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Volume 2

IDAACS'2019

The crossing point of Intelligent Data Acquisition & Advanced Computing Systems and East & West Scientists

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Metz, is a city in northeast France located at the confluence of the Moselle and the Seille rivers. Metz is the prefecture of the Moselle department and the seat of the parliament of the Grand Est region. Located near the tripoint along the junction of France, Germany, and Luxembourg, the city forms a central place of the European Greater Region and the SaarLorLux euroregion.

The French national census of 2012 estimated the population of Metz to be 119,551, while the population of Metz urban agglomeration was about 389,851.

Metz has a rich 3,000-year-history, having variously been a Celtic oppidum, an important Gallo-Roman city, the Merovingian capital of Austrasia, the birthplace of the Carolingian dynasty, a cradle of the Gregorian chant, and one of the oldest republics in Europe.

The city possesses one of the largest Urban Conservation Areas in France, and more than 100 of the city's buildings are classified on the Monument Historique list. Because of its historical and cultural background, Metz is designated as French Town of Art and History, and has been submitted on to France's UNESCO World Heritage Tentative List.

Metz is the economic heart of the Lorraine region, specialising in information technology and automotive industries. Metz is home to the University of Lorraine, Georgia Tech Lorraine, and a centre for applied research and development in the materials sector, notably in metallurgy and metallography.

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Message from the IDAACS 2019 Co-Chairmen

It's our pleasure to welcome all attendees the 2019 IEEE 10th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS), www.idaacs.net, which will be held in Metz, France, 18-21 September, 2019.

The main goal of IDAACS'2019 is to provide a forum for high-quality reports on the state-of-the-art Theory, Technology and Applications of Intelligent Data Acquisition and Advanced Computer Systems as used in different areas. A family of IDAACS Workshops has already been created since the IEEE 1st IDAACS Workshop was held in Foros, Crimea, Ukraine, July 1-4, 2001. After that the following IDAACS Conferences were held in Lviv, Ukraine, 2003, Sofia, Bulgaria, 2005, Dortmund, Germany, 2007, Rende (Cosenza), Italy, 2009, Prague, Czech Republic, 2011, Berlin, Germany, 2013, Warsaw, Poland, 2015, Bucharest, Romania, 2017. Moreover, IDAACS Symposia on Wireless Systems (SWS) were held in Offenburg, Germany in 2012, 2014, 2016 as well as in Lviv, Ukraine in 2018.

The IDAACS 2019 Conference is organized by IEEE Ukraine Section I&M / CI Joint Societies Chapter and the Research Institute for Intelligent Computer Systems, Ternopil National Economic University (TNEU) and V.M. Glushkov Institute of Cybernetics, National Academy of Sciences, Ukraine in cooperation with the ENIM (Ecole Nationale d'Ingénieurs de Metz) and LCOMS (Laboratory of Conception, Optimisation and Modelling of Systems) of University of Lorraine, France.

It is supported and sponsored by IEEE Ukraine Section, IEEE France Section, MDPI Sensors, Fondation ENIM, Metz Metropole, River Publishers, so we express our sincere gratitude to each of them.

The International Program Committee of IDAACS'2019 is co-chaired by Francesca Guerriero, Italy and Carsten Wolff, Germany, many thanks to both of them. In addition, we express our gratitude for all members of IPC. There were submitted the 314 papers by authors from the 42 countries. Many thanks to all the reviewers, their names are listed in the proceedings and their contribution to the quality and success of this Conference. After the reviewing process, the 213 papers were accepted for a publication in the Conference proceedings. All the presentations are organized into the 27 oral and the 3 poster sessions. In addition, three prominent experts are invited to deliver keynotes during plenary sessions: Jürgen Sieck, University of Applied Sciences, Berlin, Germany; Kurosh Madani, Paris-Est Créteil Val-de-Marne University, France; and Fabio Scotti, University of Milan, Italy. We appreciate their contribution to the IDAACS 2019 Conference very much.

Besides, the IDAACS 2019 remained its peculiarity providing seven special streams, and Workshops on Cyber Physical Systems and Internet of Things with 11 sessions.

Metz is the economic heart of the Lorraine region, it's home to the University of Lorraine. The university has over 60000 students, close to 6900 staff members, among which 3700 faculty and searchers, 43 teaching departments, 60 research centers, and several campuses in the entire region. Several important universities are mentioned such as the Pole Universitaire Europeen de Nancy Metz, Georgia Tech Lorraine, Ecole Nationale d'Ingénieurs de Metz (ENIM). The city economy relies on the sectors of commerce, tourism, information technology, and the metallurgical and automotive industries. The city is a center for applied research and development in the materials sector, notably in metallurgy and metallography.

Lastly, we would like to thank all our friends and colleagues from the previous IDAACS' conferences as well as new participants coming in Metz to discuss the latest achievements in the fields of Intelligent Data Acquisition and Advanced Computer Systems!

Enjoy attending the IDAACS'19 conference and the charm city of Metz!

Anatoliy Sachenko

Kondo H. Adjallah

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Table of Contents

Volume 1

Approach to Managing Data from Diverse Sources. *Vitalii I. Yesin, Mikolaj Karpinski, Maryna V. Yesina, Vladyslav V. Vilihura, Olga Veselska, Lukasz Wieclaw* 1

Comparative Analysis of Key Encapsulation Mechanisms. *Maryna Yesina, Mikolaj Karpinski, Volodymyr Ponomar, Yurij Gorbenko, Tomasz Gancarczyk, Uliana Iatsykovska* 7

A Method for Decimal Number Recovery from its Residues Based on the Addition of the Product Modules. *Mikolaj Karpinski, Stanislaw Rajba, Stanislaw Zawislak, Kornel Warwas, Mykhailo Kasianchuk, Stepan Ivasiev, Igor Yakymenko* 13

Indoor Emergency Evacuation Model Based on Artificial Bee Colony Algorithm. *Xinlu Zong, Jiayuan Du, Wei Liu, Lu Zhang, Qian Huang* 18

The Development of Distance Learning in Ukrainian Liberal Arts Institutions Based on EU Experience. *Halina Falfushynska, Aleksandra Klos-Witkowska, Bogdan Buyak, Grigory Tereshchuk, Uliana Iatsykovska, Pawel Falat, Rafal Szklarczyk* 24

Accuracy Enhancement of a Blind Image Steganalysis Approach Using Dynamic Learning Rate-Based CNN on GPUs. *Eslam M. Mustafa, Mohamed A. Elshafey, Mohamed M. Fouad* 28

The Extended Generalized Neo-Fuzzy Network and its Online Learning in Image Recognition Problem. *Nonna Kulishova, Yevgeniy Bodyanskiy, Iryna Pliss* 34

Enhancing the Performance of an Image Steganalysis Approach Using Variable Batch Size-Based CNN on GPUs. *Eslam M. Mustafa, Mohamed M. Fouad, Mohamed A. Elshafey* 40

Chaotic Map Synchronization by Common-Mode Truncation Pulses for Secure Communications. *John Kalomiros, Stavros G. Stavrinides* 45

Low Cost Outdoors WSN Parking System for Metropolitan Areas Based on RSS. *Mauricio Postigo-Málaga, Luis Porras Figueroa, José Chilo* 50

Modeling of Cognitive Evolution. *Vladimir G. Red'ko* 54

Data Piecewise Linear Approximation for Bearings Degradation Monitoring. *Fei Huang, Alexandre Sava, Kondo H. Adjallah, Zhouhang Wang* 60

The Application of the Internal Restructuring Method of the Information Resource Data According to the Sign of the Number of Series of Units to Improve the Statistical Coding Efficiency. *Vladimir Barannik, Ivan Tupitsya, Valeriy Barannik, Sergii Shulgin, Alexander Musienko, Roman Kochan, Olga Veselska* 65

A Spark-based Distributed Whale Optimization Algorithm for Feature Selection. *Hongwei Chen, Zhou Hu, Lin Han, Qiao Hou, Zhiwei Ye, Jiansen Yuan, Jun Zeng* 70

Distributed Text Feature Selection Based on Bat Algorithm Optimization. *Hongwei Chen, Qiao Hou, Lin Han, Zhou Hu, Zhiwei Ye, Jun Zeng, Jiansen Yuan* 75

A Feature Selection Method of Parallel Grey Wolf Optimization Algorithm Based on Spark. *Hongwei Chen, Lin Han, Zhou Hu, Qiao Hou, Zhiwei Ye, Jun Zeng, Jiansen Yuan* 81

Recurrent Random Delay Estimation in Networked Discrete Control Systems. *Leonid Lyubchyk, Galina Grinberg, Olha Dunaievska, Nataliia Protsai* 86

Control and Identification in Cognitive Maps with Suppressing Constrained External and Internal Disturbances in Impulse Processes. *Vyacheslav Gubarev, Viktor Romanenko, Yurii Miliavskyi* 90

Data Processing in IoT for Smart City Systems. *Oleksij Duda, Volodymyr Kochan, Natalija Kunanets, Oleksandr Matsiuk, Volodymyr Pasichnyk, Anatoliy Sachenko, Taras Pytlenko* 96

Study of the Functioning of the Distributed Computer System with a Resource Control Mechanism Based on a Network-Centric Approach. *Vadym Mukhin, Viktor Vyshnivskyi, Yaroslav Kornaga, Oksana Herasymenko, Yuriy Bazaka, Maxim Bazaliy* 100

A Wireless Sensor Network Location Algorithm Based on Whale Algorithm. *Fenghao Lang, Jun Su, ZhiWei Ye, XiaoXiao Shi, Feng Chen* 106

Multi-hop Routing Implementation in Spatially Distributed Wireless Sensor Networks for Large-Scale Environmental Monitoring Applications. *Afzal Ahmad, Muhammad Adeel Pasha, Shahid Masud, Manuel Schappacher, Assila Belhouichet, Axel Sikora* 111

Cyber Resilience Approach Based on Traffic Engineering Fast ReRoute with Policing. *Oleksandr Lemeshko, Oleksandra Yeremenko, Maryna Yevdokymenko, Anastasiia Shapovalova, Ahmad M. Hailan, Amal Mersni* 117

Data-Driven Fault Detection and Identification in Wind Turbines through Performance Assessment. *Boudy Bilal, Kondo Hloindo Adjallah, Alexandre Sava* 123

Business Models for Wireless AAL Systems – Financing Strategies. *Jelena Bleja, Henrike Langer, Uwe Grossmann* 130

Research on Short-term Electric Load Forecast Based on Grey Neural Network and Snap-drift Cuckoo Search Algorithm. *Feng Chen, Zhiwei Ye, Jun Su, Haofeng Lang, Xiaoxiao Shi, Shuqing Wang* 134

Solar Cell Data Acquisition System. *Valeriy Martynyuk, Mykola Fedula, Roman Petrus, Denis Makaryshkin, Liudmyla Kovtun* 140

An Approach to Intelligent Distributed Scanning and Analytical Processing of the Internet Inappropriate Information. *Alexander Branitskiy, Andrey Fedorchenko, Igor Kotenko, Igor Saenko* 146

The FPGA-Based Problem-Oriented On–Board Processor. *Volodymyr Opanasenko, Alexander Palahin, Stanislav Zavyalov* 152

Deep Convolutional Network with Long Short-Term Memory Layers for Dynamic Gesture Recognition. *Rostyslav Siriak, Inna Skarga-Bandurova, Yehor Boltov* 158

Network Protocols Determination Based on Raw Data Analysis for Security Assesment under Uncertainty. *Diana Gaifulina, Andrey Fedorchenko, Igor Kotenko* 163

Specialized Computer Systems Digital Bandpass Frequency-Dependent Components Rearrangement. *Hnna Ukhina, Valerii Sytnikov, Oleg Streltsov, Pavel Stupen, Dmitrii Yakovlev* 168

Computer Tools for Cargo Thefts Fighting on Railway Transport. *Ivan Kit, Andrii Fomenko, Volodymyr Vyshnia, Iryna Novosad* 172

New Direction for Malware Detection Using System Features. *Štefan Balogh, Ján Mojžiš* 176

Method of Audio Interaction with Indoor Navigation Systems. *Olha Petrova, Galyna Tabunshchyk* 184

Low- and High-level Methods for Tree Segmentation. *László Czúni, Karim Ben Alaya* 189

The universal neural network model for solving the Navier-Stokes equation. *Aleksei Lomakin, Nikolai Korsunov* 193

A Machine-Learning Based Approach for DataDriven Identification of Heating Dynamics of Buildings' Living-Spaces. *Roozbeh Sadeghian Broujeny, Kurosh Madani, Abdennasser Chebira, Veronique Amarger, Laurent Hurtar* 197

The Computer-integrated System of Assessment of Plant Condition in Closed-ground Structures. *Vitaliy Lysenko, Taras Lendiel, Dmytro Komarchuk, Alla Dudnyk, Natalia Zaets* 203

Classification Methods of Machine Learning to Detect DDoS Attacks. *Tamara Radivilova, Lyudmyla Kirichenko, Dmytro Ageiev, Vitalii Bulakh* 207

Using Clustering Analysis for Determination of Scattering Kernels in X-ray Imaging. *Anton Danyk, Serhii Radchenko, Andrii Netreba, Oleksandr Sudakov* 211

Intelligent Information System for Investment in Uncertainty. *Yuriy Kondratenko, Galyna Kondratenko, Ievgen Sidenko, Mykyta Taranov* 216

Neural Controller for Mobile Multipurpose Caterpillar Robot. *Oleksandr Gerasin, Oleksiy Kozlov, Galyna Kondratenko, Joachim Rudolph, Yuriy Kondratenko* 222

Assessment of Occupancy Estimators for Smart Buildings. *Claudia Chitu, Grigore Stamatescu, Iulia Stamatescu, Valentin Sgârciu* 228

The Basic Model of Attack Resistance Estimation for Monitoring the Program Code Integrity of the FPGA-Based Systems. *Kostiantyn Zashcholkin, Oleksandr Drozd, Oleg Sachenko, Olena Ivanova, Yurii Boliubash* 234

A method of the results preparation in addition-based circuits. *Oleksandr Drozd, Konrad Grzeszczyk, Nadiia Vasylkiv, Julia Drozd, Iryna Turchenko, Andriy Karachka* 239

Evaluation Cognitive Maps for extended technology roadmapping in IoT. *Anna Usik, Volodymyr Kazymyr* 244

Sharing of Functional and Special Means in Pipeline Floating-Point Systems with Strongly Connected Versions. *Oleksandr Drozd, Igor Kovalev, Myroslav Drozd, Oleksandr Martynyuk, Serhii Polozhaenko* 249

Augmented Reality in Telemedicine Applications Focus on Remote Training. *Mouna Kenoui* 254

Awareness Management of Stakeholders During Project Implementation on the Base of the Markov Chain. *Olena Verenych, Olena Sharovara, Mariia Dorosh, Mariia Voitsekhovska, Nataliia Yehorchenkova, Iryna Golyash* 259

Lattice Data Analytics: The Poset of Irreducibles and the MacNeille Completion. *George Markowsky, Linda Markowsky* 263

Identification of Mobile Terminal with Femtocell on Drone for Civil Protection Applications. *Roberta Avanzato, Francesco Beritelli, Mario Vaccaro* 269

Lattice Data Analytics and an Exploratory Analysis of the Carver2 Dataset. *Linda Markowsky, George Markowsky* 274

Multi-level Method of Behavioral Online Testing of Distributed Information Systems. *Oleksandr Martynyuk, Oleksandr Drozd, Hanna Stepova, Dmitry Martynyuk* 279

A Convolutional Neural Networks approach to Audio Classification for Rainfall Estimation. *Roberta Avanzato, Francesco Beritelli, Francesco Di Franco, Valerio Puglisi* 285

Twosome Modelling based Emotion Recognition in Videos. *Salma Kasraoui, Zied Lachiri, Kurosh Madani* 290

Comparison of Pixel Correlation Induced by Space-Filling Curves on 2D Image Data. *Stéphane Duguay, Steven Pigeon* 294

Vector of Diagnostic Features in the Form of Decomposition Coefficients of Statistical Estimates Using a Cyclic Random Process Model of Cardiosignal. *Vasyl Martsenyuk, Andriy Sverstiuk, Aleksandra Kłos-Witkowska, Andriy Horkunenko, Stanisław Rajba* 298

2D-Deep Neural Network and its Online Rapid Learning. *Yevgeniy Bodyanskiy, Olena Boiko, Iryna Pliss, Valentyna Volkova* 304

Dynamic Changes of the Colour Intensity of Collected Urine as a Basis for a Distant Uroflowmetry. *Leonid Godlevsky, Konstantin Shakun, Vasyl Martsenyuk, Tatyana Tatarchuk, Tatyana Stoeva, Tamara Godlevska, Ilya Shakun, Aleksandra Kłos-Witkowska* 308

On Development of Machine Learning Models with Aim of Medical Differential Diagnostics of the Comorbid States. *Vasyl Martsenyuk, Liliya Babinets, Yuliya Dronyak, Olha Paslay, Olga Veselska, Kornel Warwas, Igor Andrushchak, Aleksandra Kłos-Witkowska* 313

Web Service Interaction Modeling with Colored Petri Nets. *Aleksandr Gozhyj, Irina Kalinina, Victor Gozhyj, Victoria Vysotska* 319

New Quantum Secret Sharing Protocol Using Entangled Qutrits. *Yevhen Vasiliu, Igor Limar, Tomasz Gancarczyk, Mikolaj Karpinski* 324

Modeling and Simulation of the Services for Vehicle Charging Infrastructure Interaction. *Peter Arras, Galyna Tabunshchyk, Vyacheslav Okhmak, Sergiy Korotunov* 330

Development of Architectural Realizations of Phototherapy Computer's Systems for Prevention and Treatment. *Alexander Trunov, Alexander Belikov* 334

Application of Wireless Sensor Networks for Digital Agriculture. *Volodymyr Romanov, Igor Galelyuka, Hanna Antonova, Oleksandra Kovyrova, Volodymyr Hrusha, Oleksander Voronenko* 340

Mathematical Model of the Compact Inertial Navigation System of the Robot. *Alexey Lagunov, Alexey Orlov* 345

Human-Machine Interaction in the Remote Control System of Electric Charging Stations Network. *Anzhelika Parkhomenko, Hanna Selevych, Stanislav Kijan* 351

A Wireless Sensor Network Node Location Method Based on Salp Swarm Algorithm. *Xiaoxiao Shi, Jun Su, Zhiwei Ye, Feng Chen, Pengzi Zhang, Fenghao Lang* 357

Simulation of Gas Flow for Welding Process Control in the Arctic Environment. *Alexey Lagunov, Anton Losunov* 362

Abnormal Event Detectionin Video Basedon SVDD. *Xinlu Zong, Lu Zhang, Jiayuan Du, Liu Wei, Qian Huang* 368

NN-SANARX Model Based Control of a Water Tank System Using Embedded Microcontroller Arduino. *Vjatseslav Skiparev, Juri Belikov, Eduard Petlenkov* 372

Research on Network Intrusion Detection Based on Support Vector Machine Optimized with Grasshopper Optimization Algorithm. *Zhiwei Ye, Yiheng Sun, Shuang Sun, Sikai Zhan, Han Yu, Quanfeng Yao* 378

FPGA Implementation of Internet Key Exchange Based on Chaotic Cryptosystem. *Belqassim Bouteghrine, Mohammed Rabiai, Camel Tanougast, Said Sadoudi* 384

Image Segmentation Using Fuzzy C-means Optimized by Ant Lion Optimization. *Can Jin, Zhiwei Ye, Lingyu Yan, Ye Cao, Aixin Zhang, Lie Ma, Xiang Hu, Jiwei Hu* 388

An Improved Lightning Attachment Procedure Optimization Algorithm for Function Optimization. *Shuang Sun, Zhiwei Ye, Yiheng Sun, Sikai Zhan, Han Yu, Quanfeng Yao* 394

Abstract Model of Eavesdropper and Overview on Attacks in Quantum Cryptography Systems. *Zhengbing Hu, Yevhen Vasiliu, Oleksii Smirnov, Viktoriia Sydorenko, Yuliia Polishchuk* 399

Botnet Detection Approach for the Distributed Systems. *Oleg Savenko, Anatoliy Sachenko, Sergii Lysenko, George Markowsky* 406

Development, Validation and Testing of the Bayesian Network of Educational Institutions Financing. *Volodymyr Lytvynenko, Nataliia Savina, Mariia Voronenko, Nadia Doroschuk, Saule Smailova, Oleg Boskin, Tatyana Kravchenko* 412

Development of the Dynamic Bayesian Network to Evaluate the National Law Enforcement Agencies' Work. *Volodymyr Lytvynenko, Nataliia Savina, Mariia Voronenko, Anna Pashnina, Roman Baranenko, Nataliia Krugla, Ivan Lopushynskyi* 418

About Innovation-Investment Designing of Complex Systems by Inductive Technology of System Information-Analytical Research. *Volodymyr Osypenko, Irina Lurie, Maryna Yakobchuk, Nataliia Savina, Oleg Boskin, Volodymyr Lytvynenko* 424

Application of a Combined Approach for Predicting a Peptide-Protein Binding Affinity Using Regulatory Regression Methods with Advance Reduction of Features. *Oleksandr Murzenko, Serge Olszewski, Oleg Boskin, Irina Lurie, Nataliia Savina, Mariia Voronenko, Volodymyr Lytvynenko* 431

Algorithms for Calculating the Square Root and Inverse Square Root Based on the Second-Order Householder's Method. *Leonid Moroz, Volodymyr Samotyy, Oleh Horyachyy, Ulyana Dzelendzyak* 436

Miniaturized Off-Centered Fed Dipole Slot Antenna for Multiband Wireless Applications. *Maawia, Rabiai Mohammed, Shahid Khan, Hazrat Ali, Safdar Nawaz Khan Marwat, Muhammad Asim, Camel Tanougast* 443

Motion Detection of a Motorcycle Approaching from Behind Using Head and Torso Simulator. *Ryuichi Shimoyama, Shunta Ishitsuka* 448

EUROPA – A ROS-based Open Platform for Educational Robotics. *Georgios Karalekas, Stavros Vologiannidis, John Kalomiros* 452

An Improved Association Rule Mining Algorithm Based on Ant Lion Optimizer Algorithm and FP-Growth. *Dawei Dong, Zhiwei Ye, Yu Cao, Shiwei Xie, Fengwen Wang, Wei Ming* 458

RealTime Wireless Monitoring System of CO2 and CH4 in Juliaca-Perú. *Javier Mendoza Montoya, José Chilo* 464

Pixel-wise Road Pavement Defects Detection Using U-Net Deep Neural Network. *Rytis Augustaukas, Arūnas Lipnickas* 468

Improved Spatio-temporal Kringing and its Application to Regional Precipitation Prediction. *Yan Liu, Yanzhong Hu, Haibo Wang, Can Jin, Dawei Dong* 472

Latency Reduction Techniques for NB-IoT Networks. *Kofi Atta Nsiah, Zubair Amjad, Axel Sikora, Benoît Hilt, Jean-Philippe Lauffenburger* 478

Emergency Forecasting on the Basis of the Bifurcation Analysis Practice-Oriented to Local Climate Dynamics. *Yury Kolokolov, Anna Monovskaya* 483

Breast Cancer Detection and Classification based on Multilevel Wavelet Transformation. *Nazir Jan, Shahid Khan, Hazrat Ali, Djeldjli Djamaleddine, Camel Tanougast* 489

Capsule-Net for Urdu Digits Recognition. *Talha Iqbal, Hazrat Ali, Muhammad Muneeb Saad, Shahid Khan, Camel Tanougast* 495

Method of Assessing the State of Monuments based on Fuzzy Logic. *Sergii Telenyk, Krzysztof Czajkowski, Petro Bidiuk, Eduard Zharikov* 500

A River Flood Monitoring Technique based on Image Splitting Algorithms. *Roberta Avanzato, Francesco Beritelli, Angelo Cavallaro, Massimiliano Cuccia, Tiziana Lombardo* 507

Conceptual Foundations of the Use of Formal Models and Methods for the Rapid Creation of Web Applications. *Sergii Telenyk, Grzegorz Nowakowski, Eduard Zharikov, Jewhenii Vovk* 512

Collaborative UAV-WSN System for Data Acquisition and Processing in Agriculture. *Dan Popescu, Florin Stoican, Loretta Ichim, Grigore Stamatescu, Cristian Dragana* 519

MLP on FPGA: Optimal Coding of Data and Activation Function. *Farid Alilat, Reda Yahiaoui* 525

Feedforward Neural Network Based on Improved Gray Wolf Optimizer. *Wei Liu, Mingwei Hu, Zhiwei Ye, Yuanzhi Tang, Ziwei Wang, Li Zhang, Ming Wei* 530

SOA Based System for Big Genomic Data Analytics and Knowledge Discovery. *Veska Gancheva, Plamenka Borovska* 536

An Image Segmentation Method Based on Improved Krill Herd Algorithm and Fuzzy C-Means Clustering Algorithm. *Ziwei Wang, Zhiwei Ye, Wei Liu, Mingwei Hu, Yuanzhi Tang, Li Zhang, Ming Wei* 542

Learning Parameters in Deep Belief Networks Through Ant Lion Optimization Algorithm. *Zhiwei Ye, Yuanzhi Tang, Wei Liu, Mingwei Hu, Ziwei Wang, Li Zhang, Ming Wei* 548

Neural Network Structure Learning based on Binary Coded Ant Lion Algorithm. *Zhiwei Ye, Sikai Zhan, Shuang Sun, Yiheng Sun, Han Yu, Quanfeng Yao* 552

Thermal Design of Electronic Devices with a Forced Cooling System. *Galina Shilo, Vladimir Beskorovainyi, Evgen Ogrenich, Nataliia Furmanova, Natalia Myronova* 556

Image Classification Based on BP Neural Network and Sine Cosine Algorithm. *Haoqiu Song, ZhiweiYe, Chunzhi Wang, Lingyu Yan* 562

Parking Guide Service for Large Urban Areas. *Marina Derkach, Vladislav Lysak, Inna Skarga-Bandurova, Igor Kotsiuba* 567

Improved Model of Quantum Deterministic Protocol Implementation in Channel with Noise. *Alaa Edein Qoussini, Yousef Ibrahim Daradkeh, Shaima Mohammad Al Tabib, Sergiy Gnatyuk, Tetyana Okhrimenko, Vasyl Kinzeryavyy* 572

Volume 2

Sensing in IoT for Smart City Systems. *Volodymyr Kochan, Natalia Kunanets, Volodymyr Pasichnyk, Oleksiy Roshchupkin, Anatoliy Sachenko, Iryna Turchenko, Oleksij Duda, Vita Semaniuk, Svitlana Romaniv, Oleksandr Matsiuk* 579

Embedded On-line System for Electrical Energy Measurement and Forecasting in Buildings. *Cristina Nichiforov, Grigore Stamatescu, Iulia Stamatescu, Nicoleta Arghira, Ioana Făgărăşan, Sergiu Stelian Iliescu* 586

Incident Detection over Unified Threat Management Platform on a Cloud Network. *Muhammad Muneeb Saad, Talha Iqbal, Hazrat Ali, Mohammad Farhad Bulbul, Shahid Khan, Camel Tanougast* 592

ANTRL as a Development Platform for the Series DSL for the Learning Process. *Ihor Kandyba, Yevhen Davydenko, Valentyna Panasyuk, Alyona Shved, Mykola Fisun* 597

A Fast and Accurate Edge Detection Algorithm for Real-Time Deep-Space Autonomous Optical Navigation. *Hao Xiao, Yanming Fan, Zhang Zhang, Xin Cheng* 601

ICT Tools Supporting the Education Process: ELEANOR (E-Learning and Education Assisted by New On-line Resources). *Francesca Guerriero, Giusy Macrina, Gianfranco Salfi* 605

Automated Time Delay Estimation for Distributed Sensor Systems of Electric Vehicles. *Jakob Pfeiffer, Xuyi Wu* 609

Theoretical Error of Bearing Method in Artillery Sound Ranging. *Roman Kochan, Orest Kochan, Bogdan Trembach, Uliana Kohut, Stanislaw Zawislak, Pawel Falat, Kornel Warwas* 615

Towards Image Processing Based on System of Difference Equations. *Andrii Cheredarchuk, Oleksii Kashpirovskyi, Galyna Kriukova, Maksym Sarana* 620

Data-Analysis Methods in Detecting, Visualizing and Predicting Nuclear Power Plant Component Ageing Phenomena. *Miki Sirola, John Einar Hulsund* 624

Artificial Intelligence for Sport Activitity Recognition. *Sergei Bezobrazov, Andrei Sheleh, Sergei Kislyuk, Sergey Anfilets, Vladimir Golovko, Anatoliy Sachenko, Myroslav Komar, Vitaliy Dorosh, Volodymyr Turchenko* 628

To Experimental Imitations of Evolutional Scenarios in Local Climate Dynamics. *Yury Kolokolov, Anna Monovskaya, Vladimir Bagrov* 633

Analysis of Transient State Signatures in Electrical Household Appliances. *Augustyn Wójcik, Wiesław Winiecki, Robert Łukaszewski, Piotr Bilski* 639

Sensor Virtualization for Enabling Novel Services. *Oana Chenaru, Cristina Elena Hanganu, Dan Popescu, Loretta Ichim* 645

Impact of Metabolomics on Depression using Data Mining Techniques. *Olga Chovancova, Andrea Stafurikova, Denisa Macekova, Terezia Kiskova, Jan Rabcan, Jozef Kostolny* 651

Fire Dispersal Estimation in Videos using Background Modelling and Subtraction by Tensor Decomposition. *Ivo R. Draganov, Rumen P. Mironov, Agata H. Manolova, Nikolay N. Neshov* 656

Online Incipient Chatter Detection Based on Once-Per-Revolution Sampling and Dynamic Threshold Variant. *Yanqing Zhao, Kondo H. Adjallah, Alexandre Sava, Zhouhang Wang* 662

A User Study of the Visualization-Assisted Evaluation and Management of Network Security Detection Events and Policies. *Volker Ahlers, Bastian Hellmann, Gabi Dreo Rodosek* 668

Methodology of Transformation of Fuzzy Queries into Queries in the SQL Standard. *Grzegorz Nowakowski* 674

Digital Data Convertion Using Content Addressable Memory. *Zbigniew Kokosiński* 680

Detection and Analysis of Periodic Actions for Context-Aware Human Centric Cyber Physical System to Enable Adaptive Occupational Therapy. *Nikolay Neshov, Agata Manolova, Krasimir Tonchev, Ognian Boumbarov* 685

Spatial-Temporal Transformation of Matrix and Multilayer Algorithms of Binary Number Multiplication. *Volodymyr Gryga, Igor Kogut, Victor Holota, Roman Kochan, Stanislaw Rajba, Tomasz Gancarczyk, Uliana Iatsykovska* 691

A Cost-Efficient and Continuous Ethernet Cable Diagnosis Technique based on Undersampling. *Ahmed Yahia Kallel, Sebastian Uziel, Manuel Schappacher, Axel Sikora, Thomas Keutel, Olfa Kanoun* 695

Information Hiding Using 3D-Printing Technology. *Alexandr Kuznetsov, Oleh Stefanovych, Yuriy Gorbenko, Oleksii Smirnov, Victor Krasnobaev, Kateryna Kuznetsova* 701

Code-Based Schemes for Post-Quantum Digital Signatures. *Alexandr Kuznetsov, Anastasiia Kiian, Andriy Pushkar'ov, Danylo Mialkovskyi, Oleksii Smirnov, Tetiana Kuznetsova* 707

Side Channel Attack on a Quantum Random Number Generator. *Alexandr Kuznetsov, Oleksii Nariezhnii, Igor Stelnyk, Tetiana Kokhanovska, Oleksii Smirnov, Tetiana Kuznetsova* 713

Fuzzy-multiple Approach in Choosing Time Factor for Implementation of the Innovative Project. *Oksana Chereshnyuk, Valentyna Panasyuk, Svitlana Sachenko, Oksana Adamyk*.....718

Hierachical Model of Behavior On-line Testing for Distributed Information Systems. *Oleksandr Martynyuk, Oleksandr Drozd, Ahmesh Tamim, Bui Van Thuong, Anatoliy Sachenko, Halyna Mykhailova, Mykhaylo Dombrovskyi*.....724

The Project Management in Italian Air Force and the Touch&Go methodology. *Francesca Fabiano, Luigi Di Puglia Pugliese, Francesca Guerriero*.....730

Prosody Training Mobile Application: Early Design Assessment and Lessons Learned. *Evgeny Pyshkin, John Blake, Anton Lamtev, Iurii Lezhenin, Artyom Zhuikov, Natalia Bogach*.....735

Reliability Evaluation of Multi-State System Based on Incompletely Specified Data and Structure Function. *Elena Zaitseva, Vitaly Levashenko, Jan Rabcan, Miroslav Kvassay, Patrik Rusnak*.....741

Optimization of Complex Dynamic Objects Survey Procedure. *Orest Ivakhiv, Markiyan Nakonechnyi, Oleksandr Viter, Grygoriy Hladiy, Inna Shylinska, Taras Lendyuk*.....747

Spacecraft Telemetry Time Series Forecasting with Ensembles of Neural Networks. *Alexandr Doudkin, Yauheni Marushko, Jan Owsiński, Tadeusz Pawlowski*.....752

Realistic Mathematical Model of Passive Infrared Sensor's Signal. *Oleksandr Sudakov, Andrii Malenko*.....757

The Creation of a Free Vocal SMS and Email Sender and Reader App with Chat Style Interface. *Radu-Ştefan Ricman, Roland Szabo, Aurel Gontean*.....761

Supporting a Pharmaceutical Wholesaler in the Vehicle Fleet Organization: an Italian Case Study. *Francesca Guerriero, Rosita Guido, Giovanni Mirabelli, Vittorio Solina*.....765

Application of Generalised Reed-Muller Expansion in Development of Programmable Logic Array. *Elena Zaitseva, Vitaly Levashenko, Igor Lukyanchuk, Miroslav Kvassay, Jan Rabcan, Patrik Rusnak*.....769

Availability as a Metric for Region-Scale Telecommunication Designs. *Yuri M. Monakhov, Mikhail Yu. Monakhov, Sergei D. Luchinkin, Anna P. Kuznetsova, Maria M. Monakhova*.....775

Performance Measurements of Narrowband-IoT Network in Emulated and Field Testbeds. *Jubin Sebastian E, Axel Sikora*.....780

Comparison of Deep Autoencoder Architectures for Real-time Acoustic Based Anomaly Detection in Assets. *Maarten Meire, Peter Karsmakers*.....786

Along-Track and Cross-Track Noise Analysis of Altimeter Data Using Tensors. *Nicole Christoff, Agata Manolova, Roumen Mironov* 791

Semantic Interoperability in Cyber-Physical Systems. *Ingo Kunold, Hendrik Wöhrle, Markus Kuller, Nursi Karaoglan, Fabian Kohlmorgen, Jörg Bauer* 797

Building of the Predicate Recognition System for the NLP Ontology Learning Module. *Chang Shu, Dmytro Dosyn, Vasyl Lytvyn, Victoria Vysotska, Anatoly Sachenko, Su Jun* 802

Preservation System for Scientific Experiments in High Performance Computing: Challenges and Proposed Concept. *Kyryll Udod, Volodymyr Kushnarenko, Stefan Wesner, Volodymyr Svjatnyj* 809

Towards Reduction in MOOCs Dropouts: An Agent-Based Model for Social Network Based Collaborative Learning. *Lakshmi Sunil Prakash, Kashif Zia, Ismail Khalil* 814

Secure and Privacy Preserving Pattern Matching in Distributed Cloud-based Data Storage. *Vladimir Oleshchuk* 820

Stability Analysis of Heartbeat Control Based on the Zeeman Framework. *Mohamed Abdelhady, Yuriy Kondratenko, Wael Abouelwafa, Dan Simon* 824

Imaging Photoplethysmography: Signal Waveform Analysis. *Djamaleddine Djeldjli, Frédéric Bousefsaf, Choubeila Maaoui, Fethi Bereksi-Reguig* 830

Data Acquisition Framework for Competence Profiles Selection and Project Staffing. *Nargiza Mikhridinova, Carsten Wolff, Bassam Hussein* 835

Prediction of Surrounding Vehicles Lane Change Intention Using Machine Learning. *Abdelmoudjib Benterki, Moussa Boukhnifer, Vincent Judalet, Maaoui Choubeila* 839

Detection and Classification of Malicious Access using a Dionaea Honeypot. *Koki Saikawa, Vitaly Klyuev* 844

Field Evaluation of Low Cost Sensors Array for Air Pollution Monitoring. *Rachid Laref, Etienne Losson, Alexandre Sava, Maryam Siadat* 849

Improving Sentiment Analysis in Twitter Using Sentiment Specific Word Embeddings. *Rania Othman, Youcef Abdelsadek, Kamel Chelghoum, Imed Kacem, Rim Faiz* 854

Evaluating Array DBMS Compression Techniques for Big Environmental Datasets. *Ramon Antonio Rodriges Zalipynis* 859

A Design for a Cryptographically Secure Pseudo Random Number Generator. *Benjamin Williams, Robert E. Hiromoto, Albert Carlson* 864

Timing Characteristics of Sensor Simulation in an HIL Environment. *Igor Khimchenko, Peter Schulz* 870

Fuzzy Method with Z-numbers for Choosing Target Group of Users for UX Applications. *Arkadiusz Banasik, Marcin Lawnik* 878

Mechanical Machinery Faults Detection and Classification Based on Artificial Intelligence Techniques. *Mostafa H. Metwally, M.A. Moustafa Hassan, Galal A. Hassaan* 882

Fuzzy Logic Control for a Stand-Alone PV System with PI Controller for Battery Charging Based on Evolutionary Technique. *Omnia S. S. Hussian, Hany M. Elsayed, M. A. Moustafa Hassan* 889

The Simple Virtual Impedance Spectroscopy Based on USB DAQ Card. *Mykhaylo Dorozhovets, Małgorzata Augustyn* 895

Method of Activity of Intelligent Agent for Semantic Analysis of Software Requirements. *Olga Pavlova, Tetiana Hovorushchenko, Artem Boyarchuk* 902

Formal Aspects of Case-Based Data Modelling for Intelligent Drilling Control. *Vasyl Sheketa, Mykola Chesanovskyy, Mykola Pasyeka, Volodymyr Pikh, Yulia Romanyshyn, Viktoriia Bandura* 907

Machine Learning Based Medicine Distribution System. *Huiling Xia, Chunzhi Wang, Lingyu Yan, Xinhua Dong, Yichao Wang* 912

An Image Enhancement Optimization Method Based on Differential Evolution Algorithm and Cuckoo Search Through Serial Coupled Mode. *Zhiwei Ye, Ye Cao, Aixin Zhang,Can Jin, Lie Ma, Xiang Hu, Jiwei Hu* 916

An Image Thresholding Method Based on Differential Evolution Algorithm and Genetic Algorithm. *Zhiwei Ye, Aixin Zhang, Ye Cao, Lie Ma, Can Jin, Xiang Hu, Jiwei Hu* 921

Financial Early Warning of Listed Companies Based on Fireworks Algorithm Optimized Back- Propagation Neural network. *Chunzhi Wang, Yichao Wang, Lingyu Yan, Zhiwei Ye, Wencheng Cai, Pan Wu* 927

Evaluating the Impact of Involving Students in Producing Learning Aids in Project Management. The Animation Project. *Bassam Hussein, Carsten Wolff, Nargiza Mikhridinova* 933

Emotional Text Analysis Based on Ensemble Learning of Three Different Classification Algorithms. *WenShuo Bian, ChunZhi Wang, ZhiWei Ye, Lingyu Yan* 938

Predictive Causality of Granger Test for Long Run Equilibrium to Photovoltaic System. *Yannick Fanchette, Harry Ramenah, Philippe Casin, Michel Benne, Camel Tanougast, Kondo Adjallah* 942

Method for Detecting Error in Design of Virtual Environment. *Svitlana Antoshchuk, Olena Arsirii, Oleksandr Blazhko, Yuliia Troianovska, Tetiana Luhova* 947

Data Transmission Scheme Based on Publish/Subscribe in Workshop. *Tangxiao Yuan, Huafei Fan, Huifen Wang, Kondo Hloindo Adjallah, Zhouhang Wang* 953

International Cooperation at the University Level. Obstacles and Challenges for Incoming Students and How to Eliminate them. *Anna Badasian* 959

Methods of Proactive Management of Complex Projects Based on Neural Networks. *Viktor Morozov, Olena Kalnichenko, Maxim Proskurin* 964

Virtual Reality Implementation for Design of Warehouse Lighting. *Olexandr Kapliienko, Sergii Tabunshchyk, Galyna Tabunshchyk, Tetiana Kapliienko, Serhii Sylenko* 969

Multiple Regression Method for Analyzing the Tourist Demand Considering the Influence Factors. *Viktor Krylov, Anatoliy Sachenko, Pavlo Strubytskyi, Dmytro Lendiuk, Hrystyna Lipyanina, Diana Zahorodnia, Vitaliy Dorosh, Taras Lendyuk* 974

Fuzzy Estimation Method of Information System Providing Part Influence on the Functioning Quality. *Nadiia Vasylkiv, Lesia Dubchak, Iryna Turchenko, Iryna Ivashchuk, Ruslan Savchyshyn* 980

Virtual Model for Remote Laboratory Smart House & IoT. *Anzhelika Parkhomenko, Oleh Bilov, Artem Tulenkov, Aleksandr Sokolyanskii, Yaroslav Zalyubovskiy, Karsten Henke, Heinz-Dietrich Wuttke* 985

Remote Monitoring of the Hospital Cardiac Patients Heart Rate. *Anzhelika Parkhomenko, Yevhenii Presaizen, Olga Gladkova, Artem Tulenkov, Marina Kalinina* 991

Model of Management of Resources Production in 4P-Environment of Project-Oriented Enterprise. *Nataliia Yehorchenkova, Iurii Teslia, Oleksii Yehorchenkov, Liubov Kubiavka, Tatiana Latysheva, Yevheniia Kataieva, Olena Verenych* 997

3D Virtual Biomimetic Network: a Topology for Resilient Intelligent Wireless Sensor Networks. *Yousif E.E. Ahmed, Kondo H. Adjallah, Magdi B.M. Amin* 1002

Augmented Reality for the Abstract Paintings: Application Scenarios, Semantic Similarity Analysis and Case Study. *Olena Golembovska, Vyacheslav Kharchenko, Igor Shostak, Mariia Danova, Olena Feoktystova, Vladyslav Plietnov* 1007

ADC for Energy Measurement Systems of Microcontroller. Oleksandr Osolinskyi, Volodymyr Kochan, Anatoliy Sachenko, Orest Kochan, Zbyshek Dombrovskyi 1012

Improving Students' Qualification Level by Introducing Innovative Educational and Production Technologies. *Galina Shilo, Nataliia Furmanova, Denys Romaniuk, Anton Kalynychenko, Pavlo Kostianoi, Oksana Desyatnyuk* 1020

Modeling the Multi-Dimensional Indicators of Regional Integration Processes. *Olena Bulatova, Vitalina Kuryliak, Yevghen Savelyev, Olga Zakharova, Svitlana Sachenko* 1024

Reliability Models for a Multi-fleet of Drones with Two-level Hot Standby Redundancy Considering a Control System Structure. *Herman Fesenko, Vyacheslav Kharchenko* 1030

AvTA Based Assessment of Dependability Considering Recovery After Failures and Attacks on Vulnerabilities. *Vyacheslav Kharchenko, Yuriy Ponochovniy, Al-Sudani Mustafa Qahtan Abdulmunem, Iryna Shulga* 1036

Visualization and Interaction Techniques in Virtual Reality for Guided Tours. *Julien Letellier, Jürgen Sieck* 1041

ENISA Documents in Cybersecurity Assurance for Industry 4.0: IIoT Threats and Attacks Scenarios. *Vladimir Sklyar, Vyacheslav Kharchenko* 1046

Comparison between Maximum Power Point Tracking Techniques for Grid-Connected PV System. *Dima El-Hassan, M. A. Moustafa Hassan, Mostafa A. Elshahed* 1050

Peculiarities of Human Machine Interaction for Synthesis of the Intelligent Dialogue Chatbot. *Ievgen Sidenko, Galyna Kondratenko, Pavlo Kushneryk, Yuriy Kondratenko* 1056

eLearning Remote Simulator for Implementing Control Systems – A Case Study on a DC Motor. *Mircea Stefan Simoiu, Vasile Calofir, Ioana Făgărăşan, Cristina Nichiforov* 1062

Dynamic Nonlinear Modelling of Building Structure Using the Force Analogy Method. *Vasile Calofir, George Bogdan Nica, Grigore Stamatescu, Nicoleta Arghira* 1068

Two-Level Algebraic Method for Detection of Vulnerabilities in Binary Code. *Oleksandr Letychevskyi* 1074

Development of Large Numbers Factorization Algorithm. *Oleg Illiashenko, Vladimir Pevnev* 1078

Method of Development the Behavior Pattern. *Nataliya Shakhovska, Ruslan Shalaev, Alex Zaslavsky, Artur Kadyrov, Vitaliy Shevchuk, Sofiia Heletiy* 1082

Integrating SDN-Enabled Wireless Sensor Networks into the Internet. *Celal Çeken, Mohammed Al-Hubaishi* 1090

Scalable QAM Modulation for Physical Layer Security of Wireless Networks. *Taras Rosa, Mykola Kaidan, Juraj Gazda, Pavlo Bykovyy, Grygoriy Sapozhnyk, Taras Maksymyuk* 1095

Method of Fraudster Fingerprint Formation During Mobile Application Installations. *Tetiana Polhul, Andrii Yarovyi* 1099

Assessing the Success of R&D Projects and Innovation Projects through Project Management Life Cycle. *Mahboobeh Ramezani Farokhad, Jose Ramon Otegi-Olaso, Leonardo Sastoque Pinilla, Nerea Toledo Gandarias, Luis Norberto López de Lacalle* 1104

Compression and Transfer of Images in Wireless Sensor Networks Networks Using the Transformation of Residue Number System. *Vasyl Yatskiv, Anatoliy Sachenko, Nataliya Yatskiv, Pavlo Bykovyy, Andriy Segin* 1111

Image Recognition Methods Based on Hemming Distance. *Andrij Sydor, Diana Zahorodnia, Pavlo Bykovyy, Ivan Kit, Vasyl Koval, Konrad Grzeszczyk* 1115

How will we Build Competences for Managing the Digital Transformation? *Carsten Wolff, Azimbek Omar, Yerlan Shildibekov* 1122

A Method for Optimum Placement of Access Points in Indoor Positioning Systems. *Roman Voronov, Alex Moschevikin, Axel Sikora* 1130

Formal Description of Use Cases for Industry 4.0 Maintenance Processes Using Blockchain Technology. *Jan Stodt, Eugen Jastremskoj, Christoph Reich, Dominik Welte, Axel Sikora* 1136

6LoWPAN Protocol in Fixed Environments: A Performance Assessment Analysis. *Nin Hayati Mohd Yusoff, Nurul Azma Zakaria, Axel Sikora, Jubin Sebastian E.* 1142

VOLUME 2

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AvTA Based Assessment of Dependability Considering Recovery After Failures and Attacks on Vulnerabilities

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Abstract — **The paper describes modification of the ATA (Attack Tree Analysis) technique for assessment of instrumentation and control systems (ICS) dependability (reliability, availability and cyber security) called AvTA (Availability Tree Analysis). The techniques FMEA, FMECA and IMECA applied to carry out preliminary semi-formal and criticality oriented analysis before AvTA based assessment are described. AvTA models combine reliability and cyber security subtrees considering probabilities of ICS recovery in case of hardware (physical) and software (design) failures and attacks on components casing failures. Successful recovery events (SREs) avoid corresponding failures in tree using OR gates if probabilities of SRE for assumed time are more than required. Case for dependability AvTA based assessment (model, availability function and technology of decision-making for choice of component and system parameters) for smart building ICS (Building Automation Systems, BAS) is discussed.**

Keywords—availability tree analysis, instrumentation and control system, dependability assessment, building automation system

I. Introduction. Motivation and Objectives

Existed methods and techniques assess different attributes of dependable instrumentation and control systems (ICS) [1,2] and services such as software and hardware reliability, cyber security and availability [3,4].

These methods are based on application of reliability and security block diagrams (xBD) [5,6], fault/failure, attack and event tree analysis (xTA) [7], SW and HW failure modes and effects criticality analysis (xMECA) [8] and Markov's chain based techniques [3,5,9] and their combining [9-11]. Recovery and modification of software, caused by design faults, attacks on vulnerabilities and patcherization processes are reasons of increasing dependability complexity assessment [10].

One of the most complex task of assessment is choice of technique(s) or combining of them considering features and requirements to ICS dependability. FTA and ATA (Fault and Attack Tree Analysis) are the convenient techniques to assess reliability and cyber security [12,13] of system.

However, these techniques do not take into account recovery process parameters and maintenance strategies which are important issues for complex systems such as IoT based BAS (building automation systems) [13,14].

Besides, next challenge is development of algorithms and technology of decision-making to choice software and hardware components and configurating of ICS, recovery strategies and parameters by optimal way taking into account reliability and dependability requirements and restrictions such as recovery time, patcherization resources and so on [3,6].

Objectives of the paper are the following:

- to suggest modified so called AvTA (Availability Tree Analysis) model and AvTA based dependability assessment technique;
- to illustrate application of AvTA for BAS availability function evaluation;
- to describe procedures of assessment and decision-making of components and system parameters to meet dependability requirements to BAS.

In comparing with previous works [5,8,9] this paper describes modification of tree analysis based technique taking into account a complete set of faults and failures, reliability, security and recoverability issues.

The paper is structured as followed. Next section 2 describes approach for availability tree analysis; section 3 describes one case study for developed AvTA model of BAS. The results of the ICS AvTA modeling and availability (unavailability) function assessment are analyzed in section 4. Section 5 concludes and describes future steps.

II. Availability Tree Analysis. An Approach and Model

Failure Modes and Effects (Criticality) Analysis or FMECA [15] is a technique which is used to analyses preliminary risks of critical failures in point of view components, system and environment. If this technique consider issue of diagnostics (detection or undetection of

Author's Index

A

1. Abdelhady M. ... 824
2. Abdelsadek Y. ... 854
3. Abdulmunem A. ... 1036
4. Abouelwafa W. ... 824
5. Adamyk O. ... 718
6. Adeel Pasha M. ... 111
7. Adjallah K. H. ... 60, 123, 662, 942, 953, 1002
8. Ageiev D. ... 207
9. Ahlers V. ... 668
10. Ahmad A. ... 111
11. Ahmed Y. E. E. ... 1002
12. Al Tabib S. M. ... 572
13. Al-Hubaishi M. ... 1090
14. Ali H. ... 443, 489, 495, 592
15. Alilat F. ... 525
16. Amarger V. ... 197
17. Amin M. ... 1002
18. Amjad Z. ... 478
19. Andrushchak I. ... 313
20. Antonova H. ... 340
21. Antoshchuk S. ... 947
22. Arghira N. ... 586, 1068
23. Arras P. ... 330
24. Arsirii O. ... 947
25. Asim M. ... 443
26. Augustaukas R. ... 468
27. Augustyn M. ... 895
28. Avanzato R. ... 269, 285, 507
29. Azma Zakaria N. ... 1142

B

30. Babinets L. ... 313
31. Badasian A. ... 959
32. Bagrov V. ... 633
33. Balogh Š. ... 176
34. Banasik A. ... 878
35. Bandura V. ... 907
36. Baranenko R. ... 418
37. Barannik Valeriy ... 65
38. Barannik Vladimir. ... 65
39. Bauer J. ... 797
40. Bazaka Yu. ... 100
41. Bazaliy M. ... 100
42. Belhouichet A. ... 111
43. Belikov A. ... 334
44. Belikov J. ... 372
45. Ben Alaya K. ... 189
46. Benne M. ... 942
47. Benterki A. ... 839
48. Bereksi-Reguig F. ... 830
49. Beritelli F. ... 269, 285, 507
50. Beskorovainyi V. ... 556
51. Bezobrazov S. ... 628
52. Bian W. ... 938
53. Bidiuk P. ... 500
54. Bilal B. ... 123
55. Bilov O. ... 985
56. Bilski P. ... 639
57. Blake J. ... 735
58. Blazhko O. ... 947
59. Bleja J. ... 130
60. Bodyanskiy Ye. ... 34, 304
61. Bogach N. ... 735
62. Boiko O. ... 304
63. Boliubash Yu. ... 234
64. Boltov Ye. ... 158
65. Borovska P. ... 536
66. Boskin O. ... 412, 424, 431
67. Boukhnifer M. ... 839
68. Boumbarov O. ... 685
69. Bousefsaf F. ... 830
70. Bouteghrine B. ... 384
71. Boyarchuk A. ... 902
72. Branitskiy A. ... 146
73. Broujeny R. S. ... 197
74. Bulakh V. ... 207
75. Bulatova O. ... 1024
76. Bulbul M. F. ... 592
77. Buyak B. ... 24
78. Bykovyy P. ... 1095, 1111, 1115

C

79. Cai W. ... 927
80. Calofir V. ... 1062, 1068
81. Cao Y. ... 388, 458, 916, 921
82. Carlson A. ... 864
83. Casin P. ... 942
84. Cavallaro A. ... 507
85. Çeken C. ... 1090
86. Chang S. ... 802
87. Chebira A. ... 197
88. Chelghoum K. ... 854
89. Chen F. ... 106, 134, 357
90. Chen H. ... 70, 75, 81
91. Chenaru O. ... 645
92. Cheng X. ... 601
93. Cheredarchuk A. ... 620
94. Chereshnyuk O. ... 718
95. Chesanovskyy M. ... 907
96. Chilo J. ... 50, 464
97. Chitu C. ... 228

98. Chovancova O. 651
99. Christoff N. 791
100. Cuccia M. 507
101. Czajkowski K. 500
102. Czúni L. 189

D

103. Danova M. 1007
104. Danyk A. 211
105. Daradkeh Y. I. 572
106. Davydenko Ye. 597
107. Derkach M. 567
108. Desyatnyuk O. 1020
109. Di Franco F. 285
110. Di Puglia Pugliese L. 730
111. Djeldjli D. 489, 830
112. Dombrovskyi M. 724
113. Dombrovskyi Z. 1012
114. Dong D. 458, 472
115. Dong X. 912
116. Doroschuk N. 412
117. Dorosh M. 259
118. Dorosh V. 628, 974
119. Dorozhovets M. 895
120. Dosyn D. 802
121. Doudkin A. 752
122. Dragana C. 519
123. Draganov I. R. 656
124. Dronyak Yu. 313
125. Drozd Ju. 239
126. Drozd M. 249
127. Drozd O. 234, 239, 249, 279, 724
128. Du J. 18, 368
129. Dubchak L. 980
130. Duda O. 96, 579
131. Dudnyk A. 203
132. Duguay S. 294
133. Dunaievska O. 86
134. Dzelendzyak U. 436

E

135. El-Hassan D. 1050
136. Elsayed H. M. 889
137. Elshafey M.A. 28, 40
138. Elshahed M. 1050

F

139. Fabiano F. 730
140. Făgărăşan I. 586, 1062
141. Faiz R. 854
142. Falat P. 24, 615
143. Falfushynska H. 24
144. Fan H. 953
145. Fan Y. 601
146. Fanchette Y. 942
147. Farokhad M. R. 1104
148. Fedorchenko A. 146, 163
149. Fedula M. 140
150. Fei H. 60
151. Feoktystova O. 1007
152. Fesenko H. 1030
153. Figueroa L.P. 50
154. Fisun M. 597
155. Fomenko A. 172
156. Fouad M.M. 28, 40
157. Furmanova N. 556, 1020

G

158. Gaifulina D. 163
159. Galelyuka I. 340
160. Gancarczyk T. 7, 324, 691
161. Gancheva V. 536
162. Gazda Ju. 1095
163. Gerasin O. 222
164. Gladkova O. 991
165. Gnatyuk S. 572
166. Godlevska T. 308
167. Godlevsky L. 308
168. Golembovska O. 1007
169. Golovko V. 628
170. Golyash I. 259
171. Gontean A. 761
172. Gorbenko Yu. 7, 701
173. Gozhyj A. 319
174. Gozhyj V. 319
175. Grinberg G. 86
176. Grossmann U. 130
177. Gryga V. 691
178. Grzeszczyk K. 239, 1115
179. Gubarev V. 90
180. Guerriero F. 605, 730, 765
181. Guido R. 765

H

182. Hailan A.M. 117
183. Han L. 70, 75, 81
184. Hanganu C. E. 645
185. Hassaan G. A. 882
186. Hayati Mohd Yusoff N. 1142
187. Heletiy S. 1082
188. Hellmann B. 668
189. Henke K. 985
190. Herasymenko O. 100
191. Hilt B. 478
192. Hiromoto R. E. 864
193. Hladiy G. 747
194. Holota V. 691
195. Horkunenko A. 298
196. Horyachyy O. 436
197. Hou Q. 70, 75, 81
198. Hovorushchenko T. 902
199. Hrusha V. 340
200. Hu J. 388, 916, 921
201. Hu M. 530, 542, 548

202. Hu X. 388, 916, 921
203. Hu Y. 472
204. Hu Zhou 70, 75, 81
205. Hu Zhengbing 399
206. Huang Q. 18, 368
207. Hulsund J. E. 624
208. Hurtar L. 197
209. Hussein B. 835, 933
210. Hussian O. S. S. 889

I

211. Ichim L 519, 645
212. Iliescu S. S. 586
213. Illiashenko O. 1078
214. Iqbal T. 495, 592
215. Ishitsuka S. 448
216. Ivakhiv O. 747
217. Ivanova O. 234
218. Ivashchuk I. 980
219. Ivasiev S. 13
220. Iatsykovska U. 7, 24, 691

J

221. Jan N. 489
222. Jastremskoj E. 1136
223. Jin C. 388, 472, 916, 921
224. Judalet V. 839

K

225. Kacem I. 854
226. Kadyrov A. 1082
227. Kaidan M. 1095
228. Kalinina I. 319
229. Kalinina M. 991
230. Kallel A. Y. 695
231. Kalnichenko O. 964
232. Kalomiros J. 45, 452
233. Kalynychenko A. 1020
234. Kandyba I. 597
235. Kanoun O. 695
236. Kapliienko O. 969
237. Kapliienko T. 969
238. Karachka A. 239
239. Karalekas G. 452
240. Karaoglan N. 797
241. Karpinski M. 1, 7, 13, 324
242. Karsmakers P. 786
243. Kashpirovskyi O. 620
244. Kasianchuk M. 13
245. Kasraoui S. 290
246. Kataieva Ye. 997
247. Kazymyr V. 244
248. Kenoui M. 254
249. Keutel T. 695
250. Khalil I. 814
251. Khan S. 443, 489, 495, 592
252. Kharchenko V. 1007, 1030, 1036, 1046
253. Khimchenko I. 870
254. Kiian A. 707
255. Kijan S. 351
256. Kinzeryavyy V. 572
257. Kirichenko L. 207
258. Kiskova T. 651
259. Kislyuk S. 628
260. Kit I. 172, 1115
261. Klos-Witkowska A. 24, 298, 308, 313
262. Klyuev V. 844
263. Kochan O. 615, 1012
264. Kochan R. 65, 615, 691
265. Kochan V. 96, 579, 1012
266. Kogut I. 691
267. Kohlmorgen F. 797
268. Kohut U. 615
269. Kokhanovska T. 713
270. Kokosiński Z. 680
271. Kolokolov Yu. 483, 633
272. Komar M. 628
273. Komarchuk D. 203
274. Kondratenko G. 216, 222, 1056
275. Kondratenko Yu. 216, 222, 824, 1056
276. Kornaga Ya. 100
277. Korotunov S. 330
278. Korsunov N. 193
279. Kostianoi P. 1020
280. Kostolny J. 651
281. Kotenko I. 146, 163
282. Kotsiuba I. 567
283. Koval V. 1115
284. Kovalev I. 249
285. Kovtun L. 140
286. Kovyrova O. 340
287. Kozlov O. 222
288. Krasnobaev V. 701
289. Kravchenko T. 412
290. Kriukova G. 620
291. Krugla N. 418
292. Krylov V. 974
293. Kubiavka L. 997
294. Kulishova N. 34
295. Kuller M. 797
296. Kunanets N. 96, 579
297. Kunold I. 797
298. Kuryliak V. 1024
299. Kushnarenko V. 809
300. Kushneryk P. 1056
301. Kuznetsov A. 701, 707, 713
302. Kuznetsova A. P. 775
303. Kuznetsova K. 701
304. Kuznetsova T. 707, 713
305. Kvassay M. 741, 769

L

306. Lachiri Z. 290

307. Lagunov A. 345, 362
308. Lamtev A. 735
309. Lang F. 106, 357
310. Lang H. 134
311. Langer H. 130
312. Laref R. 849
313. Latysheva T. 997
314. Lauffenburger J.-P. 478
315. Lawnik M. 878
316. Lemeshko O. 117
317. Lendiel T. 203
318. Lendiuk D. 974
319. Lendyuk T. 747, 974
320. Letellier J. 1041
321. Letychevskyi O. 1074
322. Levashenko V. 741, 769
323. Lezhenin Iu. 735
324. Limar I. 324
325. Lipnickas A. 468
326. Lipyanina H. 974
327. Liu W. 18, 530, 542, 548
328. Liu Y. 472
329. Lomakin A. 193
330. Lombardo T. 507
331. López de Lacalle L. N. 1104
332. Lopushynskyi I. 418
333. Losson E. 849
334. Losunov A. 362
335. Luchinkin S. D. 775
336. Luhova T. 947
337. Łukaszewski R. 639
338. Lukyanchuk I. 769
339. Lurie I. 424, 431
340. Lysak V., ... 567
341. Lysenko S. 406
342. Lysenko V. 203
343. Lytvyn V. 802
344. Lytvynenko V. 412, 418, 424, 431
345. Lyubchyk L. 86

M

346. Ma L. 388, 916, 921
347. Maaoui C. 830, 839
348. Maawia 443
349. Macekova D. 651
350. Macrina G. 605
351. Madani K. 197, 290
352. Makaryshkin D. 140
353. Maksymyuk T. 1095
354. Malenko A. 757
355. Manolova A. H. 656, 685, 791
356. Markowsky G. 263, 274, 406
357. Markowsky L. 263, 274
358. Martsenyuk V. 298, 308, 313
359. Martynyuk D. 279
360. Martynyuk O. 249, 279, 724
361. Martynyuk V. 140
362. Marushko Y. 752
363. Marwat S. N. K. 443
364. Masud S. 111
365. Matsiuk O. 96, 579
366. Meire M. 786
367. Mendoza Montoya J. 464
368. Mersni A. 117
369. Metwally M. H. 882
370. Mialkovskyi D. 707
371. Mikhridinova N. 835, 933
372. Miliavskyi Yu. 90
373. Ming W. 458
374. Mirabelli G. 765
375. Mironov R. P. 656, 791
376. Mojžiš J. 176
377. Monakhov M. Yu. 775
378. Monakhov Yu. M. 775
379. Monakhova M. M. 775
380. Monovskaya A. 483, 633
381. Moroz L. 436
382. Morozov V. 964
383. Moschevikin A. 1130
384. Moustafa Hassan M. A. 882, 889, 1050
385. Mukhin V. 100
386. Murzenko O. 431
387. Musienko A. 65
388. Mustafa E.M. 28, 40
389. Mykhailova H. 724
390. Myronova N. 556

N

391. Nakonechnyi M. 747
392. Nariezhnii O. 713
393. Neshov N. N. 656, 685
394. Netreba A. 211
395. Nica G. B. 1068
396. Nichiforov C. 586, 1062
397. Novosad I. 172
398. Nowakowski G. 512, 674
399. Nsiah K. A. 478
400. Zaets N. 203

O

401. Ogrenich E, ... 556
402. Okhmak V. 330
403. Okhrimenko T. 572
404. Oleshchuk V. 820
405. Olszewski S. 431
406. Omar A. 1122
407. Opanasenko V. 152
408. Orlov A. 345
409. Osolinskyi O. 1012
410. Osypenko V. 424
411. Otegi-Olaso J. R.. 1104
412. Othman R. 854
413. Owsiński J. 752

P

414. Palahin A. 152
415. Panasyuk V. 597, 718
416. Parkhomenko A. 351, 985, 991
417. Pashnina A. 418
418. Pasichnyk V. 96, 579
419. Paslay O. 313
420. Pasyeka M. 907
421. Pavlova O. 902
422. Pawlowski T. 752
423. Petlenkov E. 372
424. Petrova O. 184
425. Petrus R. 140
426. Pevnev V. 1078
427. Pfeiffer J. 609
428. Pigeon S. 294
429. Pikh V. 907
430. Plietnov V. 1007
431. Pliss I. 34, 304
432. Polhul T. 1099
433. Polishchuk Yu. 399
434. Polozhaenko S. 249
435. Ponochovniy Yu. 1036
436. Ponomar V. 7
437. Popescu D. 519, 645
438. Postigo-Málaga M. 50
439. Prakash L. S. 814
440. Presaizen Ye. 991
441. Proskurin M. 964
442. Protsai N. 86
443. Puglisi V. 285
444. Pushkar'ov A. 707
445. Pyshkin E. 735
446. Pytlenko T. 96

Q

447. Qoussini A.E. 572

R

448. Rabcan J. 651, 741, 769
449. Rabiai M. 384, 443
450. Radchenko S. 211
451. Radivilova T. 207
452. Rajba S. 13, 298, 691
453. Ramenah H. 942
454. Red'ko V.G. 54
455. Reich C. 1136
456. Ricman R.-Ş. 761
457. Rodosek G. D. 668
458. Rodriges Zalipynis R. A. 859
459. Romanenko V. 90
460. Romaniuk D. 1020
461. Romaniv S. 579
462. Romanov V. 340
463. Romanyshyn Y. 907
464. Rosa T. 1095
465. Roshchupkin O. 579
466. Rudolph J. 222
467. Rusnak P. 741, 769

S

468. Saad M. M. 495, 592
469. Sachenko A. 96, 406, 579, 628, 724, 802, 974, 1012, 1111
470. Sachenko O. 234
471. Sachenko S. 718, 1024
472. Sadoudi S. 384
473. Saenko I. 146
474. Saikawa K. 844
475. Salfi G. 605
476. Samotyy V. 436
477. Sapozhnyk G. 1095
478. Sarana M. 620
479. Sastoque Pinilla L. 1104
480. Sava A. 60, 123, 662, 849
481. Savchyshyn R. 980
482. Savelyev Ye. 1024
483. Savenko O. 406
484. Savina N. 412, 418, 424, 431
485. Schappacher M. 111, 695
486. Schulz P. 870
487. Sebastian E J. 780, 1142
488. Segin A. 1111
489. Selevych H. 351
490. Semaniuk V. 579
491. Sgârciu V. 228
492. Shakhovska N. 1082
493. Shakun I. 308
494. Shakun K. 308
495. Shalaev R. 1082
496. Shapovalova A. 117
497. Sharovara O. 259
498. Sheketa V. 907
499. Sheleh A. 628
500. Shevchuk V. 1082
501. Shi X. 106, 134, 357
502. Shildibekov Ye. 1122
503. Shilo G. 556, 1020
504. Shimoyama R. 448
505. Shostak I. 1007
506. Shulga I. 1036
507. Shulgin S. 65
508. Shved A. 597
509. Shylinska I. 747
510. Siadat M. 849
511. Sidenko Ie. 216, 1056
512. Sieck J. 1041
513. Sikora A. 111, 478, 695, 780, 1130, 1136, 1142
514. Simoiu M. S. 1062
515. Simon D. 824
516. Siriak R. 158
517. Sirola M. 624
518. Skarga-Bandurova I. 158, 567

519. Skiparev V. 372
520. Sklyar V. 1046
521. Smailova S. 412
522. Smirnov O. 399, 701, 707, 713
523. Sokolyanskii A. 985
524. Solina V. 765
525. Song H. 562
526. Stafurikova A. 651
527. Stamatescu G. 228, 519, 586, 1068
528. Stamatescu Iu. 228, 586
529. Stavrinides S. G. 45
530. Stefanovych O. 701
531. Stelnyk I. 713
532. Stepova H. 279
533. Stodt J. 1136
534. Stoeva T. 308
535. Stoican F. 519
536. Streltsov O. 168
537. Strubytskyi P. 974
538. Stupen P. 168
539. Su J. 106, 134, 357, 802
540. Sudakov O. 211, 757
541. Sun S. 378, 394, 552
542. Sun Y. 378, 394, 552
543. Sverstiuk A. 298
544. Svjatnyj V. 809
545. Sydor A. 1115
546. Sydorenko V. 399
547. Sylenko S. 969
548. Sytnikov V. 168
549. Szabo R. 761
550. Szklarczyk R. 24

T

551. Tabunshchyk G. 184, 330, 969
552. Tabunshchyk S. 969
553. Tamim A. 724
554. Tang Y. 530, 542, 548
555. Tanougast C. 384, 443, 489, 495, 592, 942
556. Taranov M. 216
557. Tatarchuk T. 308
558. Telenyk S. 500, 512
559. Tereshchuk G. 24
560. Teslia Iu. 997
561. Thuong B. V. 724
562. Toledo Gandarias N. 1104
563. Tonchev K. 685
564. Trembach B. 615
565. Troianovska Yu. 947
566. Trunov A. 334
567. Tulenkov A. 985, 991
568. Tupitsya I. 65
569. Turchenko I. 239, 579, 980
570. Turchenko V. 628

U

571. Udod K. 809
572. Ukhina H. 168
573. Usik A. 244
574. Uziel S. 695

V

575. Vaccaro M. 269
576. Vasiliu Ye. 324, 399
577. Vasylkiv N. 239, 980
578. Verenych O. 259, 997
579. Veselska O. 1, 65, 313
580. Vilihura V.V. 1
581. Viter O. 747
582. Voitsekhovska M. 259
583. Volkova V. 304
584. Vologiannidis S. 452
585. Voronenko O. 340
586. Voronenko M. 412, 418, 431
587. Voronov R. 1130
588. Vovk J. 512
589. Vyshnia V. 172
590. Vyshnivskyi V. 100
591. Vysotska V. 319, 802

W

592. Wang C. 562, 912, 927, 938
593. Wang F. 458
594. Wang Haibo 472
595. Wang Huifen 953
596. Wang S. 134
597. Wang Y. 912, 927
598. Wang Zhouhang 60, 662, 953
599. Wang Ziwei 530, 542, 548
600. Warwas K. 13, 313, 615
601. Wei L. 368
602. Wei M. 530, 542, 548
603. Welte D. 1136
604. Wesner S. 809
605. Wieclaw L. 1
606. Williams B. 864
607. Winiecki W. 639
608. Wöhrle H. 797
609. Wójcik A. 639
610. Wolff C. 835, 933, 1122
611. Wu P. 927
612. Wu X. 609
613. Wuttke H. 985

X

614. Xia H. 912
615. Xiao H. 601
616. Xie S. 458

Y

617. Yahiaoui R. 525
618. Yakobchuk M. 424
619. Yakovlev D. 168
620. Yakymenko I. 13

621. Yan L. 388, 562, 912, 927, 938
622. Yao Q. 378, 394, 552
623. Yarovyi A. 1099
624. Yatskiv N. 1111
625. Yatskiv V. 1111
626. Ye Z. 70, 75, 81, 106, 134, 357, 378, 388, 394, 458, 530, 542, 548 552, 562, 916, 921, 927, 938
627. Yehorchenkov O. 997
628. Yehorchenkova N. 259, 997
629. Yeremenko O. 117
630. Yesin V.I. 1
631. Yesina M.V. 1, 7
632. Yevdokymenko M. 117
633. Yu H. 378, 394, 552
634. Yuan J. 70, 75, 81
635. Yuan T. 953

Z

636. Zahorodnia D. 974, 1115
637. Zaitseva E. 741, 769
638. Zakharova O. 1024
639. Zalyubovskiy Ya. 985
640. Zashcholkin K. 234
641. Zaslavsky A. 1082
642. Zavyalov S. 152
643. Zawislak S. 13, 615
644. Zeng J. 70, 75, 81
645. Zhan S. 378, 394, 552
646. Zhang A. 388, 916, 921
647. Zhang Li 530, 542, 548
648. Zhang Lu 18, 368
649. Zhang P. 357
650. Zhang Z. 601
651. Zhao Y. 662
652. Zharikov E. 500, 512
653. Zhuikov A. 735
654. Zia K. 814
655. Zong X. 18, 368

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IEEE France Section was established in 1967 and involves more than 4000 members living in France and Monaco. The France section community is organized in 29 Chapters. The IEEE France Chapter sponsors each year several prominent international conferences. It involves senior and young professional from industry companies, faculty members and students, etc. IEEE France Section supports IDAACS'2019 as a technical co-sponsor.

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TERNOPIL NATIONAL ECONOMIC UNIVERSITY

Ternopil National Economic University was established in 1966. Todayis it is a multidisciplinary educational complex consisting of seven Faculties and seven institutes that train students in nine domains and 21 majors specialties, 67 Departments, and Education and Consulting Centers.

The total number of students studying at the University is about 14,000. The TNEU academic staff includes about 863 employees, 88 of them are Doctors of Sciences, 637 are Doctors of Philosophy, Associate Professors.

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UNIVERSITÉ DE LORRAINE

University of Lorraine

Université de Lorraine (UL) is a public institution initiated by merging four universities of Lorraine in France north-eastern recently named the Grand-Est region. Though the University was founded in Lorraine in 1572, the fusion took place in 2012, to instigate a hub of scientific advancement, economic growth, and knowledge transfer. It is a multisite university incorporating 54 facilities, each with their own focus, located throughout the Lorraine region. UL enrolls 60,000 students, 6,900 staff members, 43 teaching departments and 60 research centers, which makes the UL one of the largest universities in the country. UL is the first French university in Erasmus outgoing mobility (with about 870 outgoing and 385 incomings), and welcome close to 10,000 international students. Also, it is worth to specify the multilingual aspect of many curriculums, with a network of privileged and strategic partnerships with a selected number of universities throughout the world. UL positions itself as a multidisciplinary, technological and entrepreneurial university, able to bring comprehensive answers to the economic and societal challenges of the 21stcentury, with undergraduate, graduate and postdoctoral programs.

UL is also called LUE (Lorraine Université d'Excellence) offers 15 programs promoting scientific excellence and international collaborations with a specific focus on cross-talk between fields and competencies for individual career development. The Lorraine region has been shaped since the 19th century by the mining and metallurgical industries, which fostered the development of education and research in engineering and technology (60 research units, 3,509 publications, and 400 Ph.D. defense each year). UL belongs to the University of the great region in Europe involving the Liège Universté, the Université du Luxemburg, the Universität Trier, the Kaiserslautern Technische Universität and the Universität, all located in the cross-border region of Belgium, France, Germany and Luxembourg (close to 7000 PhDs, over 10,000 faculty members and 135,000 students).

ENIM (Ecole Nationale d'Ingénieurs de Metz)

At the heart of a partnership of National Engineering schools (ENI) (a group comprised of ENI Brest, ENI Metz, ENI St Étienne and ENI Tarbes) and the University of Lorraine's INP Collegium, the National Engineering School of Metz is a public university which, since 1962, has been shaping qualified engineers in the fields of mechanical, material and industrial engineering, with teaching based on a pragmatic and practical approach.

The school offers universal and career-orientated courses lasting either three or five years, and which are accredited by the "Commission des Titres d'Ingénieur" (CTI). Its offer a 5-years engineers undergraduate and graduate programs in mechanical engineering, materials science (materials, polymers and processes), industrial manufacturing systems, industrial engineering and production, which are important sectors of research in Lorraine. As a higher-education public institution, ENIM trains more than 900 students each year for industrial systems engineering.

The ENIM programs are tailored to the needs of businesses and to a constantly-changing world, by maintaining strong links with the industrial world and with its international academic partners. The engineers training relies on a strong link with industrial companies, in particular through graduation projects and teaching on state-of-the-art equipment. The school is currently involved in a digital transformation project of its curriculum to meet the requirements of future industries.

Also, ENIM offers international exchange programs to its students, thanks to its many partnerships in America, Europe, Asia and Africa, also including double degree programs. In addition, ENIM has developed a Sino-French Institute of Engineers in Nanjing, China, in partnership with the Nanjing University of Science and Technology (NJUST) since 2015.

LCOMS (Laboratory of Conception Optimisation and Modelling of Systems)

The Laboratory of Design, Optimization and Modelling of Systems (LCOMS) is a new restructuring research project based on three previous laboratories of the 9th Scientific Department DS9: the Laboratory of Human Control and Comportemental Sciences (LASC, Ea3467), the Laboratory of Interfaces, Sensors and Microelectronics (LICM, EA1776) and the Laboratory of Theretical and Applied Computer Science (LITA, EA3097). This research unit is introduced in the context of the Lorraine University (UL) construction and it aims to carry out new pluridisciplinary and original objectives and to play a complementary and innovative role in this new university.

LCOMS is organized in two teams: « Informatics, Decision, Embedded Systems and Reliability » (IDEES), « Cognitive Stimulation, Human-Systems Interaction and Human Machine Interface » (SCAIM). These teams develop a pluridisciplinary research and work on original problems covering the fields of combinatorial optimization, scheduling, transportation, machine human interfaces, assistance to individuals and for communication, communicating systems design, intelligent sensors, data collection and reliability.

The resources include about 80 individuals, 2 research teams, 45 researchers, about thirty Ph.D students and post-doc, some administrative staff and, they profit from several services for supporting the research activities. The laboratory has an excellent scientific production level by publishing about 150 articles in international journals during the last 5 years, and it has a strong participation to high-education programs related to the scientific research and to the professional learning.

Several collaborations exist between the LCOMS teams and other French and foreign universities. These collaborations are concretized by high-level publications, national and international projects and the organization of prestigious international conferences (such as CIE45, ROADEF2017, IEEE/CoDIT14, IEEE/CIE39...). Moreover, we note the outstanding national and international visibility of LCOMS throughout the regular participation to the evaluation organizations, the international program committees and to the international journal editorial boards (such as Computers & Industrial Engineering – Elsevier, RAIRO-Operations Research - Cambridge Journals, IRBM - Elsevier, Eur J Industrial Engineering...). The originality of the pluridisciplinary objectives, the scientific complementarity of the teams, the available human resources and the great motivation are our assets to make a successful scientific project.

MDPI Sensors

Sensors (ISSN 1424-8220; CODEN: SENSC9) is the leading international peer-reviewed open access journal on the science and technology of sensors and biosensors. Sensors is published semi-monthly online by MDPI.

Open Access free for readers, with article processing charges (APC) paid by authors or their institutions.

High visibility: indexed by the Science Citation Index Expanded (Web of Science), MEDLINE (PubMed), Ei Compendex, Inspec (IET) and Scopus.

CiteScore (2018 Scopus data): 3.72; ranked 9/123 in 'Physics and Astronomy: Instrumentation' and 102/661 in 'Electrical and Electronic Engineering'.

Rapid publication: manuscripts are peer-reviewed and a first decision provided to authors approximately 17.2 days after submission; acceptance to publication is undertaken in 3.6 days (median values for papers published in this journal in the first half of 2019).

Recognition of reviewers: reviewers who provide timely, thorough peer-review reports receive vouchers entitling them to a discount on the APC of their next publication in any MDPI journal, in appreciation of the work done.

Sections: published in 11 topical sections.

Impact Factor: 3.031 (2018) ; 5-Year Impact Factor: 3.302 (2018)

Fondation ENIM

The ENIM Foundation supports the development of initial training, as well as the fundamental and applied research within the Ecole Nationale des Ingénieurs de Metz (ENIM), to offer the greatest number of students, an excellent education tailored to companies' requirements. Training future engineers requires to constantly adapt to companies' expectations, which looks for innovation and performance, and this is one of the main challenges of ENIM. To develop teachings closer to industry companies and increase the school's attractiveness, the ENIM Foundation was created in 2014, gathering patrons close to the school, individuals and companies, at the alumni initiative.

The Fondation ENIM, therefore, has several missions: to provide access to Enim's training programs to as many people as possible, to develop training courses of high quality, notably by supporting talented teachers and external speakers and to develop the educational infrastructures. In particular, it strives to ensure training adapted to changing technologies and promotes partnerships with industry to provide future graduates with learning by doing. In addition, the foundation supports research initiatives, the school's international openness, as well as any project of general interest lead by engineer students, by providing grants and financial supports to projects.

Metz Métropole is a French metropolis which includes forty-four municipalities in the Moselle department in the Grand-Est region, centered on the Metz city. It is an intercommunal institution which started with the official metropolitan statute granted to the Metz city by law in 2017. This transition to metropolitan status officially took place on January 1, 2018, without prior passing through the urban community status, which strengthens its positioning within the European Union and becomes one of Europe's attractiveness and development hubs.

Metz Métropole has evolved and improved by leading five major recent projects:

- the new district of the Amphitheater: living and exchanges area (the park la Seille) in the city center, Pompidou-Metz center, convention center.
- the Mercy's health and innovation center, in the south-east of the city, beside the district La-Grange-aux-Bois: the new Mercy hospital of Metz-Thionville regional hospital, a maternity house, and an area for health businesses and services.
- the Mettis public transport system involving two high-level service bus lines that started service in October 2013;
- the development and renovation project for the Mont Saint-Quentin district;
- construction of the new Robert-Schuman hospital gathering Metz private hospitals with craft activities on the Lauvallières district including Nouilly and Vantoux, north-east of Metz.

Among Metz Metropole missions one should also notice the following: the economic, social and cultural development and planning, the development of the metropolitan area, the management of local housing policy, Metz city politics, the management of services of collective interest, and the living environment protection and enhancement.

River Publishers

It is the mission of River Publishers to become a leading market player in the publishing and distribution of state-of-the-art, peer-reviewed, English language academic and professional content in specific STM fields; books written by academics and engineers for the institutional and professional markets.

The goal of River Publishers is to:

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- Provide service to advisors, in the form of competitive remuneration and the opportunity to develop their personal series;
- Provide service to authors, in the form of type setting and copy editing, competitive remunera tion and international commercial services;
- Make our content available at competitive prices to the institutional and professional markets;
- Make our content available in both print and electronic format, in so doing meeting with the needs and desires of the modern-day engineer, researcher and librarian;
- Support academia in the developing world, libraries and institutions that currently may not be able to afford the content typically published and offered in the STM community. We realize this by way of offering Euro 5,000 of books each year to the World Bank and European Union academic development programs;
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CiSj

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- High Performance Computing, GRIDs, Parallel and Distributed Computing;
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- IT Project Management;
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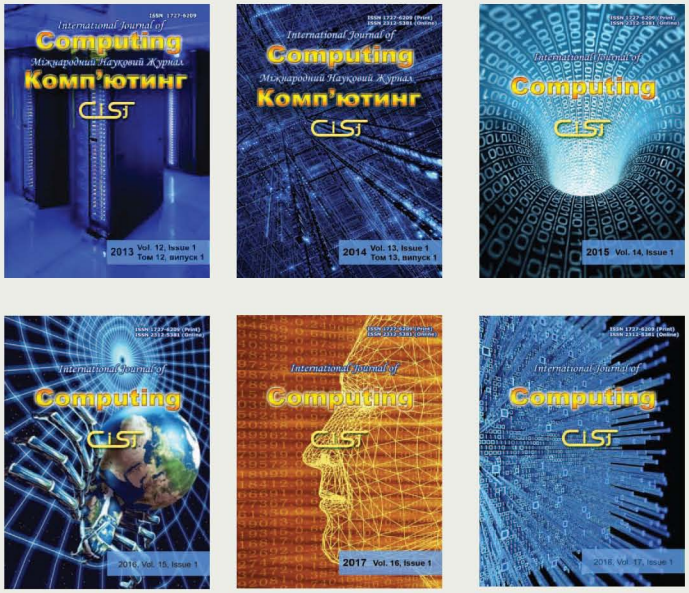
- Open Special Issue on Advanced Wireless Systems;
- Open Special Issue on Contemporary Intelligent Systems and Applications;
- Open Special Issue on Security and Post-Quantum Cryptography.



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Research Institute for Intelligent Computer Systems

The Research Institute for Intelligent Computer Systems (ICS) - www.ics.tneu.edu.ua is under joint supervision of Ternopil National Economic University and the Glushkov Institute of Cybernetics, National Academy of Science.

The ICS counts the 14 Research Groups, in particular Intelligent Distributed Systems, Intelligent Sensor Data Acquisition, Intelligent Robotic Systems, Neural Networks and Parallel Computing, Knowledge Bases and Ontologies, Information Technology and Specialized Computer Systems, Image Processing and Pattern Recognition, Cybernetics of Complex Systems, Wireless Systems and Networks, Project and Program Management based on IT and Knowledge, Information Security, Intelligent Cyber Security and Defense, Metrology of Information Measuring Systems, Simulation and Algoritmization of Complex Technological Processes. During its history, the staff of the ICS has received more than 150 invention certificates of the former USSR and 66 Ukrainian patents. There were published more than 1100 papers and 163 of them in 2018. There were defended 44 DSc and PhD theses, in particular the four in 2018.

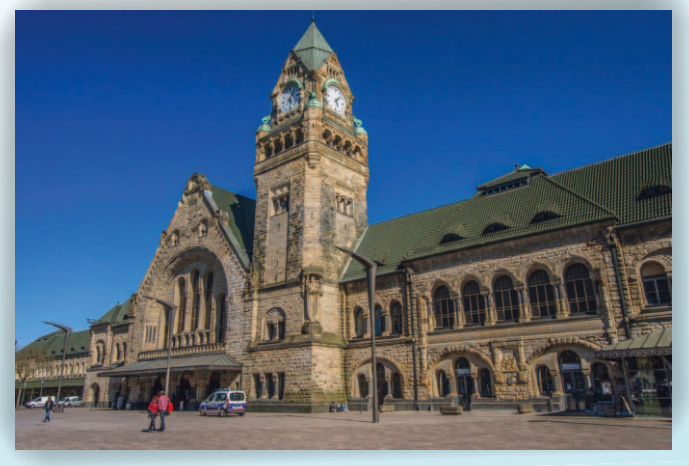
The high level of research and development of ICS has been confirmed since 1997 by awarding 20 international grants and projects within the INTAS, CRDF, NSF, NATO, STCU, and FP7 of the European Union, in particular the two in 2018. In these projects, the ICS collaborated with a huge number of world-known universities as well as governmental institutions and private companies. In addition, we are running a huge Erasmus+ project ALIOT entitled Internet of Things: Emerging Curriculum for Industry and Human Applications, which started in 2016 and DAAD project "Eastern Partnerships"which was run in 2017.

The ICS along with a Dept for Information Computer Systems and Control has established in April 2018 the Ukrainian-German Educational and Research Center, thanking to Prof. Juergen Sieck, HTW Berlin.

The ICS holds the IEEE International Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS), www.idaacs.net every two years since 2001. In particular, the last one took place in Bucharest, Romania, 21-23 September, 2017. Proceedings of the conferences are indexed in Web of Science, EI Compendex and Scopus. Now we are preparing the 10th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems, which will be held in September 18–21, 2019, University of Lorraine, Metz, France.

The ICS has been taking part in organization of International Symposia on Wireless Systems within the IDAACS Conference since 2012. The 5th IEEE International Symposium on Wireless Systems within the IDAACS Conference (IDAACS-SWS'2020) will be held in September, 2020 in Dortmund, Germany.

The staff of the ICS has a good ralationships with the IEEE Student Branch at TNEU and the Instrumentation and Measurement / Computational Intelligence Joint Societies Chapter of IEEE Ukraine Section. A Chapter held eight meetings in 2018.

IEEE Ukraine Section was founded in 1991 and counts more than 400 members, consist of 13 technical chapters, 6 student branches (and Young professionals) and WIE Affinity Group. The IEEE Ukraine Section community sponsors many international conferences each year and works actively to improve a cooperation between professionals.

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