example of how GTEM cells are used in EMC testing, highlighting the relevance of the research]

Additional Resources:
KSQ GmbH. https://ksqtx.com/ (Website of the manufacturer of the KSQ1000 comb generator, potentially containing useful specifications or application notes)
International Electrotechnical Commission (IEC). https://www.iec.ch/homepage (Website of the IEC, which publishes various standards relevant to EMC testing)

Session 5 - Poster Session A / **26**

Interactive visualization of robotic devices and the data provided by them in an augmented reality environment

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Our paper deals with designing and implementing methods for interactive visualization of dynamic spatial data using augmented reality (AR/XR). The data include the work zones of the robots and other information about the environment, e.g. lidar ranges and physical fields are also planned. Visualization takes place using AR headsets Microsoft HoloLens 2. These headsets are equipped with our in-house software modules that allow users to view data and manipulate objects in real-time. The data can of course be both measured and calculated dynamically.
As part of our development, we create suitable tools for spatial data visualization in AR/XR, including their integration and extension for the industry. In this area, the design and implementation of methods for effective data transfer between AR (respectively headset) and real devices. It is necessary to consider different formats, sources, and data characteristics (size, resolution, time dependence, uncertainty...) Applications also include voice and gesture control.
An important part of the development is also the design of suitable ergonomics applications in AR, where standardized solutions and standards have not yet been established, as is the case with the development of common 2D applications.

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Session 6 - Poster Session B / 27

GAN assisted image augmentation for efficient classification of small datasets

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Generative machine learning models are of increased interest in recent years. While they are usage is expanding to multiple fields especially with goal of replacing time consuming repeatable tasks. However such models can be utilised for improving performance of models that are designed for

classification tasks. We discuss application of Generative Adversarial Networks for image augmentation in classification of small datasets. In particular GAN assisted augmentation is compared to classical approach based of affine image transformations. For the proposed augmentation pipeline the StyleGAN2-ADA model is used as it provides built-in adaptive augmentation during the training step. This allows to compare different approaches for integrating a GAN based augmentation into a classification framework. GANs typically require large amounts of data to train effectively, which can be a limitation in scenarios where data is scarce. ADA aims to overcome this limitation by enhancing the data efficiency of GANs, allowing them to train on smaller datasets without sacrificing performance or image quality.

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Session 2 - Circuits and Measurements / **28**

Pushing the Limits Exploring the Dynamic Range in Shielding Effectiveness Measurements

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Title:
Pushing the Limits: Exploring the Dynamic Range in Shielding Effectiveness Measurements

Abstract:
This paper examines how window shape and size affect dynamic range of shielding effectiveness measurements in GTEM cell. By analysing the limitations imposed by window geometry, we provide valuable insights for researchers and engineers seeking to enhance the accuracy and reliability of their shielding effectiveness measurements. We also examine the dynamic range below theoretical cutoff frequency.

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Session 5 - Poster Session A / **29**

Numerical simulation of ceramic material extrusion

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The paper is focused on computer simulations related to the extrusion of ceramic material for continuous 3D printing. The aim is to optimize the process of extrusion of ceramic material using numerical simulations. These simulations are essential for understanding fluid dynamics in 3D printers, especially when working with complex materials such as ceramic clays and clays with additives. The speed at which the material is extruded is optimized. Depending on the printed model, suitable nozzle sizes and layer thicknesses are selected. Based on these computer models, a universal custom ceramic 3D printer was developed. This printer can create mechanically stable shapes and add fine details and decorative elements to final ceramic prints.

Session 4 - Mathematical Models and Industrial Applications / **30**

The application of real-time simulation technology in Mongolian energy system

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This paper inspects the use of real-time simulation technology in the Mongolian energy system for optimization and improved efficiency. Explored the challenges facing Mongolia's energy sector and how real-time simulation can mitigate these problems. Examined the benefits, opportunities, and best practices associated with using real-time simulation within a power grid, as well as Mongolia's transition into an advanced energy infrastructure.

Session 5 - Poster Session A / **31**

Optimization of Susceptor Induction Heating for Generation of Hot Gas

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Industrial high-temperature applications have traditionally depended on fossil energy sources, which are inherently inefficient. Consequently, there is significant interest in exploring efficient and sustainable alternatives. Induction heating technologies, known for their energy efficiency, can be powered by renewable energy sources. This study presents and models a device designed for susceptor-based induction heating of gas, capable of achieving process temperatures exceeding 1800 ℃. The

system works by injecting cold gas into a chamber filled with a highly electrically and thermally conductive porous material. This material is inductively heated and subsequently transfers heat to the gas flowing through it. The performance of this system has been experimentally validated using a hot-gas generator.

Session 5 - Poster Session A / 32

Methods and algorithms for analyzing of steady-state modes and characteristics of the wound rotor induction motor

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An electric drive based on the wound rotor induction motor (WRIM) needs to be optimized. The inclusion of additional resistances in the WRIM rotor circuit is used not only to regulate the motor current and torque during startup, but also to control the rotor speed. The efficiency of an induction drive can be increased by optimally selecting the parameters of the rheostat resistances and the programmable switching law of the starting rheostat sections. To do this, it is necessary to develop programs for numerical analysis of their operation both during startup and cargo movement. The paper deals with the problem of calculating the parameters of the starting rheostat of an induction motor with a phase rotor.
Mathematical models for analyzing the starting modes of an electric drive based on an WRIM have been developed, which allow choosing the numerical values of the resistances of the rheostat sections and their number, based on the starting conditions and the constraints that must be met during the starting process, to carry out mathematical modeling of the starting modes of the electric drive in order to verify the designed solutions. The calculation is based on an advanced mathematical model of the motor (in the form of differential equations of state) developed on the basis of (representational vectors of currents, voltages and fluxes) circuit theory, which takes into account the saturation of the magnetic circuit and the differential method of calculating static characteristics. Electromagnetic processes in the motor are described by a system of nonlinear differential equations of electrical equilibrium, composed in a fixed three-phase coordinate system or transformed to orthogonal x, y coordinates, which is solved by the continuation method by parameter in combination with the iterative Newton's method. The mathematical model of the WRIM uses real magnetization curves calculated on the basis of the geometry of the magnetic circuit and motor winding data, which makes it possible to adequately account for saturation and ensures the accuracy of the calculation results. Mathematical models created on the basis of the proposed calculation algorithm can be used to design regulated asynchronous electric drives based on WRIM and their control systems in order to form the necessary starting characteristics and control algorithms of electric drive systems based on WRIM.

Session 5 - Poster Session A / 33

Cloze tests generation for foreign language learning using transformer networks

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The aim of the paper is to evaluate automatic generation of specific kind of tests for English language learners. The kind of tests that we explore is referred to as cloze tests which are paragraphs of text with gaps which should be filled in by the learners. In the paper, we
explore efficiency of recurrent neural networks and transformer networks (BERT and ELECTRA) compared different quality metrics. The authors make the training and testing datasets available publicly. The general idea is based on paper by Felice at al.\cite{b1}. In the presented research, we extend the loss function with the Kullback–Leibler term and apply extra metrics.
The results present a promising quality of generated test for implementation in an online tool for the English language teachers and students.

Session 5 - Poster Session A / 34

ANALYSIS OF THE INFLUENCE OF THE LOCATION OF HOLES IN BRICKS ON THE ELECTRIC FIELD INTENSITY

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Intelligent construction based on wireless networks and constant connection to the Internet is becoming more and more popular. In the case of wireless communication, it is necessary to take into account not only the demand reported by the constructors of new facilities, but also the modernization of the infrastructure that has been existing for many years. The problem is assessing the reliability of a wireless link inside buildings. Both old and currently used building materials have a huge impact on the intensity of the electromagnetic field. Wave attenuation, e.g. by the material the wall is made of, may even prevent communication. The propagation of electromagnetic waves is strongly dependent on the geometry of the material (e.g. drilling in clinker bricks, admixtures, metal inserts), as well as on its electrical properties.
The aim of the article is to analyze the influence of the location of holes inside bricks on the values of electric field intensity. The subject of the analysis was an isolated system containing a wall made of clinker bricks. The influence of the variability of the width of the holes inside the bricks on the electric field values was considered. The brick was treated as a heterogeneous material. The article also presents the results of the influence of changes in the conductivity of bricks in the considered models on the electric field values. The distribution of the electric field intensity generated by a wireless communication system operating at a frequency of 2.4 GHz is presented. The numerical finite difference time domain method (FDTD) was used. The influence of drilling on the field intensity values in the area behind the wall was discussed. The obtained results may be useful in estimating the value of the damping coefficient for heterogeneous materials used in construction.

Session 5 - Poster Session A / 35

ANALYTICAL AND NUMERICAL EVALUATION OF THE EFFICIENCY OF A LOW POWER WPT SYSTEM

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There is an increase in energy demand in mobile devices. Their computing power and the number of supported sensors are constantly growing. These factors result in an increased demand for batteries with higher capacity, extending their charging time.
One way to power mobile devices is to charge them using wireless power transfer (WPT). Thanks to the concept of inductive power transfer (IPT), it is possible, among others, to wirelessly charge modern technology devices (phones, smartphones, laptops). WPT is becoming more and more widely used. Wireless charging is also suitable for lightning hard-to-reach places or intelligent buildings with sensors in the walls. WPT is considered an alternative method of charging wireless devices.
The article presents the results of the numerical and analytical analysis of the WPT system. The system consists of a transmitting and receiving surfaces, each consisting of flat spiral coils. Both

proposed approaches reduce the size and complexity of models. Two coil systems were also considered: periodic and with variable winding direction. The difference between the proposed systems is a different way of winding the coils. In the periodic system, all coils are wound in the same direction. The influence of the type of coils, winding direction, number of turns and distance between coils on the efficiency of the WPT system was compared. The analysis covered a wide frequency range from 100 kHz to 1000 kHz. The Finite Element Method (FEM) was used for the analysis. Comparing both systems, models with variable coil winding show higher efficiency values. The proposed system allows for simultaneous charging of many sensors (located e.g. in walls).

Session 1 - Machine Learning / **36**

Textual explanations for image classification using multimodal LLM

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In recent years, models based on deep neural networks have demonstrated exceptional capabilities in recognizing and classifying objects in images. Nevertheless, the issue remains with users' trust in the results of these models. In our research, we utilized the multimodal GPT-4o model, which not only classifies objects but also generates explanations for its decisions in natural language. Experiments on artificially generated images showed that both the classifications and explanations were convincing to humans. In the medical context, the model tested on images of skin lesions using the ABCDE method provided justifications that increased the credibility of the responses. These results confirm that textual explanations help users better assess the correctness of the model's answers. Consequently, trust in the model's operation significantly increases. Multimodal models like GPT-4o thus offer not only high accuracy in classification but also decision transparency. This approach is particularly important in critical applications such as medical diagnostics. We conclude that the ability to generate natural language justifications is crucial for the acceptance and trust of users in AI systems.

Session 5 - Poster Session A / **37**

Measurement and Simulation of Radiofrequency Electromagnetic Field Exposure of a Tissue Phantom with an Implanted Pacemaker Device

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The purpose of the article is to investigate electromagnetic field exposure a person with an implanted device experiences when using a mobile phone in the DCS band. This study will involve measuring, analysing, and quantifying RF-EMP exposure to understand its impact on EMF distribution and to identify potential health risks for people with implantable devices. The measurement results are compared to simulation results of RF-EMF exposure of a tissue phantom with an implantable pacemaker device to choose the best model.

Session 3 - Computer Models and Simulations / **38**

Proposal of high attenuating external magnetic field chamber for biological experiment

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This work presents the design, construction and validation of a chamber for magnetic field attenuation. The motivation for this work was set by needs of magnetic background controlling during experimental work focused on behavior of biological samples exposed to various level of the low frequency time-varying magnetic field. Thus the solution is proposed with regard to correct cultivation conditions of microbiological samples. The presented proposal benefits from the means of numerical modeling and simulations, as well as 3D printing techniques. The design process incorporates CAD software for the chamber proposal, subsequent print via 3D printer, followed by construction of attenuating chamber using mu-metal foil. Validation was performed via measurements of magnetic flux density with the chamber, which was compared and confirmed via numerical simulations using CST design Studio. All the solution steps resulted in valid and effective magnetic field attenuation chamber, suitable for use in laboratory conditions.

Since the late 1950s, there have been concerns regarding the potential health effects of non ionizing radiation from radar, other radio, and microwave sources. The potential effects of low-intensity fields, such as low-frequency magnetic fields (LF-MF) from the electric power generating, transmission, and distribution system, as well as intermediate, radio-frequency (RF), and higher-frequency radiation from gadgets like cell phones, broadcast antennas, Wi-Fi, security monitors, and so forth, have arisen more recently. These are concerns about the direct effects of exposure on humans or other organisms [1]. Because of the difficulties in establishing the direct biological effects of long-term low-level magnetic fields exposures, the lack of understood mechanisms, and difficulties in obtaining reproducible results are observed. However, there are proposal of a few theories explained the mechanisms of low-level magnetic fields exposures on the field of quantum biology.

Reactive Oxygen Species Theory was proposed by Barnes and Greenebaum [2]. They outlined a model by which changes in radical concentrations may result from exposures to LF-MF, noting that these changes can lead to biologically significant changes in metabolic rates and other processes. Transitions that alter the populations of the combined electron and nuclear states, or F states, can take place at frequencies that correspond to the energy separation between the various states in the external magnetic fields, especially at low external field intensities. This alters the average population of the singlet (S) and triplet (T) states of the electrons in the radical pair. The pair recombination rates change as a result, which can alter radical concentrations and alter biological processes.

Proton-Proton Coupling Theory assume, that a variation in cell parameters due to a resonance in Fibrosarcoma cells could be initiated by coupling the external magnetic field to the nuclear spins of the protons and changing the rate at which proton-to-proton coupling of nuclear spins in a particular configuration changes. This coupling will be strongest at frequencies that correspond to the J (Total electronic angular momentum) value for the frequency equivalent to the energy levels separating the energy difference between the nuclear spins in the two different orientations with the spins parallel or antiparallel. In turn protons in this configuration may be coupled to the active electrons and change the average population density with a quantum number that is coupled to the chemical reaction rates that are controlling the growth rate of Fibrosarcoma cells and signaling molecules such as hydrogen peroxide. The importance of nuclear spins in determining the quantum number of molecules in weak magnetic fields is discussed in various papers [2], [3] and the measured results are consistent with expectations for proton-proton coupling.

In the light of cited theories an experiments with low-level magnetic fields exposures on biological systems require an additional shielding. To access the capability of high permeability metal shielding following the initial phase of the experiment, a numerical simulation is conducted using CST Studio

Suite. A simulation of the current setup and improved setup with mu-metal shielding are carried out to evaluate positions within the incubator that are more sensitive to environmental and external fluctuations in the static field. As the outcome of simulations' results an design magnetic field attenuation chamber was proposed. The case of chamber was designed in TinkerCad and printed on high resolution 3D printer and covered with one layer of mu-metal. An additional measurements were performed to verify simulation outcome.

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Session 5 - Poster Session A / **39**

Mathematical model of an induction motor with consideration of current displacement in rotor bars using Matlab/Simulink

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A mathematical model of an induction motor with a squirrel-cage rotor is proposed that takes into account the saturation of the magnetic system and the current displacement in the rotor bars. In order to take into account the saturation of the main magnetic flux, the main magnetisation curve is used. To take into account the current displacement, the bars along with the short-circuited rings are partitioned into n layers in height. As a result n windings on the rotor are coupled to the main magnetic flux and covered by different magnetic fluxes of dissipation.

Session 6 - Poster Session B / **40**

Autoencoder-Based Anomaly Detection in Network Traffic

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Due to the continuously increasing number of resources and data available in the cloud, the threats related to the security of computer networks and IT systems are critical. Threat detection systems based on deep neural networks and anomaly detection are trained on data related to normal activity so that the network can recognize unusual patterns and behaviors in the event of an attack or an attempt to infiltrate a given IT infrastructure. This paper presents the results of developing a neural network based on an autoencoder for anomaly detection in network packet data. The network was trained on data

from the HIKARI-2021 dataset. The autoencoder aims to learn representations of normal network traffic and associate this type of traffic with a minimal reconstruction error. The obtained results were compared with those achieved by authors of other works. High accuracy and sensitivity were achieved, at the cost of rather low precision, resulting in many false-positive results. The obtained results were compared with those achieved by authors of other works. To improve the network's ability to detect anomalies, an attempt was made to enhance it by using an error threshold as a vector. The results obtained in the study indicate very high values for individual components of the vector, which results in low network accuracy. Single deviations in the training data can cause disturbances in selecting values for these components, leading to high values for classifying a given record as an anomaly. This problem can be resolved by changing the method of calculating the individual components of the vector, using only a subset of features, and deriving multiple vectors, one for each class separately, which has been described and analyzed in more detail.
Index Terms—anomaly detection, deep learning, cybersecurity, autoencoder, threat detection

Session 6 - Poster Session B / **41**

Industrial Cybersecurity and Machine Learning*

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Nowadays, we are dealing with the development of industrial technologies that bring numerous benefits, but also new threats. Many technological industries are focusing on Industry 4.0, where digitization and process automation are key, and the emerging cyber threats are becoming an increasingly significant problem. As the industry develops, cyber threats evolve. In industry, this requires constantly adapting defence strategies. However, by using machine learning, we can better predict, detect and neutralize threats, protecting key industrial resources from the growing number of cyberattacks.

Increasingly, attention is being paid to using elements of artificial intelligence (AI) for industrial security purposes. As mentioned earlier, this is becoming more important as industrial systems become more complex and exposed to various cyber threats. Machine learning is noteworthy in this context, as it can significantly enhance the security of these systems by automatically detecting anomalies and threats in real time. For example, ML models can analysis data from sensors and PLCs (Programmable Logic Controllers), identifying unusual patterns that may indicate potential attacks or failures.

Today, industry cannot work without PLC controllers, which are a main elements of process automation systems. With technological improvement, need to secure these devices from increasingly sophisticated cyber threats is growing. Machine learning appears to be a tool that can significantly enhance the security of PLC-based systems. Additionally, ML properties can be utilized for predictive maintenance of production processes, allowing for the prediction and prevention of equipment failures, thus minimizing downtime and repair costs.

At the same time, ML systems must be secured against attacks that can manipulate input data to distort the models. Cybersecurity in ML also involves protecting data privacy through techniques that allow for model training without revealing operational data. An integrated approach to cybersecurity, which includes both traditional methods and modern ML techniques, is crucial for protecting industrial infrastructure. Moreover, automating security with additional tools can increase

efficiency in responding to threats.

As ML technology evolves, it is essential to continually research and update protection strategies to keep up with the changing threat area. Finally, educating and training security teams about ML-specific threats is key to effectively protecting industrial systems.

Therefore, the goal of this work is to comprehensively present the role of machine learning in improving cybersecurity in industry, considering both the benefits that this technology brings and the challenges that need to be overcome to effectively protect industrial systems from modern cyber threats.

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Session 5 - Poster Session A / **42**

Research on the Efficiency of Parallel Computations in Relaxation Methods for the Analysis of Dynamic Systems

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Abstract—Peculiarities of the use of parallel computing for the analysis of dynamic systems are studied using the example of the Lotka-Volterra “predator-prey” model. Such relaxation methods as the Jacobi, Gauss-Seidel, SOR and their parallel implementations using Python libraries are considered. The analysis of the efficiency and accuracy of these methods, and the influence of the model parameters on the calculation results, was carried out. A graphical interface for visualization and study of population dynamics has been developed. The obtained results show the potential of parallel computing to accelerate and improve the accuracy of modeling dynamic systems.

Session 5 - Poster Session A / **43**

Modeling and study of the reactive power consumption mode of an arc furnace

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A high-performance system for stabilizing the consumption mode of reactive power of an arc furnace (AF) has been developed. The system operates using the principles of thyristor control of the equivalent inductance of the chokes included in the primary circuit of the furnace transformer. The dependencies of the artificial external characteristics of the arc furnace for multicriteria optimal control of the process to stabilize the reactive power consumption mode are substantiated. A computer model of the proposed system for reactive power optimal stabilization of the arc furnace was created. Model studies the integral indicators of dynamics and energy efficiency in the regulation of random disturbances by the proposed system and a typical arc power regulator of the arc furnace.

The obtained research results showed a comprehensive improvement in the quality indicators of the dynamics of reactive power stabilization and energy efficiency indicators AF.

Session 2 - Circuits and Measurements / **44**

Mathematical Model of a Compensated Asynchronous Motor as an Element of a Microgrid

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A mathematical model for analyzing electromagnetic and electromechanical transients and periodic modes of a compensated induction motor has been developed. The model is formulated in the normal Cauchy form and adapted for use in computer mathematics software environments. The model provides the ability to take into account the circuit, mode, and parametric features of a compensated induction motor as an element of a power supply system (microgrid), the nonlinearity of the web-ramper characteristic of the main magnetic circuit of its magnetic circuit, and the active power losses in it.

Session 3 - Computer Models and Simulations / **46**

Operating conditions of periodic coil systems in the case of deformation of the magnetic layer

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This paper presents a planar, periodic coil system composed of asymmetric elements. The properties of the selected system were considered in view of the shaping of the field distribution and the changes in properties due to local changes in the configuration of the component element.

Session 6 - Poster Session B / **47**

Evaluation of the short circuit current based on the instantenoues values analysis

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The objective of the presented paper is concentrated on the estimation of short-circuit current in electrical power systems. The most methods of short circuit current evaluation presented in the

literature are based on the analysis of numerical grid models. Numerical models comprise whole electrical systems and should be permanently bring up to date. Measurements of real system can append the numerical methods. One of such methods consists on short time short-circuit execution. It is the disturbance method. The method presented in the paper also can be treated as the disturbance method. The short circuit current contains two components - steady state component and transient component. Steady state component can be evaluated by injection to the grid the reactive current. Such method was presented by the authors in the earlier publication. The analysis presented in the presented paper is oriented on the transient component evaluation. The grid parameters are recognized by injection of the current impulse.

Session 3 - Computer Models and Simulations / **48**

Finite Element Method solver with 3D Brick Elements but without Matrix Assembly

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The paper describes a finite element method (FEM) solver for three-dimensional Poisson equation using hexahedral brick elements. This work extends the work of Valdman & Marcinkowski [1] on element-based FEM solvers that does not require assembly of the global matrix, but rather rely only on local, element matrices and a connectivity matrix.

The second part of the paper focuses on different strategies of speeding-up the code for calculating the element stiffness matrices and the connectivity matrix. The aim of the paper is to implement a solver that is able to work with models with millions of degrees-of-freedom.

Experiments of the solver ...
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Session 4 - Mathematical Models and Industrial Applications / **49**

Industrial energy storage system for photovoltaic and wind power systems - selected research results from the implementation of 0.5MWh lithium-ion energy storage system

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In recent years, the share of renewable energy sources in the Polish power system has grown very rapidly. Currently, the installed capacity in photovoltaic and wind sources constitutes over 40% of all power plants in the national power system [1]. Such a large share of unstable and very dynamic energy sources is a significant threat to the stability of the power system and ensuring a balance between supply and demand in the daily balance of electricity [2,3].

The answer to these problems may be high-power and high-capacity battery energy storage devices connected to the AC grid, among which lithium-ion technology currently dominates [4-7]. This type of energy storage can successfully balance the daily demand and energy production in the power system where there are not enough pumped-storage power plants [8,9] (in Poland, the share of these plants in relation to RES is only 5% [1]). As part of the ENERGAN strategic project, financed by The National Centre for Research and Development in Poland [10], DACPOL company has implemented

a full-scale demonstrator of lithium-ion energy storage with a capacity of 500 kWh and a power of 125 kW, which cooperates with a photovoltaic installation with a power of 250 kWp and a low-voltage AC grid (3x400 V, 50 Hz). This article contains selected research results for this energy storage device, documenting, among other things, the energy efficiency of the NMC and LFP lithium-ion technology systems and the correct operation of the complex battery management system (BMS).

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Session 1 - Machine Learning / 50

A comparative analysis of methods for preparing input data for a neural network to assess lightning hazard.

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Designing lightning protection systems by Polish standardization is a standardized, albeit ossified process. Estimating lightning risk, which is the basic stage of this procedure according to the PN-EN 62305 standard, is at risk of error and discretion. This article presents a proposal for automating the above process. Starting with the simulation of the electric field distribution around objects at risk of lightning discharge, neural networks were used to assess the location of places particularly exposed to lightning hazards.
The article contains a short description of the design of lightning protection systems in accordance with PN-EN 62305 and references to the author's previous publications. The automation elements are simulations of the electric field distribution performed in the Ansys Maxwell environment and neural networks indicating locations most at risk of lightning discharge.
An important aspect of the article is the process of preparing data for the neural network, which can be done in two ways. The first is to use the prepared model in Ansys Maxwell and the simulation

results to create an input database. The second one is the Julia environment, and the author's scripts are based on Maxwell's field equations to generate the necessary data for the neural network created in the Darknet environment.
The article also includes a comparison of both methods, conclusions drawn from the considerations, and a plan for further research on the doctoral dissertation.

Session 5 - Poster Session A / **51**

CUDA PIC/MCC implementation in Julia programming language

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This paper presents an original implementation of a Particle-in-Cell (PIC) solver with Monte Carlo Collisions (MCC), fully parallelized on CUDA GPUs and developed entirely in the Julia programming language. By leveraging Julia's capability to write CUDA kernels natively, this implementation effectively addresses the "two-language problem" commonly encountered in high-performance computing. The solver's accuracy was validated using the well-established M. M. Turner's benchmark for capacitively coupled discharges, ensuring the reliability of the results. Performance comparisons against both a sequential CPU version and a state-of-the-art CUDA C implementation reveal that, while the Julia-based solver achieves substantial speedup over the CPU counterpart, it currently falls short of the performance levels attained by the most optimized CUDA C implementations. Further refinements and optimizations are necessary to reach this approach's potential fully.

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Session 3 - Computer Models and Simulations / **52**

Adaptive Finite Element Implementation in Julia

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This paper presents the implementation of a simple adaptive 3D finite element code in the Julia programming language. The library was developed to build a tool for the automated creation of numerous simulations, forming a database

for deep neural network training. The author aims to present Julia as an extremely

Session 6 - Poster Session B / **53**

Wavelets Application for Derivative Probes Signal Integration Procedures

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The paper contains outcomes of the Authors'research in the field of the procedure development for the signals acquired by the derivative EM field probes.

Opening / **54**

Network Traffic Classification: Machine Learning vs. Deep Learning Approach

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Session 5 - Poster Session A / **55**

Design of reconfigurable circular polarization equilateral triangular antenna without and with air gap

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This paper presents a comparative performance study of an equilateral triangular patch antenna (ETPA) with and without an additional air gap substrate. The proposed antenna covers the S-band (2.4GHz-2.5GHz) for satellite communication. The antenna consists of truncated equilateral triangular patches connected at the truncated corners by two PIN diodes to the two parasitic triangular patches. A dual circular polarization is obtained by switching the PIN diodes in ON and/or OFF state. An additional air gap is introduced between the ground and the substrate to improve the gain and the bandwidth(sparameter and axial ratio).The simulated results demonstrate a 7.76 dBic realize gain, a return loss bandwidth of 195 Mhz and axial ratio bandwidth of 51 Mhz.