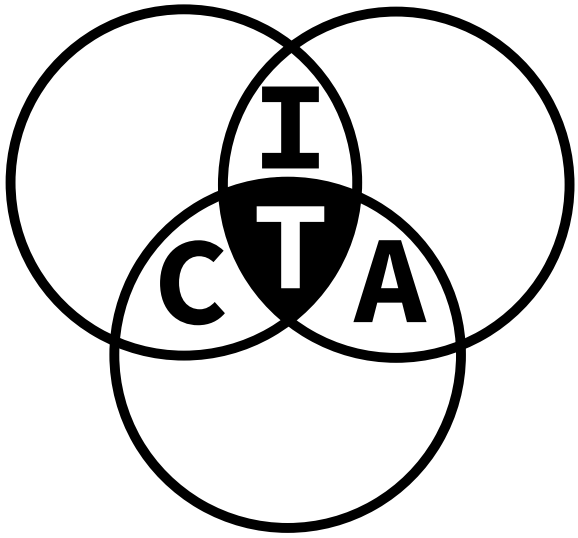
ICAT 2022
B O O K L E T



XXVII International Conference
on
Information, Communication and Automation Technologies
June 16 – 18, 2022
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 28th International Conference on Information, Communication and Automation Technologies – ICAT 2022, technically co-sponsored by the IEEE Industrial Electronics Society (IES) and IEEE Control Systems Society (CSS), which will be held on June 16-18, 2022, in Sarajevo, Bosnia and Herzegovina. ICAT 2022 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 2022 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

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General information

Date and place

28th International Conference on Information, Communication and Automation Technologies (ICAT 2022) will be held in Sarajevo, Bosnia and Herzegovina, on June 16 - 18, 2022 in Hotel Europe Sarajevo.

ICAT 2022 Secretariat

ICAT-2022 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:
- Thursday, 16.06.2022. 08:30-18:00
- Friday, 17.06.2022. 08:30-18:00

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 Thursday, 16.06.2022 @ 08:30 at Hotel Europe, our main venue.

Welcome Cocktail

Welcome cocktail will take place on Thursday, 16.06.2022 @ 19:30 and it is organized by our General Sponsor – Telemach.

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

Conference Gala Dinner

Conference Gala Dinner will take place on Friday, 17.06.2022 @ 19:30 at Restaurant "Druga kuća", Kolodvorska 9-11, Sarajevo.

For more information about the venue please visit: https://drugakuca.ba/.

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

City Tour

The City tour is scheduled for Saturday, 18.06.2022, with departure in front of the Hotel "Europe" at 13:00.

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

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Abstracts
of the

XXVIII International Conference
on
Information, Communication and Automation Technologies

ICAT 2022

Plenary talk 1-1: Miroslav Krstić: Prescribed-Time Extremum Seeking for Mobile Robots and PDEs

Date:	16.06.2022.
Time	09:00 – 10:00
Room:	

Abstract: *Prescribed-time control (PTC) has emerged in 2017 as an interesting alternative to sliding mode control (SMC) for achieving convergence in finite time. While the finite time of convergence with SMC depends on the system's initial condition, with PTC the convergence time can be set arbitrarily by the user. This is achieved by replacing the signum (discontinuous) feedback by time-varying feedback, with a gain that grows to infinity as the time approaches the terminal (prescribed) time of convergence, as in optimal control with a hard terminal constraint, encountered in classical Proportional Navigation control law in aerospace applications. I will present results, achieved over the past year – 2021 – by two of my students, Cemal Tugrul Yilmaz and Velimir Todorovski on extending PTC from stabilization and regulation problems to real-time optimization, namely, extremum seeking. Todorovski solves the problem of source seeking for mobile robots in GPS-denied environments. Yilmaz solves the problem of real-time optimization under large delays on the input and in the presence of PDE (partial differential equation) dynamics. Their designs are model-free and, most importantly, achieve convergence/optimality in a user-prescribed interval of time, independent of initial conditions.*

Plenary talk 1-2: Fabien Lotte: On Humans and Machines in Brain-Computer Interaction

Date:	16.06.2022.
Time	10:00 – 11:00
Room:	

Abstract: *Brain-Computer Interfaces (BCIs) are systems that translate users' brain activity, typically measured using ElectroEncephaloGraphy (EEG), into commands for an application. For instance, they can be used to move a computer cursor on screen towards the left or right by having users imagining left or right hand movements, recognized from EEG signals. They appear very promising for numerous applications, that I will touch upon in this talk, including assistive technologies for motor-impaired users, video games or neuroadaptive technologies, adapting the interaction content (e.g., exercice difficulty during a training task or number of information to monitor for plane pilots) to the users' mental states (e.g., mental workload or fatigue). Despite such promises, BCIs are still scarcely used outside laboratories, mainly due to a lack of reliability. They indeed often recognize erroneous commands from the users, a subtantial proportion of users are unable to use them, and they have decoding performances that vary widely both between users but also within users (e.g., across days for the same user). Thus, one of the major challenges of the BCI research community is thus to make those BCIs realiable. In this talk, I argue that for doing so, we need to consider not only the machines (in particular the machine learning algorithms used to process EEG signals) but also the human users in the Brain-Computer Interaction loop. Ideally we should also consider the human-machine interactions when designing BCIs. I will illustrate these points by research works, both from our group and others, that first aim at understanding BCI limitations, e.g., at the human level by identifying human factors (e.g., users profile, mental states or neurophysiological patterns) influencing BCI performance and variabilities and at the machine level, by computationally*

modelling these factors influences and their interaction. Then, I will present some research works that aimed at addressing these limitations, notably at the machine level, by designing robust machine learning algorithms to process EEG signals – in particular based on Riemannian geometry classifiers, and at the human level, by designing personalized BCI user training approaches. I will conclude by providing some perspective about how both the human and the machine levels should be ideally jointly integrated and optimized for future reliable BCI designs.

Plenary talk 2-1: Frede Blaabjerg: Power Electronics Technology – Quo Vadis

Date:	17.06.2022.
Time	09:00 – 10:00
Room:	

Abstract: *The world is becoming more and more electrified combined with that the consumption is steadily increasing – at the same time there is a large transition of power generation from fossil fuel to renewable energy based which all together challenges the modern power system but also gives many opportunities. We see also now big steps being taken to electrify the transportation – both better environment as well as higher efficiency are driving factors. One of the most important technologies to move this forward is the power electronics technology which has been emerging for decades and still challenges are seen in the technology and the applications it is used. This presentation will be a little forward looking (Quo Vadis) in some exciting research areas in order further to improve the technology and the systems it is used in. Following main topics will be discussed*

- *The evolution of power devices*
- *Renewable Generation*
- *Reliability in power electronics*
- *Power Electronic based Power System stability*

At last some discussions about other hot topics will be given.

Plenary talk 2-2: Haris Gačanin: Learning mechanism in next-generation wireless access

Date:	17.06.2022.
Time	10:00 – 11:00
Room:	

Abstract: *With artificial intelligence (AI) machines can be designed to perform "autonomous" tasks (e.g. planning, problem solving) without being programmed to accomplish a single (repetitive) task, while being adaptive to different environments. We presume that AI provides techniques to enable autonomous operations of wireless systems with stringent service requirements in real time. Such system requires full awareness of its environment in real time while being designed not only through data-driven methodology by ML, but through knowledge management by AI. This talk discusses challenges and opportunities to embrace AI in the design of next-generation wireless communication systems. We start discussion by summarizing the properties of training-free and training-based methods of AI in wireless environment. To understand limitations of these methods we compare the traditional optimization theory, deep learning and reinforcement learning in wireless environment. Finally, we discuss the conceptual functions of autonomous*

agent with knowledge management. The talk provokes new coming challenges and unveil interesting future directions across multi-disciplinary research areas.

Tutorial 1-1: Senka Krivić: Explainable AI and Explainable AI Planning

Date:	16.06.2022.
Time	14:30 – 16:00
Room:	

Abstract: *This tutorial will provide an introduction to Explainable Artificial Intelligence (XAI), an emerging area of research in Artificial Intelligence. As AI becomes more advanced, humans are challenged to understand and retrace how the process came to a result. The whole calculation process is turned into what is commonly referred to as a "black box" that is usually impossible to interpret. Explainable AI aims to develop techniques and methods that allow human users to comprehend and trust the results and output created by AI algorithms. The second part of the tutorial will focus on the challenges which come from the need for explainable and ethical algorithms in AI Planning and present some potential solutions. AI Planning is a field of AI that explores the process of using autonomous techniques to solve planning and scheduling problems.*

Workshop 2-1: NATO SPS G5894 QUANTUM5 WORKSHOP

Date:	17.06.2022.
Time	11:30 – 13:00
Room:	

Abstract: *Telecommunication networks are critical infrastructure for ensuring the proper functioning of social communities. With digitalization has become a more urgent need than ever, network communications that are easy to use and secure at the same time become crucial. Quantum networks have, compared to public-key cryptography secured systems, the appeal of handling most of the key-management matters transparently in the background, and due to using symmetric encryption, can work with longer-lived keys.*

Quantum key distribution (QKD), based on the laws of physics rather than the computational complexity of mathematical problems, provides an information-theoretically secure (ITS) way of establishing symmetrical binary keys between two geographically distant users. The keys are secure from eavesdropping during the transmission and QKD ensures that any third party‟s knowledge of the key is reduced to a minimum which provides the quantum-resistant encryption. In recent years, noticeable progress in the development of quantum equipment has been reflected through a number of successful demonstrations of the QKD technology. While they show the great achievements of QKD, many practical difficulties still need to be resolved, especially from the point of view of network management and organization.

Quantum Cybersecurity in 5G Networks (QUANTUM5) will practically demonstrate the application of Quantum Key Distribution (QKD) in 5G networks, providing sophisticated simulation tools and practical guidelines for further quantum technology convergence.

Notice: Pre Registration is required for the attendance.
More info at: https://www.tk.etf.unsa.ba/events/quantum5-workshop-icat/

Session 1-1: *AI and Data Science*

Chair:	**Date:**	16.06.2022.
Merve Acer	**Time**	11:30 – 13:00
	Room:	

Estimation of Washing Performance in Washing Machines with Neural Networks

Abstract: *There are many standard procedures that washing machines must provide. One of them is the washing performance, which shows the cleanliness of the laundry. This measurement, called the washing performance index, must meet the criteria determined according to the relevant standard in repeated tests. However, the washing and cleaning process is a complex process affected by many parameters such as mechanical effects, chemical effects, temperature, and amount of water. We propose an approach to determine the effect of these multi-parameter effects on washing performance and estimate the washing performance of the washing machine without the need for trial tests before the algorithm design. The approach uses artificial neural network algorithms to estimate washing performance by varying the relevant input parameters accurately. In order to establish the structure of the neural network, we have performed experimental tests on washing machines with different features and different input parameters and used them for training, validation, and test sets. According to the results obtained, it has been shown that it is possible to predict the washing performance index with neural networks accurately.*

Track: AI and Data Science
PaperId: ICAT22-000009
Authors: *Yakup Aktaş, Merve Acer Kalafat*

Development of Correction Models for Three-Electrode NO2 Electrochemical Sensor

Abstract: *Ambient conditions, especially temperature and humidity, have a huge impact on the performance of an air quality sensor. In this paper, four correction models were built to compensate the impact of ambient conditions. Linear regression and machine learning algorithms were used for building the models. Correction models were trained by using three types of measurement data. Raw measurement data was used in the first case. Secondly, measurement data was corrected and a significant improvement was shown. Lastly, measurements of various ambient conditions were used as well. Using corrected and extended measurement data brought a great improvement in accuracy of the models. A neural network correction model proved to be the most efficient in all cases. Compensating the impact of ambient conditions on the performance of an air quality sensor by using correction models was efficient and this method could be used in the air quality monitoring applications. This is of particular importance for usage of low-cost sensors for the air quality monitoring.*

Keywords: air quality monitoring stations,low-cost sensors,calibration
Track: AI and Data Science
PaperId: ICAT22-000010
Authors: *Adis Panjević, Tarik Uzunovic, Baris Can Ustundag*

Usage of user hate speech index for improving hate speech detection in Twitter posts

Abstract: *Social media is an important source of real-world data for sentiment analysis. Hate speech detection models can be trained on data from Twitter and then utilized for content filtering and removal of posts which contain hate speech. This work proposes a new algorithm for calculating user hate speech index based on user post history. Three available datasets were merged for the purpose of acquiring Twitter posts which contained hate speech. Text preprocessing and*

tokenization was performed, as well as outlier removal and class balancing. The proposed algorithm was used for determining hate speech index of users who posted tweets from the dataset. The preprocessed dataset was used for training and testing multiple machine learning models: k-means clustering without and with principal component analysis, naïve Bayes, decision tree and random forest. Four different feature subsets of the dataset were used for model training and testing. Anomaly detection, data transformation and parameter tuning were used in an attempt to improve classification accuracy. The highest F1 measure was achieved by training the model using a combination of user hate speech index and other user features. The results show that the usage of user hate speech index, with or without other user features, improves the accuracy of hate speech detection.

Keywords: sentiment analysis,natural language processing,hatred speech detection
Track: AI and Data Science
PaperId: ICAT22-000014
Authors: *Ehlimana Krupalija, Dženana Đonko, Haris Šupić*

Classification of cardiovascular disease patients

Abstract: *Nowadays, cardiovascular diseases are one of the leading causes of death. Earlier and better detection of such diseases would lead to earlier treatment and eventually to better chances of patients being able to overcome those diseases. Data mining algorithms have been proven useful in detecting several medical conditions based on patients' characteristics. In this paper, we are trying to predict whether a patient has a cardiovascular disease based on their characteristics. Using decision trees (C4.5), KNN, and Naïve Bayes, in combination with cross-validation and holdout methods, we were able to achieve relatively good results. Even better results were achieved, for some specific cases such as patients having hypertension stage 2 or 3.*

Track: AI and Data Science
PaperId: ICAT22-000050
Authors: *Emine Yaman, Fejsal Perva, Harun Tucaković*

Explorative Evaluation of Heart Rate Variability Spectral Analysis Approaches

Abstract: *The application of spectral analysis methods to the heart rate (HR) signal is challenging due to the nature of the signal itself, which is non-uniform. Methods for non-uniform signals can be applied directly, whilst the methods designed for uniform signals can be used after the signal is adequately preprocessed beforehand. Preprocessing consists of interpolation and resampling. In this paper, we have implemented a tool for explorative evaluation of various spectral analysis methods applied to HR signal. The tool is based on heat maps used for visualization of frequency metrics for the ECG signals selected from the MIT-BIH Arrhythmia Database. Evaluated methods are the Lomb-Scargle method for non-uniform signal analysis and Welch's method which is applied in conjunction with different interpolation approaches. A set of frequency-domain metrics are evaluated with the proposed tool for exploratory analysis. The evaluation indicates that the Lomb-Scargle method produces a loss of information in certain frequency bands. Furthermore, Welch method better demonstrates the difference in spectral power metrics for frequency bands of interest, irrespective of the type of interpolation used.*

Track: AI and Data Science
PaperId: ICAT22-000040
Authors: *Amina Tihak, Nahla Salaka, Dusanka Boskovic*

Session 1-2: *Mechatronics and Control Systems*

Chair:	**Date:**	16.06.2022.
Jasmin Velagić	**Time**	14:30 – 16:00
	Room:	

Fuzzy-PI contoller tuned with ICA: applied to 2 DOF robot cotrol trajectory

Abstract: *This paper proposes a Fuzzy-PI controller to force a robot manipulator to track a given trajectory. The scaling factor of takagi soguno -type- fuzzy logic and the PI parameters were tuned with imperialist competitive algorithm (ica). The proposed algorithm adequately treat height dimensional function and is able to tune the parameters of the proposed controller under the nonlinearities situation. The optimization was performed with absolute magnitude of the mean error (MAE) as a cost function under the presence of friction forces. In order to test the robustness of the tuned controller we added perturbations to output of the system (the position of the robot arm). The obtained results proves the efficiency of the proposed algorithm to find an optimal parameters and the robustness of the controller under the presence of perturbations.*

Track: Mechatronics and Control Systems
PaperId: ICAT22-000001
Authors: *Youcef Zennir, Mourad Achouri*

Semantic Visual Segmentation of a Mobile Robot Environment Using Deep Learning Model

Abstract: *This paper addresses the use of deep learning techniques in 3D point cloud labeling of environment representations for the task of a semantic visual localization of mobile robots. In contrast to standard problems resolved with Convolutional Neural Networks (CNNs), the paper deals with applying CNNs to segment point clouds that are, unlike images, unordered and unstructured. The used point clouds contain laser measurements of 3D positions (x,y,z) as well as captured RGB camera images from the scanned scene to colorize the point cloud (RGB values). The main focus of the paper is on implementation and evaluation of a hand-crafted convolution layer and the ConvPoint CNN architecture that introduces continuous convolutions for point cloud processing. The solution was implemented in the Python programming language using the PyTorch deep learning framework.*

Keywords: deep learning,Semantic segmentation,3D point cloud
Track: Mechatronics and Control Systems
PaperId: ICAT22-000008
Authors: *Jasmin Velagic, Vedin Klovo*

3D UAV Registration of Large Scale Environment Using Structure From Motion Based Approach

Abstract: *This paper treats the problem of 3D outdoor environment mapping using images acquired by Unmanned Aerial Vehicle (UAV). The main focus is on the generation of 3D model for large scale environments. In order to perform 3D model reconstruction and mapping from 2D aerial images we employed a Structure from Motion (SfM) based approach. The obtained results using this approach for different scenarios, the rubble field and village, are presented. The generated UAV 3D point cloud data are compared with the ground truth using the least square method, where the ground truth represents a reference model with high accuracy geodetic precision. The comparison of the 3D environment models with the rubble field and village scenarios and the ground truth data is also given.*

Track: Mechatronics and Control Systems
PaperId: ICAT22-000011
Authors: *Jasmin Velagic, Haris Balta*

Economic Model Predictive Control of Industrial Demand Response

Abstract: *Large industrial factories can actively participatein the energy market. This does not only provide flexibility forthe electrical grids, but also may introduce auxiliary optionsto their primary business models. However, Demand Responsestays usually in contradiction with the production goals. Supplementary revenue contracts with the energy suppliers may helphere to balance resulting production losses, thereby revealing anecessity for a trade-off. In this sense, we suggest a concept ofdemand response utilizing model predictive control for optimaladjustment of the production rate. In particular, in our study weconsider the production lines of beverage factories as a use-case.*

Keywords: model predictive control,demand response,transport equation
Track: Mechatronics and Control Systems
PaperId: ICAT22-000021
Authors: *Behzad Heydaryan Manesh, Naim Bajcinca*

Model predictive control of demand response for large scale production lines and networks

Abstract: *Utilizing demand response (DR) in industries reduces the need for expensive utilities like storage or backup plants and renders the electricity market more flexible for industrial sites. This paper proposes an MPC-based approach for such sites to respond online to ancillary service requests and participate in DR by controlling optimally the machine speeds of a production line. The optimization program we define can cope with a large number of machines within a line and run therefore efficiently online at a network level without requiring high-power computational resources. We demonstrate the significance of our approach on a beverage production line consisting of a filling machine, two labelers, one shrink packer, and 6 conveying belts connecting the machines.*

Keywords: Model Predictive Control,Demand Response,Large-Scale Systems
Track: Mechatronics and Control Systems
PaperId: ICAT22-000023
Authors: *Javad Tousi, Mohammad Al Khatib, Naim Bajcinca*

Session 1-3: *Power Engineering*

Chair:	**Date:**	16.06.2022.
Adnan Mujezinović	**Time**	16:30 – 18:00
	Room:	

Calculation of the Electric Field Intensity and Magnetic Flux Density Generated by High Voltage Overhead Transmission Lines

Abstract: *This paper considers calculation methods for the electric field intensity and magnetic flux density in the vicinity of the overhead transmission lines, as well as the calculation of alternating current (AC) corona onset electric field intensity. Calculations within this paper are made using the 2D algorithms of Charge Simulation Method (CSM) and Biot - Savart (BS) law based method. In order to obtain more accurate results, calculations are made by representing each overhead transmission line conductor with a large number of electric and magnetic field sources. By applying this approach, bundle conductors can be represented in a more realistic way and also singularity problems can be avoided when calculating electric field intensity. The presented methods are applied to a real overhead transmission line configuration, and obtained results are compared with field measurement results over the lateral profile. For considered overhead transmission line, AC corona onset electric field intensity is calculated and compared with calculated electric field intensity on the conductor's surface. A comparison of calculated and measured results shows that considered calculation methods give satisfactory results.*

Track: Power Engineering
PaperId: ICAT22-000029
Authors: *Ajdin Alihodzic, Adnan Mujezinovic, Emir Turajlic, Nedis Dautbasic*

Volt-Var Control for Smart Cities with Integrated Public Transportation System

Abstract: *The Advanced Distribution Management System (ADMS) has grown to be a highly complicated system that comprises distribution generation, batteries, power electronics, and, in case of an urban area, an electric transportation system. One of the most essential features of ADMS is maintaining node voltages and branch thermal ratings within defined limits while maintaining minimal system losses and maximizing the use of renewable energy. Voltage VAr control (VVC) is extensively used to address these challenges and is becoming increasingly significant in ADMS. A side from the necessity to manage the system status, VVC must be adaptable to accommodate future Smart City (SC) requirements such as electric-vehicle charging and energy recuperation management. The majority of existing systems control the DC electric transportation system separately from the entire AC system. This paper attempts to tackle the problem using a hybrid single model that incorporates both: AC and DC network components.*

Keywords: Volt/VAr control,ADMS,smart city
Track: Power Engineering
PaperId: ICAT22-000048
Authors: *Nermin Čolo, Senad Huseinbegović, Izudin Džafić*

Real-Time Estimation of Instantaneous Power System Fundamental Frequency

Abstract: *Instantaneous frequency measurement is a critical component of power system control and automation. Recently, electric power distribution networks with a high proportion of renewable energy have been subjected to unprecedented complexity, necessitating more complicated automation solutions. The major reasons for frequency changes include the usage of dispersed generation, the connection of non-linear loads, and the occurrence of some unforeseen system problems. This paper presents two DFT-based power system frequency measuring algorithms. It*

considers frequency variations from the system's fundamental frequency, as well as the noise generated by analog to digital converters (ADC). The IEEE Phasor Measurement Unit (PMU) latest Standard specification (IEC/IEEE 60255-118-1:2018) is used to examine these two methodologies. The methodologies are evaluated using test signals that are required to provide PMU quality evaluation and classification while accounting for process noise, ADC conversion noise, and dynamically changing input voltage and current signals. The tradeoff between DFT simplicity in implementation and needed complexity of power systems is put to the test by abrupt variations in frequency and amplitude of the fundamental component.

Keywords: power system,instantaneous frequency,fundamental component
Track: Power Engineering
PaperId: ICAT22-000037
Authors: *Vedin Klovo, Halil Lačević, Izudin Džafić*

Experimental Determination of Grounding System Impulse Impedance under High Frequency Electromagnetic Interferences

Abstract: *In this paper approach for the experimental determination of the grounding system impulse impedance under the presence of the high-frequency electromagnetic interference is presented. The considered approach is based on the application of the discrete wavelet transform on the measured signals. Validation of the considered approach has been conducted in several experiments using a vertical grounding electrode. The experimental investigation has been performed using different impulse current peak values and different front rise times. On all measured current and voltage waveforms, high-frequency interferences were registered.*

Track: Power Engineering
PaperId: ICAT22-000044
Authors: *Nedis Dautbasic, Adnan Mujezinovic, Irfan Turkovic, Maja Muftic Dedovic, Ajdin Alihodzic*

Graph Theory as an Engine for Real-Time Advanced Distribution Management System Enhancements

Abstract: *Graphs could be used to illustrate a wide range of practical challenges. The word network is usually used to denote a graph in which the elements are associated with the vertices and edges, emphasizing its relevance to power systems. This paper focuses on two common graph theory applications in Advanced Distribution Management Systems (ADMS): topology tracing and fast gain matrix computing. Topology tracing is a critical component of any ADMS. Its primary function is to generate a branch-node model by traversing branches and closed switches. The gain matrix is built during each iteration of the weighted least squares (WLS) state estimation method, which utilizes the normal equations technique. The gain matrix is sparse with a nonzero structure that remains unchanged throughout iterations. This study describes a method for predicting the nonzero structure of the gain matrix directly from the network graph and measurement locations. The suggested method for computing the gain matrix is at least seven times faster than the MATLAB built-in implementation, making it suitable for constructing efficient real-time power system state estimation software for ADMS.*

Track: Power Engineering
PaperId: ICAT22-000045
Authors: *Izudin Džafić*

Session 2-1: *Power Engineering, Mechatronics and Control Systems*

Chair:	**Date:**	17.06.2022.
Wael Alsabbagh	**Time**	11:30 – 13:00
	Room:	

No Need to be Online to Attack - Exploiting S7-1500 PLCs by Time-Of-Day Block

Abstract: *In this paper, we take the threat approach presented in our former paper [8] a step further in the direction of exploiting PLCs offline, and extend our experiments to cover the latest and most secured Siemens PLCs line i.e. S7-1500 CPUs. The attack scenario conducted in this work aims at confusing the behavior of the target system when adversaries are not connected to the victim PLC or to its control network at the point zero for the attack. Our approach is comprised of two stages. First, an attacker patches the PLC with a malicious Time-of-Day interruptblock once he gains access to an exposed PLC. Then he triggers the interrupt at a later time the attacker wishes when he is completely disconnected to the system's network. For a real-world implementation, we tested our attack on a Fischertechnik system using an S7-1500 CPU that supports the newest version of the S7CommPlus protocol i.e. S7CommPlus v3. Our experimental results showed that we could infect the target PLC successfully and conceal our malicious interrupt block in the PLC memory until the very moment we already determined. This makes our attack stealthy as the engineering station can not detect that the PLC got infected. Finally, we presented security and mitigation methods to prevent such a threat.*

Track: Mechatronics and Control Systems
PaperId: ICAT22-000027
Authors: *Wael Alsabbagh, Peter Langendörfer*

Behavioral modeling of knitted shape memory membrane

Abstract: *Programmable matter is a system of elements (e.g., smart matters, modular robots, ...) that is programmed via user input or autonomous sensing to form a certain shape, by altering its physical characteristics. This paper presents a programmable and reusable device to be used, for example in 4D prototyping and Haptics, using the shapeshifting abilities of smart materials such as shape memory alloys to exhibit a certain behavior controlled by stimulus (heat energy). More precisely, these materials can be programmed and integrated into devices or systems to function according to suitable configurations and conditions (e.g., shape making), via stimuli control as programming means, and wherein the behavior can be modelized using appropriate equations. The programmable device presented in this paper is a shape memory membrane, that makes 3D forms out of a knitted architecture to match a target model, using the shape memory effect. Simulation results using COMSOL are presented and analyzed to model the thermo-mechanical behavior and establish the device's programming model.*

Keywords: programmable matter,shape memory alloy,4D prototyping
Track: Mechatronics and Control Systems
PaperId: ICAT22-000028
Authors: *Ahmed Amine Chafik, Jaafar Gaber, Souad Tayane, Mohamed Ennaji*

Mitigating Power Peaks in Automotive Power Networks by Exploitation of Flexible Loads

Abstract: *In the recent decades, the complexity of the automotive power network (APN) has been steadily increasing. This growing complexity is due to the electrification of former mechanical*

components and the increasing integration of telecommunication and entertainment devices. Additionally, autonomousdriving functionalities lead to safety requirements that have to be met by the power supply infrastructure. Another challenge is the deviation in update cycles of the vehicle platform and the entertainment and telecommunication components. Thus, a modular and flexible power network management which allows for plug-and-play integration of new components is needed. In a previous contribution, we presented an auction-based approach for a modular load management in modern vehicles with multiple voltage levels. In this paper, we extend this basic approach by predictive measures in order to exploit flexible load capabilities by load shifting or load shaping. This leads to mitigated power peaks in the APN. As a result, the strain on the battery storage can be reduced and the forced deactivation of comfort components can be prevented. We demonstrate the working principle in a simulative study and show the effectiveness of the combination between the basic auction-based load management and the predictive extension introduced in this paper.

Keywords: Auction-based load management,Automotive power network,Predictive load shifting
Track: Mechatronics and Control Systems
PaperId: ICAT22-000031
Authors: *Tobias Schürmann, Nils Kutter, Stefan Schwab, Sören Hohmann*

Mixed-criticality communication scheme for networked mobile robots

Abstract: *We present an adaptive mixed-criticality based algorithm for weight-based task scheduling and communication resource allocation in the context of a Cyber-Physical System (CPS). The weight-based algorithm is motivated by the continuous computation of the task's criticality and updates the weight of the CPS subsystem to be used in the task scheduler and the cost function of the optimal resource allocation problem. To demonstrate the algorithm performance, we consider a set of robots driving on a grid and performing a set of tasks with a different mixed-criticality profile, controlled and connected via a wireless channel with limited communication resources.*

Track: Communication and Information Technologies
PaperId: ICAT22-000020
Authors: *Shaban Guma, Aydin Sezgin, Naim Bajcinca*

State of Charge Estimation on Constrained Embedded Devices

Abstract: *The broader use of devices powered by rechargeable batteries, especially constrained embedded devices, makes the efficient Battery Management System (BMS) increasingly more important. The estimation accuracy of the amount of remaining charge in the battery is critical as it affects the device's operation and reliability. For that reason, the estimation of state-of-charge (SoC) is considered one of the main functionalities of a BMS. However, SoC estimation remains a complex task that depends on a range of internal and external factors. Most traditional SoC estimation methods are either computationally complex, require special laboratory equipment or additional configuration efforts. In addition, most methods require continuous measurement of battery parameters, which, in turn, renders these methods not applicable to the class of constrained embedded devices. This paper aims to extend the Coulomb counting method to the class of duty-cycled energy-constrained devices by designing an algorithm that combines voltage-based evaluation and pre-recorded task power profiles to estimate the SoC. In addition, a setup for identifying the battery parameters and algorithm validation setup were also developed and described in the paper.*

Keywords: State-of-charge estimation,Constrained embedded devices,Battery parameters identification
Track: Power Engineering
PaperId: ICAT22-000038
Authors: *Edin Omerovic, Edin Golubovic, Tarik Uzunovic*

Session 2-2: *Communication Engineering & Information Technologies*

Chair:	**Date:**	17.06.2022.
Miralem Mehić	**Time**	14:30 – 16:00
	Room:	

Quantum Channel Characteristics from the Point of View of Stability

Abstract: *The article presents a series of measurements conductedon the fully-functional international Quantum Key Distributionsystem. These measurements primarily focus on theQuantum Bit Error Rate (QBER), which is the most importantparameter of the quantum channel. This parameter was observedand measured for 16 days under the quantum channel's operatingconditions to determine any correlations between the QBERand other quantum link parameters, such as secret key rate. Athorough statistical analysis of the measured data was performedas a part of this investigation and is presented in the paper.*

Keywords: QKD,QBER,Secret Key Rate
Track: Communication and Information Technologies
PaperId: ICAT22-000015
Authors: *Patrik Burdiak, Filip Lauterbach, Jan Rozhon, Martina Slivova, Miroslav Voznak, Emir Dervisevic, Miralem Mehic, Matej Plakovic*

Simulations of Denial of Service Attacks in Quantum Key Distribution Networks

Abstract: *A QKD network can be considered an add-on technology to a standard communication network that provides IT-secure cryptographic keys as a service. As a result, security challenges resulting in the suspension of functional work must be addressed. This study analyzes a Denial of Service (DoS) attack on the Key Management System (KMS), one of the critical components of the QKD network in charge of key management and key provisioning to authorized consumers. Through simulation methods performed in the QKDNetSim, we show that legitimate customers experience significantly worse service during an excessive DoS attack on KMS.*

Keywords: quality of service,quantum key distribution networks,simulations
Track: Communication and Information Technologies
PaperId: ICAT22-000036
Authors: *Emir Dervisevic, Filip Lauterbach, Patrik Burdiak, Jan Rozhon, Martina Slivova, Matej Plakalovic, Mirza Hamza, Peppino Fazio, Miroslav Voznak, Miralem Mehic*

Bloom filter based acceleration scheme for flow table lookup in SDN switches

Abstract: *Flow table lookup is a well-known bottleneck in software-defined network switches. Associative lookup is the fastest but most costly method. On the other hand, an approximate flow classification based on Bloom filters has an outstanding cost-benefit ratio but comes with a downside of false-positive results. Therefore, we propose a new flow table lookup scheme based on Bloom filters and RAM, which offers a good compromise between cost and performance. We solve the problem of false positives of primary Bloom filters by verifying the results and, if necessary, by linearly searching the contents of secondary RAM. Also, we provide a practical implementation in the FPGA-based SDN switch and experimentally show that the proposed solution can achieve better performance than the classic linear search at the low cost typical of Bloom filters.*

Keywords: software-defined networking,Bloom filter,flow table lookup

Track: Communication and Information Technologies
PaperId: ICAT22-000024
Authors: *Enio Kaljic, Almir Maric, Pamela Njemcevic*

High-Speed FPGA-Based Ethernet Traffic Generator

Abstract: *New generation networks are facing ever greater demands. When testing new network devices that must process packets at extremely high rates, it is essential to test their functionality and desired performance under maximum traffic load. As a result, in order to test the hardware, a traffic generator is required. This paper proposes an affordable and extensible high-speed FPGA-based Ethernet traffic generator. The proposed solution is able of fully utilizing a 40GbE link, with the possibility of manipulating traffic characteristics at the level of an individualpacket. Although intended to run on the DE10-Pro system, the proposed design is portable to other FPGA boards with minimal development effort and changes.*

Keywords: FPGA,Traffic Generator,Network Tester
Track: Communication and Information Technologies
PaperId: ICAT22-000042
Authors: *Matej Plakalovic, Enio Kaljic, Miralem Mehic*

Improvement of Confidential Messages Secure Routing over Paths with Intersection in Cyber Resilient Networks

Abstract: *The paper presents an improved method of confidential messages secure routing over intersecting paths in cyber resilient networks. It allows making fuller use of the available network resources. Within the method, the level of network security of routes, networks, and confidential messages, in general, was assessed due to the compromise probability of the network links. In turn, the message compromise probability is calculated by the formula of total probability, considering the level of network security of bridges in the network structure without prior calculation of disjoint paths set. According to the numerical study results of the method application, the most significant gain in terms of the message compromise probability has been obtained at a relatively low level of cyber threats in the network. The secure routing method was implemented and presented by software prototypes of secure routing protocols that can form the basis of advanced routing protocols supporting network security metrics.*

Keywords: network security,secure routing,compromise probability
Track: Communication and Information Technologies
PaperId: ICAT22-000039
Authors: *Oleksandr Lemeshko, Oleksandra Yeremenko, Amal Mersni, Juraj Gazda*

The Effects of Pilot-based Carrier Phase Estimation on Performance of Coherently Detected Signals Propagating in TWDP Channels

Abstract: *In this paper, the error performance of coherent systems in presence of imperfect carrier phase estimation is investigated for signals propagating over the two-ray with diffuse power (TWDP) fading channels, in case when synchronization is performed using pilot carrier located out of the signal's bandwidth. In that sense, closed-form approximate average binary error probability (ABEP) expressions are derived for binary and quadrature phase shift keying (BPSK and QPSK) modulated signals, with the carrier extracted using phase-locked loop (PLL) and phase noise approximated by Tikhonov probability density function (PDF). Derived expressions are calculated for various combinations of channel and phase loop parameters, enabling us to observe their effects on overall system performance. The accuracy of derived expressions is verified through their comparison with the exact ABEPs obtained by numerical integration of the appropriate expressions.*

Keywords: TWDP fading channel,Tikhonov distributed phase noise,imperfect carrier synchronization
Track: Communication and Information Technologies
PaperId: ICAT22-000032
Authors: *Pamela Njemcevic, Enio Kaljic, Almir Maric*

Session 2-3: *AI, ML, Data Science & Software Engineering*

Chair:	**Date:**	17.06.2022.
Emir Turajlić	**Time**	16:30 – 18:00
	Room:	

PMU Spoof Detection via Image Classification Methodology against Repeated Value Attacks by using Deep Learning

Abstract: *Various devices and monitoring systems have been developed and deployed in order to monitor the power grid. Indeed, several real-world cyberattacks on power grid systems have been publicly reported. For the transmission and distribution, Phasor Measurement Units (PMUs) constitute the main sensing equipment of the overall wide area monitoring and situational awareness systems by collecting high-resolution data and sending them to Phasor Data Concentrators (PDCs). In this paper, we consider data spoofing attacks against PMU networks. The data between PMUs and PDC(s) are sent through the legacy networks, which are subject to many attack scenarios under with no, or inadequate, countermeasures in protocols, such as IEEE 37.118-2. We consider one potential attack, where an adversary may simply keep injecting a repeated measurement through a compromised PMU to disrupt the monitoring system. This attack is referred to as a Repeated Last Value (RLV) attack. We develop and evaluate countermeaures against RLV attacks using a 2D Convolutional Neural Network (CNN)-based approach, which operates in frames for each second mimicking images, in order to avoid the computational overhead of the classical sample-based classification algorithms, such as SVM. Further, we take this frame-based approach and use it with Support Vector Machine (SVM) for performance evaluation. Our preliminary results show that frame-based CNN as well as SVM provide promising results for RLV attacks while the efficacy of CNN over SVM frame becomes more pronounced as the attack intensity increases.*

Keywords: CNN,PMU,Spoofing
Track: Communication and Information Technologies
PaperId: ICAT22-000046
Authors: *Alvin Huseinović, Yusuf Korkmaz, Halil Bisgin, Saša Mrdović, Suleyman Uludag*

Computer Vision with 3D Point Cloud Data: Methods, Datasets and Challenges

Abstract: *The scientific discipline of Computer Vision (CV) is a fast developing branch of Machine Learning (ML). It addresses various tasks important for robotics, medicine, autonomous driving, surveillance, security or scene understanding. The development of sensor technologies enabled wide usage of 3D sensors, and therefore, it increased the interest of the CV research community in creating methods for 3D sensor data. This paper outlines seven CV tasks with 3D point cloud data, state-of-the-art techniques, and datasets. Additionally, we identify key challenges.*

Track: AI and Data Science
PaperId: ICAT22-000052
Authors: *Jasmin Velagic, Amila Akagic, Senka Krivic, Harun Dizdar*

Multilevel image thresholding based on Rao algorithms and Kapur's Entropy

Abstract: *In the fields of computer vision and digital image processing, image segmentation denotes a process whereby an image is segmented into multiple regions. Image segmentation based on multilevel thresholding has received significant attention in recent literature. In this paper, a multilevel thresholding approach based on three different Rao algorithms and Kapur's entropy is investigated. The performance of the considered thresholding methods is evaluated on a dataset of 10 standard benchmark images using the mean of objective function values, the*

standard deviation of objective function values, and the best objective function value obtained over a fixed number of independent runs. The experimental results demonstrate the effectiveness of the multilevel thresholding approach based on Rao algorithms and Kapur's entropy.

Track: AI and Data Science
PaperId: ICAT22-000025
Authors: *Emir Turajlic, Emir Buza, Amila Akagic*

Application of Artificial intelligence in the diagnosis of Hepatitis C

Abstract: *Hepatitis C is an inflammatory condition of the liver caused by the hepatitis C virus. Diagnosis of the disease itself is difficult because the incubation period is long, often the disease is initially without some characteristic symptoms, but also due to a lack of laboratory methods. Artificial intelligence is increasingly being used nowadays to make it easier and faster to assess the illness. In this study, a database of 1000 respondents divided into two groups was used to develop the Artificial Neural Network (ANN): healthy (n = 200) and sick (n = 800). Monitoring parameters were: albumin, alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, bilirubin, acetylcholinesterase and anti-HCV antibodies. The overall accuracy of the developed ANN was 98.43%, which indicates that the potential of artificial intelligence in diagnosing hepatitis C is enormous, and in the future, attention should be paid to the development of new systems with as much data as possible.*

Keywords: artificial intelligence,artificial neural network,hepatitis C
Track: AI and Data Science
PaperId: ICAT22-000017
Authors: *Amela Drobo, Lucija Džambo, Majda Đogić, Lemana Spahić Bećirović, Alisa Smajović, Ervina Bečić, Lejla Gurbeta Pokvić, Almir Badnjević*

Deep Reinforcement Learning in Smart Grid: Progress and Prospects

Abstract: *The combination of reinforcement learning and deep learning has shown some remarkable results in many scientific fields. Deep reinforcement learning algorithms are particularly good at understanding and modeling adaptive decision-making in dynamic environments. In recent years, this concept has been successfully applied to smart grids. In this paper, we provide a brief introduction to the concepts of reinforcement and deep reinforcement learning to the power system engineers and present research progress and prospects in the field. Additionally, we identify smart grid engineering domains that need extensive pattern-based modeling as being particularly suitable for deep reinforcement learning.*

Track: Power Engineering
PaperId: ICAT22-000030
Authors: *Amila Akagic, Izudin Džafić*

Session 3-1: *ICAT Special Session*

Chair:	**Date:**	18.06.2022.
Tarik Uzunović	**Time**	09:00 – 10:30
	Room:	

Human-like Hitting Strategies for a Ball Bouncing Robot

Abstract: *Hand-eye coordination control is one of the dexterous operational skills of mankind. This study reproduces human-like hitting strategies based on hand-eye coordination techniques for bouncing a ping pong ball with a robotic manipulator holding a paddle and an RGB-D camera. The target ball and the background are first separated by using the color information. The target ball's position in the world coordinate frame can therefore be obtained by incorporating the depth information. Analysis of forces exerted on the ball is able to predict its future motion trajectory. In addition, a to-the-center and an adaptive learning hitting strategies based on manipulation skills of humans are developed to overcome difficulties caused by uncertainties and unknown parameters for the successive bouncing task. The to-the-center strategy tends to bounce the ball towards the center of the paddle, not just vertically upwards in a classical approach, in order to maintain the ball in the reachable region. However, the adaptive learning strategy provides controls of the inclination and the hitting force for the paddle according to previous bounce behavior of the ball. Actual bouncing experiments with a three degrees-of-freedom robotic wrist were conducted using three different bouncing strategies: the classical vertical approach, the to-the-center strategy, and the adaptive learning strategy. Experimental results demonstrate that the proposed adaptive learning hitting strategy displays best bouncing performance in terms of average bouncing number of times and average distance of contact point away from the center.*

Keywords: hand-eye coordination,intelligent robots,RGB-D camera
Track: Mechatronics and Control Systems
PaperId: ICAT22-000003
Authors: *Chi-Cheng Cheng, Yi-Min Chiu, An-Sheng Liu*

Application of Machine Learning for GUI Test Automation

Abstract: *This paper examines the implementation of machine learning (ML) capabilities in a test automation suite, specifically for automation of graphical user interface (GUI) testing on an electronic design automation (EDA) tool within an integrated circuit (IC) physical design, verification, and implementation flow. We present a case study using existing tests to extract information and propose an ML implementation framework that consists of three modules, which can be adopted as a systematic pattern for test development. Our study focusses on implementation of the third module in this framework. We use the learnings from iterative testing patterns on a set of EDA tools provided by the Calibre RealTime interfaces from Siemens Digital Industries Software. The goal is to reduce human effort in selection and implementation of test cases and reallocate those resources to integral parts of the testing process like, approving and acting. We first establish metrics and variables, utilize VGG16 architecture for image classification and perform training on test data, and achieve an ML model based on accuracy and precision. Using this result, we present ML implementation as part of the script development process and analyze its impact. Based on our results, we conclude the third module of a framework for inclusion of ML in a regression testing suite for GUI test automation.*

Keywords: convolutional neural network,pattern recognition,GUI test automation
Track: AI and Data Science
PaperId: ICAT22-000006
Authors: *Ritu Walia*

A Semantic Mapping System Based on Scene Classification for Indoor Mobile Robots

Abstract: *With the increasingly complex application scenarios of indoor mobile robots, traditional navigation methods based on metric maps have been unable to meet people's needs. Mobile robots not only need to perceive the spatial geometric information of the environment, but also need to deeply and comprehensively understand the semantic information of the environment in order to perform tasks such as complex behavioral decision-making and human-computer interaction. In this paper, we propose a semantic mapping system for indoor environments based on a monocular camera and a laser. The semantic mapping system adopts the technique of scene classification to construct the scene semantics of indoor environments, in which the semantic classifier is embedded into a recurrent neural network to better learn the correlation of consecutive frames. Experimental results indicate that the proposed semantic mapping system exhibits great performance in the robustness and accuracy of semantic mapping.*

Track: Mechatronics and Control Systems
PaperId: ICAT22-000051
Authors: *Xu Song*

A Methodology to Develop Extended Reality Applications for Exhibition Spaces in Museums

Abstract: *Web 2.0 brought the development of social networks and new elements of interaction that were incorporated into Web sites and devices that supported them. In the field of museums, the emergence of Web 2.0 and Museum 2.0 has made it possible to improve access to information regarding art collections. Due to the COVID-19 pandemic, museums have opted for the introduction of technology permitting virtual access to their collections. However, many applications were developed using traditional development process without considering a methodology dedicated to extended reality applications. This paper describes a methodology for the implementation of extended reality applications to exhibition spaces in museums. Using a quasi-experiment, we evaluate the data collection stage of the proposed methodology to develop an extended reality application to visit exhibition spaces in a museum. Results show that the proposed methodology helps to the software engineers/designers in the development process of extended reality applications.*

Keywords: extended reality application,software development process,museum exhibition spaces
Track: Software Engineering and Information Systems
PaperId: ICAT22-000053
Authors: *Dayana Agudo, Christian Barreto-Paredes, Otto Parra, Maria Fernanda Granda*

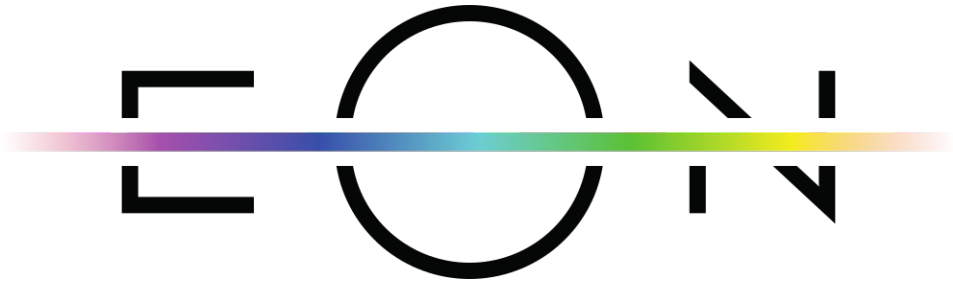
Alternator with controllable frequency and amplitude

Abstract: *The article discusses two types of power converters for obtaining sinusoidal signals at the output with the desired amplitude and frequency. In the first case, the source of energy is a constant voltage, in the second - a three-phase voltage source. In both cases, the output value of the converter is a sinusoidal voltage without higher harmonics. In the second version, the power factor of the consumed energy is one.*

Keywords: Power converter,Sliding mode,Tracking systems
Track: Mechatronics and Control Systems
PaperId: ICAT22-000012
Authors: *Isaac Chairez, Vadim Utkin*

Notes:

telemach



Javno preduzeće
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