

**XII NATIONAL CONFERENCE
WITH INTERNATIONAL PARTICIPATION**

ELECTRONICA 2021



PROGRAMME

**27 – 28 May 2021
Sofia**

**National Science and Technical Centre
108 Rakovski Str.
&
Virtual rooms**

**XII NATIONAL CONFERENCE
WITH INTERNATIONAL PARTICIPATION
“ELECTRONICA 2021”**

Organized by:

**The Union of Electronics, Electrical Engineering and
Telecommunications (CEEC),
Technical University of Sofia (TU-Sofia),
IEEE Bulgarian Section and
Faculty of Electronic Engineering and Technologies (FEET)**



In cooperation with:

Federation of the Scientific and Technical Unions in Bulgaria (FNTS),
Bulgarian Academy of Sciences (BAS),
University of Applied Sciences - Offenburg,
Riga Technical University,
VDE – Germany and
Leading Electronics Companies.

XII NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION “ELECTRONICA 2021”

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XII NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION “ELECTRONICA 2021”

	Hour	Event	Discussion
Wednesday 26 May	15.00-18.00	Registration of participants & test the system (Virtual room 1) Webex software	
Thursday 27 May	10.00-10.30	Opening Session Hall 105A & Virtual room 1	
	10.30-12.45	Scientific Session 1 Hall 105A & Virtual room 1	Virtual room 2
	12.45-13.15	Lunch break	Virtual room 2
	13.15-15.15	Scientific Session 2 Hall 105A & Virtual room 1	Virtual room 2
	15.15-15.30	Coffee break	Virtual room 2
	15.30-16.15	Invited papers Hall 105A & Virtual room 1	
	16.30-17.30	Discussion Opportunities for cooperation within the framework of the European University of Technology (EUT+) and business needs Hall 105A & Virtual room 1	
	17.30-18.00	„Alumni meeting”- Informal discussion Hall 105A & Virtual room 1	
Friday 28 May	09.00 -11.15	Scientific Session 3 Hall 4 & Virtual room 1	Virtual room 2
	11.15 -11.30	Coffee break	Virtual room 2
	11.30 -13.00	Scientific Session 4 Hall 4 & Virtual room 1	Virtual room 2
	13.00 -13.30	Lunch break	Virtual room 2
	13.30-15.00	Scientific Session 5 Hall 4 & Virtual room 1	Virtual room 2
	15.30 -16.30	Invited papers Hall 4 & Virtual room 1	
	16.45 -17.45	Scientific Session 6 Hall 4 & Virtual room 1	Virtual room 2
	17.45 -18.00	Coffee break	Virtual room 2
	18.00 -18.30	Scientific Session 7 Hall 4 & Virtual room 1	Virtual room 2
	18:30	Closing Session Hall 4 & Virtual room 1	
	18.30 -19.00	Форум ”ЕЛЕКТРОНИКА“ Hall 4 & Virtual room 1	Virtual room 2

<https://e-university.tu-sofia.bg/e-conf/index.php?konf=176>

[Virtual room 1](#) -

<https://technicaluniversityofsofia.my.webex.com/technicaluniversityofsofia.my/j.php?MTID=m9b7e99ed806e53403d5e6949a8ace292>

[Virtual room 2](#) - <https://meet.google.com/zoe-qscm-odd>

Opening Session 10.00 - 10.30

Hall 105A & [Virtual room 1](#), Thursday 27 May 2021

Scientific Sessions 1 and 2, 10.30 -15.15

Hall 105A & [Virtual room 1](#), Thursday 27 May 2021

Invited papers 15.30 – 16.15

Hall 105A & [Virtual room 1](#), Thursday 27 May 2021

Sensorless model-based MPPT of micro-wind energy conversion systems using topological Artificial Neural Networks

Dr. Massimiliano Luna - National Research Council of Italy (CNR) - Institute of Marine Engineering (INM)

Discussion 16.30-17.30

Hall 105A & [Virtual room 1](#), Thursday 27 May 2021

Opportunities for cooperation within the framework of the European University of Technology (EUt+) and business needs

- Prof. Marius Neag - Technical University of Cluj-Napoca, Romania
- Assoc. Prof. Elica Gieva – Technical University of Sofia, Bulgaria
- Leading Electronics Companies.

Scientific Sessions 3, 4 and 5, 9.00-15.00

Hall 4 & [Virtual room 1](#), Friday 28 May 2021

Invited papers 15.30 - 16.30

Hall 4 & [Virtual room 1](#), Friday 28 May 2021

Towards quantum technologies using nanophotonics.

Dr. Christophe Couteau - Associate Professor/Enseignant Chercheur
Director of the Laboratory Light, nanomaterials & nanotechnologies - L2n
University of Technology of Troyes (UTT) & CNRS ERL 7004, Troyes, France

Scientific Sessions 6 and 7, 16.45-18.30

Hall 3 & [Virtual room 1](#), Friday 28 May 2021

Closing Session 18.30

Scientific Session 1

INFORMATION AND COMMUNICATION TECHNOLOGIES

Hall 105A & [Virtual room 1](#), Thursday 27 May, 10.30 – 12.45

Chairpersons: Seferin MIRTCHEV, Stefan PATCHEDJIEV

1.1. PREDICTING VULNERABILITY TYPE IN COMMON VULNERABILITIES AND EXPOSURES (CVE) DATABASE WITH MACHINE LEARNING CLASSIFIERS

Veneta Yosifova, Antoniya Tasheva, Roumen Trifonov

Vulnerability type is not part of the standard CVE scheme, so the ability to determine it based only on the text description would be a very useful for automated vulnerability handling. The growing number of hardware and software vulnerabilities discovered every year makes it more difficult for manual classification. This justifies the need for automatic machine learning classification. We researched performance of base ML classifier algorithms, such as Linear Support Vector Classification, Naive Bayes, and Random Forest Classifier. To measure the performance of our classifiers, we use precision, recall, and f1-score evaluation metrics. Previous studies have focused on machine learning methods predicting platform vendor and products, vulnerability scoring, software vulnerabilities exploitation. Our study aims to show that machine learning is suitable for automated vulnerability type classification.

1.2. ENABLING TECHNOLOGIES FOR SAFETY CRITICAL COMMUNICATIONS

Ventsislav Trifonov, Ivaylo Atanasov, Emilia Dimitrova, Evelina Pencheva

Softwarization and intelligence will be key features of future high-speed railway systems which have to provide dependable, safety, and secured service. Advanced technologies such as Network Function Virtualization, Software Defined Networking, Edge computing, and Artificial Intelligence have the potential to contribute to the railway system autonomy improving the operation and customer experience. The paper explores the capabilities of edge computing and artificial intelligence and presents a methodology to achieve flexible railway system design and autonomic operation and management.

1.3. THE DECISION HIERARCHICAL MODEL OF CYBERSECURITY RISK ASSESSMENT

Valentina Petrova

This paper examines the application of AHP in evaluating cybersecurity decision making and suggests a model of cybersecurity risk assessment based on eight criteria of cybersecurity and three cybersecurity alternatives. The main goal is to present for cybersecurity and decision makers a model that ensures the confidentiality, integrity and availability of cybersecurity systems. It can be used to conduct cost-benefit analysis, design and optimize cybersecurity in the systems.

1.4. DIGITAL COMPETENCIES OF PUBLIC ADMINISTRATION EMPLOYEES RELATED TO CYBERSECURITY

Neda Chehlarova, Georgi Tsochev, Monka Kotseva, Radoslav Miltchev

Here is presented second part of the results of a survey on digital competencies related to the security. Representatives of public administration and students from the specialties "Information Technology in Industry" - Bachelor's degree and "Computer and Software Engineering" - Master's degree, research area 5.3 "Communication and computer equipment" from the Technical University of Sofia took part in the survey in 2020.

1.5. ANN ELECTROMAGNETIC DESIGN OPTIMIZATION

Iliana Marinova, Valentin Mateev

This paper presents an artificial neural network (ANN) approach for design optimization of electromagnetic planar coil. Radial basis function ANN is used for objective function problem interpolation. ANN model that employs, in a natural and effective way, an inversion algorithm providing a solution of the electromagnetic device design problem. The model combines two types of ANN and applies a neural network inversion algorithm. Further development of this optimization model can propose an efficient solution to the electromagnetic device design problem. The model is applied to the magnetic planar high frequency coil design. The results obtained show the effectiveness of the proposed optimization model.

1.6. PERFORMANCE ASPECTS OF A SERVICE AT THE NETWORK EDGE

Ivaylo Atanasov, Vladislav Vladislavov, Ventsislav Trifonov, Evelina Pencheva

Programmability opens the network interfaces for development of innovative applications which improve user experience and network performance. Enablers for network programmability include microservice-based architecture and cloud-native implementation. The functionality of fifth generation core network is defined as services which support REpresentational State Transfer (REST) interfaces. Distributed cloud capabilities at the network edge also expose REST-based application programming interfaces (APIs). The paper presents the results of emulation of REST API aimed at performance evaluation. The focus is on latency injected by requests and the respective responses.

1.7. APPLYING THE ISO/IEC 25010 QUALITY MODELS TO ASSESSMENT APPROACH FOR INFORMATION SYSTEM

Elisaveta Trichkova-Kashamova

This study addresses issues related to evaluating the quality and effectiveness of software products. Attention is paid to the evaluation of the quality and efficiency of such software products by solving an optimization problem. The lack of direct quantitative evaluations of products requires them to be evaluated. The solution to the problem is to minimize the subjective factor of influence in the evaluation. The idea of overcoming this problem is to apply a common evaluation scheme based on objective product requirements. This scheme is implemented through an approach of quality and efficiency assessment based on ISO/IEC 25010 quality models standard.

1.8. INFORMATION TECHNOLOGY SUPPORT FOR TRAFFIC LIGHTS CONTROL

Krasimira Stoilova, Todor Stoilov, Stanislav Dimitrov

Application of information technologies support for traffic lights control is presented. The control task is formalized as a bi-level hierarchical problem solved in MATLAB environment. The traffic lights control is applied for a network of eight crossroads in urban area in Sofia. The optimal problem is numerically tested with traffic intensity data and graphical interpretations are given. Comparison with the classical optimization control problem gives benefits for the bi-level optimization model.

1.9. CONTROL OF TRAFFIC LIGHTS BY MEANS OF INTELLIGENT METHODS

Stanislav Dimitrov, Yordanka Boneva, Kristina Pavlova

Traffic congestions are a problem in large cities. They lead to many negative consequences in the fields of economic, environment and health. Proper adjustment of traffic light settings in urban environments is the main means of control over the stated problems. This paper investigates a network of crossroads situated in central Rome in the area Municipio V. The study presented in this

paper offers alternative approaches to optimization of signal timings of traffic lights in the network. Comparison is made between the current settings, the Buyanov et al optimization approach, the nonlinear optimization approach and the bi-level optimization approach. Signal timings for the current settings and for the three optimization approaches are imported in the traffic simulation software suit Aimsun and the output results of the four simulations are compared. The analysis and evaluation of the output data gives advantage to the nonlinear approach followed by the bi-level optimization approach as far as different traffic indicators are concerned e.g., delay, flow, speed, queue etc. The effectiveness of the used optimization methodologies is graphically presented.

1.10. EFFICIENT TWO-ELEMENT ARRAY ANTENNA

Peter Apostolov

In this paper, an approach for the improvement of two-element array antenna selectivity is studied. A modulating function with an S-shaped graph is offered. The parameter of the function changes the gradient of the function graph and the array factor selectivity, respectively. An appropriate approach to eliminate the dependence between the array factor selectivity and element distance is applied. As a result, an array of two elements with azimuth and elevation selectivity is obtained. The array factor has no side lobes and the main lobe can be arbitrarily narrow. Also, the array factor is independent of the interelement distance and can be steered in azimuth without selectivity deterioration or side lobes occurrence. The described array antenna properties are examined with Matlab® simulations. Also, an exact formula for half-power bandwidth angle for binomial array antennas is proposed.

1.11. BAND-PASS AND BAND-STOP FILTERS SYNTHESIS USING SIGMOIDAL FUNCTION

Peter Apostolov, Aleks Meklyov, Vanyo Kostov

In the paper, an application of the Complementary Integral Gaussian Error Function for bandpass and band-stop filters is examined. Analytical expressions for magnitude response and the respective parameters are offered. The described theory is supported with Matlab® examples for linear phase digital band-pass, band-stop filter and filter banks.

1.12. PERFORMANCE COMPARISON OF IP NETWORK USING MPLS AND MPLS TE

Ivan Nedyalkov, Georgi Georgiev

In the present work, a comparison is made in the performance of a virtual IP network using MPLS and MPLS TE. Initially, the network working with MPLS was studied, and then the studies were performed with configured MPLS TE. For the purposes of the research, known and well-known tools for monitoring of IP networks were used, as well as mathematical distributions (for additional evaluation) for the packet arrival times.

1.13. ACTIVE LEARNING STRATEGIES APPLIED FOR TEACHING THE TOPIC OF REGISTERS

Adriana Borodzhieva, Ivanka Tsvetkova, Snezhinka Zaharieva, Dimitar Dimitrov, Valentin Mutkov

The paper presents active learning strategies for improving the teaching and learning processes when studying the topic of registers in the course “Digital Electronics” at the University of Ruse. Active learning is applied for attracting students’ attention during the classes, increasing their motivation and final grades.

1.14. MOBILE DEVICES AND PORTATIVE CLASSROOM BASED ON RASPBERRY PI COMPUTERS

Ademi Ospanova, Berik Tuleuov, Aizhan Zharkimbekova, Lazzat Kusseпова, Mukhammedrakym Mangmuryyn

In this paper the possibility of using Raspberry Pi microcomputers for effective training in practical skills of operating systems and computer networks administration and configuration is described. The algorithm for assembling a mobile device based on it and installing the software is given. The necessary resources and stages of the developing of individual training kits are provided.

Scientific Session 2

IoT APPLICATIONS

Hall 105A & [Virtual room 1](#), Thursday 27 May, 13.15 - 15.15

Chairpersons: Ivailo PANDIEV, Peter YAKIMOV

2.1. INTEGRATED SENSOR TECHNOLOGY FOR DATA ANALYSIS TO DERIVE A PRODUCT SERVICE-RELATED BUSINESS MODEL

Michael Grethler, Marin Marinov, Jivka Ovtcharova, Jieyang Peng, Bernhard D. Valnion, Andreas Kimmig

As a manufacturer of innovative potato, beet and vegetable technology, GRIMME Landmaschinenfabrik GmbH & Co. KG, wants to use new business models and technologies to build up further competitive advantages. In addition to the development of a business concept based on the high availability of a complex harvesting machine, the technical requirements for this are presented in this article. Using the example of increasing the availability of a potato harvester through sensor-based monitoring of the pick-up belt in conjunction with weather and soil data, it is shown how an innovative availability-oriented business model can be realised. Unplanned machine downtimes due to a defective pick-up belt are prevented with the help of an IoT application in conjunction with data analytics by detecting this at an early stage or predicting the failure.

2.2. FPGA BASED CANNY: ADVANCED INTEGER DIVISION ALGORITHM

Dimitre Kromichev

Proposed is an advanced integer division algorithm wherein divisor is a constant. It is to be used in Gaussian filtering module of FPGA based Canny. The algorithm is explored for mathematical accuracy, maximum operating frequency and minimum number of clock cycles on the basis of ten Intel (Altera) FPGA families.

2.3. ANALYSIS AND DESIGN OF INTELLIGENT SIGNAL PROCESSING STRATEGIES

Michael Grethler, Marin Marinov, Jivka Ovtcharova

In availability-oriented business models (vGM), the provider guarantees the customer that the capital good is ready for use. To ensure availability, the states of the relevant components must be disclosed and visualized. In this context, the components of individual tangible assets are developed further in such a way that data on their condition is generated and evaluated when the tangible asset is used, so that recommendations for action can be derived for the product service system (PSS) provider and its customers. To this end, monitoring concepts are developed and implemented on the basis of experimental studies. The focus of the intelligent evaluation and processing of the MR sensor signals is to obtain realistic raw data and to be able to trace these back to component

conditions. On the other hand, the sensor evaluations are to be verified against the component states. State-describing parameters will be developed. In the Grimme use case, the hydraulic drive of the take-up belt is to be monitored. The tests were carried out in a reduced laboratory environment compared to the use case. The test results and experience are incorporated into the signal processing strategies for the use case. A method for data reduction was designed.

2.4. THE USE OF DIFFERENT SQL SERVERS FOR RESOURCE OPTIMIZATION ON MOBILE SENSOR SYSTEMS

Iskren Kandov, Anatolii Aleksandrov, Goran Goranov

The design of mobile sensor systems is a set of different types of hardware modules that interact with each other by installing and configuring various application or user software packages. Additional software installation can exceed the performance of the hardware modules, leading to increased power consumption, increased processing time, and even overloading and failure of the entire system. Configuring the mobile sensor system to work as a web server allows the processed information from the sensor modules to be stored in a database and published on the Internet. Different types of SQL servers uses different hardware resources and also allows different methods for optimization the information that are stored.

2.5. PIEZORESISTIVE MEMS ENABLED SOLUTIONS FOR IOT

Vladimir Stavrov, Galina Stavreva, Emil Tomerov, Maria Vilani, Stefan Kotsev, Dimitar Chakarov

Recent results in exploitation of contact displacement microsensors with embedded flexures and piezoresistors in forces monitoring for object recognition, are summarized. Method for precise calibration of the sensors was developed and advantages of using said sensors with high dynamic range and digitally tunable sensitivity, are illustrated.

2.6. POWER PROFILE SIMULATION AND OPTIMIZATION OF BATTERY-LESS LORAWAN SENSOR NODE

Stanislav Asenov, Dimitar Tokmakov

In the last few years, IoT devices have multiplied their number and functionality. These devices are located all over the world, and batteries are their main source of energy. However, these batteries are short-lived and full of dangerous chemicals that harm our environment. In addition, replacing batteries is a difficult process, in most cases even more expensive than the devices themselves, which leads to their disposal or even worse to environmental pollution. Battery power supplies are not an efficient solution for the future development of IoT devices and the network. The idea of alternative power supply via battery-free devices is running on long-life capacitors charged with energy harvesters. In this paper, we present a Matlab Simulink model of a battery-less LoRaWAN sensor unit to characterize the performance of the device without a battery, as well as to determine the optimal capacitor needed by the device. The results show that without battery LoRaWAN devices are feasible if the correct configuration is selected for different application behavior and environmental conditions (ie energy harvest). A mathematical analysis is also presented to determine the capacity of the battery-free sensor node.

2.7. DISTRIBUTED INTERNET OF THINGS SYSTEM FOR CO2 MONITORING WITH LORAWAN

Valentin Mateev, Iliana Marinova

In this work a distributed internet of things system for CO2 emissions monitoring, has been designed. LoRa radio frequency technology is employed with LoRaWAN communication protocol. The system consists of Arduino based distributed measurement devices connected by gateway

stations which are transferring data to online cloud server for further processing and visualization on distant portable devices. The system is pointed on industrial internet of things applications e.g. for multi nodal distributed monitoring of electric power supply networks, local smart-grids, etc.

2.8. CAPTURING AND TRANSFERRING OF ACOUSTIC INFORMATION IN A CLOSED ROOM VIA WIRELESS ACOUSTIC SENSOR NETWORK

Snezhana Pleshkova, Kostadin Panchev

Recent researches and discoveries in acoustic sensors and acoustic sensor networks provide many opportunities for explorers and engineers to create new sensing systems and to improve the existing ones. There are a lot of applications including noise pollution monitoring, acoustic calibration of closed rooms, search missions, environment monitoring, accident detection etc. But these networks are different from the classical wireless sensor networks because of their characteristics. It is a challenge to combine a low-energy and less complicated protocols for data transfer and processing of acoustic information with the privacy of the data and a secure communication. To find a solution of this issue it is necessary to develop efficient algorithms. The main task of one acoustic sensor node is to detect acoustic signals from different transmission points or in various receiving points and to provide the needed information for an acoustic environment analysis. The aim of the article is to develop a methodology for measuring test audio signals at multiple points in an enclosed space using a wireless acoustic sensor network. The captured test audio signals should be transmitted to a computer (server of the wireless acoustic sensor network) for the purpose of their processing and analysis for determination of the acoustic parameters and the acoustic picture of the closed room.

2.9. AN OPEN-SOURCE GUI APPLICATION FOR FLASH PROGRAMMING OF IOT MICROCONTROLLERS

Lubomir Bogdanov, Ratcho Ivanov

The following paper presents an implementation of a GUI program that can flash microcontrollers of NXP's most popular family – the LPC. The program uses a UART interface to communicate with the ROM bootloader and that makes this method suitable for updates in the field with the help of a Wi-Fi to UART bridge. Any IoT device that uses the low-power LPC can benefit from it. The application is open-source and freeware, and can be used for production, as well as for hobby projects.

2.10. ENERGY CONSUMPTION OF ASSEMBLY INSTRUCTIONS IN LOAD-STORE MICROPROCESSOR ARCHITECTURES

Lubomir Bogdanov, Georgi Zhelezov

The paper presents results from measurement of energy consumption of assembly instructions' addressing modes in load-store microprocessors. The selected example architecture for conducting the research is the ARM Cortex-M4F which is widely used by IoT devices. An insight of the measurement setup is given, so that other scientists could use the same approach in related experiments.

2.11. INFORMATION TECHNOLOGY APPLICATION FOR REAL ESTATE MARKETING

Todor Stoilov, Krasimira Stoilova, Miroslav Vladimirov

Information technology support for analyzing dynamically changed set of numerical data is provided in this research. The data concern the changes of costs and returns for the case of investing in real estate market in Bulgaria. Computer support for considerable amount of calculations is used. The information part of the research concerns developments of appropriate algorithm for data

processing. The paper uses two portfolio models and incorporates them in a derived algorithm for evaluation and recommendation of decision in investment in real estates. The algorithm is applied to real data of the Bulgarian real estate market.

2.12. REAL-TIME ABNORMAL HUMAN ACTIVITY DETECTION USING 1DCNN-LSTM FOR 3D SKELETON DATA

Plamen Hristov

Over the last several years, in parallel with the advent of deep learning and the accessibility of depth sensors, home care supervision has risen in demand. This is becoming even more evident with the ongoing COVID-19 epidemic, which has put vulnerable people like the elderly and handicapped at even a more significant health risk and created a need for online and distance-based alternatives for human interaction. As such, a lightweight method for real-time Abnormal Human Activity Detection is proposed. It uses a rolling window approach when processing videos of activities and pinpointing the exact frames where an abnormality occurs. A combination of a One-Dimensional Convolutional neural network (CNN) and a Long Short-Term Memory (LSTM) network is used, both overlapping in applications but having different pros and cons. The method achieves a precision of 96.6% and 94.3% accuracy on the UR Fall Dataset.

Scientific Session 3

INDUSTRIAL AND POWER ELECTRONICS

Hall 4 & [Virtual room 1](#), Friday 28 May, 9.00 - 11.15

Chairpersons: Nikolay HINOV, Dimitar ARNAUDOV

3.1. FREQUENCY DOMAIN MODELING OF DC-DC CONVERTER WITH AUTOMOTIVE APPLICATION

Georgi Zashev, Vladimir Dimitrov, Dimitar Arnaudov

A Well designed power supply may not grab your attention, but the inappropriate one, definitely will. Nowadays switched-mode power supply (SMPS) are used in wide range of applications, meaning they are exposed to diverse perturbations, which can lead to undesired behavior. That's why the good design and stable behavior of the SMPS is so critical and may be crucial for some applications. The focus of this article, and its main point is to show us, which of currently available ways for analyses during the design phase, is mostly representative to the real case measurements. The results of the described below different design approaches, will be compared and analyzed by their pros and cons.

3.2. PROBABILITY ANALYSIS OF RELIABILITY AND AVAILABILITY OF SUPERCAPACITOR BATTERY STACK

Prodan Prodanov, Dobroslav Dankov

Supercapacitors battery stack (SBS) are widely used in energy storage systems and electric vehicles. The higher requirements for their reliability, safety and reducing the unexpected failures lead to analysis of their maintainability, availability expected failures. An analysis of maintainability and availability of the supercapacitor battery stacks is especially important, when this devices are used in systems with uninterruptible processes and electric vehicles. For the estimation of the availability and expected failures of SBS it is necessary to apply three types of analysis – analysis of failure rates of supercapacitors or SBS, probability analysis of also called Markov Analysis and Theory for Preventive Maintenance do define the optimal time for maintenance activity and interval reliability. With combining this three types of analysis it is possible to determine the probability states,

expected failures, effectiveness of possible protection circuits, maintenance activity and redundancy of SBS.

3.3. INVESTIGATING THE INFLUENCE OF PASSIVE COMPONENTS TOLERANCES IN SWITCH MODE BOOST CONVERTER DYNAMIC CHARACTERISTICS

Ivan Hristov, Nikolay Hinov

The paper presents investigation the impact of output capacitors parameter variations over the frequency response behaviour of boost converter switch mode power supply.

3.4. FPGA IMPLEMENTATION OF MICROSTEPPING CONTROL OF STEPPER MOTOR WITH ADVANCED MIXED CURRENT DECAY

Dancho Ivanov, Ivan Maradzhiev, Tsvetana Grigorova

The present paper describes the implementation of a microstepping control of a stepper motor with advanced mixed current decay mode. The proposed development is based on a programmable field array (FPGA) and a galvanically separated ADC, which allows continuous measurement and filtering of current through the windings of the motor used. The maximum reached frequencies of the control pulses supplied to the motor windings for the proposed algorithm with advanced mixed current decay mode and microstepping control without current decay mode are compared.

3.5. SPEED SYNCHRONIZATION BY MOTION TRACKING METHOD REALIZED ON FPGA

Goran Goranov, Petar Panaiotov, Valentina Rankovska

A synchronization method has been implemented by monitoring the speed of a labeling machine to automatically place labels on the glass jar. For this purpose, hardware-based on FPGA - Spartan 6 has been developed, as well as VHDL program code. An important point in the development is the adaptation of the module to work as a PLC and the software implements the motion tracking method, which is more convenient for calculation than DSP.

3.6. USE OF SPC (STATISTICAL PROCESS CONTROL) FOR QUALITY CONTROL AND MANAGEMENT OF AN AUTOMATIC PRODUCTION LINE

Valentin Tsenev

The SPC (Statistical process control) method was used to assess the quality in the production of connectors and the model remained permanently active for process stability control. Based on the collected data, SPC analysis was performed using the software product QSTATLAB and a measurable score was obtained by PPK and CPK. Based on the obtained results, actions have been taken to improve the quality of the manufactured product. A conclusion was made on the basis of the obtained results with conclusions regarding the preservation of the stability and suitability of the process.

3.7. USE OF MSA (MEASUREMENT STATISTICAL ANALYSIS) FOR EVALUATION OF MEASURING SYSTEMS FOR QUALITY CONTROL OF AN AUTOMATIC PRODUCTION LINE

Valentin Tsenev, Uliana Asenova

The MSA (Measurement statistical analysis) method was used to evaluate the measuring systems for quality assessment in the production of connectors (electromechanics) for the automotive industry on an automatic production line. Based on the collected data, an analysis of the capabilities of the measuring system was performed using QSTATLAB. A conclusion was made on the basis of

the obtained results with conclusions regarding the admissibility of the process and its improvement.

3.8. STATE PLANE ANALYSIS OF AN LLC DC-DC CONVERTER OPERATING ABOVE THE RESONANT FREQUENCY

Aleksandar Vuchev, Tsvetana Grigorova

A theoretical study of an LLC DC-DC converter operating above the resonant frequency is realized. On the basis of a state plane analysis expressions are derived to calculate the initial conditions for the differential equations describing the processes in the tank circuit. It is shown that all quantities depend on only one variable.

3.9. EXPERIMENTAL INVESTIGATION OF A SERIES RESONANT DC-DC CONVERTER WITH A SYMMETRICAL CONTROLLED RECTIFIER

Angel Lichev, Aleksandar Vuchev

A prototype of a series resonant DC-DC converter has been investigated. A phase-shift control method has been implemented with a frequency variation within a restricted range. As a result, the output characteristics of the converter working almost as an ideal current source have been derived. Moreover, a linearization of the control characteristic has been achieved.

3.10. OUTPUT AND CONTROL CHARACTERISTICS OF AN LLC DCDC CONVERTER OPERATING ABOVE RESONANT FREQUENCY BASED ON THE STATE PLAN ANALYSIS

Tsvetana Grigorova, Aleksandar Vuchev

The paper presents an LLC resonant DC-DC converter's output and control characteristics for frequency control received by state plane analysis. It also expands on the quantities on which the choice of the main circuit elements, used in the design procedures of the LLC converter, depends. A comparison between the results obtained by the state plane analysis and those received from the first harmonic approximation method is proposed.

3.11. INVESTIGATION OF BIDIRECTIONAL DC-DC CONVERTER FOR REGENERATING BRAKING FOR ULTRALIGHT ELECTRIC VEHICLE

Evgeni Malev

This paper presents the realization of a prototype of bidirectional DC-DC converter for ultralight electric vehicle. The topology of the converter in buck – boost with sliding mode control. To the converter are also designed control and power supply system. The behavior of the feedback is analyzed: signals from the voltage and current sensors to the operational amplifiers and the signals from the output comparator to the microcontroller unit.

3.12. CONTROL OF DV/DT THROUGH THE GATE OF A FIELD-EFFECT TRANSISTOR IN FORWARD-MODE CONVERTERS

Yanka Ivanova, Svetoslav Ivanov

A central issue in reducing the size and cost of MOSFET power converters is to control or limit dv/dt during the switching process. Load side snubbers and clamp circuits are bulky and expensive. Increasing the gate resistors values is cheap and simple but switching times as well as power losses are increased. In this article the authors suggest to use a gate-side control loop to limit the switching transients. No extra components are needed on the load side. The only extra component is a resistive divider, connected in parallel to the power MOSFET as the midpoint is used for feedback on dv/dt to sense the voltage transients. The overall losses are reduced, compared to the traditional

method, where the gate resistor value is increased to limit the switching speed. The proposed method can easily be integrated in an intelligent gate-drive circuit.

3.13. RESEARCH ON SPACE VECTOR MODULATION FOR TWO-PHASE INDUCTION MOTOR SIX-SWITCH INVERTER

Valerijs Maricevs, Kaspars Kroics

3.14. STUDY OF MULTI-PORT DC-DC CONVERTER FOR ENERGY STORAGE SYSTEM

Faruk Ahmeti, Dimitar Arnaudov

The paper presents a modelled operation of an energy storage system based on supercapacitors. Resonant transducers are used in the system. Features of the modes of operation in the transfer of energy when there are several sources are described. A simulation model of the system developed in LTSpice software is shown.

Scientific Session 4

ELECTRONIC SYSTEMS AND CIRCUITS

Hall 4 & [Virtual room 1](#), Friday 28 May, 11.30 - 13.00

Chairpersons: Katya ASPARUHOVA, Marin MARINOV

4.1. DEVELOPMENT OF LABORATORY SYSTEM FOR INVESTIGATION OF CMOS DIGITAL POTENTIOMETERS BASED ON AD5143 EVALUATION BOARD

Ivailo M. Pandiev

This paper describes a laboratory system designed for study of monolithic CMOS digital potentiometers. The developed laboratory system is based on EVALAD5143DBZ evaluation board, which is built around a quadchannel digital potentiometer AD5143. The AD5143 has 10k Ω nominal resistance with 256 positions of the wipers and is a widely used electronic device in analog signal processing circuits. Based on an analysis of the operational principle and the functionality of the EVAL-AD5143DBZ board, an assignment for laboratory practice has been written. Furthermore, through experimental testing, the students can understand the operability and efficiency of specific analog circuits with wide practical application. In particular, the developed system is intended for students on the Master's degree program of "Electronics" at the Technical University of Sofia.

4.2. STUDY OF ELECTRONIC CIRCUITS WITH OPERATIONAL AMPLIFIERS USING INTERACTIVE ENVIRONMENTS FOR DESIGN AND ANALYSIS

Daniela Shehova, Katya Asparuhova, Slavi Lubomirov

The paper presents computer models designed for undergraduate students in the engineering programs of higher education in order help the studying of linear circuits with OpAmp. The models allow the study of inverting and non-inverting amplifiers with OpAmp, different variants of transimpedance amplifiers with photodiodes. Using the NI Multisim Analog Devices Edition software environment allows experimental research like working with kits in the university laboratories. The developed electronic tools allow the teachers to formulate individual projects for each student, and the students - to independently conduct research on the given project. The results of the experimental studies also are showed and discussed in the paper. They have been tested in the training of students in the discipline of analog circuitry at the Faculty of Physics and Engineering Technologies, University of Plovdiv Paisii Hilendarski and in optoelectronics at the Department of

Electronics, Faculty of Electronic Engineering and Technologies Technical University of Sofia in conducting online training during quarantine COVID-19.

4.3. MICROCONTROLLER INTERRUPTS EMULATION USING FPGA

Valentina Rankovska, Goran Goranov

In the present work, an approach is proposed for studying the hardware interrupts mechanism implemented in most of the PIC18 microcontrollers. For this purpose, a hardware emulation of the logic circuit for the interrupts handling in the Intel's FPGA circuit is realized. This is a way for the students to get acquainted with this process in practice. Along with this, the wide possibilities for a realization of digital and microprocessor blocks using programmable logic are demonstrated.

4.4. FPGA IMPLEMENTATION OF ALL DIGITAL PHASE LOCKED LOOP FOR ADC SYNCHRONIZATION WITH THE MAINS FREQUENCY

Dimiter Badarov, Georgy Mihov

One of the most accurate Analog-to-Digital converters are of the integrating type. Their measurement speed is low but they have high precision. One of the important features in the laboratory environment is the ability to suppress the mains frequency interference signals. If the first integration phase is with period multiple of the mains period the interference is completely suppressed. A completely digital Phase Locked Loop is designed to provide the converter with clock frequency exactly multiple of the mains frequency. The whole system is implemented on FPGA programmable logic device.

4.5. RESEARCH AND ANALYSIS OF THE ELECTROMOTIVE VOLTAGE GENERATED BY SEEBECK AND PELTIER MODULES

Kaloyan Ivanov, Ivaylo Belovski, Anatoliy Aleksandrov

By the transition to "green" energy, the potential benefits of the thermoelectric modules (TEM) should be taken into account in this field. The thermoelectric generation utilizing the thermal energy from various natural and industrial sources can supply power to low consumption devices and almost fully replace batteries as energy source. To make this transition economically feasible and environmentally friendly, it is necessary to analyze to what extent can the thermoelectric refrigerators effectively substitute the thermoelectric generators in mode of e.m.f. generation. The aim of the present work is to investigate and compare the output characteristics of Seebeck and Peltier modules by the utilization of comparatively low temperatures – up to 100 °C.

4.6. AN ADAPTIVE MOBILE ROBOT CONTROL FOR AUTONOMOUS FOLLOWING IN FRONT OF A PERSON

Plamen Petrov, Veska Georgieva, Ivan Kralov, Stilyan Nikolov

This paper addresses the control of an autonomous mobile robot in a specific case, when the robot following a person in front of him. Using a leader-follower formation approach combined with a look-ahead concept, a human-robot kinematic model in error coordinates with respect to a local Cartesian coordinate system is developed. A nonlinear feedback control is designed using local information from onboard sensor for the relative human-robot position and orientation. An adaptive control is proposed to estimate the unknown human linear and angular velocities. The effectiveness of the proposed robot control is validated via simulation tests and experiments.

4.7. AN APPROACH FOR MODELING ENERGY FLOWS IN RESIDENTIAL PREMISES

Snezhinka Zaharieva, Iordan Stoev, Valentin Mutkov, Teodora Petrova

Providing the necessary comfort in residential premises requires the use of certain energy resources. Considering the high cost, mainly on electricity for domestic purposes, the management of energy flows by power and timing parameters is of particular importance. This management is related to the specifics of living in the premises in the home. For this purpose, the specifics of the room and its energy characteristics are taken into account and the process of the microclimate in the room is modelled. The article presents an adapted model of energy flows in residential premises, based on physical and empirical dependencies, as well as software to simulate its principle of operation. The main goal is to achieve the desired comfort temperature, with reduced electricity consumption.

4.8. BAND-STOP FILTER TUNING FOR POWER-LINE INTERFERENCE REJECTION IN ECG SIGNALS

Georgy Mihov, Dimiter Badarov

The paper proposes a procedure for digital band-stop filter tuning on purpose to extract power-line interferences from ECG signals. The procedure consists of three stages: i) - an inaccurate auxiliary bandpass filter is applied to the signal, which inaccurately extracts the power-line interference; ii) - with an additional filter the deviation of the power-line frequency from its nominal value is determined; iii) - parameters of a precise band-stop filter are corrected from the determined interference frequency deviation. To work with an ECG signal at a high sampling rate, an appropriate reduction of the digital filters used is proposed.

4.9. USE OF INFRARED THERMOGRAPHY TO MONITOR THE PHYSIOLOGICAL CONDITION OF DAIRY COWS

Hristo Hristov, Kalin Dimitrov, Toncho Penev

The aim of the study was to investigate the possibility of using infrared thermography (IRT) as a tool to monitor the physiological condition of dairy cows. Our goal is to monitor cows at normal temperatures. As physiological parameters began to change with the onset of heat stress, we focused on a group with temperature and humidity index (THI) values below 72. In our study, we monitored surface temperature at various points in the body, rectal temperature (RT) and Frequency of Breathing. We chose these parameters because they give the most accurate data on physiology and can be objectively measured. Thermography images of the udder surface temperature (UST), leg surface temperature (LST) and shoulder surface temperature (SST) of the cows were taken. Surface temperatures were extracted from the photos using specialized software. The data were processed and analyzed statistically. The correlation coefficient between UST and SST was 0.90, between RT and Frequency of Breathing was 0.65, between LST and UST was 0.45 and between LST and SST was 0.39. In conclusion, we can say that IRT can be used to monitor the physiological condition of dairy cows.

4.10. INNOVATIVE APPROACHES IN EMBEDDED SYSTEMS TEACHING. THE SMART HOME PROJECT

Valentina Rankovska

A brief overview of innovative approaches in embedded systems learning is presented. The need for the application of project-based learning (PBL) and the Conceive-design-implement-operate (CDIO) framework is justified. A model of a smart home is suggested – a complex object, allowing the students to study the operation of individual building blocks of embedded systems. As it has a variety of peripheral modules, it is especially suitable for embedded systems firmware design and implementation.

Scientific Session 5

NANOOELECTRONICS AND ADVANCED MATERIALS

Hall 4 & [Virtual room 1](#), Friday 28 May, 13.30 - 15.15

Chairpersons: George ANGELOV, Valentin KAMBUROV

5.1. MEASUREMENT OF THE DEFORMATION OF PCB AND SMD DURING SURFACE MOUNTING

Valentin Tsenev, Valentin Videkov, Branimir Pavlov

Based on the standard for testing in surface mounting, an area of critical deformation during the assembly of elements has been determined. A methodology for testing and determining the deformation has been chosen, as well as tools for conducting experimental measurements. The results of practical measurements of deformations after soldering are presented. A conclusion is made on the basis of the obtained results with conclusions regarding the admissibility of the process according to the standard.

5.2. ANALYSIS OF A 3-CONDUCTOR TRANSMISSION LINE WITH NONLINEAR RESISTIVE LOADS

George Angelov

This paper analyzes electromagnetic compatibility aspects of lossless transmission lines terminated by nonlinear loads introduced by C. Paul. We consider mutual interaction between two lines and do not neglect the influence of the receptor line which leads to more general mathematical model just mentioned by C. Paul. The system of functional equations is solved by fixed point method.

5.3. POSSIBLE USAGE OF COMPLEX PIEZOELECTRIC STRUCTURES IN DUAL PURPOSE MODE

Dimo Kolev, Svetoslav Kamenov, Velimira Todorova

The piezoelectric transducers can be used as sensors, actuators and/or energy harvesters. The current trends for the electronic systems are consisted in integrating multiple functionalities and increasing their potentialities with the implementation of elements with dual purpose. The dual purpose is actually the simultaneous usage of sensors as actuators or generators of small energies. The piezoelectric devices have abilities to act simultaneously as actuators or generators and sensors as their functionality can be readily switched but there are some problems in utilizing them in such mode of operation.

5.4. APPLICATION OF DIE BONDER T-3002-PRO FOR SOLDERS TESTING IN SMT

Svetozar Andreev, Valentin Videkov, Georgi Kolev

The results of expanding the capabilities of the T-3002-PRO die bonder machine for testing solders in surface mounting are presented. By using a modified tool to the working head and additional tool on the working table, a possibility to test the mechanical parameters of solders is obtained. It is possible to compare the hardness of different solders at different temperatures. A methodology for testing the tensile bond strength of mounted elements is also applied. Experimental results from the use of advanced features are presented.

5.5. MICROELECTRONICS SKILL ALLIANCE – NEED ANALYSIS OF MICROELECTRONICS SECTOR

Slavka Tzanova

The skill shortage in microelectronics needs to be addressed to sustain the competitiveness of the European sector. Microelectronics Skill Alliance (METIS) project is a concerted effort of stakeholders from industry and education & training to improve the supply of suitably qualified people into the labour market, also by making careers in microelectronics more attractive and relevant to young people with a focus on gender inclusion

5.6. IMPLEMENTATION OF AN INTERNATIONALISED MASTER DEGREE COURSES IN NANOELECTRONICS AND NANOTECHNOLOGIES IN ASIAN UNIVERSITIES

Slavka Tzanova

The NanoEI project has so far enabled creation of twenty seven courses that facilitated transfer of knowledge in nanoelectronics and allied subjects between EU's higher education institutions that have been part of the project with the partner institutes in China, Malaysia, India and Israel. This paper summarises the results of the pilot test in the four Asian countries before the pandemic situation and presents the new teaching initiatives during the COVID pandemics to rise the effectiveness and attractiveness of distant education.

5.7. FABRICATION OF CONDUCTIVE COPPER PATTERNS BY PHOTOCATALYST-ACTIVATED ELECTROLESS DEPOSITION

Pavel Venev, Bozhidar Stefanov, Vesselina Milusheva, Boriana Tzaneva, Valentin Videkov

We present a noble-metal-free procedure for selective electroless deposition of copper patterns on a porous anodic alumina substrate. The substrate was functionalized with a titanium dioxide capping layer via sol-gel dip-coating in order to improve its chemical stability in an alkaline copper plating electrolyte (pH>13). The photocatalytic properties of the titanium dioxide allow for selective deposition of copper seeds by UV irradiation through a photomask. The seed layer was then developed into conductive patterns using the same plating electrolyte. The effects of UV-irradiation and electroless deposition duration on the sheet resistance and wettability of the copper surface by three types of solder pastes were studied.

5.8. INVESTIGATION OF THE POSSIBILITIES FOR ELECTROLESS NICKEL-COBALT COATING ON TITANIUM ALLOYS FOR ELECTRICAL SPARK DEPOSITION

Rayna Dimitrova

The paper concerns the study of the possibilities for electroless application of a nickel-cobalt-phosphorus alloy on titanium and titanium alloy TiAl6V4 substrates when pre-galvanic activation is used. The creation of a nickel alloy coating will allow further electrospray deposition with less erosional impact on the substrate and better adhesion of the hardalloyed coating to a titanium and titanium alloy. The influence of the pre-copper plating and the use of cobalt in the pre-activation of the surface on the percentage of phosphorus in the electroless coating were evaluated. CEM and EDX methods, as well as microhardness testing were used to assess the quality of the applied coatings.

5.9. MICROSTRUCTURAL ANALYSIS AND ELECTRORESISTANCE INVESTIGATION OF HARDALLOYED ELECTROSPARK-DEPOSITED COATINGS ON TIAL6V4 ALLOY

Valentin Kamburov, Serjoga Valkanov, Todor Penyashki, Georgy Kostadinov, Valentin Mateev, Iliana Marinova, Rayna Dimitrova, Antonio Nikolov, Mara Kandeve

The article discusses the possibilities for electrical spark deposition (ESD) of hardalloyed coatings on titanium alloy TiAl6V4 with classic and multicomponent compositions electrode materials. The deposited coatings have been studied for their mechanical properties and their electro-resistive testing results. Surface topography, microhardness and thickness were used as main indicators for evaluation of the properties of hardalloyed ESD coatings on titanium alloy.

Scientific Session 6

INSTRUMENTATION AND MEASUREMENT

Hall 4 & [Virtual room 1](#), Friday 27 May, 16.45 - 17.45

Chairpersons: Marin MARINOV, Georgi NIKOLOV

6.1. EXPERIMENTAL SETUP FOR PERFORMANCE EVALUATION OF OPTICAL SENSORS

Borislav Ganev, Todor Djamiykov, Marin Marinov, Katya Asparuhova

An experimental setup is presented, which allows to study and characterize integrated optical sensors. The system consists of a small integrating sphere that can be illuminated by various sources such as white and colored LEDs, calibrated sources or halogen lamps type. The design allows easy installation and configuration of measuring instruments (light meter, standard calibrated photodiode). The control of the parameters of the tested sensors, data collection and processing is performed using a microcontroller ESP 32 in the LabVIEW programming environment. Preliminary studies of the characteristics of color sensors and calibrated sources are presented.

6.2. HIGH-RESOLUTION PARTICULATE MATTER MONITORING AND MAPPING IN URBAN ENVIRONMENTS

Borislav Ganev, Marin Marinov, Dimitar Nikolov, Andrey Ivanov

Urban air pollution is a major threat to human health. The location and time intervals of peak concentrations of major urban air pollutants are essential for effective air quality management and sustainable urban development. PMs have established themselves as a major polluter in a number of large urbanized regions, such as Sofia. The paper proposes an approach for mobile monitoring, for determining the spatiotemporal distribution of three size fractions of PM (PM1, PM2.5, and PM10) and documenting the reached concentrations with the help of dynamically updated heat maps. This facilitates the determination of the places and times at which the concentrations of pollutants are highest, and hence the detailed study of the sources of pollution.

6.3. EXPERIMENTAL – THEORETICAL MODEL OF GALVANOMAGNETIC IC TYPE MLX91206

Dimitar Georgiev, Dobroslav Dankov, Prodan Prodanov

The stimulation study of an electronic circuit of current meters with galvanomagnetic integrated circuits (GMIC) is necessary to check the functionality even before its physical realization. GMIC models are usually missing and need to be synthesized. The presented method for synthesizing a macromodel includes experimental imaging of GMIC characteristics, regression analysis for

analytical representation of the characteristics, and use of functional blocks to represent the model in PSpice. The obtained simulation results are compared graphically with the experimental ones to check the accuracy of the presented macromodel.

6.4. OPPORTUNITIES FOR ONLINE ENGINEERING TRAINING IN ELECTRONICS

Nina Spasova, Stoyan Bogdanov, Ava Chikurteva

In the process of remote education the most noticeable problems concerned by all lecturers are practical exercises in engineering. In this article are covered some of the web applications which can be use for design and electrical schematics online as part of remote educational process. An exemplary embodiment of electronic circuits using a simulator is presented. Comparisons are made between the results of the simulator and the real schemes. The obtained results show that the tools for simulation and design of electronic circuits are suitable for application in the process of distance learning.

6.5. EMBEDDED SYSTEM FOR MEASURING FREQUENCY RESPONSE OF AUDIBLE AND ULTRASONIC DEVICES

Lubomir Bogdanov

The paper shows an implementation of an embedded system controlled by a host device that produces sounds of different frequencies for underwater frequency response measurements. The developed tools aim at characterization of ultrasonic devices that prevent cetacean mammals from being trapped in fishing nets.

6.6. DISTRIBUTED SYSTEM FOR ERGONOMIC PERSONALIZATION OF SHARED AUTONOMOUS VEHICLES: PROOF OF CONCEPT STUDY

Dimitar Iliev

This study focuses on the technical implementation of a proof of concept for a distributed system which can change the ergonomic characteristics of a shared autonomous vehicle depending on user specific parameters and the status of vehicle modules and sensors. This would allow the vehicle to adapt not only to the user's requirements but also to conditions detected by the vehicle such as driver drowsiness, travel mode (e.g., autonomous cruise mode) or dangerous road conditions.

6.7. ENHANCING ENERGY EFFICIENCY OF LORAWAN PROTOCOL

Stanislav Asenov, Dimitar Tokmakov

In the last few years, IoT devices have multiplied their number and functionality. These devices are located all over the world, and batteries are their main source of energy. In this paper the usage of wireless LoRaWAN sensor node in smart internet of things applications was analyzed. The main focus of the article is on reducing power consumption by wireless LoRaWAN sensor nodes. An analysis of the energy consumption of the various components of the architecture of the wireless sensor nodes is performed. An energy model of the energy consumed by the sensor nodes is presented and analyzed. The result of the analysis provides an accurate identification of the main energy consumers, the magnitude of their consumption and an in-depth understanding of the key mechanisms that need to be applied to improve energy efficiency in wireless sensor nodes. The emphasis is on the presented energy efficient protocol. Three action scenarios from the sensor nodes are presented, outlining the main guidelines and strategies for improving the efficiency of the wireless nodes. In addition, the research results reveal the magnitude of energy savings that can be achieved by implementing improved duty cycle mechanisms in wireless sensor nodes.

6.8. Gamification and ECVET approach

Rosen Petkov

The paper presents methodology issues and practical cases how to develop serious games and combine them with the ECVET approach. Concrete examples from the author experience in training projects and training games development is showcased. The combination of e-games and ECVET is the contribution in the area of self-assessment of informal learning. ECVET approach allows clear understanding of the results, flexibility and possibility for transferability.

Scientific Session 7

INNOVATION MANAGEMENT IN ELECTRONICS

Hall 4 & [Virtual room 1](#), Friday 28 May, 18.00 - 18.30

Chairpersons: Nikolai HINOV, Lidia GALABOVA

7.1. CONTEMPORARY ITSM FRAMEWORKS COMPARATIVE ANALYSIS

Roumiana Ilieva, Nikola Gaydarov

One of the most common problems when selecting a best practice framework to adopt is that there is no common way to do it. Many frameworks claim to cover same topics with the same level of detail. The purpose of this article is to make a practical analysis of several IT Service Management best practice frameworks based on the common management level. This simple comparison model can be applied to any organization without additional investment.

7.2. INDICATORS FOR EFFECTIVENESS AND EFFICIENCY OF IMPLEMENTATION OF ENTERPRISE RESOURCE PLANNING SYSTEM

Kiril Angelov

The development of modern industrial production, based on the principles of Industry 4.0 and Industry 5.0 inevitably implies the introduction of entire digitalization of information flows used for management of the industrial enterprise. In this regard, the implementation of business information systems of ERP class is obligatory process for any modern production, not only in order to optimize internal processes for the company, but also because of the need for reliable and effective integration with other actors in the supply chain. This report presents the author's views on how to assess the effectiveness and efficiency of an ERP system in specific business conditions. In this regard, a group of indicators has been developed that report different influences on the efficiency and effectiveness of the implementation of an Enterprise Resource Planning System.

7.3. APPLICATIONS OF ARTIFICIAL INTELLIGENCE FOR OPTIMIZATION OF BUSINESS PROCESSES IN ENTERPRISE RESOURCE PLANNING SYSTEMS

Kiril Angelov

This article outlines the main opportunities for implementing the methods and developed ICT solutions of artificial intelligence (AI) in the field of Enterprise Resource Planning Systems. Author explores different possible implementations of AI in the ERP such as: process of Implementation of ERP; Customer relationship management; Supply Chain Management; Production; Product Lifecycle Management; Human Resources; Financial Management etc.

ФОРУМ “ЕЛЕКТРОНИКА”

Hall 4 & [Virtual room 1](#), Friday 28 May, 18.30

