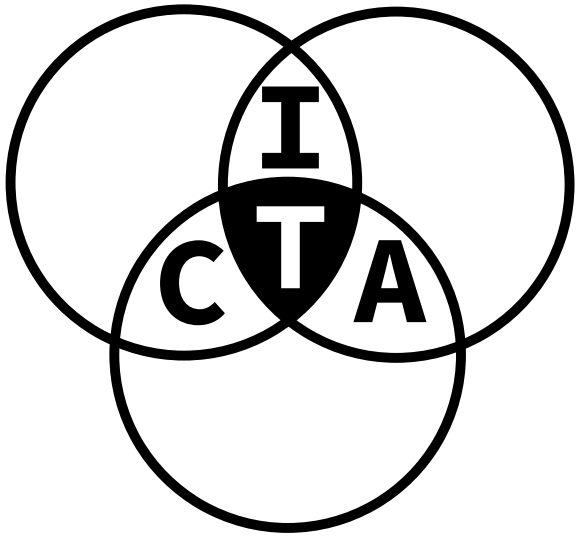
ICAT 2023
B O O K L E T



29th International Conference
on
Information, Communication and Automation Technologies
June 11 – 14, 2023
Sarajevo, Bosnia and Herzegovina

Organized by

Faculty of Electrical Engineering Sarajevo

Welcome message

Dear Colleagues,

On behalf of the organizing committee, we are pleased to welcome you to the 29th International Conference on Information, Communication and Automation Technologies – ICAT 2023, technically co-sponsored by the IEEE Industrial Electronics Society (IES), IEEE Control Systems Society (CSS), and IEEE Systems, Man, and Cybernetics Society (SMCS), which will be held on June 11-14, 2023, in Sarajevo, Bosnia and Herzegovina. ICAT 2023 aims to create a forum for scientists and practicing engineers throughout the world to present the latest research findings and ideas in the areas of computer science, information technologies, control systems, communication technologies and power engineering.

Sarajevo is the capital of Bosnia and Herzegovina and the country's administrative, economic, cultural, education and sport center. Sarajevo is known as "Jerusalem of Europe". For several hundred years, the borders of two great empires, the Ottoman and Austro-Hungarian, which represented the two poles of the world at that time – East and West, Islamic and Christian – met in Bosnia and Herzegovina. This made the country and its capital a crossroads for different worlds – a place where the Orient met Occident in the heart of the Balkans. Sarajevo is one of those rare cities where, during a ten-minute walk, you can see places of worship for the world's most important monotheistic religions: Orthodox and Catholic churches, synagogues, and mosques. All these traditions have given Sarajevo a specific aroma and a particular cultural mix.

As the ICAT 2023 organizing committee, we will make every effort to make your visit a unique experience for you, with productive technical and memorable social activities. We look forward to the opportunity of meeting you and hosting you..

General Chairs
Ljiljana Trajković
Tarik Uzunović

Table of Contents

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General information

Date and place

29th International Conference on Information, Communication and Automation Technologies (ICAT 2023) will be held in Sarajevo, Bosnia and Herzegovina, on June 11 - 14, 2024 in Hotel Holiday Sarajevo.

ICAT 2023 Secretariat

ICAT-2023 Secretariat
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URL: http://icat.etf.unsa.ba

Official language

The official language of the Conference is English.
All presentations must be made in official language.

Registration

Registration desk will be opened for registration and general information on:
- Sunday, 11.06.2023. 16:00 - 18:00
- Monday, 12.06.2023. 09:00 - 14:00
- Tuesday, 13.06.2023. 09:00 - 14:00

Registration fees can be paid in cash (in local currency only) at the conference registration desk.

Internet access

Internet access is available at the hotel premises (ask for internet vouchers at the registration desk).

Message center

Message center will be situated at the Registration desk of the Conference.

Social events

Opening Ceremony

Opening ceremony will take place on Monday, 11.06.2023 @ 09:30 at Hotel Holiday (Room Holiday), our main venue.

Conference Gala Dinner

Conference Gala Dinner will take place on Monday, 11.06.2023 @ 19:00.

Transportation will be organized (a bus will pick up participants at 18:30 in front of the conference venue).

For any additional information about dinner please ask at the Registration Desk or visit conference web site.

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- Zlatan Akšamija, University of Utah, USA
- Zoran Salčić, University of Auckland, New Zealand

Abstracts
of the

29th International Conference
on
Information, Communication and Automation Technologies

ICAT 2023

Plenary talk 1-1: *Karl H. Johansson: Traffic control using automated vehicles: distributed sensing, actuation, and learning*

Date:	12.06.2023
Time	10:00 – 10:45
Room:	Holiday

Abstract: *While the long-term benefits of introducing connected and automated vehicles into road traffic are widely understood to be revolutionary, there is much debate about whether its early stages will cause an increase in congestion and issues related to human-driven vehicles. Notwithstanding, connected vehicles acting as mobile sensors and actuators could enable traffic predictions and control at a scale never before possible, and thereby a much more efficient use of the available and future road infrastructure. In this talk, we will present how new freight transport technology based on automated truck platoons can be the backbone for such a system. Some fundamental theoretical and experimental results on the control and coordination of truck platoons will be presented. How such platoons influence traffic flows by acting as a moving bottleneck will be discussed together with traffic models suitable for designing novel traffic control systems. It will also be argued that these models are possible to learn automatically from data gathered by platoons acting as traffic flow sensors. Experiments show that relatively few connected vehicles are enough to mitigate congestion and improve traffic conditions significantly. The presentation is based on joint work with many students and postdocs at KTH and researchers at Swedish automotive industry.*

Plenary talk 1-2: *David Abbink: Worker-Robot Relations – shaping the future of physical work*

Date:	12.06.2023
Time	10:45 – 11:30
Room:	Holiday

Abstract: *In a time of complex societal challenges around an ageing population and mounting labour shortages, we need to find new ways to live, consume and work. Technological developments may help to address these challenges, but physical work performed by people will remain important for vital sectors such as flexible manufacturing, healthcare and logistics. A new generation of robots presents the opportunity to shape the future of physical work in a meaningful way. Cognitive robots, with their learning capabilities for moving and manipulation, will respond to and learn from workers, while workers will learn from and adapt to these new robots on the workfloor - creating new opportunities for workplace innovation, while increasing risks of misalignment. Understanding how this reciprocal learning evolves requires a new relational perspective that jointly considers processes of change and learning between robots, workers, organisations and other stakeholders. These emerging worker-robot relations (WRRs) hold an unprecedented potential for societal impact. So far, WRR development has been left to market pull and technology push, and the unintended consequences for work and worker wellbeing will only be identified in hindsight. David will present his perspective on the future of work and very recent work he is doing in leading a consortium of roboticists, HRI experts, designers, psychologists, organisational scholars and ethicists. Together they aim to proactively maximise the potential of increasing capabilities in cognitive robots for a meaningful, just and viable future of work..*

Plenary talk 2-1: *Petar Popovski: Satellite Connectivity: 6G Wireless and Distributed Intelligence*

Date:	13.06.2023
Time	09:30 – 10:15
Room:	Holiday

Abstract: *Wireless mobile generations until 5G have been focused exclusively on terrestrial communications. With the emergence of small satellites and large Low Earth Orbit (LEO) constellations, non-terrestrial networks (NTN) become key components of the upcoming 6G wireless networks. Leveraging the proper constellation design, as well as the necessary communication and processing capabilities, LEO constellations have the ability of providing global coverage, even for low latency Internet services. Due of this, dense constellations of hundreds or even thousands of small satellites flying in LEO are currently under deployment. The first part of the talk will cover fundamentals of satellite constellation design, communications and networking, with a focus on mega constellations in LEO. The second part of the talk will be dedicated to distributed machine learning algorithms that take advantage of the predictable satellite connectivity.*

Plenary talk 2-2: *Petar Veličković: Reasoning Algorithmically: from Toy Experiments to AGI Modules*

Date:	13.06.2023
Time	10:15 – 11:00
Room:	Holiday

Abstract: *Neural networks that are able to reliably execute algorithmic computation may hold transformative potential to both machine learning and theoretical computer science. On one hand, they could enable the kind of extrapolative generalisation scarcely seen with deep learning models. On another, they may allow for running classical algorithms on inputs previously considered inaccessible to them. Over the past few years, the pace of development in this area has gradually become intense. As someone who has been very active in its latest incarnation, I have witnessed these concepts grow from isolated 'toy experiments', through NeurIPS spotlights, all the way to helping detect patterns in complicated mathematical objects (published on the cover of Nature) and supporting the development of generalist reasoning agents. In this talk, I will give my personal account of this journey, and especially how our own interpretation of this methodology, and understanding of its potential, changed with time. It should be of interest to a general audience interested in graphs, (classical) algorithms, reasoning, and building intelligent systems.*

Workshop 1-1: Artificial Intelligence Applications in Healthcare and Biomedicine

Chair:	**Date:**	12.06.2023
Abdulhamit Subasi	**Time**	15:30 – 17:30
	Room:	Holiday

Abstract: *Artificial Intelligence (AI) applications have emerged as game-changers in healthcare and biomedicine, transforming the landscape of medical research and patient care. AI algorithms have the ability to process and analyze massive amounts of data, enabling faster and more accurate diagnosis of diseases. By leveraging machine learning techniques, AI can identify patterns and anomalies in medical images, such as X-rays and mammograms, facilitating early detection of conditions like tumors and abnormalities. This not only improves patient outcomes but also reduces the burden on healthcare systems by enabling early intervention and preventive measures. In addition to diagnosis, AI has also proven its potential in personalized medicine and treatment planning. By analyzing patient data, including genetic profiles and medical histories, AI algorithms can generate tailored treatment plans that take into account individual factors such as genetic predispositions, lifestyle choices, and drug interactions. This personalized approach allows healthcare professionals to optimize treatment strategies, improving efficacy and reducing the risk of adverse effects. Furthermore, AI-powered virtual assistants and chatbots are enhancing patient engagement and support by providing 24/7 access to accurate medical information, answering queries, and even monitoring patient health remotely. As AI continues to advance, its applications in healthcare and biomedicine hold great promise for improving patient outcomes, increasing efficiency, and driving innovation in the field.*

Workshop 2-1: Industrial Workshop by Infineon

Chairs:	**Date:**	13.06.2023
Dr. Leonhard Kormann	**Time**	15:00 – 16:30
Dr. David Brunner	**Room:**	Holiday

Abstract: *Ready for Mission Future? Join our Infineon sessions at ICAT 2023*
Let's talk about the challenges faced and the innovative solutions developed:
"Next Generation of Head-up Display with Infineon MEMS Mirrors to make cars safer and smarter":
Infineon's advanced technology offers a host of benefits, including form factor, energy efficiency, and cost-effectiveness that outshine state-of-the-art solutions – despite the tough challenges imposed by automotive environments on system robustness. Join us on this exciting journey towards creating the future of Automotive Headup Display technology and learn how Infineon develops and controls MEMS Mirrors to do just that.
In addition to that, participating students will gain valuable insights into Infineon's overall mission, the importance of the IPCEI project, and the exciting opportunity to start an internship or pursue a PhD with our IPCEI program.
We are looking forward to connecting with you.

Session 1-1: Mechatronics & Control Systems 1

Chair:	**Date:**	June 12, 2023
Bakir Lačević	**Time**	12:00 - 14:00
	Room:	Holiday

Perspective Projection Approach to a Faster UAV Navigation and Obstacle Avoidance Learning

Authors: *Stefani Kecman (Faculty of Electrical Engineering University of Sarajevo), Dinko Osmankovic (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Interest in research of the navigation problem for Unmanned Aerial Vehicles (UAVs) is on the rise. The aim of such a task is reaching a goal position while avoiding obstacles on the way. In this paper, we propose a different approach to Deep Reinforcement Learning (DRL) of navigation decision making process by introducing the reward function based of Artificial Potential Fields (APF). The validation of the proposed approach is performed by the comparison to the state-of-the-art approach. In terms of training performance, success rate, memory usage and the inference time, our approach, though sparser in terms of perceived information about the environment, yield better results.*

Track: AI and Data Science
PaperId: ICAT23-000008

KF-RRT: Obstacles Tracking and Safe Dynamic Motion Planning for Robotic Manipulators

Authors: *Hadzem Hadžić (Faculty of Electrical Engineering University of Sarajevo), Dinko Osmanković (Faculty of Electrical Engineering University of Sarajevo), Bakir Lačević (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *This paper presents KF-RRT algorithm: a novel approach to path planning for robotic manipulators in dynamic environments. It is based on a modified RRT algorithm combined with Kalman filtering technique. RRT modification implies two aspects. The first one is related to continuous update of structure/ordering within the tree to accommodate for online execution of the algorithm. The second one relies on forest-based replanning by combining connected components. On the other hand, Kalman filter is used to track/predict the motion of obstacles. Virtually augmented obstacles influence the growth of trees, which yields the improved safety margin of the resulting motion. KF-RRT is validated within a simulation study, where it is compared to competing algorithms.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000009

A Simple and Elegant Method for Computing the Inverse Z-transform of Rational Functions

Authors: *Željko Jurić (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Finding the inverse z-transform of a rational function is usually considered a completely routine task with nothing special to say about it. However, practically all the procedures described in the engineering literature for doing this task can be very laborious for manual calculation when the function whose inverse z-transform is sought has multiple poles. This is often a problem for students when solving homework and exam tasks. The situation is particularly awkward when the poles are ugly numbers. Additionally, the described procedures are very unsuitable for programming on a computer. This paper proposes a simple, elegant and student-friendly way to calculate the inverse z-transform of a rational function. In addition to the basic variant, which is most suitable for manual calculation when the poles are relatively nice numbers, there are also variants that may be more suitable in other cases, including a variant that is extremely suitable for programming on a computer, even on the programmable calculators.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000013

LPV state-feedback control of a robotic manipulator via LMI optimization

Authors: *Zoltán Téczely (Budapest University of Technology and Economics), Bálint Kiss (Budapest University of Technology and Economics)*

Abstract: *This paper presents an LPV model-based controller synthesis case study on a 2-DOF robotic manipulator. A polytopic LPV formulation was chosen with two scheduling variables. An $\boldsymbol{H}\infty$ control strategy was used for the reference tracking objective which was implemented through LMI optimization and was compared to a nominal $\boldsymbol{H}\infty$ controller and feedback linearization extended with PD reference tracking criterion. The solution was tested on a real-life robotic arm located at BME Robotics Laboratory. Numerical evaluation was based on a joint measure of performance and robustness.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000016

E-VCU Software Toolbox for ARM Cortex-R4 Processor based Electric Vehicle Control

Authors: *Mostafa Abdelkhalek (Department of Aeronautical Engineering Istanbul Technical University), Afsin Baran Bayezit (Department of Shipbuilding and Ocean Engineering Istanbul Technical University), Ismail Bayezit (Department of Aeronautical Engineering Istanbul Technical University), Yasin Bircan (Department of Electronic Design, Altnay e-Mobility Inc.), Aytug Cakir (Department of Research and Development, TOFAS Inc.), Furkan Kurtoglu (Department of Research and Development, TOFAS Inc.), Deniz Mandaci (Department of Electronic Design, Altnay e-Mobility Inc.), Gokhan Erunlu (Department of Electronic Design, Altnay e-Mobility Inc.), Baris Fidan (Department of Mech. and Mechatronics Eng. University of Waterloo)*

Abstract: *Electric Vehicles (EVs) are essential for addressing climate change but developing a safe and reliable EV presents significant challenges. Compliance with functional safety standards, such as IEC 61508 and ISO 26262, is vital for EV manufacturers. However, the traditional approach of writing functional safety-compliant C code for Electric Vehicle Control Unit's (E-VCU) is complex, time-consuming, and prone to errors. Companies who provide selective hardware with model-based design support with specific software environment such as dSPACE, VECTOR, SpeedGoat and NI, are increasingly preferred by the industry to address these issues. As such, we propose a MATLAB/Simulink toolbox that allows users to do development on the TMS570LS31x microcontroller through Simulink interface to address the same issues. Our toolbox streamlines the design process by allowing for easy and efficient development of software models without requiring extensive hard coding. Additionally, the selected software environment provides tools to verify and validate the functional safety compliance of the Simulink models, ensuring the resulting product meets automotive grade safety-critical*

standards. We test our library using a novel TMS570LS31x-based E-VCU on a test bench and a real electric car. The system's functionality is monitored using our data logger blocks and Graphical User Interface (GUI) application in real-time.

Track: Mechatronics and Control Systems
PaperId: ICAT23-000029

A Multi-Heuristic Search-based Motion Planning for Automated Parking

Authors: *Bhargav Adabala (FH Joanneum), Zlatan Ajanovic (TU Delft)*

Abstract: *In unstructured environments like parking lots or construction sites, due to the large search-space and kinodynamic constraints of the vehicle, it is challenging to achieve realtime planning. Several state-of-the-art planners utilize heuristic search-based algorithms. However, they heavily rely on the quality of the single heuristic function, used to guide the search. Therefore, they are not capable to achieve reasonable computational performance, resulting in unnecessary delays in the response of the vehicle. In this work, we are adopting a Multi-Heuristic Search approach, that enables the use of multiple heuristic functions and their individual advantages to capture different complexities of a given search space. Based on our knowledge, this approach was not used previously for this problem. For this purpose, multiple admissible and non-admissible heuristic functions are defined, the original Multi-Heuristic A* Search was extended for bidirectional use and dealing with hybrid continuous-discrete search space, and a mechanism for adapting scale of motion primitives is introduced. To demonstrate the advantage, the Multi-Heuristic A* algorithm is benchmarked against a very popular heuristic search-based algorithm, Hybrid A*. The Multi-Heuristic A* algorithm outperformed baseline in both terms, computation efficiency and motion plan (path) quality.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000028

Session 1-2: AI & Data Science

Chair:	**Date:**	June 12, 2023
Amila Akagić	**Time**	12:00 - 14:00
	Room:	Drina

Using temporal user profiles in collaborative filtering recommender system

Authors: *Bakir Karahodža (Faculty of Traffic and Communications University of Sarajevo), Dženana Đonko (Faculty of Electrical Engineering University of Sarajevo), Haris Šupić (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Time-aware recommender systems extend traditional recommendation methods by revealing user preferences over time or observing a specific temporal context. Among other features and advantages, they can be used to provide rating predictions based on changes in recurring time periods. Their underlying assumption is that users are similar if their behavior is similar in the same temporal context. Existing approaches usually consider separate temporal contexts and generated user profiles. In this paper, we create user profiles based on multidimensional temporal contexts and use their combined presentation in a user-based collaborative filtering method. The proposed model provides user preferences at a future point in time that matches temporal profiles. The experimental validation demonstrates that the proposed model is able to outperform the usual collaborative filtering algorithms in prediction accuracy.*

Track: AI and Data Science
PaperId: ICAT23-000010

SqueezeJet-3: An HLS-based Accelerator for Edge CNN Applications on SoC FPGAs

Authors: *Panagiotis Mousouliotis (School of Electrical and Computer Engineering, University of Thessaloniki), Nikolaos Tampouratzis (School of Electrical and Computer Engineering, University of Thessaloniki), Ioannis Papaefstathiou (School of Electrical and Computer Engineering, University of Thessaloniki)*

Abstract: *Most FPGA-based Convolutional Neural Network (CNN) hardware accelerators target the datacenter rather than edge processing units. To further fill this gap, this work presents SqueezeJet-3 and the corresponding design flow of a novel FPGA-based embedded system, consisting of software and hardware for accelerating edge CNN inference. SqueezeJet-3 is optimized for accelerating small ImageNet class CNNs, such as SqueezeNet v1.1 and ZynqNet, on low-end low-cost SoC FPGA devices. SqueezeJet-3 is evaluated against the DietChai accelerator, which is part of Xilinx's ChaiDNN v2 framework, in terms of performance, resource utilization, power, and accuracy; the results demonstrate that for the acceleration of SqueezeNet v1.1, SqueezeJet-3 is better than DietChai in all categories. Our evaluation results also show that, by using the presented design framework, a developer can implement FPGA accelerators for larger CNNs, such as the VGG16, with similar performance to the accelerators designed by Angel-Eye and fpgaConvNet frameworks which are optimized for VGG16-like CNN networks.*

Track: AI and Data Science
PaperId: ICAT23-000012

Proposal of a model for credit risk prediction based on deep learning methods and SMOTE techniques for imbalanced dataset

Authors: *Adaleta Gicic (Faculty of Electrical Engineering University of Sarajevo), Donko Dženana (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Implementation of credit scoring models is a demanding task and crucial for risk management. Wrong decisions can significantly affect revenue, increase costs, and can lead to bankruptcy. Together with the improvement of machine learning algorithms over time, credit models based on novel algorithms have also improved and evolved. In this work, novel deep neural architectures, Stacked LSTM, and Stacked BiLSTM combined with SMOTE oversampling technique for the imbalanced dataset were developed and analyzed. The reason for the lack of publications that utilize Stacked LSTM-based models in credit scoring lies exactly in the fact that the deep learning algorithm is tailored to predict the next value of the time series, and credit scoring is a classification problem. The challenge and novelty of this approach involved the necessary adaptation of the credit scoring dataset to suit the time sequence nature of LSTMbased models.This was particularly crucial as, in practical credit scoring datasets, instances are not correlated nor time dependent. Moreover, the application of SMOTE to the newly constructed three-dimensional array served as an additional refinement step. The results show that techniques and novel approaches used in this study improved the performance of credit score prediction.*

Track: AI and Data Science
PaperId: ICAT23-000015

The synergy of Linear Regression, Fuzzy Functional Dependencies and Linguistic Summaries: A Case of Heat Islands in Bratislava

Authors: *Erika Mináriková (Faculty of Economic Informatics University of Economics in Bratislava), Miljan Vučetić (Artificial Intelligence Department Vlatacom Institute of High Technology, Faculty of Informatics and Computing Singidunum University), Miroslav Hudec (Faculty of Economic Informatics University of Economics in Bratislava, Faculty of Economics VSB–Technical University of Ostrava)*

Abstract: *The last decade has witnessed a rapid development of computational intelligence models in many scientific and industry fields. One of challenges is the lack of interpretability and explainability of the mechanism underlying the models. In this paper, we propose a methodology for evaluating and explaining influences by linear regression and by fuzzy logic techniques, which have been shown as promising approaches for the explainable computational intelligence. Precisely, fuzzy functional dependencies are able to verify regression result and explain intensities linguistically, whereas linguistic summaries can reveal intensities of relations among the subdomains of considered features. The proposed synergy is experimentally evaluated on the problem of explaining the influence of geographical features on the urban heat islands in the Bratislava downtown. Urban planning and development should consider environmental aspects. Thus, a support which is validated by three diverse approaches is more reliable.*

Track: AI and Data Science
PaperId: ICAT23-000023

Early Stage Flame Segmentation with Deep Learning and Intel's OpenVINO Toolkit

Authors: *Medina Kapo (Faculty of Electrical Engineering University of Sarajevo), Adnan Šabanović (Faculty of Electrical Engineering University of Sarajevo), Amila Akagic (Faculty of Electrical Engineering University of Sarajevo), Emir Buza (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *With the advancements of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL), it is now possible to greatly speed up the processes of predicting certain anomalies and prevent unforeseen situations and disasters. One example of such an environmental disaster is the problem of early-stage flame segmentation. It is not only important to create a model capable of pattern recognition with high accuracy but also to optimize it for real-time execution. In this paper, we demonstrate the capabilities of Deeplabv3+ for early-stage flame segmentation on a custom-made dataset with challenging conditions, and near real-time execution with the adoption of the OpenVINO toolkit. Acceleration of the inference process in the range of 70.46% to 93.46% is achieved, while the speed of the inference process when using the GPU with FP16 precision is increased by almost 2 times when compared to FP32 precision. The impact of our findings is significant, as early-stage flame segmentation is a critical component of disaster prevention in environmental settings. Our results demonstrate the potential of using the OpenVINO toolkit for the acceleration of the inference process.*

Track: AI and Data Science
PaperId: ICAT23-000049

Analysing Transfer Learning Efficacy with Different Feature Sets for Occupancy Detection

Authors: *Ermin Omeragic (Faculty of Computer and Information Science University of Ljubljana), Ozan Orhan (EnOcean GmbH), Tarik Uzunovic (Faculty of Electrical Engineering University of Sarajevo), Edin Golubovic (EnOcean GmbH)*

Abstract: *Occupancy detection is one of the key elements in improving the energy performance of buildings. Due to their nature, occupancy detection models could be trained on old building data and adapted to new buildings for faster onboarding. We explore and analyse the transfer learning framework applied to occupancy detection. We use a combination of Long-short Term Memory neural network and convolutional neural network architectures and test the transfer learning framework on three datasets. The results show that the transferred models perform better than non-transferred models in almost all metric and dataset combinations.*

Track: AI and Data Science
PaperId: ICAT23-000022

Session 1-3: Software Engineering & Information Systems

Chair:	**Date:**	June 12, 2023
Saša Mrdović	**Time**	15:30 - 17:30
	Room:	Drina

Using Genetic Algorithms for Load Balancing in Cloud Computing

Authors: *Lejla Hodžić (Faculty of Electrical Engineering University of Sarajevo), Saša Mrdović (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *The cloud has become an essential part of modern computing, and its popularity continues to rise with each passing day. Currently, cloud computing is faced with certain challenges that are, due to the increasing demands, becoming urgent to address. One such challenge is the problem of load balancing, which involves the proper distribution of user requests within the cloud. This paper proposes a genetic algorithm for load balancing of the received requests across cloud resources. The algorithm is based on the processing of individual requests instantly upon arrival. The conducted test simulations showed that the proposed approach has better response and processing time compared to round robin, ESCE and throttled load balancing algorithms. The algorithm outperformed an existing genetic based load balancing algorithm, DTGA, as well.*

Track: Software Engineering and Information Systems
PaperId: ICAT23-000011

Enhancing Performance of CUDA Quicksort Through Pivot Selection and Branching Avoidance Methods

Authors: *Irvin Ćatić (Faculty of Electrical Engineering University of Sarajevo), Mehmed Mujić (Faculty of Electrical Engineering University of Sarajevo), Novica Nosović (Faculty of Electrical Engineering University of Sarajevo), Tarik Hrnjic (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *This paper presents a fine-tuned implementation of the quicksort algorithm for highly parallel multicore NVIDIA graphics processors. The described approach focuses on algorithmic and implementation-level improvements to achieve enhanced performance. Several fine-tuning techniques are explored to identify the best combination of improvements for the quicksort algorithm on GPUs. The results show that this approach leads to a significant reduction in execution time and an improvement in algorithmic operations, such as the number of iterations of the algorithm and the number of operations performed compared to its predecessors. The experiments are conducted on an NVIDIA graphics card, taking into account several distributions of input data. The findings suggest that this fine-tuning approach can enable efficient and fast sorting on GPUs for a wide range of applications.*

Track: Software Engineering and Information Systems
PaperId: ICAT23-000014

VoteChain - A Blockchain-Based Voting Platform

Authors: *Aldin Kovačević (Department of Information Technologies International Burch University), Dino Kečo (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Due to increasingly widespread electoral corruption, citizens are slowly starting to lose trust in the fairness of democratic elections. The main objective of VoteChain is the elimination of the aspect of trust from the electoral process, in order to make voting more secure, transparent, and easily accessible. This paper proposes and implements a robust system that enhances voting efficiency by creating an electronic platform on top of a distributed Bitcoin Cash blockchain ledger. Blockchain represents a time-stamped series of immutable data records shared across a distributed network. When utilized in the context of voting, it guarantees full anonymity, vote integrity, and a fair, incontrovertible ledger with verifiable election results to all voters. Moreover, the system offers the ability to vote via any Internet-enabled computer or smartphone, dramatically decreasing the overall election organization costs. The system is envisioned as an application that connects to the Bitcoin Cash blockchain network via a custom feature-rich library. After discussing the system's characteristics, design, and underlying technology, this paper presents an example election scenario explaining how VoteChain works in-depth. In the end, the system's possible shortcomings are outlined, along with its prospective evolution and potential improvements that can be implemented.*

Track: Software Engineering and Information Systems
PaperId: ICAT23-000019

Parallel DNA sequencing with exact and approximate string-matching algorithms

Authors: *Amila Begovic (Faculty of Electrical Engineering University of Sarajevo), Senija Kaleta (Faculty of Electrical Engineering University of Sarajevo), Eldar Panjeta (Faculty of Electrical Engineering University of Sarajevo), Elma Polutan (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *String-matching algorithms are concerned with locating specific patterns within larger strings or text files. This problem of exact sequence matching is studied in various fields of molecular biology, data compression, and information retrieval. Therefore, the goal of this paper is to address problems that string matching algorithms have when used on DNA sequences. The main obstacles are the pattern and text lengths that are used as input data. The main content and the whole goal is to adapt the parallel string matching problem to a larger size of text and adapt exact brute force to fit the idea of a DNA matching that can not have 100% matching. To achieve that idea is to implement naive k-mismatches that allow matching to 99% which is acceptable when talking about DNK sequences.*

Track: Software Engineering and Information Systems
PaperId: ICAT23-000038

Session 2-1: Mechatronics & Control Systems 2

Chair:	**Date:**	June 13, 2023
Senad Huseinbegović	**Time**	11:30 - 13:30
	Room:	Holiday

Decentralized Multi-Robot Formation Control Using Reinforcement Learning

Authors: *Juraj Obradovic (Faculty of Electrical Engineering and Computing, University of Zagreb), Stjepan Bogdan (Faculty of Electrical Engineering and Computing, University of Zagreb), Marko Krizmancic (Faculty of Electrical Engineering and Computing, University of Zagreb)*

Abstract: *This paper presents a decentralized leader-follower multi-robot formation control based on a reinforcement learning (RL) algorithm applied to a swarm of small educational Sphero robots. Since the basic Q-learning method is known to require large memory resources for Q-tables, this work implements the Double Deep Q-Network (DDQN) algorithm, which has achieved excellent results in many robotic problems. To enhance the system behavior, we trained two different DDQN models, one for reaching the formation and the other for maintaining it. The models use a discrete set of robot motions (actions) to adapt the continuous nonlinear system to the discrete nature of RL. The presented approach has been tested in simulation and real experiments which show that the multi-robot system can achieve and maintain a stable formation without the need for complex mathematical models and nonlinear control laws.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000026

Control-Oriented Modeling and Cascade Control of Container Ships

Authors: *Ahmad Irham Jambak (Department of Mechatronics Engineering Istanbul Technical University), Ismail Bayezit (Department of Aeronautical Engineering Istanbul Technical University), Omer Kemal Kinaci (Department of Shipbuilding and Ocean Engineering Istanbul Technical University), Baris Fidan (Department of Mechanical and Mechatronics Engineering University of Waterloo)*

Abstract: *The development of autonomous ship motion control is gaining importance in the maritime transportation industry as autonomous ships can improve safety, efficiency, capacity, and environmental impact while reducing labor costs. However, most research on this topic has focused on nonlinear ship models coupled with complex control system designs, which are not feasible for some scenarios such as executing turning maneuver in real-time application for typical mass-produced cargo ships due to needs for high computational capability. To address this issue, this paper presents a practical control-oriented ship model using a superposed nonlinear propeller model on a linear ship motion dynamics. The developed model is validated using standard turning circle tests and a cascaded control algorithm is designed for waypoint tracking. The algorithm is tested with different scenarios to evaluate its ability to move the ship along prescribed trajectories, and simulation results show successful performance of the controller. Overall, this approach provides a reliable and practical solution for controlling autonomous ships in real-time applications.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000030

Trajectory Tracking of the Octo-Rotor Unmanned Aerial Vehicle Exposed to Parametric Uncertainties and External Disturbances Using First Order Sliding Mode Control

Authors: *Almir Salihbegovic (Faculty of Electrical Engineering University of Sarajevo), Vedad Capin (Faculty of Electrical Engineering University of Sarajevo), Emir Sokic (Faculty of Electrical Engineering University of Sarajevo), Osmic Nedim (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Control design for trajectory tracking of multi-rotor aerial vehicles (MAVs) represents a challenging task due to the under-actuated property, highly nonlinear and cross-coupled dynamics, modeling errors, parametric uncertainties and external disturbances. This paper presents the design of the first order sliding mode control (FOSMC) algorithm for trajectory tracking of the octo-rotor unmanned aerial vehicle (UAV) in the presence of various disturbances. The highly nonlinear octo-rotor UAV dynamics is considered via the generalized framework for MAVs modeling. The stability analysis of the closed-loop system is presented using the Lyapunov based approach. The developed FOSMC exhibits finite-time convergence of the octo-rotor trajectories to the sliding manifold and the asymptotic stability of the equilibrium in the presence of vanishing disturbances. Simulation studies show a superior tracking performance and robustness properties of the FOSMC in comparison with the concurrent techniques for trajectory tracking of the octo-rotor UAV in the presence of internal and external disturbances.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000031

Vision-guided Unified Task and Motion Planning for Multiple Robots in Cluttered Environments

Authors: *Ilknur Umay (System Design Engineering University of Waterloo), William Melek (Mechanical&Mechatronics Engineering University of Waterloo), Baris Fidan (Mechanical&Mechatronics Engineering University of Waterloo)*

Abstract: *Efficient coordination of multiple mobile and fixed base robot arms to perform independent or cooperative tasks in a shared workspace while avoiding collisions is a challenging research problem that has been studied across various robotic fields. Although robotic systems are commonly used in industrial applications such as automotive production, they typically operate independently with limited collaboration between two or more units. In this study, we propose a unified methodology for motion and task planning for multiple robot arm systems with high degrees of freedom that are simultaneously performing different tasks in a shared workspace. Our methodology introduces an integration module between the high-level task planning module and low-level motion planning module to achieve reliable and collision-free execution of tasks. We also introduce the concept of a dynamic shared space graph (D-SSG) to assess the cooperation between arm pairs that share certain parts of the workspace, which is essential for selecting arm sequences and scheduling each arm to perform a task or sub-task.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000033

Discrete-Time Sliding Mode Based Speed Controller for Electric Vehicle with Four In-Wheel Motors

Authors: *Vedad Halimić (Faculty of Electrical Engineering University of Sarajevo), Selmir Gajip (Faculty of Electrical Engineering University of Sarajevo), Senad Huseinbegović (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *In this paper, the control of the electric vehicle with in-wheel motor drives is presented. Electric vehicle control is implemented through a drive motor control strategy based on the theory of discrete-time sliding mode. The speed controller is obtained as a combination of discrete-time first order sliding mode control and discrete-time realization of super twisting control algorithm that is commonly used in second-order sliding mode. The design of the proposed speed controller is performed using a discrete-time model of electrical drive. Various tests were performed in Matlab/Simulink software to validate the electronic differential system, vehicle model and engine control algorithm for different types of vehicle movement.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000044

Generic Motion Primitives-based Safe Motion Planner under Uncertainty for Autonomous Navigation in Cluttered Environments

Authors: *Bahaaeldin Elsayed (Systems Theory and Automatic Control Otto von Guericke University Magdeburg), Rolf Findeisen (Control and Cyber-Physical Systems Technische Universit¨at Darmstadt)*

Abstract: *The safe and efficient operation of autonomous vehicles in cluttered environments with uncertainties remains an ongoing research challenge. Current planning algorithms often use simplified models that do not fully exploit the system's dynamic potential and can lead to collisions, or violate the constraints. To address this issue, we propose a novel moving horizon planning and control approach using the concept of motion primitives. Our approach formulates the planning problem as an optimization over generic motion primitives sets and incorporates ideas from robust predictive control for collision avoidance and handling uncertainties. The proposed approach reduces computational complexity while improving the feasibility of the generated path. We reformulate the problem as a mixed integer linear optimization program and present simulation results demonstrating that our approach maximizes vehicle functionality while avoiding obstacles. The proposed framework is tested on simulation scenarios. The results demonstrate its effectiveness and robustness in generating safe, efficient, and reliable trajectories for autonomous systems operating in uncertain environments, highlighting its potential for real-world implementation.*

Track: Mechatronics and Control Systems
PaperId: ICAT23-000036

Session 2-2: Power Engineering 1

Chair:	**Date:**	June 13, 2023
Slaven Peleš	**Time**	11:30 - 13:30
	Room:	Drina

Towards Efficient Alternating Current Optimal Power Flow Analysis on Graphical Processing Units

Authors: *Kasia Swirydowicz (Advanced Computing, Mathematics and Data Division Pacific Northwest National Laboratory), Nicholson Koukpaizan (National Center for Computational Sciences Oak Ridge National Laboratory), Shrirang Abhyankar (Electricity Infrastructure and Buildings Division Pacific Northwest National Laboratory), Slaven Peleš (Computational Sciences and Engineering Division Oak Ridge National Laboratory)*

Abstract: *We present a solution of sparse alternating current optimal power flow (ACOPF) analysis on graphical processing unit (GPU). In particular, we discuss the performance bottlenecks and detail our efforts to accelerate the linear solver, a core component of ACOPF that dominates the computational time. ACOPF analyses of two large-scale systems, synthetic Northeast (25,000 buses) and Eastern (70,000 buses) U.S. grids [1], on GPU show promising speed-up compared to analyses on central processing unit (CPU) using a state-of-the-art solver. To our knowledge, this is the first result demonstrating a significant acceleration of sparse ACOPF on GPUs.*

Track: Power Engineering
PaperId: ICAT23-000003

Selection of Location and Power of Photovoltaic Plant in Distribution Network using Fuzzy Logic

Authors: *Nedis Dautbašić (Faculty of Electrical Engineering University of Sarajevo), Faris Likić (Faculty of Electrical Engineering University of Sarajevo), Adnan Mujezinović (Faculty of Electrical Engineering University of Sarajevo), Irfan Turković (Faculty of Electrical Engineering University of Sarajevo), Maja Muftić Dedović (Faculty of Electrical Engineering University of Sarajevo), Ajdin Alihodžić (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *The paper presents an algorithm for determining the optimal connection location and power of a photovoltaic plant in a distribution network. The proposed algorithm is based on the use of the fuzzy logic and power flow calculation method. The fuzzy logic is used for the selection of candidate buses for the photovoltaic plant connection, while load flow analysis is used for the verification of voltage conditions and power losses in the distribution network. For each of the candidate buses photovoltaic plant of a certain power range was considered. The practical application of the considered algorithm was demonstrated on a part of Sarajevo's 10 kV distribution network.*

Track: Power Engineering
PaperId: ICAT23-000051

Application of Discrete-Time Analytic Signals in Power System Analysis

Authors: *Dženita Džafić (Faculty of Electrical Engineering University of Sarajevo), Izudin Džafić (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Power system analysis often involves studying the dynamics of oscillatory signals and transient events. Analytic signals provide a useful representation of real-meaured signals that contain both oscillatory and non-oscillatory components. This work examines the application of discrete-time analytic signals to analyze power system signals using Kung's and Prony's method. These methods are used to estimate the oscillatory modes present in power system signals and their associated parameters. The performance of the methods is evaluated on simulated and real power system data. The analytic signal-based techniques are shown to produce accurate results and offer benefits for automated power system monitoring and disturbance analysis.*

Track: Communication and Information Technologies
PaperId: ICAT23-000021

Experimental Investigation of Telecommunications Equipment Supply Power Quality

Authors: *Rusmir Skopljak (BH Telecom Joint Stock Company Sarajevo), Ajdin Alihodžić (Faculty of Electrical Engineering University of Sarajevo), Maja Muftić Dedović (Faculty of Electrical Engineering University of Sarajevo), Nedis Dautbašić (Faculty of Electrical Engineering University of Sarajevo), Adnan Mujezinović (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Due to the significant growth in the number of devices, the range of services it provides, and strict air conditioning requirements, the telecommunications infrastructure is becoming an increasingly important electricity consumer. The efficiency of the power supply system and the power quality are significant challenges in the design and maintenance of telecommunications infrastructure elements. In such systems, power electronic converters play an indispensable role. This paper discusses the results of power quality measurements for supply systems of telecommunications devices. The power supply systems of telecommunications devices with different power converters were analyzed. Also, the power supply of a mobile telephony base station at a remote location was considered, with special reference to the reaction of battery storage in the event of a power outage. Obtained results demonstrate that it is necessary to treat such consumers with special care and take measures to limit their emission of current harmonics.*

Track: Power Engineering
PaperId: ICAT23-000047

Feature importance analysis for power circuit breaker vibration-based condition assessment

Authors: *Kerim Obarcanin (DV Power Stockholm, Sweden), Bakir Lacevic (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *This paper provides an overview of the influential parameters for the power circuit breaker condition assessment based on the vibration fingerprint. By creating the feature subsets based on the domain of computation originating from the vibration fingerprint, the features are firstly ranked by four features ranking algorithms. To confirm the ranked feature contribution to the classification performance, 11 different machine learning classifiers are trained. The training of the classifier is performed on the complete feature set where afterward the same classifiers are*

trained with the subset of the features ordered by the ranking algorithms. The ranking and the classifier performance yield the concept of kurtosis in the time and frequency domain as a highly promising feature for binary classification which credibly reflectsthe circuit breaker's mechanical condition.

Track: Power Engineering
PaperId: ICAT23-000024

Session 3-1: AI, Data Science and ICT

Chair:	**Date:**	June 14, 2023
Senka Krivić	**Time**	09:30 - 11:30
	Room:	Holiday

Statistical filtering methods for feature selection in arrhythmia classification

Authors: *Ajdin Fejzic (Faculty of Electrical Engineering University of Sarajevo), Amina Tihak (Faculty of Electrical Engineering University of Sarajevo), Dusanka Boskovic (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *In this study we demonstrate the appropriate use of statistically based filtering methods for feature selection and describe the application to Heart Rate Variability (HRV) features used to distinguish between arrhythmia and normal sinus rhythm electrocardiogram (ECG) signals. The initial set of HRV features is evaluated using both correlation and statistical significance tests. Normality assumption is assessed for each feature in order to select appropriate correlation methods and significance tests. In addition, the impact of outliers on the statistical test results is illustrated by an explorative analysis of correlation before and after outlier removal. Finally, a reduced set of features is selected, and the decision process guided by correlation and statistical significance test results is described and discussed.*

Track: AI and Data Science
PaperId: *ICAT23-000052*

Early Stage Flame Segmentation with DeepLabv3+ and Weighted Cross-Entropy

Authors: *Adnan Šabanović (Faculty of Electrical Engineering University of Sarajevo), Negra Ahmetspahić (Faculty of Electrical Engineering University of Sarajevo), Medina Kapo (Faculty of Electrical Engineering University of Sarajevo), Emir Buza (Faculty of Electrical Engineering University of Sarajevo), Amila Akagic (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *The main focus of this study is early-stage flame detection, where the number of flame pixels in the image is very scarce. To address this challenge, a custom-made dataset was created specifically for early-stage flame detection, encompassing challenging environmental conditions. The DeepLabv3+ architecture with ResNet-50 backbone was employed for training and weighted cross-entropy was used to effectively handle the imbalanced nature of the dataset. As a result, the model achieved a mean Intersection over Union (mIoU) value of 0.7519, demonstrating robust performance in challenging conditions. The model exhibited accurate flame pixel detection and flame shape identification in images with low flame content but high smoke levels. Additionally, the model performed well in night-time conditions, accurately identifying flame regions and shapes. An important aspect of the model's performance was its ability to correctly identify images with no flames, thereby reducing false alarms and making it suitable for UAV-based flame detection tasks.*

Track: AI and Data Science
PaperId: *ICAT23-000050*

Computation of Discrete-Time Analytic Signals

Authors: *Dženita Džafić (Faculty of Electrical Engineering University of Sarajevo), Izudin Džafić (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *Complex signals play an important role in signal processing and communication systems. This paper focuses on two types of complex signals: complex baseband and analytic bandpass signals. Analytic signals contain only the positive frequency components of the original signal and can be efficiently computed using the FFT algorithm. Complex baseband signals represent modulated signals and can be generated using techniques such as quadrature modulation or discrete complex downconversion. Analytic bandpass signals have a non-zero centered bandwidth and can be generated using the FFT method or by directly generating a complex bandpass signal. In both cases, the signal can be manipulated using complex mixers and filters.*

Track: Communication and Information Technologies
PaperId: *ICAT23-000020*

Average SEP of M-ary PSK in Composite IG/TWDP Fading Channels

Authors: *Pamela Njemcevic (Faculty of Electrical Engineering University of Sarajevo), Almir Maric (Faculty of Electrical Engineering University of Sarajevo), Mirza Hamza (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *In this paper, error performance analysis for M-ary phase shift keying (PSK) system in the inverse gamma two-ray with diffuse power (IG/TWDP) composite fading channel is presented. Using Fourier series approach, the average symbol error probability (ASEP) expression is derived in terms of hypergeometric functions, which can be evaluated using standard software packages. Derived expression is used to investigate degradation of error performance cased by shadowing, in regard to those obtained by considering only the TWDP multipath fading. All obtained results are verified by Monte-Carlo simulation.*

Track: Communication and Information Technologies
PaperId: *ICAT23-000041*

J-Net:Convolutional Neural Network based on Grey Binary Wolf Optimization Model for Classification of Skin Lesion

Authors: Javeria Amin (Department of Computer Science, University of Wah), Nadia Gul (POF Hospital and Wah Medical College), Syeda Aleena Naqv (Department of Computer Science, University of Wah)

Abstract: *Worldwide monkeypox virus is slowly spreading with the decline virus of COVID-19. It is feared by people because they think it will spread like the virus COVID-19. As a result, it is essential to find them earlier than they spread widely within the community. The deep learning models perform a vital role in disease detection at an initial stage. In this research, a method is proposed that consists of three steps such as features extraction, selection, and classification of skin lesions. The features are extracted from the proposed Javeria Network named (J-Net) which consists of the seven layers such as convolution, parametric rectified linear unit, batch-normalization, softmax, and classification. This model is trained from scratch on the optimal hyperparameters such as an Adam optimizer, 8 batch-size, and 100 training epochs. The extracted features from the J-Net having the dimension of 12768 × 97682 that fed to the binary*

wolf optimization model on the selected hyperparameters for best features selection. The best-selected features with the dimension of 12768 × 34471 are supplied to Neural network, SVM, and KNN classifiers for discrimination between measles, chicken pox, monkeypox, and normal skin images. The method performance is accessed on publicly available datasets which provide an accuracy of 99.9% which is far better compared to the existing methods.

Track: AI and Data Science
PaperId: *ICAT23-000053*

Session 3-2: Power Engineering 2

Chair:	**Date:**	June 14, 2023
Mirza Batalović	**Time**	09:30 - 11:30
	Room:	Drina

Simulation of Electrical Stress Control System inside medium voltage Cable Termination using COMSOL Mph Software Platform

Authors: *Mirza Batalović (Faculty of Electrical Engineering University of Sarajevo), Mirza Matoruga (Elektroprenos - Elektroprijenos BiH), Hamid Zildžo (Faculty of Electrical Engineering University of Sarajevo), Fuad Pašalić (INT BH Sarajevo Design and Development Department)*

Abstract: *This paper considers simulation of electrical stress system control for optimization of electrical stresses inside medium voltage cable termination. Optimization of electrical stresses is accomplished by inserting the layer with high permittivity value and with nonlinear characteristic of electrical conductivity, on the inner cable insulation. The study was carried out through simulations using software tool COMSOL Mph, entirely based on Finite Element Method (FEM). The main goal of this paper is to accomplish the optimal value of relative dielectric permittivity of inserted layer that results with most uniform electric field distribution on cable insulation.*

Track: Power Engineering
PaperId: ICAT23-000048

Application of HHT for Identification of Low-Frequency Electromechanical Oscillatory Modes, Their Character and Damping

Authors: *Maja Muftić Dedović (Faculty of Electrical Engineering University of Sarajevo), Samir Avdaković (Faculty of Electrical Engineering University of Sarajevo), Ajdin Alihodžić (Faculty of Electrical Engineering University of Sarajevo), Nedis Dautbašić (Faculty of Electrical Engineering University of Sarajevo), Adin Memić (Faculty of Electrical Engineering University of Sarajevo), Adnan Mujezinović (Faculty of Electrical Engineering University of Sarajevo)*

Abstract: *This paper presents the use of the Hilbert-Huang Transform (HHT) to identify low-frequency electromechanical oscillatory modes, their characteristics, and damping. As these oscillations can have varying features, locations, and impacts on power systems, identifying and monitoring them is crucial for the monitoring, protection, and control of modern power systems. The Hilbert-Huang transform (HHT) is a technique used to analyze non-linear and non-stationary time series data. This involves breaking down the data into components using Empirical Mode Decomposition (EMD), which generates components with varying amplitudes and frequencies. The EMD process includes an inner loop called sifting, which produces an Intrinsic Mode Function (IMF) until the signal reaches a mean value of zero or a maximum number of iterations. The obtained IMF is a characteristic function of a fundamental oscillation that is symmetrical around the abscissa. The dominant oscillatory mode's frequency can be determined by applying the Hilbert transformation to the first IMF, and the damping ratio and damping can be calculated by fitting a least square line to the logarithmic instantaneous amplitude of the first IMF. To demonstrate the efficacy of the methodology, three case studies are examined. The first case involves generating a synthetic signal to simulate a load angle change with a defined frequency and damping. In the second case, a small disturbance in mechanical power change in the Single Machine System is simulated. The third case simulates a three-phase short circuit on*

the transmission line using the IEEE 39 bus test system. The results are compared to modal analysis conducted in DigSilent PowerFactory software. The application of HHT yielded satisfactory and promising results in identifying the dominant mode's oscillation frequency and damping.

Track: Power Engineering
PaperId: ICAT23-000045

Blockchain-enabled Energy Marketplace

Authors: Ameni Boumaiza (Qatar Environment and Energy Research Institute), Antonio Sanfilippo (Qatar Environment and Energy Research Institute)

Abstract: *The emergence of distributed energy generation through home and commercial PV applications has led to the creation of a new role called an energy prosumer, which blurs the traditional distinction between energy producers and consumers. Blockchain technology automates direct energy transactions through a distributed database architecture based on cryptographic hashing and consensus-based verification, providing consumers, prosumers, energy providers, and utilities with a unique, affordable, and secure energy-trading solution. This study aims to deploy a general ABM simulation framework for electricity exchange and demonstrate the predicted power profiles of households as well as the functionality of any blockchain process. An original version of a robust multi-agent structure was built and simulated for a Transactive Energy (TE) type Distributed Energy Resources (DER) within the ECCH microgrid that is dependent on blockchain engineering. Recent proposals for blockchain-based LEMs use auction systems to balance supply and demand in the future, which require precise short-term projections of energy output and consumption of specific households. This study evaluates the forecast accuracy achievable for specific households using cutting-edge energy forecasting techniques and analyzes the impact of prediction errors on market outcomes in three different supply scenarios. Although an LSTM model can produce reasonably low forecasting errors, the prediction procedure will be adjusted to the configuration of an LEM built on a blockchain. Therefore, this research distinguishes itself significantly from earlier experiments that attempt to estimate the time sequence of smart meters in general.*

Track: Power Engineering
PaperId: ICAT23-000042

Data Modeling and Simulation for Local Energy Marketplace

Authors: Ameni Boumaiza (Qatar Environment and Energy Research Institute), Antonio Sanfilippo (Qatar Environment and Energy Research Institute)

Abstract: *Recently, policymakers have been increasingly focused on residential demand response (RDR) programs due to the critical peak load that is generated by residential consumers. However, residential customers often take a reactive approach to price or incentive-based signals, which causes RDR actions to lag behind market changes. This paper presents a comprehensive evaluation of demand response profiles using social and agent-based modeling simulations (ABM). The utility is produced by generation companies, residential customers participate in demand response (DR) events, retailers bridge the gap between the supply and demand sides, and the distributed system operator (DSO) regulates the market for maximum social welfare. Real data from 628 residential households in Qatar was used to verify the proposed methods and model. The results of the study suggest that a distributed energy exchange based on blockchain technology among agents can provide significant benefits for both the demand and supply sides. The proposed methods and models can be used by market operators, retailers, policymakers, and utility companies in Qatar to evaluate proactive RDR results in an interactive multi-entity market.*

Track: Power Engineering
PaperId: ICAT23-000043

Notes: