

**RESEARCH INSTITUTE  
FOR INTELLIGENT COMPUTER SYSTEMS**

**TERNOPIL NATIONAL ECONOMIC UNIVERSITY,  
MINISTRY OF EDUCATION AND SCIENCE, UKRAINE**

**V.M. GLUSHKOV INSTITUTE FOR CYBERNETICS,  
NATIONAL ACADEMY OF SCIENCES, UKRAINE**

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## FOREWORD

The ICS counts the 16 Research Groups which are described below. During its history, the ICS staff has received more than 145 invention certificates of the former USSR and 76 Ukrainian patents. There were published more than 1600 papers and 151 of them in 2021. There were defended 55 DSc and PhD theses.

A competence and expertise of ICS staff has been confirmed since 1997 by awarding 24 international grants and projects within the INTAS, CRDF, NSF, NATO, STCU, and FP7, DAAD, Erasmus+ of the European Union. In these projects, the ICS collaborated with a huge number of world-known universities as well as governmental institutions and IT companies. We continued to run the two European projects: DAAD project ViMaCs Virtual Master Cooperation Data Science (ViMaCs) - Phase 2 and Erasmus+ project WORK4CE: Cross-domain competences for healthy and safe work in the 21st century.

Additional 16 projects have been completed funded by the Ministry of Education and Science, Ukraine.

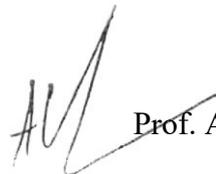
The ICS holds the IEEE International Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS) every two years since 2001. Proceedings of the conferences are indexed by WoS, EI Compendex and Scopus. The eleventh IEEE conference IDAACS'2021 was held online on September 22-25, 2021 at the Krakow Polytechnic. Tadeusz Kosciuszko, Krakow, Poland.

The ICS staff has a good relationship with the IEEE Student Branch at WUNU and the Instrumentation and Measurement / Computational Intelligence Joint Societies Chapter of IEEE Ukraine Section. A Chapter has run the five meetings in 2021.

The International Journal of Computing is issued quarterly in cooperation with the Glushkov Institute for Cybernetics, National Academy of Science, Ukraine. The Journal is indexed by Scopus Elsevier as well as Finnish publication forum, Norwegian Social Science Data Services, Google Scholar, and Index Copernicus. The four regular issues were published in 2021.

Finally, I would like to thank to Dr. Taras Lendyuk, Dr. Diana Zahorodnia, Dr. Pavlo Bykovyy, and Dr. Oleksandr Osolinskyi for their help in preparing, editing and designing this report.

Enjoy,



Prof. Anatoliy Sachenko

March 15, 2022

# 1. GENERAL INFORMATION

## ICS History

The mission of the Research Institute for Intelligent Computer Systems (ICS) is to develop the international research projects and improve project management in the field of Computing with the participation of inter-university teams.

The ICS counts the 16 Research Groups, in particular Intelligent Distributed Systems Group, Intelligent Sensor Data Acquisition Group, Intelligent Robotic Systems Group, Neural Networks and Parallel Computing Group, Knowledge Bases and Ontologies Group, Information Technology and Specialized Computer Systems Group, Image Processing and Pattern Recognition Group, Wireless Systems Security Group, Project and Program Management based on of Information Technologies and Knowledge Group, Cybernetics of Complex Systems Group, Information Security Group, Intelligent Cyber Security and Defense Group, Metrology of Information Measuring Systems Group, Design and Testing of FPGA Component for Safety Related Systems, Virtual Instruments for IoT, Big Data and Data Sciences, Human-Computer Interaction.

## ICS Management

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 Scientific Advisor – Prof. Anatoliy Sachenko  
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## ICS Frame

### Intelligent Distributed Systems Group (IDS)

Principal researchers – Prof. Anatoliy Sachenko, Dr. Pavlo Bykovyy  
 Group members:

- Volodymyr Kochan
- Myroslav Komar
- Olexandr Osolinskyi
- Vasyl Yatskiv

### Intelligent Sensor Data Acquisition Group (ISDA)

Principal researcher – Prof. Volodymyr Kochan  
 Group members:

- Pavlo Bykovyy
- Mykhailo Dombrovsky
- Zbyshek Dombrovsky
- Orest Kochan
- Olexandr Osolinskyi
- Oleksiy Roshchupkin
- Radislav Smid

- Iryna Turchenko
- Nadia Vasylykiv

### **Intelligent Robotic Systems Group (IRS)**

Principal researchers – Prof. Robert Hiromoto, Dr. Vasyl Koval

Group members:

- Oleh Adamiv
- Vladimir Golovko
- Anatoliy Sachenko

### **Neural Networks and Parallel Computing Group (NNPC)**

Principal researchers – Prof. Vladimir Golovko, Dr. Volodymyr Turchenko

Group members:

- Vitaliy Dorosh
- Volodymyr Kochan
- Myroslav Komar
- Anatoliy Sachenko

### **Knowledge Bases and Ontologies Group (KBO)**

Principal researchers – Prof. Uwe Grossmann, Prof. Sergey Rippa

Group members:

- Taras Lendyuk
- Andriy Melnyk
- Anatoliy Sachenko
- Serhiy Voznyak

### **Information Technology and Specialized Computer Systems Group (ITSCS)**

Principal researcher – Prof. Yaroslav Nykolaychuk

Group members:

- Orest Volynskyy
- Arthur Voronych
- Natalia Vozna
- Oleg Zastavnyy

### **Image Processing and Pattern Recognition Group (IPPR)**

Principal researchers – Prof. Viktor Krylov, Prof. Bohdan Rusyn

Group members:

- Pavlo Bykovyy
- Ivan Kit
- Anatoliy Sachenko
- Diana Zagorodnya
- Denys Zolotukhin

### **Wireless Systems Security Group (WSS)**

Principal researchers – Prof. Vasyl Yatskiv, DSc Taras Maksymyuk

Group members:

- Robert Hiromoto
- Andrii Kaniovskiy
- Anatoliy Sachenko
- Jürgen Sieck
- Taras Tsavolyk
- Orest Volynskyy
- Natalia Yatskiv

### **Project and Program Management based on of Information Technologies and Knowledge Group (PPMITK)**

Principal researchers – Prof. Sergey Bushuyev, Prof. Carsten Wolff

Group members:

- Mykhailo Dombrovsky
- Zbyshek Dombrovsky
- Oksana Dunets
- Grygoriy Gladiy
- Taras Lendyuk
- Sergey Rippa
- Anatoliy Sachenko
- Oleg Sachenko
- Iryna Turchenko
- Nadiia Vasylykiv

### **Cybernetics of Complex Systems Group (CCS)**

Principal researcher – DSc Roman Pasichnyk

Group members:

- Dmytro Bodnar
- Grygoriy Gladiy
- Igor Dobrotvor
- Andriy Melnyk
- Yuriy Pigovskyy

### **Information Security Group (IS)**

Principal researchers – Prof. Mykola Karpinsky, Prof. Sergiy Lysenko

Group members:

- Pavlo Bykovyy
- Lesya Dubchak
- Myroslav Komar

### **Intelligent Cyber Security and Defense Group (ICSD)**

Principal researchers – Prof. George Markowsky, Prof. Oleg Savenko

Group members:

- Pavlo Bykovyy
- Vladimir Golovko
- Stepan Ivasiev
- Volodymyr Karpinskyy
- Myroslav Komar
- Sergiy Lysenko
- Vasyl Yatskiv

### **Metrology of Information Measuring Systems Group (MIMS)**

Principal researcher – Prof. Roman Kochan

Group members:

- Andrii Karachka
- Volodymyr Kochan
- Olexandr Osolinskyi
- Hryhorii Sapozhnyk
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### **Design and Testing of FPGA Component for Safety Related Systems (DTFPGA)**

Principal researchers – Prof. Vladimir Opanasenko, DSc Kostiantyn Zashcholkin

Group members:

- Viktor Antoniuk
- Miroslav Drozd
- Oleksandr Martynyuk
- Olexandr Osolinskyi

### **Virtual Instruments for IoT (VIIoT)**

Principal researcher – Prof. Orest Kochan

Group members:

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- Ivan Kit
- Volodymyr Kochan
- Oleksandr Osolinskyi

### **Big Data and Data Sciences (BDDS)**

Principal researchers – Prof. Natalya Shakhovska, Prof. Vasyl Lytvyn

Group members:

- Volodymyr Kochan
- Myroslav Komar
- Khrystyna Lipyanina-Goncharenko
- Anatoliy Sachenko
- Oleg Savenko

### **Hybrid Systems of Computational Intelligence (HSCI)**

Principal researcher – Prof. Yevgeniy Bodyanskiy

Group members:

- Olha Chala
- Serhii Kostiuk
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## 2. ICS RESEARCH STAFF

### Senior Staff

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Founder and president of the Ukrainian Project Management Association, Head of Project Management Department at Kyiv National University of Construction and Architecture. Member of the Board of Directors, a member of the Certification Department, First Assessor in seven countries, International Validator of Certification Programs at International Project Management Association (IPMA), Head of PPMITK Group (2014).

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### Uwe Grossmann



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**Taras Lendyuk**

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**Research interests:** economic-mathematical ultisen, project management.

**Khrystyna Lipyanina-Goncharenko**

Bachelor (2011), Economic Cybernetics, Ternopil National Economic University, Master (2012), Economic Cybernetics, Ternopil National Economic University, Lecturer at Department for Information Computer Systems and Control (2019), PhD (2019), Senior Lecturer at Department for Information Computer Systems and Control (2020), SACTPC Group member (2019).

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**Sergiy Lysenko**

2005 – graduated from Khmelnytskyi National University with a degree in Computer Systems and Networks. 2011 – defended a candidate's thesis on the topic: "Adaptive information technology for diagnosing computer systems for the presence of Trojan programs" on 05.13.06 - "Information technologies". 2013 – obtained the academic title of associate professor of the Department of System Programming, IS group.

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### Vasyl Lytvyn



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### Taras Maksymyuk



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### George Markowsky



A Professor and Chair of Computer Science Missouri University of Science and Technology. George Markowsky has published 115 journal papers, book chapter, book reviews and conference papers on various aspects of Computer Science and Mathematics.

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**Research interests:** from pure mathematics to the application of mathematics and computer science to biological problems. He has also built voice controlled and enhanced keyboard terminals for use by paralyzed individuals.

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**Research interests:** embedded computer systems, signal processing, information theory and data encoding, autonomous sensors, low-level sensor networks.

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**Research interests:** microprocessors

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**Research interests:** software development, web-design, distributed systems, computer systems architectures.

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### Sergey Rippa



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**Research interests:** pattern recognition systems with small databases; systems of synthesis, processing and recognition of complex structured images.

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**Research Interests:** Labour protection.

**Anatoliy Sachenko**

Specialist in Information Measurement Technology (1968), Ph.D. in Electrical Engineering (1978), Scientific Advisor of Branch Research Laboratory for Automated Systems and Networks (1984), DSc in Computer Engineering (1988), Prof. of Department for Information Computer Systems and Control (1991), Honored Inventor of Ukraine (1992), Full Member of Ukrainian Academy of Economic Cybernetics (1998) and New-York Academy of Sciences (1998), Member of Specialized Scientific Council in State University "Lviv Polytechnic" (1994), Chairman of Specialized Scientific Council K58.082.02 at TNEU (2002), Editor-in-Chief of International Journal of Computing, Doctoral Dissertations Chapter Editor in "IEEE I&M Magazine", Head of Department for Information Computer Systems and Control, Dean of Institute for Computer Information Technologies (1994-2005), Scientific Advisor of the ICS (2004), IDAACS 2001-2013 Co-Chairman, Head of IDS Group (2004), Co-Head of ICSD (2014), NNPC Group Member (2004), KBO, WSS Groups Member (2008), IPPR, PPMITK and SACTPC Groups Member (2014).

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**Research interests:** Artificial intelligent systems, distributed sensor networks, computational, intelligence, intelligent robotics systems, parallel computation systems, cybersecurity and safety systems, project management, wireless sensor networks.

### Oleg Sachenko



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**Research interests:** spaces and data repositories; intelligent decision support systems; methods of data integration and aggregation; methods of eliminating uncertainties; design of distributed information systems.

### Jürgen Sieck



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**Research Interests:** multimedia, computer graphics, virtual reality and wireless communication.

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**Research interests:** signal processing, theory of information and data encryption.

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**Research interests:** computer systems design, information theory and data decoding, lower computer networks.

**Carsten Wolff**

A full professor for computer science at Dortmund University of Applied Sciences and Arts since 2007. He studied electrical engineering and economics at Paderborn University and did a PhD in electrical engineering at the Heinz Nixdorf Institute. In his industrial career, Dr. Wolff was in the semiconductor industry (Infineon AG). He is a founding member of the research centre PIMES ([www.pimes.de](http://www.pimes.de)).

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**Research interests:** development of methodology and tools for embedded systems, processing technologies and transmission projects in the field of mechatronic systems, mobile communication and renewable energy sources.

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**Research interests:** image identification, image analysis algorithms for computer recognition systems.

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**Research interests:** neural networks

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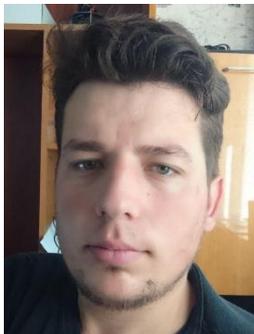


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**Research interests:** Computer Graphics, 3D Modeling, VFX.

### 3. RESEARCH PROJECTS

#### Current

#### [Project 1] “Virtual Master Cooperation Data Science” (ViMaCs)

Grant holder – Dortmund University of Applied Sciences (FH Dortmund)

Managers: prof. Dr. Carsten Wolf, Prof. Stefan Recker (FH Dortmund)

Partner universities:

- Kyiv National University of Construction and Architecture (KNUBA) - prof. Sergey Bushuyev.
- Ternopil National University of Economics (TNEU) - prof. Anatoly Sachenko
- National University "Zaporizka Polytechnic" (NUZP) - prof. Galina Tabunshchik

Duration: 2019 – 2021.

The goal: to build a virtual training and laboratory infrastructure for online teaching and a portfolio of modules in the field of "Data Science".

Task:

1. Building a common IT environment, including a common e-learning platform
2. Development of 4 online educational modules for 6 ECTS:
  - KNUBA "Business analysis and decision-making"
  - TNEU "Data Collection and Processing"
  - NUSP "Artificial Intelligence and Data Analysis"
  - FH Dortmund "Cloud data processing systems"
3. Pilot training in specialized schools 4 times a year
4. Pilot training of teachers for interuniversity distribution of modules
5. Creating a community of practice for continuous content evolution

TNEU team:

- Anatoliy Sachenko;
- Pavlo Bykovyy;
- Oleksandr Osolinskyi;
- Mykhailo Dombrovskiy;
- Iryna Turchenko.

**Link tom project web-site:** <https://go-study-europe.de/vimacs/>

**[Project 2] DAAD program “International Study and Training Partnerships” (ISAP)**

Grant holder: Berlin University of Applied Sciences (HTW Berlin), prof. Jurgen Zick.

The head of the program from TNEU is Doctor of Technical Sciences, Prof. Sachenko Anatoly Oleksiyovych

Implementation period: 2019 - 2021.

Goal: strengthening partnership relations and cooperation between German universities and universities in the countries of the Middle East / Southeast and Eastern Europe, as well as in the Caucasus and Central Asia; promoting cooperation for the reconciliation of academic degrees (Bologna Process)

Main tasks:

- strengthening existing and starting new stable partnerships;
- exchange of scientists, graduates and students;
- structural improvement of research and study conditions in partner countries;
- internationalization of German and foreign universities.

TNEU team:

- - Sachenko Anatoly Oleksiyovych;
- - Pavlo Evgenovich Bykovy;
- - Iryna Vasylivna Turchenko.

## **[Project 3] WORK4CE: Cross-domain competences for healthy and safe work in the 21st century**

**Grant holder:** Zaporizhia Polytechnic National University

### **Participants from Ukraine:**

- Zaporizhia Polytechnic National University
- Kyiv National University of Construction and Architecture
- Ternopil National University of Economics

### **Foreign partners:**

- Fachhochschule Dortmund
- Katholieke Universiteit Leuven
- Universidad del Pais Vasco/ Euskal Herriko Unibertsitatea
- Azerbaijan Respublikasi Dövlətqomruk Komitəsinin Akademiyası
- Azərbaycan Dövlət Neft və Sənaye Universiteti
- Azerbaijan Architecture and Construction University

**Duration:** 2020 – 2023 pp.

### **Goals and content of the project:**

Development of a new form of cooperation between universities and enterprises in the era of digital technologies to improve the employability of graduates; providing the latest competencies related to the competencies required for employment to shape the workplace of the future (Competence Model for Work 4.0 and Digital Transformation Maturity Model); promotion of international and interdisciplinary development of the educational content of the competence model for work 4.0.

### **Tneu Team:**

- Pavlo Bykovyy;
- Nadiia Vasylykiv;
- Grygoriy Hladiy;
- Zbyshek Dombrovskiy;
- Mykhailo Dombrovskiy;
- Diana Zahorodnia;
- Andriy Karachka;
- Myroslav Komar;
- Volodymyr Kochan;
- Vasyl Koval;
- Ivan Kit;
- Taras Lendyuk;
- Khrystyna Lipianina-Honcharenko;
- Oleksandr Osolinskyi;
- Anatoliy Sachenko;
- Oleg Sachenko;
- Iryna Turchenko.

**Link to project web-site:** <https://work4ce.eu/>

## Completed projects

### **[Project 4] Methods and means of structural-statistical identification of hierarchical objects by characteristic points of their contours**

Principal investigator of project – PhD Diana Zahorodnia;  
Co-investigator – PhD Hrustyna Lipyana-Goncharenko.

Duration: 2019 –2020

**Objectives:** development of methods and tools aimed at improving the efficiency of automated video surveillance systems by reducing the amount of data processed.

#### **Main results of the project:**

- An analysis of known methods of identification and classification of objects for video surveillance systems.
- A method of combined adaptive identification of objects based on a hierarchical principle has been developed.
- A method of data classification based on cluster analysis methods has been developed.
- Algorithmic solutions of the proposed method of combined adaptive identification of objects based on the hierarchical principle are developed.
- Algorithmic solutions of the proposed method of data classification based on cluster analysis methods are developed.
- Experimental researches of the offered methods and algorithms are carried out.

#### **Team:**

- Diana Zahorodnia;
- Vitaliy Dorosh;
- Hrustyna Lipyana-Goncharenko;
- Ivan Kit;
- Andriy Kaniovskyi;
- Denys Zolotukhin;
- Andriy Sydor;
- Dmytro Lendiuk.

**[Project 5] DAAD program “International Study and Training Partnerships” (ISAP)**

Grant holder: Berlin University of Applied Sciences (HTW Berlin), prof. Juergen Sieck.

The head of the program from TNEU is Doctor of Technical Sciences, Prof. Anatoliy Sachenko

Duration: 2019 - 2021.

Goal: strengthening partnership relations and cooperation between German universities and universities in the countries of the Middle East / Southeast and Eastern Europe, as well as in the Caucasus and Central Asia; promoting cooperation for the reconciliation of academic degrees (Bologna Process)

Main tasks:

- strengthening existing and starting new stable partnerships;
- exchange of scientists, graduates and students;
- structural improvement of research and training conditions in partner countries;
- internationalization of German and foreign universities.

TNEU team:

- Anatoliy Sachenko;
- Pavlo Bykoviy;
- Iryna Turchenko.

**[Project 6] Methods for intelligent processing and analysis of Big Data based on deep neural networks**

Principal investigator of project – Prof. Anatoliy Sachenko;

Co-investigator – Dr Myroslav Komar.

Duration: 2018 –2019

**Objectives:** to increase the efficiency and performance of Big Data intelligent processing and analysis by developing effective methods of data compression and classification, and pattern recognition using deep neural networks.

**Main results of the project:**

- Known methods of data protection against computer attacks were analyzed.
- Data compression method based on deep neural networks was developed, using network traffic parameters in an intrusion detection system.
- A method for data classification based on deep neural networks was developed in order to prevent attacks against information telecommunication networks.
- An image recognition method was developed based on knowledge of Big Data using deep neural networks.
- A method for parallel deep neural network training was developed to solve the problems of Big Data compression and classification.
- Algorithms of the proposed methods of intelligent processing and analysis of Big Data based on deep neural networks were proposed.
- Deep neural networks architecture was proposed to solve the problems of Big Data compression and classification.
- Experimental studies of the proposed methods and algorithms have been carried out

**Team:**

- Anatoliy Sachenko;
- Myroslav Komar;
- Volodymyr Kochan;
- Vasyl Koval;
- Vladimir Golovko;
- Vasyl Yatskiv;
- Nadiia Vasylykiv;
- Taras Lendyuk;
- Pavlo Bykovyy;
- Diana Zahorodnia;
- Vitaliy Dorosh;
- Oleksandr Osolinskyy;
- Grygoriy Gladiy;
- Oleksiy Roshchupkin;
- Volodymyr Turchenko

**[Project 7] Erasmus+ALIOT**

Grantholder – Prof. Chris Phillips, Newcastle University, Newcastle, UK

National coordinator – Prof. Vyacheslav Kharchenko, National Aerospace University KhAI, Kharkiv

Leader of ICS TNEU team – Prof. Anatoliy Sachenko, ICS, Ternopil National Economic University

Duration: 2016 – 2020

**Objectives:** to develop and update curricula for masters, graduate students and industrial company specialists in the field of development, research and application of Internet of Things (IoT) in accordance with the needs of modern society.

**Interim project results:**

- Three working meetings of all project participants were held in Chernivtsi, February, 2018; Kyiv, May, 2018, and Newcastle and Leeds, UK, July, 2018 to announce the interim results of the team and the tasks for a given period.
- Curricula were developed.
- The content of the developed courses and modules was discussed. The structure of books and manuals was developed and discussed according to the proposed courses and modules.
- Regular working meetings of the ICT-TNEU team were held (see information on the websites <http://www.tneu.edu.ua/>, [www.iosu.tneu.edu.ua](http://www.iosu.tneu.edu.ua) та [www.ics.tneu.edu](http://www.ics.tneu.edu))

**Team:**

- Anatoliy Sachenko;
- Myroslav Komar;
- Volodymyr Kochan;
- Vasyl Yatskiv;
- Vasyl Koval;
- Grygoriy Gladiy;
- Iryna Strubytska;
- Zbyshek Dombrovskiy;
- Mykhailo Dombrovskiy
- Oksana Dunets;
- Pavlo Bykovyy;
- Diana Zahorodnia;
- Oleksandr Osolonskyy;
- Vitaliy Dorosh

**[Project 8] DAAD programme “Eastern Partnerships”**

Project Co-investigator: Prof. Anatoliy Sachenko

Co-investigator – Dr Iryna Turchenko

Duration: 2017 – 2019

**Objectives:**

- Strengthening partnerships and cooperation between German HEI and HEI in the Middle East/ South Eastern and Eastern Europe as well as Caucasus and Central Asia
- Fostering cooperation for alignment of academic degrees (Bologna process)

**Main project results:**

- Strengthening of existing and initiating new sustainable partnerships
- Research, graduate and student exchanges
- Sustainable structural improvement of conditions for conducting research and studying in partner-countries
- Contribution to internationalisation of German and foreign HEI

**Team:**

- Anatoliy Sachenko;
- Pavlo Bykovyy;
- Iryna Turchenko.

## **[Project 9] Theoretical Foundations and Hardware for Improving the Productivity of Wireless Sensor Networks**

Principal investigator of project – Dr. Vasyl Yatskiv

Duration: 2017 – 2018

**Objectives:** The project is aimed at solving the scientific and applied problem of improving the productivity of Wireless Sensor Networks (WSN) by developing effective methods of noise-immune encoding and adaptive data transmission schemes, providing error-immune and asymmetric computing complexity methods of data compression. At the same time, important criteria for evaluating the developed methods are the following ones: hardware complexity, computational complexity and energy costs for the implementation of algorithms.

### **Main project results:**

- development of methods for correction of multiple errors based on modular correction codes with low computational complexity of the decoding algorithms;
- study of computational complexity of the correction codes of the Residue Number System with a special system of modules;
- development of the method of data transmission in WSN on the basis of adaptive error control scheme and modular correction codes;
- investigation of the influence of noise on algorithms of data compression in WSN;
- development of new data compression methods resistant to noise and error propagation during decoding with asymmetric computational complexity of coding algorithms (the complexity of coding algorithms is less than the complexity of decoding algorithms);
- conducting experimental research of the transmission of compressed data under the influence of various types of noise;
- development and implementation on the FPGA of the reconfigurable special processor of noise-immune data encoding on the basis of modular correction codes;
- writing data compression algorithms in Verilog language and implementation of data processing devices in WSN on FPGA.

### **Team:**

- Vasyl Yatskiv;
- Anatoliy Sachenko;
- Volodymyr Kochan;
- Mykhailo Kasyanchuk;
- Natalia Yatskiv;
- Ihor Yakymenko;
- Stepan Ivasiev;
- Orest Volynskyy;
- Taras Tsavolyk.

## **[Project 10] Methods of Protection against Computer Attacks based on Neural Networks and Artificial Immune Systems**

Principal investigator of project – Prof. Anatoliy Sachenko;

Co-investigator – Dr Myroslav Komar.

Duration: 2016 – 2017

**Objectives:** The development of a new intelligent information technology based on the theory of artificial neural networks, fuzzy logic and artificial immune systems to increase the reliability of computer attacks detection and classification.

### **Main project results:**

- An analysis of known methods of protection against computer attacks was carried out.
- A modified method for constructing a detector of computer attacks based on neural networks and artificial immune systems was developed.
- A method for reducing the amount of information based on neural networks of high trust with the use of multichannel neural network detectors for constructing a hierarchical classifier of computer attacks was developed.
- A generalized architecture of intelligent computer-based system to prevent computer attacks was developed.
- Experimental studies of developed methods and algorithms were conducted, which confirmed the reliability of detection and classification of computer attacks and improvement of the safety level.
- An approach was proposed to improve the security of the system designed to prevent computer attacks by implementing neural network detectors on FPGA and introducing a subsystem of decision-making based on the rules of the Mamdani fuzzy inference.

### **Team:**

- Anatoliy Sachenko;
- Myrolav Komar;
- Volodymyr Kochan;
- Vladimir Golovko;
- Vasyl Yatskiv;
- Lesia Dubchak;
- Pavlo Bykovyy;
- Diana Zahorodnia;
- Vitaliy Dorosh;
- Taras Tsavolyk;
- Stepan Ivasiev;
- Grygoriy Sapozhnyk;
- Andriy Karachka.



## **[Project 11] Distributed Sensor Networks with Computing Nodes Reconfiguration**

Principal investigator: Prof. Anatoliy Sachenko

Co-investigator: Dr. Igor Maykiv

**Foreign partner:** Technical University of Moldova, Moldova

**Duration:** 2014 – 2015

**Objectives:** Development of methods for structural synthesis of universal modules with the reconfiguration possibility.

### **Main project results:**

- Method for structural synthesis of universal modules comprising functional analysis, structural synthesis and the search for a set of optimal solutions was developed on the basis of morphological analysis and synthesis. The proposed method combines lexicographical criterion advantages (L-criterion) for the selection of electronic components during functional analysis and absolute criterion of preference (optimality Pareto,  $\pi$ -criterion) during the search for a set of optimal solutions that are considered in scientific literature as alternative methods for finding optimal solutions. The combination of L- and  $\pi$ -criteria allows us to reduce the number of alternatives synthesized during structural synthesis. A formalized discrete optimization solution is versatile for a wide range of problems of optimal structural synthesis of computing systems.
- A new universal module structure with improved functional properties was designed due to separate data processing and sharing as well as reconfiguration of hardware and software using Field Programmable Gate Arrays (FPGAs).
- A 4-level model that graphically shows information relationships between different processes of receiving and transmitting messages in the controller serial interfaces, which is an effective tool of their implementation both during functional analysis and structural synthesis, was developed.
- An experimental model of network application processor with the capability of reconfiguring was created and the methodology of its testing was developed.

### **Team:**

- Anatoliy Sachenko;
- Igor Maykiv;
- Volodymyr Kochan;
- Nadia Vasylkiv;
- Oleksiy Roshchupkin;
- Diana Zahorodnia;
- Yuriy Ivanyshak;
- Olexandr Osolinsky;
- Taras Lendyuk;
- Oksana Dunets.

## **[Project 12] Wireless Multimedia Sensor Networks on the Base of Modular Arithmetics and Galois Codes for Videomonitoring Systems**

Principal investigator: Prof. Anatoliy Sachenko

Co-investigator: Dr. Vasyl Yatskiv

**Foreign partner:** Pedagogical University Huazhong, China.

**Duration:** 2013 – 2014

**Objectives:** developing of improved methods for training artificial neural networks on heterogeneous parallel computing systems referring to Grid, which provide high efficiency of parallelization and development of grid-based library functions for parallel training of artificial neural networks.

### **Main project results:**

- New methods of data coding and transmitting based on modular arithmetic were developed, which enable increased efficiency of wireless multimedia sensor networks (WMSN). Methods were designed for devices with limited hardware resources and autonomous power supply.
- Method of network coding is based on data of Residue Number System. The overall bandwidth of wireless sensor networks was investigated as well as the scope of data transmission schemes for different residues.
- Method of coding and redundancy reducing of multimedia data without the loss in Residue Number System, which allows us to reduce image processing in 2-3 times by splitting the image into the modules of Residue Number System and parallel encoding of the obtained residues, was developed. Application of Huffman codes for residues compressing provides lossless compression ratio depending on the class of images: 1,6 – 4 – for photo-realistic images; 4 – 8 – for images with large areas of the same color.
- Method of improving data reliability based on modified correcting code of Residue Number System, which is characterized by a lower computational complexity and allows us to increase the efficiency of encoding about 5 times comparing with R – source code RNS and Reed – Solomon RS (127, 87), was developed.

### **Team:**

- Anatoliy Sachenko
- Yaroslav Nykolaychuk
- Natalia Yatskiv
- Vasyl Yatskiv
- Orest Volynskyy
- Petro Humenyi

**[Project 13] Neural network method for improving the accuracy of information-measurement systems of ultraviolet radiation**

Principal investigator: Prof. Anatoliy Sachenko

Project was completed within inter-university network Erasmus Mundus together with partners from Alaxender Ioan Kuza University, Iassi, Romania.

Duration: 2013 – 2014

**Objectives:** development of new neural network method for improving the accuracy of information measuring systems for measurement of ultraviolet radiation.

**Research methods:** structural and functional analysis (error analysis in measuring systems for measuring UV radiation level and UV sensors); methods of neural networks theory, the method of gradient ascent in the space of weight coefficients and neurons thresholds (for NN training); simulation methods (for experimental research of developed methods); technique for primary transformer investigation.

**Project results:**

- The methods of signal processing of multiparameter sensors were proposed. Simulations were conducted in MathLab.
- The software for modeling of the real multiparameter sensors behavior was developed. The software allows us to enter the model random and systematic errors and identify the limits of the proposed methods.
- Ukrainian Patent application for invention and useful model was received.

**Team:**

- Anatoliy Sachenko
- Oleksiy Roshchupkin
- Volodymyr Kochan

## **[Project 14] Methods and Tools of Building Wireless Multimedia Sensor Networks Based on Modular Arithmetic**

Principal investigator – Prof. Yaroslav Nykolaychuk

Duration: 01.01.2013 – 31.12.2014

**Objectives:** development of methods and tools for data encoding and transmitting in wireless multimedia sensor networks aimed at improving the reliability of their operation and functionality.

**Abstract:** New methods and algorithms for data encoding and transmitting using mathematical tools of modular arithmetic were developed, aimed at improving the performance of wireless multimedia sensor networks (WMSM). A Verilog – encoder model for noise-immune data encryption using modified correcting codes was designed.

### **Main results:**

- The method of adaptive coding and transmission of multimedia data based on modular arithmetic and multipath routing using adaptive distribution packages and their transfer from multipath routing, is developed, which provides the efficiency of the total bandwidth of wireless sensor networks.
- The method of network data coding based on the Residue Number System (RNS), which provides reduction of data amount by 50%, including the retransmission of packages that are necessary for message recovery, was developed. The proposed method allows us to select relatively simple modules of various bit-widths, though the bit-width of residues transmitted through the common route is approximately equal to the bit-width of residues on specific routes. The developed method of network coding improves overall network bandwidth by about 60%.
- A modified correcting code of Residue Number System was developed, which is characterized by the simplified procedure of check symbols formation, providing increased efficiency of encoding approximately in 5 times as compared with other correcting codes. Using modified correcting codes of RNS in wireless sensor networks allows us to improve the reliability and overall network bandwidth by reducing the number of retransmissions.

### **Team:**

- Yaroslav Nykolaychuk
- Anatoliy Sachenko
- Vasyl Yatskiv
- Natalia Yatskiv
- Natalia Vozna
- Petro Humenny
- Orest Volynsky

## **[Project 15] Efficient Parallel Batch and Single Pattern Neural Network Training Algorithms Using Open MPI and GPU-computing**

Principal investigator: Dr. Volodymyr Turchenko

Partners: Prof. Jack Dongarra, Innovative Computing Lab, University of Tennessee, Knoxville, TN, USA.

Grant: Fulbright Scholar Program 2012/13

**Duration:** 09/2012 – 06/2013

**Objectives:** test enhanced batch pattern parallel algorithm for NN training by changing the parameters of the internal algorithms of MPI collective functions on different parallel architectures; develop GPU-based versions of the parallel batch and single pattern algorithms for NN training; test experimentally the efficiency of the improved GPU-based version of the algorithms in comparison with their Open MPI implementations.

### **Main results:**

1. The parallelization efficiency of the neural network training algorithm on the example of the recirculation neural network model has been researched. The Open MPI, OpenMP and CUDA-based versions of the parallel batch pattern training algorithm for recirculation of neural network were implemented using C language. The parallelization efficiency of the developed algorithms has been researched on many-core parallel machine with 48 AMD Opteron 6180 SE processors, on computational cluster with 48 Intel Xeon E5520 processors, on 60-core Intel GPU Xeon Phi Coprocessor 5110P card and Nvidia Tesla C2050 GPU card using its 64 cores only (total is 1024). The experimental research of the developed algorithm using Open MPI technology showed the parallelization efficiency of 75% on 48 processors of the many-core system, 60% on 48 processors of the cluster, 70% on 60 processors of the Intel GPU Xeon Phi card. The experimental research of the developed algorithm using OpenMP technology showed lower figures, 40% of parallelization efficiency on 48 processors of the many-core system. The experimental research of the developed algorithm using CUDA technology showed 14-times speedup on one Nvidia Tesla GPU card. The developed algorithms are included to the developing library PaGaLiNNeT capable to speed-up scientific computations based on neural networks on general-purpose and hybrid (CPU+GPU) high performance computing systems.
2. The research project entitled “An Adaptive End-to-End Approach for Terabit Data Movement Optimization” was investigated. The goal of this project is to develop a novel architecture and related approaches to the end-to-end optimization of terabyte size data movement on next-generation networking and storage system technologies. The moving scientific data sets at terabits per second transfer rates over wide-area networks between geographically dispersed data centers were modeled. The set of events which describe a drop of the bandwidth in the communication network was obtained. A predictive model based on artificial neural networks to predict the duration of the event and the value of the maximum bandwidth drop was developed. I have used the developed library for parallel neural network training PaGaLiNNeT (developed by me within my previous project) and the model of a multi-layer perceptron. The experimental researches showed that the modeled events have stochastic nature and therefore it is necessary to tune the neural network model to provide desirable prediction results. This scientific collaboration with the host institution will be continued in the future.

### **Published results:**

1. Turchenko V., Bosilca G., Bouteiller A. and Dongarra J. “Efficient Parallelization of Batch Pattern Training Algorithm on Many-core and Cluster Architectures”, Proceedings of the 7<sup>th</sup> IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems, Sep 12-14, 2013, Berlin, Germany, pp. 692-698.

## **[Project 16] Neural Network Methods for Evaluation of Microprocessor Power Consumption While Performing Instructions**

Principal investigator: Dr. Zbyshek Dombrovsky

**Duration:** 2010 – 2012

**Objectives:** development of hardware-software complex, which allows to built mathematical models of processor cores power consumption.

**Main tasks:**

- development of appropriate specialized hardware, which allows to evaluate power consumption of instruction execution in normal microprocessor operation mode;
- development of testing methods (calibration) of created hardware;
- using artificial neural networks to predict power consumption of the instruction execution modes (addressing, conditions, etc.) which were not completely tested experimentally;
- using the experiment planning methods for additional decreasing of experiments volume.

**Team:**

- Anatoliy Sachenko
- Volodymyr Kochan
- Andrii Borovyi
- Oleh Havryshok
- Ihor Maykiv
- Orest Volynskyy

**Published results:**

2. A. Borovyi, V. Kochan, Th. Laopoulos, Sachenko A. Improved Sorting Methodology of Data-processing Instructions, International Journal of Computing, vol. 10, issue 1, 2011, pp. 50-55.
3. A. Borovyi, I. Maykiv, R. Kochan, Z. Dombrovskyy, V. Kochan. The Unit of Measurement of Consumers Pulse Energy, Patent of Ukraine 90922 UA, MPK (2009) G05F 5/00 G01K 17/00, no. A2008 06325 ; applied 13. 05. 2008; published 10. 06. 2010, Bulletin no. 11.
4. Time-domain analysis of ARM7TDMI core instructions [Text] / A. Borovyi, V. Kochan, Th. Laopoulos, A. Sachenko // Proceedings of the 6th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS'2011). – Vol. 2. – [S. L. : s. N.], 2011. – September 15-17. – P. 785 –790.

## [Project 17] Human Biometric Identification in Video Surveillance Systems

**Foreign partner:** Technical University of Sofia, Bulgaria

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Bulgaria: Dr. Ognian Bumbarov

**Duration:** 2009 – 2010

**Objectives:** design of intelligent biometrical sub-system for detection and recognition of human faces in the video surveillance systems for monitoring of public places, database support of staff or factory's visitors etc.

### Main tasks:

- development of methods and algorithms for movement detection on the captured videoframes;
- development of methods and algorithms of videoframes preliminary processing by skin color;
- improvement of methods and algorithms for detection and tracing of human face;
- development of methods and algorithms for face recognition.

### Team:

- Anatoliy Sachenko
- Ihor Paliy
- Yuriy Kurylyak
- Taras Leshko

### Published results:

1. Ihor Paliy, Anatoliy Sachenko, Yuriy Kurylyak, Ognian Boumbarov, Strahil Sokolov. Combined Approach to Face Detection for Biometric Identification Systems // Proceedings of 5<sup>th</sup> IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, 21-23 September 2009, Rende (Cosenza), Italy, pp. 425-429.
2. Ognian Boumbarov, Strahil Sokolov, Plamen Petrov, Anatoliy Sachenko, Yuriy Kurylyak. Kernel-based Face Detection and Tracking with Adaptive Control by Kalman Filtering // Proceedings of 5<sup>th</sup> IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, 21-23 September 2009, Rende (Cosenza), Italy, pp.434-439.
3. Y. Kurylyak, I. Paliy, A. Sachenko, A. Chohra, K. Madani. Face Detection on Grayscale and Color Images using Combined Cascade of Classifiers // International Journal of Computing. –Ternopil (Ukraine). – 2009. – Vol. 8, Issue 1. – pp. 61-71.
4. Y. Kurylyak A Real-Time Motion Detection for Video Surveillance System // Proceedings of 5<sup>th</sup> IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS2009). – Rende (Cosenza), Italy, 2009. – pp.386-389.
5. Paliy I.O. Methods of Face Detection in Systems of Computer Recognizing on the Base of Combined Cascade of Neural Network Classifiers. – PhD Thesis, Ternopil National Economic University. – Ternopil. – 2009.

**[Project 18] Parallel Grid-aware Library for Neural Networks Training – PaGaLiNNeT**

Principal investigator: Dr. Volodymyr Turchenko

Scientific advisor: Prof. Anatoliy Sachenko

Partners: Prof. Lucio Grandinetti, Center of Excellence on High Performance Computing, Department of Electronics, Computer Science and Systems, University of Calabria, Italy.

Grant No FP7 MC IIF 221524 – 908524 according to the 7<sup>th</sup> EU Frame Programme, Grant of Marie Curie for researches from the third countries (International Incoming Fellowships – IIF), return phase

**Duration:** 2011 – 2012

**Objectives:** development of the enhanced training methods for artificial neural networks in heterogeneous parallel computing systems within the Grid; providing the high efficiency of parallelization and development of the Grid-based library for parallel neural networks training.

**Main results:**

- As a part of the project design three levels of grid-based library are created: (i) at the level of a single supercomputer / cluster homogeneous computing nodes, (ii) at the heterogeneous computing nodes within a cluster, (iii) at the grid of computing system with heterogeneous hosts and heterogeneous communication channels between them. A parallel version of the library for the level (i) was installed on parallel machines with ccNuma architecture. A strategy for resource brokering based on Pareto optimization [1] is implemented in C programming language and included in the library. The developed library for the level (i) which includes the routines for parallel training of multilayer perceptron [2] and recurrent neural network was used for the prediction of the stock price for financial markets. The results are published in [6]. A parallel version of the library for the level (ii) was developed and installed on the computing cluster of heterogeneous architectures. The resource brokering sub-routine based on Pareto optimization [1] is called from the code of resource broker separately before executing the main task. The performance analysis of computing nodes of the cluster is based on a modified BSP-based model with improved computational complexity of parallel training algorithm for multilayer perceptron [2]. The results are published in [5];
- Within the application of parallel algorithms for neural network training to speed up the execution of practical tasks, an application task of convolution neural network for the detection of the number of micronucleus in the human lymphocytes is considered. The accurate detection of the number of micronucleus in the human lymphocytes can be used as biological dosimeter in order to relieve the presence and the action of carcinogenic factors and could enhance the correctness of the final medical response. It was proven the application of convolution NN for the development of this task because this NN model provides good detection properties and showed good detection results of the more complicated task of human face detection. The human lymphocyte images were acquired by the image flow cytometer which causes the different types of noise that influence on the acquired image. We have tested the CNN for the images altered by a zoom factor. The CNN provides no false alarms for each zoom factor. The number of false negative detections is much lower in comparison with the pattern matching method, implemented as a LABVIEW routine (IMAQ Match Pattern method) inside the flow cytometer. The detection rate of 87.5% provided by the CNN is much higher than 25% of detection rate by the IMAQ Match Pattern method on the considered example images. The results are published in [3, 4].

**Published results:**

1. Turchenko V.O. Brokering methodology of Grid-resources using Pareto-optimality // Measuring and Computing Technologies Equipment in Technological Processes. – 2011. # 1. – pp. 312-318.
2. Turchenko V.O. Efficiency Comparison of Multilayer Perceptron Group Training on Parallel Computer and Computation Cluster // Transactions KPI. Informatics, management and computing technology: Proceedings – Kyiv: Vek+. – 2011. – No. 54. – pp. 130-138.
3. Paliy I., Lamonaca F., Turchenko V., Grimaldi D., Sachenko A. Detection of Micro Nucleus in Human Lymphocytes Altered by Gaussian Noise Using Convolution Neural Network, Proceedings of 2011 IEEE International Instrumentation and Measurement Technology Conference (I2MTC 2011), 2011, Binjiang, Hangzhou, China, pp. 1097-1102.
4. Lamonaca F., Turchenko V., Grimaldi D. Aspetti innovativi della progettazione hardware e software di citofluorimetro ad immagini, Atti del XXVIII Congresso Nazionale Gruppo Misure Elettriche ed Elettroniche, 2011, Genova, Italy, pp. 289-290.
5. Turchenko V., Puhol T., Sachenko A., Grandinetti L. Cluster-Based Implementation of Resource Brokering Strategy for Parallel Training of Neural Networks, Proceedings of the 6<sup>th</sup> IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems IDAACS2011, Sep 15-17, 2011, Prague, Czech Republic, pp. 212-217.
6. Turchenko V., Beraldi P., De Simone F., Grandinetti L. Short-term Stock Price Prediction Using MLP in Moving Simulation Mode, Proceedings of the 6<sup>th</sup> IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems IDAACS2011, Sep 15-17, 2011, Prague, Czech Republic, pp. 666-671.
7. Turchenko V. Efficiency Comparison of Batch Pattern Training Algorithm of Multilayer Perceptron on Parallel Computer and Computational Cluster, Scientific Journal of National Technical University of Ukraine “Kyiv Polytechnic Institute”, Kyiv, 2011, No 54, pp. 130-138 (in Ukrainian).
8. Sachenko A., Kulakov Yu., Kochan V., Turchenko V., Bykovvy P., Borovy A. Computer Networks: A Tutorial, Ternopil, Ekonomichna dumka, 2012, 476 p. // Chapter 15. Grid-computations based on network technologies, pp. 416-439 (in Ukrainian).
9. Turchenko V., Grandinetti L., Sachenko A. Parallel Batch Pattern Training of Neural Networks on Computational Clusters, Proceedings of the 2012 International Conference on High Performance Computing & Simulation (HPCS 2012), July 2 – 6, 2012, Madrid, Spain, pp. 202-208.
10. Turchenko V., Golovko V., Sachenko A. Parallel Batch Pattern Training of Recirculation Neural Network, Proceedings of the 9<sup>th</sup> International Conference on Informatics in Control, Automation and Robotics (ICINCO 2012), July 28 – 31, 2012, Rome, Italy, pp. 644-650.
11. Turchenko V., Golovko V., Sachenko A. Parallel Training Algorithm for Radial Basis Function Neural Network, 7<sup>th</sup> International Conference on Neural Networks and Artificial Intelligence (ICNNAI'2012), October 10-12, 2012, Minsk, Belarus, pp. 47-51.

## [Project 19] Development of Intelligent Video Surveillance Systems

Principal investigator: Dr. Volodymyr Kochan

Project executed together with the Glushkov Institute for Cybernetics, Prof. Vitaliy Boyun.

**Duration:** 2009 – 2010

**Objectives:** development of highspeed and relevant video surveillance system on the basis of intelligent videocamera, which allows us to decrease information streams between camera and workstation central processor, as well as to read and process large images with high frame rate.

### Main tasks:

- increasing of efficiency of communication channels between intelligent videocamera and personal computer;
- development of methods and algorithms for videoframes preliminary processing by skin color and movement;
- development of methods and algorithms for human face recognition on the basis of the combined cascades classifiers, classifier training paralleling, and improvement of neural network training method in the frame of combined cascade;
- development of algorithms for faces tracing;
- development of software and highlevel programe interface for interaction with intelligent camera; coding of developed algorithms in processor computer code for digital processing of intelligent videocamera images.

### Team:

- Anatoliy Sachenko
- Ihor Paliy
- Yuriy Kurylyak

### Published results:

1. Kurylyak Y.O., Sachenko A.O. Method of background image renewal for movement segmentation // Proceedings of 10-th International Conference “Modern Information and Electronic Technologies” (SIET’2009). – Odessa (Ukraine), 2009. – Vol. 1. – pp. 44.
2. Paliy I.O. Training of neural network classifiers with combined cascade for face detection // Proceedings of 10-th International Conference “Modern Information and Electronic Technologies” (SIET’2009). – Odessa (Ukraine), 2009. – Vol. 1. – pp. 42.
3. Paliy I. Face detection on grayscale and color images using combined cascade of classifiers // International Journal of Computing. – 2009. – Vol. 8. – Issue 1. – pp.61-71.

## **[Project 20] Development of 3D Localization Methods for Navigation of Mobile robot**

**Foreign partner:** Kaunas Technical University, Lithuania

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Lithuania: Prof. Rimvydas Simutis

**Duration:** 2009 – 2010

**Objectives:** developing the unified structure for autonomous mobile robot control and providing 3D localization and navigation in non-structured environment with dynamical objects by using new methods and means which allow us to improve the navigation characteristics of mobile robots and use already known methods for new applications.

### **Main tasks:**

- 1) Analysis of already known methods for designing the structure of control system for mobile robots (MR) and development of unified structure for autonomous MR control.
- 2) Development of Dataflow Diagram (DFD) for robot control system and analysis of time characteristics of DFD main modules. Setting of requirements for main MR modules.
- 3) Development of improved methods and means of MR control system:
  - a) Development of new method of acquisition and processing of sensor data;
  - b) Development of MR 3D localization methods.
- 4) Development of hardware and software for autonomous MR.
- 5) MR composing according to the requirements set in point 2, taking into account the applied problems and MR hardware/software means developed in points 3-4.
- 6) Verification and testing of MR prototype functioning.

### **Team:**

- Anatoliy Sachenko
- Vasyl Koval
- Oleh Adamiv
- Viktor Kapura

### **Published results:**

1. Roth H., Sachenko A., Koval V., Chanim J., Adamiv O., Kapura V. The 3D Mapping Preparation using 2D/3D Cameras for Mobile Robot Control // *Artificial Intelligence journal*, Donetsk, Ukraine. – 2008. – Vol. 4. – pp. 512-521.
2. Adamiv O., Sachenko A., Kapura V. Gradient Method for Autonomous Robot Navigation // *Proceedings of the Ninth International Conference “Modern Problems of Radio Engineering, Telecommunications and Computer Science” (TCSET’2008)*. – Lviv-Slavsko (Ukraine), 2008. – pp. 640-642.
3. O. Adamiv, V. Koval, V. Dorosh, G. Sapozhnyk, V. Kapura Mobile Robot Navigation Method for Environment with Dynamical Obstacles // *Proceedings of the 5-th IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS’2009)*. – Rende (Cosenza), Italy, 2009. – pp.515-518.
4. O. Adamiv, A. Lipnickas, A. Knyš. A stereovision system for autonomous robot navigation in 3-D // *Proceedings of 10-th International Conference “Modern Information and Electronic Technologies” (SIET’2009)*. – Odessa (Ukraine), 2009. – Vol. 1. – pp. 28.

## **[Project 21] Development of Stereovision Methods and Devices for Autonomous Navigation of Mobile Robots**

**Foreign partner:** University of Sigen, Germany

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Germany: Prof. Hubert Roth

**Duration:** 2008 – 2009

**Objectives:** Development of stereovision methods for autonomous navigation of mobile robots.

### **Main tasks:**

- Development of stereo camera preliminary data processing methods for future integration with a mobile robot:
- Methods of generation of stereo images;
- Image filtering and analysis methods.
- Development of stereo image fusion and mobile robot 3D environment map generation techniques:
- Image description methods;
- Stereo image corresponding points search and 3D environment map generation methods.
- Development and implementation of sensor data fusion algorithms.
- Verification and testing of the developed methods using a mobile robot.

### **Team:**

- Anatoliy Sachenko
- Vasyl Koval
- Oleh Adamiv
- Viktor Kapura

### **Published results:**

1. Roth H., Sachenko A., Koval V., Chanim J., Adamiv O., Kapura V. The 3D Mapping Preparation using 2D/3D Cameras for Mobile Robot Control // Artificial Intelligence journal, Donetsk, Ukraine. – 2008. – Vol. 4. – pp. 512-521.
2. Adamiv O., Sachenko A., Kapura V. Gradient Method for Autonomous Robot Navigation // Proceedings of the Ninth International Conference “Modern Problems of Radio Engineering, Telecommunications and Computer Science” (TCSET’2008). – Lviv-Slavsko (Ukraine), 2008. – pp. 640-642.
3. H. Roth, A. Sachenko, V. Koval, O. Adamiv, V. Kapura Evaluation of Camera Calibration Methods for Computer Vision System of Autonomous Mobile Robot // Proceedings of 10-th International Conference “Modern Information and Electronic Technologies” (SIET’2009). – Odessa (Ukraine), 2009. – Vol. 1. – pp. 29.

## **[Project 22] Development of Design and Optimization Methods for Breach Detection Systems**

**Foreign partner:** Institute of Technology, Gebze, Turkey

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Turkey: Dr Serkan Aksoy

**Duration:** 2008 – 2009

**Objectives:** development of a Computer Aided Design (CAD) system for development of perimeter security systems optimized for quality-price, reliability-price criteria and further testing of the CAD system on real security systems.

### **Main tasks:**

- Analysis of existing solutions and formation of a set of criteria and limitations for functional and cost analysis of security systems. Development of improved components and database for security systems.
- Development of methods and algorithms for structural synthesis and multi-criteria optimization of security systems. Development of a CAD system for security systems design based on the developed methods and algorithms.
- Development of a pilot security system with the use of the developed CAD. Testing of the pilot system.
- Carrying out a comparative analysis of the developed pilot system against existing systems. Introduction of necessary changes to the CAD system based on the conducted analysis.
- Carrying out the pilot security system testing to measure risks of undetected intrusions and risks of false alarms. Introduction of necessary changes to the pilot security system based on the conducted tests.
- Testing of the CAD system.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Kochan
- Volodymyr Turchenko
- Pavlo Bykovyy

### **Published results:**

1. Bykovyy P. Design optimization of distributed technical security systems using a genetic algorithm // Visnyk of Vinnitsa Polytechnic Institute. – 2008, Issue #6, pp 28-34.
2. Bykovyy P., Pigovsky Yu., Kochan V., Sachenko A., Markowsky G., Aksoy S. Genetic Algorithm Implementation for Distributed Security Systems Optimization // Proceedings of the IEEE International Conference on Computational Intelligence for Measurement Systems and Applications (CIMSMA 2008), 14-16 July 2008. – Istanbul, Turkey. – pp. 120-124.
3. Bykovyy P.Ye., Kochan V.V. Cryptographically secure protocol for networks of security sensors // Proceedings of 10-th International Conference “Modern Information and Electronic Technologies” (SIET’2009). – Odessa (Ukraine), 2009. – Vol. 1. – pp. 189.
4. Bykovyy P.Ye. Distributed sensor network for security systems // International journal of Computing. – Ternopil (Ukraine). – 2009. Vol. 8, Issue 2. – pp. 157-164.
5. P. Bykovyy, V. Kochan, Y. Kinakh, A. Sachenko, O. Roshchupkin, S. Aksoy, G. Markowsky. Data Communication Crypto Protocol for Security Systems Sensor Networks // Proceedings of 5<sup>th</sup> IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS’2009). – Rende (Cosenza), Italy, 2009. – pp. 375-379.
6. P. Bykovyy, Y. Pigovsky, A. Sachenko, A. Banasik. Fuzzy Inference System for Vulnerability Risk Estimation of Perimeter Security // Proceedings of 5<sup>th</sup> IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS’2009). – Rende (Cosenza), Italy, 2009. – pp. 380-384.

## **[Project 23] Computer Telecommunication System Based on Noise Signals**

Principal investigator: Prof. Yaroslav Nikolaychuk

Project is executed together with JSC Ternopil Radio Plant 'Orion', chief designer Volodymyr Kordyak.

**Duration:** 2007 – 2009

**Objectives:** to increase noise-immunity and active range of radio stations, produced by the Orion plant; introduce a mode of code based on division of transmission channels; develop a computerized system of data acquisition based on autonomous sensors.

**Project tasks:**

- Design of a noise-signal based radio station with a low range of operation for construction companies;
- Analysis of possible application areas for 2D noise signals;
- Analysis of possible application areas and prospective customers of computer systems based on autonomous sensors.
- Preparation of project solutions related to radio system serving and construction areas.

**Team:**

- Yaroslav Nykolaychuk
- Oleh Zastavnyy
- Nazar Krutskevyeh

**Published results:**

1. Nykolaychuk Y., Krutskevyeh N., Zastavniy O. Multibases Processors of Two-dimensional Correlation for Noise Immunity of Transfer Information // Proc. Of the IEEE International Workshop on Intelligent Data Acquisition and Advancing Computing Systems (IDAACS'2007). – 2007. – Dortmund (Germany). – pp. 315-317.

## **[Project 24] Dynamically Reprogrammable Network Capable Application Processor with Internet Capability**

**Foreign partner:** Esensors Inc., USA

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from USA: Dr Darold Wobschall, PhD

**Grant #**UE2-2534-TE-07.

**Duration:** 2007 – 2009

**Objectives:** to enter the US smart sensors market with the Network Capable Application Processor (NCAP) developed within the project CRDF #UE2-2534-TE-03 – device oriented on software data processing in smart distributed measurement and control systems which uses adaptive software reconfiguration for intelligent functions execution (self-adapting and self-training). The developed NCAP will have the following features:

- ability to work in distributed measurement control systems utilizing the Internet;
- online remote reprogramming of user application software;
- support of a wide set of network interfaces;

### **Main tasks:**

- the minimal set of the design documentation sufficient for production of a prototype NCAP was developed;
- two prototype NCAP devices have been developed and undergo testing;
- testing of certain NCAP modules was performed, the NCAP software was developed as well.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Kochan
- Roman Kochan
- Andrew Stepanenko
- Ihor Maykiv
- Iryna Turchenko
- Natalia Vozna

### **Published results:**

1. Maykiv I., Stepanenko A., Wobschall D., Kochan R., Kochan V., Sachenko A., Vasylykiv N. Remote Reprogrammable NCAPs: Issues and Approaches // Proc. Of the IEEE International Workshop on Intelligent Data Acquisition and Advancing Computing Systems (IDAACS'2007). – 2007. – Dortmund (Germany). – pp. 109-113.
2. Maykiv I.M., Kochan V.V., Bilousov I.A. Project analysis of methods of serial interfaces controllers realization // Transactions of Ternopil State technical University. – 2009. – No. 1. – pp. 110-115.
3. Maykiv I.M. Investigation of I2C interface controllers realizations method on the programmed logical matrix // Proceedings of 5-th International Youth Conference “Modern Problems of Radiotechnics and Telecommunication”. – Sevastopol (Ukraine), 2009. – pp. 284.
4. Maykiv I.M., Kochan V.V. Software-hardware controller of consecutive interfaces in network nodes of data acquisition // Proceedings of 10-th International Conference “Modern Information and Electronic Technologies” (SIET'2009). – Odessa (Ukraine), 2009. – Vol. 1. – pp. 138.
5. Maykiv I.M. Methodology of structural synthesis of network capable application processors // Proceedings of National Conference in Ternopil Ivan Pul'uj State Technical University. – Ternopil (Ukraine), 2009. – pp. 176.

6. Maykiv I.M. Software-hardware method of sequential interfaces controllers realization // Proceedings of 11-th International Conference “System Analysis and Information Technologies” (SAIT-2009). – Kyiv (Ukraine), 2009. – pp. 437.
7. Maykiv I.M. Network capable application processor for distributed measuring-control systems // Transaction “Problems of Informatization and Control”, Kyiv (Ukraine). – 2009. – No. 2 (28). – pp. 187-191.
8. Maykiv I.M. Universal control of serial interfaces // Transactions of Chernivtsi University. Series: Physics. Electronics, Chernivtsi (Ukraine). – 2009. – No. 3 (186). – pp. 130-135.
9. Maykiv I.M., Stepanenko A.V., Wobschall D. A method for structural synthesis of network capable application processors. // International Journal of Computing – Ternopil (Ukraine). – 2009. – Vol. 8. – Issue 2. – pp.126-138.
10. I. Maykiv, D. Wobschall, A. Stepanenko, R. Kochan, A. Sachenko, V. Kochan. Multi-port Serial NCAP using IEEE1451 Smart Transducer Standard // Proceedings of IEEE Sensor Application Symposium (SAS-2009). – New Orleans, LA, (USA), 2009. – pp. 293-297.
11. I. Maykiv, A. Stepanenko, D. Wobschall, R. Kochan, V. Kochan, A. Sachenko. Universal Controller of Serial Interfaces // Proceedings of the 5-th IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2009). – Rende (Cosenza), Italy, 2009. – pp. 121-125.
12. Iryna Turchenko. Methods for Improving Efficiency of Data Processing Obtained from Multi-parameter Sensors in Distributed Computer Systems. Ph. D. Thesis on speciality 05.13.05 – Computer Systems and Components.- Ternopil National Economic University.- Ternopil.- 2008.- 200 p. (in Ukrainian)
13. Natalia Vozna. Forming and Organizing of Structured Data Movement in Multilevel Distributed Computer Systems. Ph. D. Thesis on speciality 05.13.05 – Computer Systems and Components.- Ternopil National Economic University. – Ternopil. – 2009. (in Ukrainian)

## **[Project 25] Ternopil Education Communication Center**

**Foreign partner:** University of Maine, USA

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from USA: Prof. George Markowsky

Project is granted by NATO Program of Security through Science Network Infrastructure Grant, and performed together with the University of Maine, USA.

**Duration:** 2006 – 2009

**Objectives:** create common communication center for universities of Ternopil, integrate educational networks of Ternopil Universities, introduce high-speed network for training and research.

### **Main tasks:**

- Connect educative institutions of Ternopil to Internet through Ternopil Education Communication Center;
- Make a basis for cooperation of all universities of Ternopil;
- Make a basis for educative and research cooperation between universities of Ternopil and University of Maine and other researchers;
- Provide high-speed access to UARNET and GEANT networks;
- Provide abilities for holding video-conferences between Ternopil and other cities;
- Develop a prototype of a system, that can be implemented in other areas of Ukraine;
- Implement 16 processor clusters for GRID-processing that will be used in universities – project members;
- Introduce on-line library;
- Provide Wi-Fi service for universities of Ternopil.

### **Team:**

- Anatoliy Sachenko
- Serhiy Voznyak
- Ihor Romanets'
- Roman Romanyak

### **Published results:**

1. Sachenko A. Ternopil Education Communication Center // Innovation and Communication Security (ICS) Panel Meeting. – 2006. – Kyiv (Ukraine).
2. G. Markowsky, A. Sachenko, S. Voznyak, V. Spilchuk, R. Romanyak, V. Turchenko, I. Romanets. The Ternopil Educational Communication Center – A NATO Project to Integrate Regional Information Technology Resources. Computing, 2008, Vol. 7, Issue 1.
3. Palagin O., Alishov N., Markowsky G., Sachenko A., Turchenko V. Security Tools for GRID-systems // Proceedings of the 2007 International Conference on Security and Management. -2007. Las Vegas, NV (USA).

## **[Project 26] Instruction Parameters Analysis for Power Modeling of Embedded Microprocessors**

**Foreign partner:** Aristotle University of Thessaloniki, Thessaloniki, Greece

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Greece: Prof. Theodore Laopoulos

Project is granted by Ministry of Education and Science of Ukraine and Greek Government (agreement #M/85-2006), and performed together with the Aristotle University of Thessaloniki, Greece.

**Duration:** 2006 – 03.2008

**Objectives:** to determine power consumption of each parameter while executing the following instructions by the processor: determining number and value of registers, immediate values, values and addresses of operands, address of command call, pipeline panel and substitution, examination and analysis of correlation of instruction parameters in power consumption of instructions; examination and analysis of each parameter in power consumption of instructions; developing accurate power models for execution level of ARM7TDMI processor instructions.

### **Main tasks:**

Additional investigating of instruction parameters power consumption and developing of measurement methodology using existing measurement setup; developing new approach in measurement methodology that can determine processor configuration. Due to this approach it is possible to measure and analyze correlation of instruction power consumptions according to instruction parameters; determine power consumption; analyze and process power consumption values; develop power models for instructions; experimentally prove achieved theoretical results.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Kochan
- Volodymyr Turchenko
- Andrii Borovyi

### **Published results:**

1. Borovyi A., Kostandakos V., Kochan V., Sachenko A., Yaskilka V. Analysis of CPU's Instructions Energy Consumption Device Circuits // Proceedings of Fourth IEEE International Workshop on Intelligent Data Acquisition and Advancing Computing Systems (IDAACS'2007). – 2007. – Dortmund (Germany). – pp. 42-46.
2. Borovyi A., Kochan V. Analysis of Microcontroller Instructions Power Consumption Measurement Circuits. Visnyk of Khmelnytsky National University. – 2007. – Vol. 1. – #2. – pp. 105-109.
3. Borovyi A.M., Kochan V.V., Turchenko V.O. Stand for investigation of current moment value consumed by microprocessor // Transaction of Ternopil State Technical University. – 2009. – No. 1. – pp. 131-137.
4. Borovyi A.M. Analysis of power consumption by ARM7TDMI processor kernel // Proceedings of National Conference in Ternopil Ivan Pul'uj State Technical University. – Ternopil (Ukraine), 2009. – pp. 101.
5. A. Borovyi, V. Kochan, Z. Dombrovskyy, V. Turchenko, A. Sachenko Device for Measuring Instant Current Values of CPU's Energy Consumption // Proceedings of the 5-th IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2009). – Rende (Cosenza), Italy, 2009. – pp.126-130.

## **[Project 27] Financial Analytics Method with Applications of Knowledge Bases**

Principal investigator from RIICS: Prof. Anatoliy Sachenko

This is a joint project between National University of the State Taxation Department of Ukraine, Irpin, Ukraine and Research Institute for Intelligent Computer Systems, Ternopil, Ukraine.

**Duration:** 09.2008 – 11.2008

**Objectives:** evaluation of the present state and selection of priority directions for implementation of intelligent information technologies of financial analytics and knowledge bases in governmental resource management processes.

### **Main tasks:**

- evaluation of the present state and investigation of theoretical research in information technologies for financial analytics with application of knowledge bases in management of governmental institutions;
- investigation of possible intelligent computer technologies application in the domain of financial analytics ontologies in governmental management;
- evaluation of the state and perspectives of ontology intelligent tools using methods of financial analytics;
- development of technologies in area of intellectulazation of information-analytical processes and creation of financial analytics knowledge bases in governmental management;
- the conducted activity enabled to provide functional completeness of solutions to the defined research tasks and creation of documentation as per the Requirements Specification;
- research and creation of the output documentation were performed on the basis of a systematic approach, conceptual completeness of results and consistency;
- the conducted work follows the principal of minimal implementation costs for the proposed solutions.

### **Team:**

- Anatoliy Sachenko
- Taras Lendyuk

### **Published results:**

1. Palagin A., Rippa S. and Sachenko A. Conceptualization and problems of ontologies // Journal of Artificial Intelligence, 2008 Vol. 3, pp 374-379.

## **[Project 28] Development of Effective GRID-technologies for Ecology Monitoring Using Satellite Data**

Principal investigator from ICS: Prof. Anatoliy Sachenko

Principal investigator NSAU: Prof. Nataliya Kussul

Collaborative project of Scientific-Technologic Centre in Ukraine and National Sciences Academy of Ukraine has been performed together with the Space Research Institute of National Sciences Academy of Ukraine and National Aerospace Agency of Ukraine, Kyiv.

**Grant** STCU #3872

**Duration:** 12.2005 – 12.2007

**Objectives:** Development of an effective distributed computations techniques that provide simple and transparent solutions to the computationally-complicated tasks in different areas, especially associated with space data processing.

### **Main tasks:**

- developing methodology for constructing temporal interpolation earth atmosphere photographs;
- developing methodology for predicting solar activity and corresponding algorithms for holding parallel computations;
- developing parallel implementation modeling methods algorithms for dynamics of main processes in multi-component ground environments with the corresponding cluster.
- developing GRID-service for monitoring and control solutions process in systems;
- developing GRID-service for balancing system loading;
- developing GRID-service for visualization of computational results;
- developing GRID-service for granting users' access to system;
- developing service for system security purposes;
- combining some clusters or computational networks into one complex for searching solution to the same task.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Turchenko
- Viktor Demchuk

### **Published results:**

1. Turchenko V., Demchuk V., Sachenko A. Interplanetary Shock Arrival Time Prediction Using Multi-Layer Perceptron // Proceedings of the 4<sup>th</sup> IEEE Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS'2007. – 2007. – Dortmund (Germany). – pp. 185-190.
2. Turchenko V. An Approach to IP Shock Arrival Time Prediction Using Approximating Neural Network // International Journal of Information Technology and Intelligent Computing. – 2007. – No. 4. – Vol. 1.
3. V. Turchenko, V. Demchuk, A. Sachenko, Y. Veremeyenko. An Approach to Interplanetary Shocks Prediction Using Single ACE/EPAM Channel Data // Proceedings of the Fourth International Conference on Neural Networks and Artificial Intelligence ICNNAI'2006. – 2006. – Brest (Belarus). – pp. 140-144.

**[Project 29] Development of Web Ontologies as Data Exchange and Decision Support Tools to Facilitate Economic Cooperation between Ukraine and USA**

**Foreign partner:** New Jersey Institute of Technology, USA

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from USA: Dr. Yefim Kats

Project had been performed according to Research program of the US National Science Foundation.

**Grant #** NSF-04-12

**Duration:** 2004 – 2007

**Objectives:** develop Web-ontologies as data exchange and decision making instrument for promotion of economic partnership between Ukraine and USA.

**Main tasks:**

- Standard ontology dictionary used in economic interchange, including dictionaries for typical e-commerce models, identification.
- Identifying objects as classes or relations with adequate limiting interpretation.
- Identifying specific ontology relations for (intelligence) agents based on automated processing.
- Developing Windows object library compatible apparatus for measuring possible ontology errors.

**Team:**

- Anatoliy Sachenko
- Roman Pasichnyk
- Yuriy Pihovsky
- Andrii Melnyk

**Published results:**

1. Pasichnyk R., Sachenko A. Semantic WEB-Search Developing by Problem-Oriented Ontology Means // Proceedings of the IEEE International Workshop IDAACS'2007. – 2007. – Dortmund (Germany). – pp. 445-448.
2. Hrusha V. Specifics of Ontologies Design and Application in proceedings of the 11<sup>th</sup> scientific conference of Ternopil State Technical University. – 2007. – Ternopil: TSTU. – pp. 78.
3. R. Pasichnyk, A. Sachenko, A. Melnyk “Formalization of ontology creation process using base classes” in proceedings of the 13<sup>th</sup> national conference “Modern problems of applied mathematics and informatics”, Lviv, October 3-5 2006, P.162-163.
4. Master thesis by Andrii Melnyk was defended in 2006.
5. Course thesis by Andrii Melnyk was defended in 2005.
6. Master thesis by Vitaliy Kharchuk was defended in 2004.

## **[Project 30] Dynamically Reprogrammable Network Capable Application Processor with Internet Capability**

Principal investigator: Prof. Anatoliy Sachenko

The project is funded under the Ministry of Education and Science of Ukraine

**Grant** #0107U005985.

**Duration:** 08.2007 – 12.2007

**Objectives:** to enter the US smart sensors market with the Network Capable Application Processor (NCAP) developed within the project CRDF #UE2-2534-TE-03 – device aimed at software data processing in smart distributed measurement and control systems which uses adaptive software reconfiguration for intelligent functions execution (self-adapting and self-training). The developed NCAP will have the following features:

- ability to work in distributed measurement control systems utilizing the Internet;
- online remote reprogramming of user application software;
- support of a wide set of network interfaces.

### **Main tasks:**

- a minimal set of the design documentation sufficient for production of a prototype NCAP had been developed, which allowed to choose its elemental basis and embodiment;
- there was developed a package of structural documentation;
- there was developed software for interface microcontroller providing software support of hardware drivers for supported interfaces – data link layer, IP protocol (Internet Protocol) – network layer, TCP protocol (Transport Control Protocol) – transport layer, HTTP protocol (Hypertext Transfer Protocol) – session layer, dynamical HTML-page, where the data is presented and received by all supported interfaces and can be read – presentation layer;
- two prototype NCAP devices had been developed and underwent testing that allows to debug application software of its microcontrollers and their interaction between each other, as well as with the server and measuring-control modules in real time.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Kochan
- Roman Kochan
- Andrew Stepanenko
- Ihor Maykiv
- Pavlo Bykovyy

### **Published results:**

1. Maykiv I., Stepanenko A., Wobschall D., Kochan R., Kochan V., Sachenko A., Vasylykiv N. Remote Reprogrammable NCAPs: Issues and Approaches // Proc. Of the IEEE International Workshop on Intelligent Data Acquisition and Advancing Computing Systems (IDAACS'2007). – 2007. – Dortmund (Germany). – pp. 109-113.
2. Stepanenko A., Maykiv I., Wobschall D., Kochan R., Kochan V., Sachenko A, Multi-port Serial NCAP Using IEEE1451 Smart Transducer Standard // Proceedings of the IEEE Sensor Application Symposium SAS'2009, 17-19 February, 2009, New Orleans, USA, pp. 293-297.

**[Project 31] Investigation of the Intelligent Properties of Re-Configurable Network Capable Application Processor in Adaptive Distributed Instrumentation and Control Systems**

**Foreign partner:** Sensors Development and Applications Group, National Institute Standards and Technologies, USA

Principal investigator from Ukraine: Dr. Volodymyr Kochan

Principal investigator from USA: Kang Lee

This project has been performed within US Civilian Research and Development Foundation (Cooperative Grant Program).

**Grant #** CRDF.CGP. UE2-2534-TE-03

**Duration:** 2005 – 2006

**Objectives:** Development of the IEEE-1451 standard compatible Network Capable Application Processor (NCAP) with dynamic software and hardware reconfiguration and investigation of its self-adaptive and intelligent properties in information-measurement systems.

**Main tasks:**

- Investigation of the NCAP intelligent properties to be used with smart sensors, deployed in distributed information measurement systems with different architectures and functional requirements.
- Extension of the NCAP's functional features compatible with the IEEE1451 standard to support dynamic online reprogramming of software and a set of network interfaces.
- Development and investigation of the prototype NCAP and its programming methodology.

**Team:**

- Volodymyr Kochan
- Anatoliy Sachenko
- Roman Kochan
- Oleh Adamiv
- Iryna Turchenko
- Andriy Stepanenko

**Published results:**

1. Kochan V., Lee K., Kochan R., Sachenko A. Approach to Improving Network Capable Application Processor Based on IEEE 1451 Standard // Computer Standards & Interfaces. – 2005. – Vol. 28. – Issue2. – pp. 141-149.
2. Stepanenko A., Lee K., Kochan R., Kochan V., Sachenko A. Development of a Minimal IEEE1451.1 Model for 8051-Compatible Microcontrollers // Proc. Of the 2006 IEEE Sensors Applications Symposium. – 2006. – Houston, Texas (USA). – pp. 88-93.
3. Kochan R., Kochan V., Sachenko A., Maykiv I., Turchenko V, Markowsky G. Interface and Reprogramming Controller for Dynamically Reprogrammable Network Capable Application Processor (NCAP). // Proc. Of 3-th IEEE International workshop on Intelligent Data Acquisition and Advancing Computing Systems (IDAACS'2005). – 2005. – Sofia (Bulgaria). – pp. 639-642.
4. Kochan R., Kochan V., Sachenko A., Maykiv I. NCAP Based on FPGA // Proc. Of the IEEE Instrumentation and Measurement Technology Conference IMTC/2005. – 2005. – Ottawa, Ontario (Canada). – pp. 813-817.
5. Kochan R., Lee K., Kochan V., Sachenko A. Development of a Dynamically Reprogrammable NCAP // Proc. Of the IEEE Instrumentation and Measurement Technology Conference IMTC/2004. – 2004. – Como (Italy). – pp. 1188-1193.
6. Roman Kochan. Improvement of components of precision distributed information control systems: Ph.D. Theses on speciality 05.11.16 / Ternopil Academy of National economy. – Ternopil, 2005. – 193 p.

## **[Project 32] Methods and Algorithms for Face Detection and Recognition for Real Time Video Surveillance Systems**

**Foreign partner:** Belarus State University of Informatics and Radio Electronics, Belarus

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Belarus: Prof. Rauf Sadykov

This project has been performed in frames of State fund of fundamental research programs, Ministry of Education and Science of Ukraine order #356 dated to 14.06.05.

**Duration:** 2005 – 2006

**Objectives:** Development of algorithms for preliminary processing of images based on segmentations and development of algorithms and software for face detection in static vision conditions.

### **Main tasks:**

- Development of effective algorithms and software for capturing face images in video stream;
- Development of approximate 3-dimension face models;
- Development of algorithms for selection of informative features and classification of images according to modified syntactical discriminator functions;
- conducting experimental diagnosis and configuration of proposed algorithms for achieving maximum results of program model;
- development of a software system which implements the designed recognition scheme.

### **Team:**

- Anatoliy Sachenko
- Vasyl Koval
- Ihor Paliy
- Yuriy Kurylyak
- Victor Kapura

### **Published results:**

1. Y. Kurylyak. System of Face Detection at Static Images. – 2006. – 83p.
2. Y. Kurylyak, Ihor Paliy, Vasyl Koval, Anatoliy Sachenko. Improved Method of ace Detection Using Color Images // Proceedings of the International Conference “Modern Problems of Radio Engineering, Telecommunications and Computer Science” TCSET’2006. – Feb’28 – Mar’4, 2006. – Lviv-Slavske, Ukraine. – pp. 186-188.
3. A. Sachenko, V. Koval, I. Paliy, Y. Kurylyak. Approach to Face Recognition Using Neural Networks // Proceedings of the IEEE Second International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS’2005, Sofia, Bulgaria, September 5-7, 2005, pp. 112-115.

**[Project 33] Development of Methods and Tools for Improvement of Robot Navigation in a non-Structured Environment**

**Foreign partner:** Kaunas Technical University, Lithuania

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Lithuania: Dr Arunas Raudis

This project has been performed in frames of State Fund for Fundamental Research Programs, Ministry of Education and Science of Ukraine order #174 dated by 23.03.05.

**Duration:** 2005 – 2006

**Objectives:** Development of methods and tools for improvement of mobile robot navigation in non-structured environment.

**Main tasks:**

- Development of methodology for creation of a mobile robot management system, which reflects schemes for conforming mobile robot subsystems for ensuring unobstructed navigation in non-structured environment.
- Development and implementation of main concepts for processing sensor data and creating environmental local map to improve robot navigation in non-structured environment with the help of artificial neural networks.
- Development and implementation of effective and self-adaptive methods for robot navigation and pathway planning.
- Research of experimental methods (with the use of imitation modeling and neural network resources).

**Team:**

- Anatoliy Sachenko
- Vasyl Koval
- Oleh Adamiv
- Yuriy Kurylyak
- Maxym Lunochkin
- Serhiy Maystrenko

**Published results:**

1. Koval V., Adamiv O. The Software Structure Development for Mobile Robot Control // Proceedings of the IEEE Second International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS'2005. – 2005. – Sofia (Bulgaria). – pp. 120-124.
2. Oleh Adamiv. Models and Intelligent Means of Autonomous Mobile Robot Adaptive Control: Ph.D. Theses on speciality: 05.13.23 / Ternopil National Economic University. – Ternopil, 2007. – 166 p.

## **[Project 34] Development of Parallel Neural Networks Training Algorithms on Advanced High Performance Systems**

**Foreign partner:** Parallel Computing Laboratory, Department of Electronics, Computer Science and Systems, University of Calabria, Italy

Principal investigator from Ukraine: Dr. Volodymyr Turchenko

Principal investigator from Italy: Prof. Lucio Grandinetti

**Grant #** INTAS YSF 03-55-2493

**Duration:** 2004 – 2006

### **Main tasks:**

- Develop a parallel algorithm of enhanced data integration method using C programming language and MPI parallelization technology.
- Design and implement in C programming language and MPI parallelization technology two new methods of coarse-grain neural network parallelization which provides high efficiency of parallelization at the certain training parameters of neural networks and dynamic mapping method, which is more universal than static and shows better efficiency at different initial parameters of neural networks and provides parallelization. A series of on-line computational experiments of the above mentioned algorithms of the parallel machines SGI Origin 300, NEC TX-7 is performed and the computational grid consists of the cluster of double-processor Compaq personal computers under Linux operation system and Globus middleware package.
- Develop and implement in C programming language using MPI and MPE libraries the fine-grain parallel training algorithm of multilayer perceptron with parallelization of the outputs of hidden layer neurons at the initial stage of information processing inside neural network module.
- Compare the advantages and disadvantages of middleware technologies, in particular Globus, in a case of coarse-grain parallelization algorithm of Integration Historical Data Neural Networks with dynamic mapping on the parallel computer Origin 300 without using middleware package and on the computational grid operated by Globus middleware package.

### **Published results:**

1. V. Turchenko. Parallel Algorithm of Dynamic Mapping of Integrating Historical Data Neural Networks, Information Technologies and Systems, 2004, Vol. 7, No. 1, pp. 45-52, ISSN: 0135-5465, <http://www.tanet.edu.te.ua/iics/vtu/B7.pdf>.
2. V. Turchenko, V. Demchuk. Efficiency Analysis of Parallel Routine Using Processor Time Visualization, International Scientific Journal of Computing, 2005, Vol. 4, Issue 1, pp. 12-18, ISSN: 1727-6209, <http://www.tanet.edu.te.ua/computing/Computing2005Vol4Issue1-12-18.pdf>.
3. V. Turchenko. Computational Grid vs. Parallel Computer for Coarse-Grain Parallelization of Neural Networks Training, Lecture Notes in Computing Science LNCS 3762, Edited by Robert Meersman, Zahir Tari, Pilar Herrero, Berlin, Heidelberg, New York, Springer-Verlag, 2005, pp. 357-366, ISSN: 0302-9743, [http://dx.doi.org/10.1007/11575863\\_55](http://dx.doi.org/10.1007/11575863_55).
4. V. Turchenko, C. Triki, L. Grandinetti, A. Sachenko. Efficiency Estimation of Parallel Algorithm of Enhanced Historical Data Integration on Computational Grid, International Scientific Journal of Computing, 2005, Vol. 4, Issue 3, pp. 9-19, ISSN: 1727-6209, <http://www.tanet.edu.te.ua/computing/Computing2005Vol4Issue3-9-19.pdf>.
5. V. Turchenko. Fine-Grain Approach to Development of Parallel Training Algorithm of Multi-Layer Perceptron, Artificial Intelligence, 2006, Vol. 1, pp. 94-102, ISSN 1561-5359, <http://www.tanet.edu.te.ua/iics/vtu/B1.pdf>.

## **[Project 35] Development of a Web-based Measurement System with Distributed Intelligence**

**Foreign partner:** Laboratory of Signal Processing and Information Measurement University of Sannio, Benevento, Italy

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Italy: Prof. Pasquale Daponte

Project was performed under the Ministry of Education and Science of Ukraine order #M/79-2004, state registration #0104U006975.

**Duration:** 2004 – 2006

**Objectives:** to create a distributed measurement system (based on Intranet and Internet technologies), that can provide high accuracy sensor data processing by the use of artificial neural networks. The system's feature is remote units working in real time mode during long delays in data link layer, and costs decrease is achieved by shifting of some intelligent functions to a main server.

### **Main tasks:**

- Development of distributed measurement system architecture with either Internet- or Intranet-technologies.
- Research and design of networked software structures. Development of software for distributed system using Web-technologies.
- Testing and verification of the developed software for distributed measurement system.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Turchenko
- Volodymyr Kochan
- Roman Kochan
- Iryna Turchenko
- Volodymyr Hrusha
- Olexandr Osolinskiy

### **Published results:**

1. V. Hrusha, O. Osolinskiy, P. Daponte, D. Grimaldi, R. Kochan, A. Sachenko, I. Turchenko. Distributed Web-based Measurement System // IEEE Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications. 5-7 September 2005, Sofia, Bulgaria – pp. 355 -358.
2. V. Hrusha, O. Osolinskiy, R. Kochan, G. Sapojnyk Development of Web-based instrumentation, Proc. Of the International Conference “Modern Problems of Radio-Engineering, Telecommunications and Computer Science” TCSET’2006, February 28 – March 4, 2006, Lviv-Slavsko, Ukraine – pp. 199-201.
3. V. Hrusha, O. Osolinskiy, P. Daponte, D. Grimaldi, R. Kochan, A. Sachenko, I. Turchenko. Distributed Web-based Measurement System // IEEE Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications. 5-7 September 2005, Sofia, Bulgaria – pp. 355 -358.
4. I. Turchenko, V. Kochan, A. Sachenko, R. Kochan, A. Stepanenko, P.Daponte D. Grimaldi “Simulation Modeling of Neural-Based Method of Multi-Sensor Output Signal Recognition” in Proceedings of 2006 IEEE Instrumentation and Measurement Technology Conference IMTC/06. – April 24-27, 2006. – Sorrento (Italy). – pp. 1530-1535.

## **[Project 36] Design of Distributed Sensor Network for Ayers Island Security Using Value Analysis Technology**

**Foreign partner:** Department of Computer Science, University of Maine, USA

Projects investigator from Ukraine: Prof. Anatoliy Sachenko

Projects investigator from USA: Prof. George Markowsky

Project had been performed within the frames of the First Steps to Market program of the US Civilian Research and Development Foundation.

**Grant #** CRDF FSTM UM2-5012-TE-03

**Duration:** 2003 – 2005

**Objectives:** investigating possibilities for developing distributed sensor network with defined features for providing security Ayers Island, Orono, ME, USA.

### **Main tasks:**

- Analyze component and perimeter security systems vendors, examine well-known perimeter security systems.
- Propose algorithm for defining key functional indicators for perimeter security distributed systems components that can optimize preparing procedure for CAD, intended for design and optimization according to functional-price characteristics security system. This algorithm usage filled DB with functional-price characteristics for perimeter area security systems components that are unified and eligible for creating CAD.
- Morphological matrix method was proposed for optimization according to functional-price characteristics of designed security systems and selecting variants of DSN that create Paret boundaries for all alternative variants according to two key functional characteristics.
- CAD software module was developed, functions for all modules were described, and major requirements to perimeter area security systems CAD were established. Proposed CAD allows us to design projects perimeter area security systems, using perimeter area security systems components database.
- Demonstrate CAD version that was used for developing perimeter area security systems for Ayers island in Orono, ME according to quality, reliability and price characteristics.

### **Team:**

- Anatoliy Sachenko
- Volodymyr Turchenko
- Volodymyr Kochan
- Pavlo Bykovyy

**Published results:**

1. Bykovyy P. Choosing of Technical & Economic Indices for Knowledge Base of Perimeter Security Systems // Proceedings of the 2004 IEEE International Conference on Intelligent Systems 3. – 2004. Bulgaria. – pp. 54-57.
2. I. Turchenko, V. Turchenko, V. Kochan, P. Bykovyy, A. Sachenko and G. Markowsky. “Database Design for CAD System Optimizing Distributed Sensor Networks for Perimeter Security.” Proceedings of the 8<sup>th</sup> IASTED International Conference on Software Engineering and Applications SEA’2004 (2004): 59-64. (USA)
3. R. Kochan, V. Kochan, A. Sachenko, I. Maykiv, I. Turchenko and G. Markowsky. “Network Capable Application Processor based on FPGA.” Proceedings of the 22<sup>nd</sup> IEEE Instrumentation and Measurement Technology Conference IMTC 2005 II (2005): 813-817. (Canada)
4. P. Bykovyy, I. Maykiv, I. Turchenko, O. Kochan, V. Yatskiv and G. Markowsky. “A Low-Cost Network Controller for Security Systems.” Proceedings of the 3<sup>rd</sup> IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS’05 (2005): 388-391. (Bulgaria)

**[Project 37] Development of Intelligent Precision System for Thermal Objects Control**

**Foreign partner:** Department of Automatics, the University of Mons, Belgium

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Belgium: Prof. Marcel Remy

The project had been performed under the NATO (Cooperative Science & Technology Sub-Program).

**Grant** NATO PST.CLG.977647

**Duration:** 2002 – 2004

**Objectives:** development of precision and self-adaptive temperature control system for temperature objects with multi-zone linked control.

**Main tasks:**

- Analysis of precision thermal objects and their control systems;
- Analysis of error control system components and ways for reducing their influence on general system error.
- Development of constructive-technological and structural-algorithmic methods for improving accuracy of measuring channels and control channels for multi-zone thermal objects.
- Development of result processing methods for defining thermal objects parameters.
- Adaptation of random small perturbation method for thermal objects with multi-zone linked control.

**Team:**

- Anatoliy Sachenko
- Roman Pasichnyk
- Volodymyr Kochan
- Volodymyr Turchenko
- Roman Kochan
- Nadia Vasylykiv
- Yuriy Pihovsky
- Mykola Derlytsya

**Published results:**

1. Derlytsya M., Pigovsky Y., Pasichnyk R., Kochan V. Improved Control System of Multi-Zone Thermal Object // Scientific Journal of Khmelnytsky Podillya Technical University. – 2004. – No. 2. – Vol. 1. – pp. 30-33.
2. Kochan V., Vasylykiv N., Chyrka M. The Error Evaluation of Temperature Measurement in Diffusion Furnace // Proceedings of the VIII International Conference Temperature. – 2003. – Lviv (Ukraine). – pp. 33.
3. Sachenko A., Kochan V., Pasichnyk R. Development of the Simulation Model of Thermocouples // Proceedings of the IEEE Instrumentation and Measurement Technology Conference IMTC/2003. – 2003. – Vail, CO. – pp. 1673-1677.
4. Derlytsya M. Improvement of the PC Based System of Optimal Control of Multi-Zone Thermal Object // Master Thesis, Ternopil Academy of National Economy. – 2004.
5. Pigovsky Y. Simulation Model for Effectivity Control of the Chip Manufacturing Process // Master Thesis, Ternopil Academy of National Economy. – 2004.

**[Project 38] Using Multisensor Fusion and Neural Networks Techniques for Robot Control**

**Foreign partner:** Laboratory of Robotics Systems, University of La Coruña, Spain

Principal investigator from Ukraine: Prof. Anatoliy Sachenko

Principal investigator from Ukraine: Prof. Richard Duro

The project had been performed under the NATO (Cooperative Science & Technology Sub-Program).

**Grant** NATO PST.CLG.978744

**Duration:** 2002 – 2004

**Objectives:** development and implementation of main concepts of merging sensor data, using neural networks for controlling mobile robot. It is assumed that robot moves in unknown (dangerous for human) environment. Main purpose is the endpoint reached through obstructions.

**Main tasks:**

- Development of new methods for merging sensor data, using neural networks.
- Development of algorithms and software for merging sensor data subsystem.
- Hardware implementation of merging methods for sensor data on mobile robot.
- Verification and testing procedures of developed engines for merging sensor data on mobile robot.

**Team:**

- Anatoliy Sachenko
- Volodymyr Turchenko
- Vasyl Koval
- Oleh Adamiv

**Published results:**

1. Koval V. The Fusion of Structured Light and Video Image for Mobile Robot Control // Scientific and Technical Journal Artificial Intelligence. – 2004. – Donetsk (Ukraine). – No1.
2. Koval V. The Method of Obstacle Detection Using Fusion Technique of Heterogeneous Sensors // ASU and Automatic Devices. – 2004. – Kharkiv (Ukraine). – pp. 128-135.
3. Koval V., Turchenko V., Kochan V., Sachenko A., Markowsky G. Smart License Plate Recognition System Based on Image Processing Using Neural Network // Computing. – 2003. – Vol. 2. – Issue 2. – pp. 40-46.
4. Adamiv O., Koval V., Turchenko I. Predetermined Movement of Mobile Robot Using Neural Networks // International Scientific Journal Computing. – 2003. – Ternopil (Ukraine). – Vol. 2. – Issue 2. – pp. 64-68.
5. Koval V., Turchenko V., Sachenko A., Becerra J., Duro R., Golovko V. Infrared Sensor Data Correction for Local Area Map Construction by a Mobile Robot // The Lecture Notes in Artificial Intelligence, LNAI2718. – 2003. – pp. 306-315.
6. Koval V. The Method of Local Area Map Construction for Mobile Robot // Scientific Journal of Ternopil State Technical University I.Pulyuj. – 2002. – Ternopil (Ukraine). – Vol. 8. – No2. – pp. 80-88.
7. V. Koval, “Adversary merging sensor data algorithm on ultisensory systems”, // Sensors and systems, #7 (38) Sep. 2002. Pp.39-41.
8. Vasyl Koval. Methods and Algorithms of Map Development of Mobile Robot Environment Using Sensor Data Fusion: Ph.D. Theses on speciality 05.13.23 / Ternopil Academy of National Economy; NAS of Ukraine; State Research Institute of Information Infrastructure. – Ternopil, 2004. – 208 p.

**[Project 39] Development of an Intelligent Sensing Instrumentation Structure**

**Foreign partners:** Electronic Laboratory, Aristotle University, Thessaloniki, Greece, Parallel Computations Laboratory, University of Calabria, Italy, Department of Electronics at Brest Polytechnic Institute, Belarus.

Principal investigator from Ukraine: Prof. Anatoliy Sachenko  
 Principal investigator from Greece: Prof. Theodore Laopoulos  
 Principal investigator from Italy: Prof. Lucio Grandinetti  
 Principal investigator from Belarus: Prof. Volodymyr Golovko

The project had been performed under the “INTAS Open Call” program, grant # INTAS OPEN 97-0606.

**Duration:** 1999 – 2001

**Objective:** development of information measurement system for increasing measurement accuracy using automated correction of instrumental compound measurement error.

**Research tasks:**

- Target area analysis and requirements definition for intelligent sensor measurement system;
- Development of distributed structure for intelligent sensor measurement system;
- Development of methods for evaluating the results of processing with the target objective to increase the system operational characteristics;
- Development and testing of the prototype intelligent sensor measurement system.

**Team:**

- Anatoliy Sachenko
- Volodymyr Kochan
- Volodymyr Turchenko
- Roman Kochan

**Published results:**

1. Sachenko A., Kochan V., Turchenko V., Tymchyshyn V., Vasylykiv N. Intelligent Nodes for Distributed Sensor Network // Proceedings of the 16<sup>th</sup> IEEE Instrumentation and Measurement Technology Conference IMTC/99. – 1999. – Venice (Italy). – Vol. 3. – pp. 1479-1484.
2. Golovko V., Grandinetti L., Kochan V., Laopoulos T., Sachenko A., Turchenko V., Tymchyshyn V. Approach of an Intelligent sensing Instrumentation Structure Development // Proceedings of the IEEE International Workshop on Intelligent Signal Processing WISP'99? Budapest, Hungary, 4-6 September, 1999. – pp. 336-341.
3. Sachenko A., Kochan V., Turchenko V., Laopoulos T., Golovko V., Grandinetti L. Features of Intelligent Distributed Sensor Network Higher Level Development // Proceedings of the 17<sup>th</sup> IEEE Instrumentation and Measurement Technology Conference IMTC/2000. – 2000. – Baltimore (USA). – pp. 335-340.
4. Sachenko A., Kochan V., Turchenko V., Golovko V., Savitsky Y., Dunets A., Laopoulos T. Sensor Errors Prediction Using Neural Networks // Proceedings of the IEEE-INNS-ENNS International Joint Conference on Neural Networks IJCNN'2000. – 2000. – Como (Italy). – Vol. IV. – pp. 441-446.
5. Sachenko A., Kochan V., Kochan R., Turchenko V., Tsahouridis K., Laopoulos Th. Error Compensation in an Intelligent Sensing Instrumentation System, 18<sup>th</sup> IEEE Instrumentation and Measurement Technology Conference IMTC/2001. – 2001. – Budapest (Hungary). – pp. 869-874.
6. Turchenko V., Kochan V., Sachenko A., Laopoulos Th. The New Method of Historical Data Integration Using Neural Networks // Proceedings of the International Workshop on Intelligent

- Data Acquisition and Advanced Computing Systems IDAACS'2001. – 2001. – Foros (Ukraine). – pp. 21-24.
7. Turchenko V., Kochan V., Sachenko A. Estimation of Computational Complexity of Sensor Accuracy Improvement Algorithm Based on Neural Networks // Lecture Notes in Computing Science, No 2130, Ed. By G.Gooss, J.Hartmanis and J. van Leeuwen, Springer-Verlag, Berlin, Heidelberg, New York. – 2001. – pp. 743-748.
  8. Volodymyr Turchenko. Neural Network Methods and Means of Efficiency Improvement of Distributive Networks of Sensor Data Acquisition and Processing: Ph.D. Theses on speciality 05.13.13 / Lviv National Polytechnical University. – Lviv, 2001. – 188 p.
  9. Volodymyr Tymchychyn. Efficiency Increasing of Specialized Computer System Design on the Base of Typical Microprocessor Platforms: Ph.D. Theses on speciality 05.13.13 / Lviv National Polytechnical University. – Lviv, 1999. – 200 p.
  10. Patent of Ukraine 25609A, MKI G06F 15/00. Two-Wired Local Area Network, Signal Repeater and Invertor for Using in it / V. Kochan, V. Tymchyshyn (Ukraine); Applied 30.10.97 # 97105295; Issued 30.10.98.
  11. Patent of Ukraine 25498A, MKI G06F 11/00. Method of Communication Channel Bandwith Increasing on the Base of Serial Interface and Device for it Realisation / V. Kochan, V. Tymchyshyn (Ukraine); Applied 27.01.98 # 98010432; Issued 30.10.98.

## 4. RESEARCH ACTIVITIES

### IDAACS Conferences and Symposia

#### *A – IDAACS Conferences*

Prof. Lucio Grandinetti (Italy), Prof. Theodore Laopoulos (Greece) and Prof. Anatoliy Sachenko (Ukraine) proposed the idea of IDAACS Workshop during the working meeting in Cetraro, Italy, in June 2000. One of the main strategic goals of IDAACS is promotion of the close scientific cooperation between the research teams and scientists from the countries of Western and Eastern Europe. Therefore, the Workshop's motto is "IDAACS – the crossing point of Intelligent Data Acquisition & Advanced Computing Systems and East & West Scientists". In 2011 the name 'IDAACS Workshop' has transformed in 'IDAACS Conference'. Since 2001 the following IDAACS Workshops and Conferences have been organized:

- IDAACS'2001. July 1-4 2001, Foros, Crimea, Ukraine.
  - Workshop Chairman: Anatoliy Sachenko
  - Co-Chairmen of International Program Committee (IPC): Theodore Laopoulos, Greece, Robert E. Hiromoto, USA
  - Statistics: 70 participants, 18 countries, 112 papers, 30 oral and 35 poster presentations, 280 P., 1 Vol.
  - Special Issues: International Journal of Computing
  - Sponsors: INTAS, NEC, HP invent, Science & Technology Center in Ukraine (STCU), Aval bank, Institute of Computer Information Technologies, IEEE Instrumentation & Measurement Society, IEEE Region 8.
- IDAACS'2003. August 8-10 2003, National University "Lviv's Polytechnic", Lviv, Ukraine.
  - Workshop Co-Chairmen: Anatoly Sachenko, Bohdan Stadnyk, Ukraine
  - IPC Co-Chairmen: Lucio Grandinetti, Italy, Fernando Lopes Pena, Spain
  - Statistics: 85 participants, 21 countries, 112 papers, 60 oral and 52 poster presentations, 529 P., 1 Vol.
  - Special Issues: International Journal of Computer Standards & Interfaces, IEEE Transactions on Instrumentation and Measurement, International Journal of Computing, Sensors & Systems
  - Sponsors: Ternopil Academy of National Economy (TANE) of IEEE Instrumentation & Measurement Society, STCU at MES of Ukraine, Aval bank.
- IDAACS'2005. September 5-7 2005, Technical University of Sophia, Sophia, Bulgaria.
  - Workshop Co-Chairmen: Anatoliy Sachenko, Ukraine, Plamenka Borovska, Bulgaria
  - IPC Co-Chairmen: Domenico Grimaldi, Italy, Peter A. J. Reusch, Germany
  - Statistics: 99 participants, 27 countries, 147 papers, 96 oral and 51 poster presentations, 738 P., 1 Vol.
  - Special Issues: International Journal of Computer Standards & Interfaces, IEEE Transactions on Instrumentation and Measurement, Journal of Computing, Sensors & Systems
  - Sponsors: TANE, Technical University of Sophia, STCU, IEEE Bulgaria Section, IEEE Computer Chapter of Bulgaria Section.
- IDAACS'2007. September 6-8 2007, University of Applied Sciences Fachhochschule Dortmund, Dortmund, Germany.
  - Workshop Co-Chairmen: Anatoliy Sachenko, Ukraine, Peter J. A. Reusch, Germany
  - IPC Co-Chairmen: Richard Duro, Spain, Wieslaw Winiecki, Poland

- Statistics: 105 participants, 35 countries, 180 papers, 95 oral and 52 poster presentations, 720 P., 1 Vol.
  - Special Issues: IEEE Transactions on Instrumentation and Measurement, Journal of Computing, Sensors & Systems
  - Sponsors: TNEU, University of Applied Sciences Fachhochschule Dortmund, IEEE Instrumentation & Measurement Society, RWE Systems AG, DSW21, Anna and Hermann Reusch Foundation, the Deutsche Forschungsgemeinschaft (German Research Foundation).
- IDAACS'2009. September 21-23 2009, Department of Electronics, Informatics and Systems, University of Calabria, Rende, Italy.
    - Workshop Co-Chairmen: Anatoliy Sachenko, Ukraine, Domenico Grimaldi, Italy
    - IPC Co-Chairmen: Vladimir Oleschuk, Norway, Dominique Dallet, France
    - Statistics: 122 participants, 25 countries, 142 papers, 86 oral and 56 poster presentations, 722 P., 1 Vol.
    - Special Issues: River Publishers, International Journal of Computing
    - Sponsors: Ukraine I&M / CI Joint Societies Chapter, University of the Calabria, Department of Electronics at University of the Calabria, IEEE Ukraine Section, IEEE Instrumentation & Measurement Society, IEEE Italy Section, IEEE Region 8. Workshop participants approved the IPS proposal to change the status from "Workshop" to "Conference"
- IDAACS'2011. September 15-17 2011, Czech Technical University in Prague, Prague, Czech Republic.
    - Conference Co-Chairmen: Anatoliy Sachenko, Ukraine, Domenico Grimaldi, Italy
    - IPC Co-Chairmen: Dana Petcu, Romania, Axel Sikora, Germany
    - Statistics: 197 participants, 32 countries, 197 papers, 96 oral and 51 poster presentations, 738 P., 1 Vol.
    - Special Issues: International Journal of Computing, Sensors & Transducers Journal, Computer Standards & Interfaces.
    - Sponsors: IEEE Ukraine I&M / CI Joint Societies Chapter, TNEU, Czech Technical University in Prague, Faculty of Electrical Engineering at Czech Technical University, Office of Naval Research, Honeywell spol. S r.o., H TEST a.s., authorized distributor of Agilent Technologies Agilent Technologies H TEST a.s., IEEE Ukraine Section, IEEE Czechoslovakia Section, IEEE Instrumentation & Measurement Society, IEEE Region 8, River Publishers.
- IDAACS'2013. September 12-14, 2013, Hochschule für Technik und Wirtschaft, University of Applied Sciences Berlin (HTW Berlin), Berlin, Germany.
    - Conference Co-Chairmen: Anatoliy Sachenko, Ukraine, Jürgen Sieck, Germany
    - IPC Co-Chairmen: Vladimir Haasz, Czech Republic, Kurosh Madani, France
    - Statistics: 185 participants, 28 countries, 185 papers, 120 oral and 60 poster presentations, 940 pages, 2 volumes.
    - Special Issues: River Publishers, Journal of Cyber Security and Mobility, International Journal of Computing, Elsevier Engineering Applications of Artificial Intelligence, Sensors & Transducers Journal.
    - Sponsors: IEEE Ukraine I&M / CI Joint Societies Chapter, TNEU, University of Applied Sciences in Berlin, IEEE Instrumentation & Measurement Society, Office of Naval Research, The University of Maine, IEEE Region 8, River Publishers, IEEE Ukraine Section.
- IDAACS'2015. September 24-26, 2015, Faculty of Electronics and Information Technology and Faculty of Mathematics and Information Science, Warsaw University of Technology, Warsaw, Poland.
    - Conference Co-Chairmen: Anatoliy Sachenko, Ukraine, Wiesław Winiecki, Poland
    - IPC Co-Chairmen: Robert Hiromoto, USA, Linas Svilainis, Lithuania
    - Statistic: 180 participants, 29 countries, 185 papers, 24 oral and 3 poster sessions, 991 pages, 2 volumes.

- Special Issues: River Publishers, Journal of Cyber Security and Mobility, International Journal of Computing, Elsevier Engineering Applications of Artificial Intelligence.
  - Sponsors: IEEE Ukraine I&M / CI Joint Societies Chapter, TNEU, University of Applied Sciences in Berlin, IEEE Instrumentation & Measurement Society, Office of Naval Research, the University of Maine, IEEE Region 8, River Publishers, IEEE Ukraine Section.
- IDAACS'2017. September 21-23, 2017, Faculty of Automatic Control and Computer Science, University "Politehnica" of Bucharest (UPB), Romania.
    - Conference Co-Chairmen: Anatoly Sachenko, Ukraine, Grigore Stamatescu, Romania.
    - IPC Co-Chairmen: Dora Blanco Heras, Spain, John Kalomiros, Greece.
    - Statistic: 194 participants, 35 countries, 213 papers, 24 oral and 3 poster sessions, 1143 pages, 2 volumes.
    - Special Issues: River Publishers, International Journal of Computing.
    - Sponsors: IEEE Ukraine I&M / CI Joint Societies Chapter, TNEU, Faculty of Automatic Control and Computers, University "Politehnica" of Bucharest (UPB), Asti Automation, IEEE Ukraine Section, IEEE Romania Section, Romanian Society of Automation and Technical Informatics (SRAIT), TÜV AUSTRIA ROMANIA, Festo, River Publishers.
- IDAACS'2019. 18-21 September 2019 p., Technical Institute Ecole Nationale d'Ingénieur de Metz (ENIM) University of Lorraine, Metz, France.
    - Conference Co-Chairmen: Anatoliy Sachenko, Ukraine; Kondo Hloindo Adjallah, France.
    - IPC Co-Chairmen: Francesca Guerriero, Italy; Carsten Wolff, Germany
    - Statistics: 178 participants, 42 countries, 213 papers, two volumes (Volume 1, 1–578 pages, Volume 2, 579–1147 pages).
    - Special Issues: River Publishers
    - Sponsors: IEEE Ukraine Section I&M / CI Joint Societies Chapter; Research Institute for Intelligent Computer Systems; Ternopil National Economic University; ENIM (Ecole Nationale d'Ingénieur de Metz); LCOMS (Laboratory of Conception, Optimisation and Modelling of Systems); University of Lorraine; IEEE Ukraine Section; IEEE France Section; MDPI Sensors; River Publishers.

## Eleventh IEEE International Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS'2021)



The eleventh IEEE conference IDAACS'2021 was held online on September 22-25, 2021 at the Krakow Polytechnic, Tadeusz Kosciuszko, Krakow, Poland.



Honorary chairman of the symposium: Anatoly Sachenko, Ukraine. Co-chairs of the symposium: Zbigniew Kokosiński and Volodymyr Samoty (Poland). IPC co-chairs: Theodore Laopoulos (Greece) and Piotr Bilski (Poland).

The International Program Committee consisted of 161 people. As a result of the review process, 219 articles from 90 submissions from 42 countries (206 co-authors) were accepted and published.

There were three reports by invited speakers: Assoc. Antonio Luque (Director, Department of Electronics, IEEE Region 8,

University of Seville, Spain) "Monitoring of microfluidic systems for biomedical applications", Assoc. Szymon Lukasik (Faculty of Physics and Applied Informatics, Institute of Systems Research of the University of Science and Technology, Polish Academy of Sciences, Poland) "Nature-inspired metaheuristics in unsupervised learning" and Assoc. Yuriy Demchenko (senior researcher of the research group of system and network engineering, University of Amsterdam, Amsterdam) "Big data infrastructure and technology for the operational implementation of Data Science projects".

For 4 days, 175 participants were registered and took an active part in the sessions and discussions.



Unfortunately, due to the restrictions of COVID-19, it was not possible to hold the symposium on-site in Krakow, so we had to switch to an online format.

The following institutions and companies were involved in the organization and sponsorship of the symposium: IEEE Ukraine Section I&M / CI Joint Societies Chapter; Research Institute for Intelligent Computer Systems, West Ukrainian National University and V.M. Glushkov Institute of Cybernetics, National Academy for Sciences of Ukraine, Ukraine; West Ukrainian National University; Faculty of Electrical and Computer Engineering; Cracow University of Technology; IEEE Ukrainian Section; IEEE Poland Section; MDPI Sensors; River Publishers, EFENTO - Producer of a full range of wireless, low power IoT sensors working with any cloud platform, Dortmund University of Applied Sciences and Arts.

All accepted articles have been submitted for inclusion in IEEE Xplore (Scopus and Web of Science) as well as other databases (A&I).

### ***B – IDAACS Symposia***

The first IEEE International Symposium on Wireless Systems within the Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS'2012) was held in 2012.

- IDAACS-SWS'2012. September 20-21'2012, University of Applied Sciences in Offenburg, Offenburg, Germany.
- Symposium Honorary Chairman: Anatoliy Sachenko, Ukraine;
- Workshop Co-Chairmen: Evren Eren, Uwe Grossmann, Juergen Sieck, Axel Sikora, Germany
- Statistics: participants from 12 countries, 39 papers, 27 oral presentations, 127 P., 1 Vol.
- Special Issues: International Journal of Computing, Sensors & Transducers Journal, Computer Standards & Interfaces.
- Sponsors: Faculty of Electrical Engineering and Information Technology at Offenburg University of Applied Sciences, IEEE Ukraine Section IM/CIS Joint Chapter, IEEE Instrumentation & Measurement Society.

The second IEEE International Symposium on Wireless Systems within the Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS'2014) was held in 2014.

- IDAACS-SWS'2014. September 11-12'2012, University of Applied Sciences in Offenburg, Offenburg, Germany.
- Symposium Honorary Chairman: Anatoliy Sachenko, Ukraine;
- Symposium Co-Chairmen: Svitlana Antoshchuk, Volodymyr Brovko, Ukraine, Evren Eren, Uwe Grossmann, Juergen Sieck, Axel Sikora, Germany
- Statistics: participants from 7 countries, 15 papers, 15 oral presentations, 127 P., 1 Vol.
- Sponsors: Faculty of Electrical Engineering and Information Technology at Offenburg University of Applied Sciences, IEEE Ukraine Section IM/CIS Joint Chapter, IEEE Instrumentation & Measurement Society.

The third IEEE International Symposium on Wireless Systems within the Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS'2016) was held in 2016.

- IDAACS-SWS'2016. September 26-27'2016, University of Applied Sciences in Offenburg, Offenburg, Germany.
- Symposium Honorary Chairman: Anatoliy Sachenko, Ukraine;
- Symposium Co-Chairmen: Volodymyr Brovko, Ukraine, Evren Eren, Uwe Grossmann, Axel Sikora, Germany
- Statistics: participants from 9 countries, 24 papers, 24 oral presentations, 146 pages, 1 Volume

- Sponsors: Faculty of Electrical Engineering and Information Technology at Offenburg University of Applied Sciences, IEEE Ukraine Section IM/CIS Joint Chapter, IEEE Instrumentation & Measurement Society.

The fourth IEEE International Symposium on Wireless Systems within the Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS'2018) was held in 2018.

- IDAACS-SWS'2018. September 20-21'2018, National University "Lviv Polytechnics" (NULP) Lviv, Ukraine
  - Symposium Honorary Chairman: Anatoliy Sachenko, Ukraine;
  - Symposium Co-Chairmen: Ivan Prudyus, Orest Ivakhiv, Ukraine, Axel Sikora, Germany
  - Co-Chairmen of IPC: Mykhaylo Klymash, Ukraine, Uwe Grossmann, Germany
  - Statistics: participants from 12 countries, 51 papers, 146 pages, 1 Volume
  - Sponsors: Lviv Polytechnic National University; Faculty of Electrical Engineering and Information Technology, Offenburg University of Applied Sciences; Research Institute for Intelligent Computer Systems, Ternopil National Economic University and V.M. Glushkov Institute of Cybernetics, National Academy for Sciences of Ukraine; IEEE Ukraine Section I&M / CI Joint Societies Chapter; IEEE Ukraine Section; Ministry of Education and Science of Ukraine; Cypress.

The fifth IEEE International Symposium on Wireless Systems within the Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS'2020) was held in 2020.

- IDAACS-SWS'2020. 17-18 September 2020., online at the Dortmund University of Applied Sciences and Arts (Fachhochschule Dortmund), Dortmund, Germany
  - Symposium Honorary Chairman: Anatoliy Sachenko, Ukraine;
  - Co-Chairmen of IPC: Uwe Grossmann, Christof Roehrig, Axel Sikora, Carsten Wolff, Germany, Orest Ivakhiv, Ukraine
  - Co-Chairmen of IPC: Vladimir Oleshchuk, Norway, Jürgen Sieck, Germany
  - Statistics: participants from 23 countries, 58 papers, 318 pages, 1 volume.
  - Sponsors: Dortmund University of Applied Sciences and Arts (Fachhochschule Dortmund); Research Institute for Intelligent Computer Systems; IEEE Ukraine Section I&M / CI Joint Societies Chapter; IEEE Ukraine Section; IEEE Germany Section IM Chapter; IEEE Germany Section; EuroPIM; River Publishers.

## International Journal of Computing

The International journal of Computing was founded on the basis of Branch Research Laboratory of Automated Systems and Networks in 2002. Its main goal is to present results in the field of Computer Science, Computer Engineering and Information Technology. The official language of the Journal is English. Journal is issued 4 times per year.

Since November 2016, the IJC Journal is indexed in Scopus Elsevier. In addition, the Journal is indexed by Finnish publication forum, Norwegian Social Science Data Services, Google Scholar, and Index Copernicus International.

The Journal's Editor-in-Chief is Prof. Anatoliy Sachenko, the Executive Editor is PhD, Dr Volodymyr Turchenko, and Associated Editors are Prof. Robert E. Hiromoto, University of Idaho, USA and Prof. Volodymyr Kochan. The Journal staff includes Mr. Taras Lendyuk, the Technical Editor, Dr Inna Shylinska, the Language Editor and Mrs. Halyna Kryva, the Economist.

The Editorial Board consists of more than 75 recognised scientists from 17 countries: Australia, Bulgaria, Czech Republic, France, Germany, Greece, Italy, Japan, Lithuania, Norway, Poland, Portugal, Romania, Spain, Ukraine and USA.

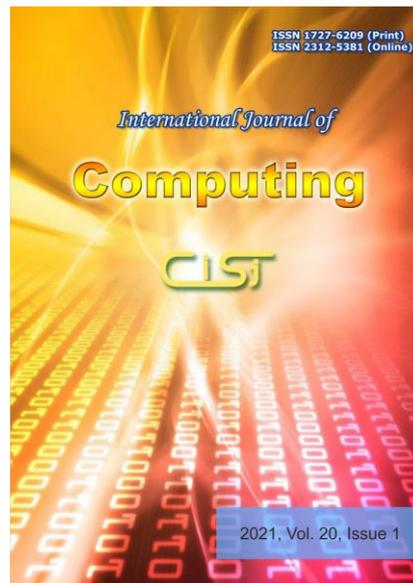
Journal Topics are: Algorithms and Data Structure, Software Tools and Environments; Bio-Informatics; Computational Intelligence; Computer Modeling and Simulation; Cyber and Homeland Security; Data Communications and Networking; Data Mining, Knowledge Bases and Ontology; Data Science; Digital Signal Processing; Distributed Systems and Remote Control; Education in Computing; Embedded Systems; High Performance Computing, GRIDs, Parallel and Distributed Computing; Human-Computer Interaction; Image Processing and Pattern Recognition; Intelligent Robotics Systems; Internet of Things; IT Project Management; Systems and Control; Wireless Systems.

### Published issues

- 2021, Vol. 20, Issue 4
- 2021, Vol. 20, Issue 3
- 2021, Vol. 20, Issue 2
- 2021, Vol. 21, Issue 1
- 2020, Vol. 19, Issue 4
- 2020, Vol. 19, Issue 3
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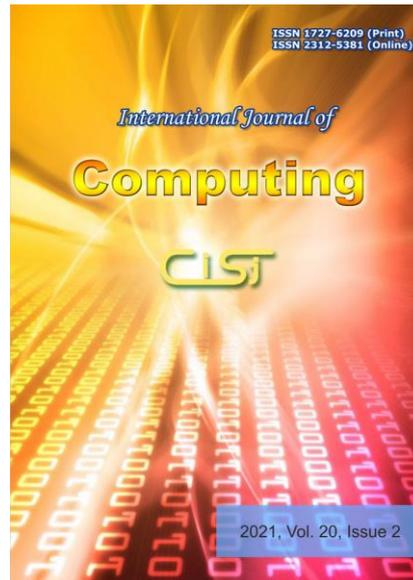
- 2010, Vol. 9, Issue 3 – Special Issue on Wireless Systems
- 2010, Vol. 9, Issue 2
- 2010, Vol. 9, Issue 1 – Special Issue on Interactive Systems in Culture and Creative Industries
- 2009, Vol. 8, Issue 2
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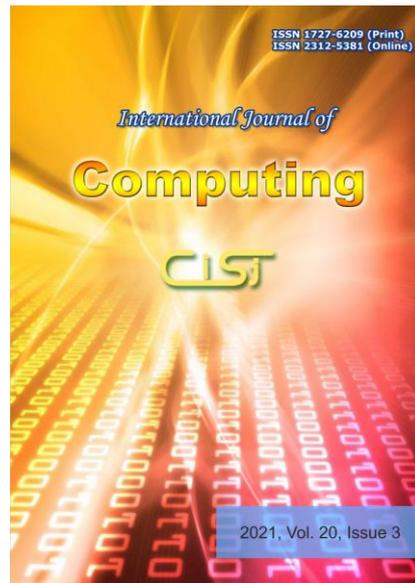
1. Yevgeniy Bodyanskiy, Anastasiia Deineko, Viktoria Skorik, Filip Brodetskyi. Deep Neural Network with Adaptive Parametric Rectified Linear Units and its Fast Learning. – pp. 11-18.
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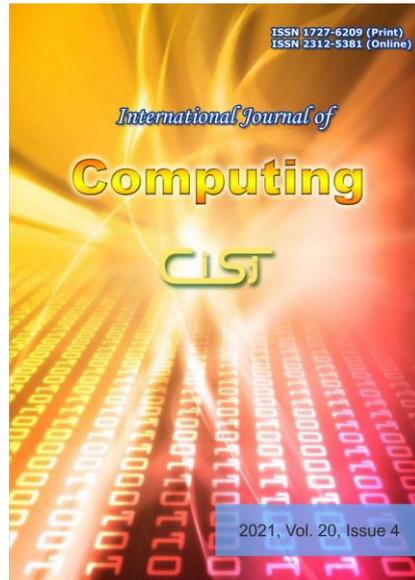
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5. Chetana Belavadi, Vandana Sudhakar Sardar, Shilpa Shashikant Chaudhari. Alarm Pattern Recognition in Continuous Process Control Systems using Data Mining. – pp. 333-341.
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9. Dmitro Karlov, Ivan Tupitsya, Maxim Parkhomenko, Oleksandr Musienko, Albert Lekakh. Compression Coding Method Using Internal Restructuring of Information Space. – pp. 360-368.
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12. Ajay Kumar Gottom, Arunmetha Sundaramoorthy, Aravindhyan Alagarsamy. High Speed Approximate Carry Speculative Adder in Error Tolerance Applications. – pp. 383-390.

## Journal Contents, 2021, Vol. 20, Issue 4



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2. Vladik Kreinovich, Oscar Galindo, Olga Kosheleva. Many Known Quantum Algorithms Are Optimal: Symmetry-Based Proofs. – pp. 411-423.
3. Ikenna Rene Chiadighikaobi, Norliza Katuk, Baharudin Osman. DMUAS-IoT: A Decentralised Multi-Factor User Authentication Scheme for IoT Systems. – pp. 424-434.
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5. Nikolay A. Ignatev, Erkin R. Navruzov. Estimates of the Complexity of Detecting Types of DDOS Attacks. – pp. 443-449.
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7. S. Balaji, S. Sankara Narayanan. Hybrid Deep-GAN Model for Intrusion Detection in IoT Through Enhanced Whale Optimization. – pp. 456-467.
8. R. Sivakani, M. Syed Masood. Analysis of COVID-19 and its Impact on Alzheimer's Patient using Machine Learning Techniques. – pp. 468-474.
9. Juan C. Arcila-Diaz, Carlos Valdivia. A Microservice-based Software Architecture for Improving the Availability of Dental Health Records. – pp. 475-481.
10. Borys Pleskach. Energy Consumption Monitoring with Evaluation of Hidden Energy Losses. – pp. 482-488.
11. Layla A. Al.Hak. Diabetes Prediction Using Binary Grey Wolf Optimization and Decision Tree. – pp. 489-494.
12. Yurii Iliash. A Generalized Method of Decreasing Data Redundancy. – pp. 495-501.

### Specialized Scientific Council K58.082.02

Specialized scientific council in specialties:

- 05.13.05 – Computer Systems and Components;
- 05.13.06 – Information Technologies;

In 2021, the following dissertations were defended:

– V. I. Tymets - candidate's thesis on the topic: "Methods, means and information technologies for the detection of the recurrent laryngeal nerve" in the specialty 121 - Software engineering. Scientific supervisor: Doctor of Technical Sciences, Professor Dyvak M.P. Specialized academic council of DF 58.082.006 at the West Ukrainian National University.

– Kovbasisty A.V. - candidate's thesis on the topic: "Mathematical and software support for the functioning of information web resources under the conditions of their different structuring" in specialty 121 - Software engineering. Scientific supervisor: Doctor of Technical Sciences, Professor Dyvak M.P., Specialized Academic Council DF 58.082.009 at the West Ukrainian National University.

– Papa O.A. - candidate's thesis on the topic: "Modeling the effectiveness of web services for the provision of administrative services" in the specialty 121 - Software engineering. Scientific supervisor: Ph.D., associate professor Pukas A.V. Specialized academic council of DF 58.082.010 at the West Ukrainian National University.

### IEEE Instrumentation & Measurement/Computational Intelligence Joint Societies Chapter

The Instrumentation & Measurement / Computational Intelligence Joint Societies Chapter of IEEE Ukraine Section were established on June 7, 2005. A current Chairman of the Chapter is Prof. Volodymyr Kochan, and a current Vice-Chairman is Prof. Anatoliy Sachenko. The Chapter consists of 18 members from Lviv, Ternopil, Khmelnytsky, Kyiv, Zaporizhzhya, Odessa and Kherson, in particular:

- Prof. S. Antoshchuk, Odessa National Polytechnic University
- Dr P. Bykovyy, Ternopil National Economic University
- Prof. M. Dorozhovets, Lviv National Technical University
- Prof. A. Drozd, Odessa National Polytechnic University
- Prof. O. Ivakhiv, Lviv National Technical University
- Prof. R. Kochan, Lviv National Technical University
- Dr O. Kochan, Ternopil National Economic University
- Prof. V. Kochan, Ternopil National Economic University
- Prof. V. Krylov, Odessa National Polytechnic University
- Dr S. Lysenko, Khmelnytsky National University
- Prof. V. Lytvynenko, Kherson National Technical University
- Dr V. Mukhin, National Technical University of Ukraine “Kyiv Polytechnic Institute”
- Dr O. Osolinskyi, Ternopil National Economic University
- Prof. S. Rippa, National University of the State Taxation Department of Ukraine
- Prof. A. Sachenko, Ternopil National Economic University
- Dr V. Turchenko, Ternopil National Economic University
- Dr G. Shilo, Zaporizhzhya National Technical University
- Dr V. Yatskiv, Ternopil National Economic University

List of technical meetings, which were held by I&M/CI Chapter:

- I. On February 24, 2021, an online meeting of the IEEE I&M/CI Branch was held as part of the webinar of the Department of Information Computing Systems and Management. Presentations were presented: Doctor of Technical Sciences, Prof. Serhiy Babichev (Jan Evangelista Purkinje University in Usti na Laba, Czech Republic / Kherson State University) on the topic "Techniques of gene expression profiles processing for the purpose of gene regulatory networks reconstruction" and Ph.D., prof. Natalia Shakhovska (Lviv Polytechnic National University) on the topic "The hierarchical classifier for COVID-19 resistance evaluation". A total of 36 participants were present.



- II. On April 21, 2021, an online meeting of the IEEE I&M/CI Branch was held as part of the webinar of the Department of Information Computing Systems and Management. Presentations were presented: Doctor of Technical Sciences, Prof. Yevgenia Bodyanskyi (Kharkiv National University of Radio Electronics) on the topic "Fast Pattern Recognition using Combined Learning of Neural Networks" and Ph.D., prof. Tatiana Govorushchenko (Khmelnyskyi National University) on the topic "Intelligent Information-Analytical Technologies for Improving the Software Quality by Assessing the Sufficiency of Information at Initial Stages of the Life Cycle." A total of 60 participants were present.



- III. On June 16, 2021, an online meeting of the IEEE I&M/CI Branch was held as part of the international workshop "Advances & Challenges in Computing". Reports were presented by: Doctor of Technical Sciences, Professor Oleksandr Drozd (Odesa Polytechnic State University) on the topic: "Models, Methods and Means of Resilient Computing"; Doctor of Technical Sciences, Professor Volodymyr Romanov (V.M. Hlushkov Institute of Cybernetics, National Academy of Sciences of Ukraine) on the topic: "Wireless Sensor Networks with Elements of Artificial Intelligence for Medicine". Anatoly Sachenko, Doctor of Technical Sciences, Professor of the Department of Information and Computing Systems and Management, Ternopil National University, on the topic: "Information about research projects, conferences and workshops". A total of 34 people took part in the seminar.

- IV. On October 20, 2021, an online meeting of the IEEE I&M/CI Branch was held as part of the international workshop "Advances & Challenges in Computing". Presentations were presented: Ph.D., associate professor Eduard Manzyuk (Khmelnyskyi National University) on the topic: "Theoretical and applied grounds of human-oriented information technologies based on the principles of ethics and trust in artificial intelligence / Theoretical and applied grounds of human-oriented information technologies on the principles of ethics and trustworthy artificial intelligence"; Ph.D., associate professor Elizaveta Hnatchuk (Khmelnyskyi National University) on the topic: "Intelligent information technology for supporting the medical decision-making based on legal grounds". A total of 31 people took part in the seminar.



- V. On December 28, 2021, an online meeting of the IEEE I&M/CI Branch was held as part of the international workshop "Advances & Challenges in Computing". Reports were presented: Doctor of Technical Sciences, Professor Vitaly Velychko and Master of Science Kirill Malakhov (V.M. Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine) on the topic: "Deep learning and inductive inference technologies composition for the development of ontology-related systems"; PhD, Professor Vladik Kreinovich (University of Texas at El Paso) on the topic: "Fourier Transform and Other Quadratic Problems under Interval Uncertainty". Prof. Anatoliy Sachenko (scientific head of the Research Institute of Intelligent Computer Systems) "Information about research projects, conferences and seminars". A total of 20 people took part.



## **IEEE Student Branch**

The Institute of Electrotechnical and Electronics Engineers (IEEE) Student Branch at Ternopil National Economic University (TNEU) was founded in 1998.

Student Branch involves students of the Faculty of Computer Information Technologies, PhD students and junior researchers of TNEU. The 3 active members of the Student Branch were in 2019. The Branch Committee consists of the Chairperson – O. Dunets, a Student Branch Advisor is Prof. Anatoliy Sachenko.

Members of the IEEE Student Branch at TNEU take a part in international schools as well as international conferences and projects. Also, they assisted in organization and preparation of the series of Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS) ) – IDAACS'2003, IDAACS'2005, IDAACS'2007, IDAACS'2009, IDAACS'2011, IDAACS'2013, IDAACS'2015, IDAACS'2017 and IDAACS'2019.

The main advantages of IEEE membership include access to IEEE electronic resources, IEEE subscription in the scientific magazines and popular scientific literature “Spectrum”, “Computer”, “IEEE Transaction on Instrumentation and Measurement”; assistance and discounts for participation at international conferences, for example, being a member of IEEE a scientist could win a travel grant to the conference in the country region (Ukraine, along with Europe, Middle East and Africa, belongs to region 8). Almost all conferences sponsored by IEEE offer discounts to students for registration fee, participation in competitions organized by IEEE in the region.

Overall, IEEE supports scientific activities of students and young scientists, supporting them in the development of their scientific career, increases collaboration between scientists from different universities and international scientific – educational organizations. For example, IEEE members have access to a digital library of articles Xplore IEEE conferences, are printed journals IEEE, have the opportunity to join the scientific communities in different scientific fields can win grants to visit academic conferences and receive a discount when registering them. Also, between branches and regions there is a contest for the best scientific article or website and mobile robots. Each of these competitions is accompanied by cash prizes.

## Other Research Activities

- [Org 1] Sergey Bushuyev**
- Reviewing 15 papers for international and national conferences.
  - Reviewing 12 articles in international and national scientific journals.
  - Member of the organizing / program committee:
- [Org 2] Volodymyr Kochan**
- Member of the Editorial Board of International Journal of Computing.
  - Reviewing the papers for international and national conferences.
  - Member of the organizing committee of the IDAACS'2021 conference, September 22-25, 2021.
- [Org 3] Vasyl Koval**
- Subreviewer of the International Conference “Modern Computer Information Technologies (ACIT'2021)”;
  - Manager of the research seminar “Advances & Challenges in Computing, A2C” hold by the Research Institute for Intelligent Computer Systems, WUNU;
  - Head of the research seminar of the Department of ICSC, WUNU;
- [Org 4] Roman Pasichnyk**
- Reviewing 8 papers in international and national journals and conferences;
  - Member of the Program Committee and Head of the 12 Workshop of the international conference “Advanced Computer Information Technologies”, (ACIT'2021);
  - Member of the Specialized Scientific Council D.58.082.02 at WUNU.
- [Org 5] Sergey Rippa**
- Reviewing the 6 papers for international and national conferences.
  - Reviewing the 2 articles in international and national scientific journals.
- [Org 6] Anatoliy Sachenko**
- Chairman of the Specialized Scientific Council D 58.082.02 at WUNU;
  - Editor-in-Chief, International Journal of Computing;
  - Editor-in-Chief, “International Journal for Information Engineering and Electronic Business”;
  - Reviewing 25 papers for international and national conferences.
  - Reviewing 2 PhD Thesis.
  - Member of the program committee of 6 international conferences
  - Go-Chairman of “11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS 2021)”
- [Org 7] Volodymyr Turchenko**
- Deputy Editor at International Journal of Computing, participated in preparing four issues of the Journal, reviewed 2 articles.
  - Reviewing papers for international conferences IDAACS'21, IJCNN'21, PDP'21.
  - Reviewing papers for journals Computer Science, Advances in Cyber-Physical Systems, IEEE Journal of Biomedical and Health Informatics.
  - Reviewer of applications of the Fulbright Academic Exchange Program in Ukraine
- [Org 8] Vasyl Yatskiv**
- Member of the Program Committee of the international conference “Advanced Computer Information Technologies”, (ACIT'2021);
  - Head of Cisco Networking Academy at West Ukrainian National University.

## 5. ACADEMIC ACTIVITIES

### Cooperation Agreements with Universities and Companies

- [Agreement 1] Donetsk National Technical University, Ukraine.
- [Agreement 2] Zaporizhya National Technical University, Ukraine.
- [Agreement 3] Institute for Cybernetics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.
- [Agreement 4] Institute of Space Research, National Academy of Sciences of Ukraine and NCAO, Kyiv, Ukraine.
- [Agreement 5] Institute of Artificial Intelligence, Donetsk.
- [Agreement 6] Odessa National Polytechnic University, Ukraine.
- [Agreement 7] Technical University of Sofia, Bulgaria.
- [Agreement 8] University of Calabria, Italy.
- [Agreement 9] Tsinghua University, China.
- [Agreement 10] University of Maine, USA.
- [Agreement 11] University of New Hampshire, USA
- [Agreement 12] University of South Carolina, USA.
- [Agreement 13] Physics-Mechanics Institute of G. Karpenko, National Academy of Sciences of Ukraine, Lviv, Ukraine.
- [Agreement 14] University of Siegen, Germany
- [Agreement 15] Chernivtsi National University by Yu.Fedkovich, Chernivtsi, Ukraine
- [Agreement 16] Wuhan University of Technologies, Wuhan, Hubei, China
- [Agreement 17] Kaunas University of Technology, Lithuania
- [Agreement 18] Hochschule für Technik und Wirtschaft Berlin, University of Applied Sciences, Germany
- [Agreement 19] Fachhochschule Dortmund, University of Applied Sciences, Germany
- [Agreement 20] Pre-Carpathian National University by Vasyl Stefanyk, Ivano-Frankivsk, Ukraine
- [Agreement 21] Silesian Technical University, Poland.
- [Agreement 22] Warsaw University of Technology, Poland
- [Agreement 23] National University of State Tax Service of Ukraine, Irpin, Kiev region.
- [Agreement 24] National University of Water and Environmental Engineering, Rivne, Ukraine.
- [Agreement 25] Kiev National University of Construction and Architecture, Ukraine.
- [Agreement 26] Lviv State University of Life Safety, Lviv, Ukraine
- [Agreement 27] Ivan Franko National University of Lviv, Lviv, Ukraine

### Defended Theses and Awarded Degrees

- [Def 1] Myroslav Petrovych Komar, dissertation work for obtaining the scientific degree of Doctor of Technical Sciences, "Methodological foundations of information technology of intellectual analysis and processing of big data", 05.13.06 - information technologies, scientific consultants: Doctor of Technical Sciences, Professor Sachenko A.O., Golovko V.A.
- [Def 2] Roman Volodymyrovych Trach, dissertation work for obtaining the scientific degree of Doctor of Technical Sciences, "Cognitive mechanisms of construction project management based on VIM technologies", 05.13.22 - project and program management, scientific consultant, Doctor of Technical Sciences, prof. Bushuev S.D.
- [Def 3] Svitlana Vasylivna Biloschytska, dissertation work for obtaining the scientific degree of Doctor of Technical Sciences, "Chain value-oriented information technology of management of the development of higher education institutions", 05.13.22 - project and program management, scientific consultant, Doctor of Technical Sciences, Prof. Bushuev S.D.

### Defended Master Theses

- [DefMas 1] Stanislav Oleksandrovych Novosad, Method of Predicting Election Results Based on a Neural Network with Fuzzy Logic, Ph.D., associate professor, V.V. Kochan
- [DefMas 2] Inna Yuriivna Anisimova, Method of Forming a Training Set for Segmentation of Tender Organizers Based on Machine Learning, H.V. Lipianina-Honcharenko
- [DefMas 3] Vasyl Andriyovych Baschiv, Algorithm for Integration of Speech Recognition Systems into the Environment for Writing Program Code, Ph.D., M. P. Komar
- [DefMas 4] Dmytro Maryanovych Vinchkovsky, Botnet Detection Method Based on Distributed Systems, PhD, Professor, A. O. Sachenko
- [DefMas 5] Vitaliy Serhiyovych Digai, An Intelligent Method of Products Catalog Forming for Online Store, Ph.D., associate professor, V. S. Koval
- [DefMas 6] Rostyslav Ihorovych Dyakiv, Method of Monitoring System Resources of Operating Systems Ph.D., associate professor, I. V. Turchenko
- [DefMas 7] Vitaly Volodymyrovych Ivakhiv, Methods and Tools for Integration of Distributed Big Data Processing Systems with Deep Learning Models, Ph.D., M. P. Komar
- [DefMas 8] Maksym Petrovych Koval, Improved Time Management and Task Planning Model, Ph.D., associate professor, V. S. Koval
- [DefMas 9] Dmytro Serhiyovych Kostyuk, Information Processing Method in Determining the End-to-End Conversion Function of the Data Acquisition Channel, Ph.D., Associate Professor, V.V. Kochan
- [DefMas 10] Artem Viktorovych Melyanchuk, Method of Voice Command Recognition Using Artificial Neural Networks Ph.D., associate professor, V. S. Koval
- [DefMas 11] Vlas Mykolayovych Pinchuk, Method of Data Processing in the Studying the Channel Transmission Function in Extended Frequency Range, Ph.D., associate professor, V. V. Kochan
- [DefMas 12] Nazariy Ihorovych Polivanchuk, Method of Developing an Intelligent Guide with AR Support, Ph.D., M. P. Komar
- [DefMas 13] Nazar Ihorovych Verbytsky, Modeling of Project Management Systems for Enterprise, Doctor of Economics, Associate Professor, H. M. Gladiy
- [DefMas 14] Vladyslav Mykhailovych Dombrovsky, Process Improvement Project Management for Industry 4.0, Ph.D., Professor, A. O. Sachenko
- [DefMas 15] Victor Yevhenovych Pavlat, Model of Proactive Project Team Management, Ph.D., N. M. Vasylykiv
- [DefMas 16] Volodymyr Volodymyrovych Snaichuk, Forming an IT Project Team Based on Workplace Design, O. A. Sachenko
- [DefMas 17] Elyzaveta Mykhailivna Antonyuk, Adaptive Project Management for the Smart Greenhouse, Ph.D., M. Z. Dombrovskiyi
- [DefMas 18] Bohdana Dmytrivna Bilavich, Project Management of a Digital Transformation for Small Business Entity, Ph.D., Associate Professor, I. V. Turchenko
- [DefMas 19] Nazarii Vadimovich Bilinets, Project Management of Critical Information Infrastructure Resource Allocation Based on Fuzzy Logic, Doctor of Technical Sciences, Professor, A. O. Sachenko
- [DefMas 20] Yuriy Stepanovych Girshy, Development of Project Timing Management Tools, O. A. Sachenko
- [DefMas 21] Taras Oleksiiovych Dutkevich, IT Project Management Model of Distance Learning Process, T. V. Lendyuk
- [DefMas 22] Sofiya Igorivna Zhuravel, Project Management Method Based on Fuzzy Logic, Ph.D., N. M. Vasylykiv
- [DefMas 23] Andriy Zubyk, Forming an IT Project Team Based on Individual Characteristics of Participants, O. A. Sachenko
- [DefMas 24] Dmytro Andriovych Ostapiv, Project Management of Critical Information Infrastructure Resource Allocation Based on Genetic Algorithm, Doctor of Technical Sciences, Professor, A. O. Sachenko
- [DefMas 25] Kristina Arkadiivna Rozhko, IT Project Management Model in a Pandemic, Ph.D., N.

- M. Vasylykiv
- [DefMas 26] Yaroslav Volodymyrovych Sorochan, Improved Method of Managing the Content of the Project to Ensure the Energy Efficiency of Municipal Infrastructure, O. A. Sachenko
- [DefMas 27] Filbert Aboagye Okere, Transport sector development projects management in Ghana Ph.D., associate professor, I. V. Turchenko
- [DefMas 28] Kenneth Appianing Asomaning Barrister, Energy sector development projects management in Ghana, Ph.D., M. Z. Dombrovskiy
- [DefMas 29] Maria Bohdanivna Herovych, A Neural Network Method for Collecting, Processing and Analyzing Data from Network Packets of Local Wireless Networks, Ph.D., M. P. Komar
- [DefMas 30] Yuliya Andriivna Kopka, Model of verification and validation of IT project products, Ph.D., N. M. Vasylykiv
- [DefMas 31] Roman Mykolayovych Kuchereshko, Method of Building a Decision Support System Based on Computational Intelligence, Ph.D., M. P. Komar
- [DefMas 32] Ostap Andreyovych Peleshchak, Method of Providing Protection Against Active Attacks in Wireless Sensor Networks, Ph.D., associate professor, V.V. Kochan
- [DefMas 33] Iryna Andriivna Lyapandra, Method of Recovering Lost Information When Processing Big Data Doctor of Science, Professor, A. O. Sachenko
- [DefMas 34] Ivan Ivanovich Seh, Methods and Tools of Ensuring Security in the Internet of Things Environment, Ph.D., associate professor, V.V. Kochan
- [DefMas 35] Vasyl Vitaliyovych Kholod, Neural Network and Semantic Models for Building Decision-Making Systems, Ph.D., M. P. Komar
- [DefMas 36] Viktor Stepanovych Bilous, Neural Network Models and Algorithms for Big Data Analysis and Processing, Ph.D., MP Komar
- [DefMas 37] Viktoriya Viktorivna Vasyuchyn, A Method of Detecting Botnets in Local Area Networks, PhD, Professor, A. O. Sachenko
- [DefMas 38] Roman Volodymyrovych Solonyuka, Mobile Access Control Algorithms for Public Places Ph.D., MP Komar
- [DefMas 39] Set Ikau Abaido, Mobile Application for Booking Home and Individual Services, Ph.D., P. E. Bykovy
- [DefMas 40] Henry Alexksil Cooper, Software System for Testing Websites on Vulnerabilities, PhD, Professor, A. O. Sachenko
- [DefMas 41] Abdul Aziz Sepa Seid Mayo, Augmented reality application "WUNU guide", Ph.D., associate professor, I. V. Turchenko
- [DefMas 42] Benjamin K. Kolako Jier, Hardware-software control module micro grid, PhD, Z. I. Dombrovskiy
- [DefMas 43] Lena Akyuae, Mobile Application for Learning English, T.V. Landyuk
- [DefMas 44] Oleg Ihorovych Pigur, Analysis and Visualization of Economic Activity of Ukraine, H. V. Lipianina-Honcharenko
- [DefMas 45] Andrii Andriyovych Korynevych, Web Service for Peer-to-Peer Video Streaming, Ph.D., Associate Professor, I. V. Turchenko
- [DefMas 46] Vasyl Mykolayovych Oliynyk, Analysis and Visualization of Offenses in Ukraine, H. V. Lipianina-Honcharenko
- [DefMas 47] Anastasiya Olehivna Pavlikovych, Web-based Educational Process Management System in a Higher Education Institution, Ph.D., M. P. Komar
- [DefMas 48] Roman Mykolayovych Pysulyak, Software System for Monitoring the Activities of Employees of the Organization, O. A. Sachenko
- [DefMas 49] Maryan Vasyliovych Syrvatka, Software and Hardware System for Remote Monitoring of Technological Objects, H.V. Sapozhnyk

## Internship of Staff, PhD Students and Students

### *Staff Internship*

- [Internship 1] Hryhoriy Mykhailovych Hladii, associate professor of the department of information and computing systems and management, IT company "ORANGE35" March-April 2021.
- [Internship 2] Oleksandr Romanovych Osolinsky, associate professor of the Department of Information and Computing Systems and Management, University of Bielsko-Bialya (Republic of Poland), September - December 2021.
- [Internship 3] Vasyl Serhiyovych Koval, associate professor of the department of information and computing systems and management, IT company Smart Insight, October 2021.
- [Internship 4] Myroslav Petrovych Komar, Associate Professor of the Department of Information and Computing Systems and Management, University of Bielsko-Bialya (Republic of Poland), November 2021. - January 2022
- [Internship 5] Khrystyna Volodymyrivna Lipianina-Honcharenko, Associate Professor of the Department of Information and Computing Systems and Management, University of Bielsko-Bialya (Republic of Poland), November 2021. - January 2022

### *Student Internship*

- [Internship 6] Kenneth Appianing Asomaning Barrister, Research Institute of Intelligent Computer Systems of WUNU, Ternopil, Ph.D., Associate Professor, I. V. Turchenko
- [Internship 7] Stanislav Oleksandrovych Novosad, PE "MagnetikVan" Ternopil, Ph.D., MP Komar
- [Internship 8] Nazarii Ihorovych Polivanchuk, "Vetelo" LLC, Lviv, Ph.D., M. P. Komar
- [Internship 9] Inna Yuriivna Anisimova, "Treklam" LLC, Ternopil, Ph.D., M. P. Komar
- [Internship 10] Vasyl Andriyovych Baschiiy, Company "UpLab Software" (FOP I.M. Barmak) Ternopil, Ph.D., M. P. Komar
- [Internship 11] Dmytro Maryanovych Vinchkovsky, "Apiko Ukraine" LLC, Ternopil, Ph.D., M. P. Komar
- [Internship 12] Vitaliy Serhiyovych Digai, FOP "Stepanenko", Ternopil, Ph.D., M. P. Komar
- [Internship 13] Rostyslav Ihorovych Dyakiv, LLC "N-IX DELIVERY" Lviv region, Skolivskyi district, village Slavske, Ph.D., M. P. Komar
- [Internship 14] Vitaly Volodymyrovych Ivakhiv, "Treklam" LLC, Ternopil, Ph.D., M. P. Komar
- [Internship 15] Maksym Petrovych Koval, Apiko Ukraine LLC, Ternopil, candidate of technical sciences, M. P. Komar
- [Internship 16] Dmytro Serhiyovych Kostyuk, PE "MagnetikVan" Ternopil, Ph.D., M. P. Komar
- [Internship 17] Artem Viktorovych Melyanchuk, PE "MagnetikVan", Ternopil, Ph.D., MP Komar
- [Internship 18] Vlas Mykolayovych Pinchuk, FOP "Stepanenko", Ternopil, Ph.D., M. P. Komar
- [Internship 19] Vladyslav Mykhailovych Dombrovsky, KVP "Neotek" LLC, Ternopil, Doctor of Economics, Associate Professor, H. M. Gladiy
- [Internship 20] Nazar Ihorovych Verbytsky, "NETCRACKER" LLC, Odesa, Doctor of Economics, Associate Professor, H. M. Gladiy
- [Internship 21] Victor Yevhenovych Pavlat, "Apiko Ukraine" LLC, Ternopil, Doctor of Economics, Associate Professor, H. M. Gladiy
- [Internship 22] Volodymyr Volodymyrovych Snaichuk, Apiko Ukraine LLC, Ternopil, Doctor of Economics, Associate Professor, H. M. Gladiy
- [Internship 23] Yelyzaveta Mykhailivna Antonyuk, FOP "Revuk V. R." Dubrovytsia, candidate of economic sciences, associate professor, H. M. Gladiy
- [Internship 24] Bohdana Dmytrivna Bilavich, "Remote Helpers" Company (FOP Dembovskyi S.L.), Candidate of Economic Sciences, Associate Professor, H. M. Gladiy
- [Internship 25] Nazarii Vadimovich Bilinets, LLC "International Engineering Systems", Ternopil, Doctor of Economics, Associate Professor, H. M. Gladiy

- [Internship 26] Yuriy Stepanovych Hirshy, Research Institute of Intelligent Computer Systems of WUNU, Ternopil, Doctor of Economics, Associate Professor, H.M. Gladyy
- [Internship 27] Taras Oleksiiiovych Dutkevich, FOP "Garmider V.L., p. Bzovytsia, Zborivsky district, Ternopil region, Doctor of Economics, Associate Professor, H.M. Gladiy
- [Internship 28] Sofia Igorivna Zhuravel, "Apiko Ukraine" LLC, Ternopil, Doctor of Economics, Associate Professor, H.M. Gladiy
- [Internship 29] Andrii Serhiyovych Zubyk, Research Institute of Intelligent Computer Systems of WUNU, Ternopil, Doctor of Economics, Associate Professor, H. M. Gladiy
- [Internship 30] Dmytro Andriovych Ostapiv, FOP "Stepanenko", Ternopil, Doctor of Economics, Associate Professor, H. M. Gladiy
- [Internship 31] Kristina Arkadiivna Rozhko, "MagneticVan" PE, Ternopil, Doctor of Economics, Associate Professor, H.M. Gladiy
- [Internship 32] Yaroslav Volodymyrovych Sorochan, "Treklam" LLC, Ternopil, Candidate of Economic Sciences, Associate Professor, H. M. Gladiy
- [Internship 33] Viktor Stepanovych Bilous, LLC "International Engineering Systems", Ternopil, Ph.D., M. P. Komar
- [Internship 34] Roman Volodymyrovych Solonynka, "Treklam" LLC, Ternopil, Ph.D., M. P. Komar
- [Internship 35] Maria Bogdanivna Herovych, Apiko Ukraine LLC, Ternopil, Ph.D., M. P. Komar
- [Internship 36] Yuliya Andriivna Kopka, LLC "BPO NEXTDOR" Lviv, Ph.D., M. P. Komar
- [Internship 37] Roman Mykolayovych Kuchereshko, FOP "Stepanenko", Ternopil, Ph.D., M. P. Komar
- [Internship 38] Ostap Andriyovych Peleshchak, Research Institute of Intelligent Computer Systems of WUNU, Ternopil, Ph.D., M. P. Komar
- [Internship 39] Iryna Andriivna Lyapandra, FOP "Stepanenko" Ternopil, Ph.D., M. P. Komar
- [Internship 40] Ivan Ivanovich Seh, Research Institute of Intelligent Computer Systems of WUNU, Ternopil, Ph.D., M. P. Komar
- [Internship 41] Vasyl Vitaliyovych Kholod, "Treklam" LLC, Ternopil, Ph.D., M. P. Komar
- [Internship 42] Viktoriya Viktorivna Vasyuchyn, Research Institute of Intelligent Computer Systems of WUNU, Ternopil, Ph.D., M. P. Komar

## 6. PUBLICATIONS

### Monographs (Parts of Monographs), Books (Parts of Books)

- [Publ 1]. A.I. Krysovaty, A.I. Guley, B.O. Yazlyuk, H.V. Lipianina-Honcharenko, V.I. Maksymovich, A.M. Butov. Basics of the digital economy. Ternopil: WUNU, 2021. – 274 p.
- [Publ 2]. Sapozhnyk G.V., Bilosevych I.A., Oleksyuk M.P. Occupational and environmental protection: educational and methodological manual. "Recommended for publication by the Academic Council of the Kremenets Regional Humanitarian and Pedagogical Academy named after T. Shevchenko (protocol No. 13 dated February 22, 2021)" Kremenets: VC KOGPA named after T. Shevchenko, - 2021. - 264c.
- [Publ 3]. Komar M.P. Dissertation abstract for obtaining the scientific degree of Doctor of Technical Sciences. FO-P Shpak V. B. 2021, 44 p.
- [Publ 4]. D.I. Bodnar. Fractional-rational approximation of indicators of effectiveness of regional development programs. – Ternopil: WUNU University Opinion, 2021.
- [Publ 5]. O. P. Adamiv, O. S. Bashutska, D. I. Bodnar, L. M. Buyak, O. G. Wozniak, I. V. Danylyuk. Methods and models of management of complex systems. – Ternopil, WUNU University Opinion. 2021.
- [Publ 6]. D. I. Bodnar, I. B. Bilanyk. Parabolic regions of convergence of branched chain fractions of a special form, DNVZ "Prykarpattia National University named after Vasyl Stefanyk": Ivano-Frankivsk, 2021.

### Journal Papers

- [Publ 7]. Stamatescu, G.; Sachenko, A.; Popescu, D. Convergence of Intelligent Data Acquisition and Advanced Computing Systems. *Sensors*, 2021, 21, 2262, pp. 1-4.. <https://doi.org/10.3390/s21072262>
- [Publ 8]. Tetiana Biloborodova, Lukasz Scislo, Inna Skarga-Bandurova, Anatoliy Sachenko, Agnieszka Molga, Oksana Povoroznyuk, Yelyzaveta Yevsieieva. Fetal ECG signal processing and identification of hypoxic pregnancy conditions in-utero. *Mathematical Biosciences and Engineering*, 2021, Volume 18, Issue 4, pp. 4919-4942. doi: 10.3934/mbe.2021250
- [Publ 9]. Golovko, V., Kroshchanka, A., Mikhno, E., Komar, M., Sachenko, A. (2021). Deep Convolutional Neural Network for Detection of Solar Panels. In: Radivilova, T., Ageyev, D., Kryvinska, N. (eds) *Data-Centric Business and Applications. Lecture Notes on Data Engineering and Communications Technologies*, vol 48b pp 371–389, Springer, Cham. [https://doi.org/10.1007/978-3-030-43070-2\\_17](https://doi.org/10.1007/978-3-030-43070-2_17)
- [Publ 10]. O. Dulishkovych, H. Lipyana, O. Sachenko, T. Lendyuk, O. Osolinskiy, I. Kit. Business Process Management of Virtual Enterprise based on Augmented Reality. *Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021)*, Slavsko, Lviv region, Ukraine, February 16-18, 2021, pp. 422-431. <http://ceur-ws.org/Vol-2851/paper39.pdf>.
- [Publ 11]. R. Gramyak, H. Lipyana-Goncharenko, A. Sachenko, T. Lendyuk, D. Zahorodnia. Intelligent Method of a Competitive Product Choosing based on the Emotional Feedbacks Coloring. *Proceedings of the 2nd International Workshop on Intelligent Information Technologies & Systems of Information Security with CEUR-WS (IntelITSIS 2021)*, Khmelnytskyi, Ukraine, March 24–26, 2021, pp. 346-357. <http://ceur-ws.org/Vol-2853/paper31.pdf>.
- [Publ 12]. H. Lipyana-Goncharenko, V. Brych, S. Sachenko, T. Lendyuk, P. Bykovyy, D. Zahorodnia. Method of Forming a Training Sample for Segmentation of Tender Organizers on Machine Learning Basis. *Proceedings of the 5th International Conference on Computational Linguistics and Intelligent Systems (COLINS 2021)*. Volume I: Main

- Conference, Lviv, Ukraine, April 22-23, 2021, pp. 1843-1852. <http://ceur-ws.org/Vol-2870/paper134.pdf>.
- [Publ 13]. H. Lipyana, S. Sachenko, T. Lendyuk, V. Brych, V. Yatskiv, O. Osolinskiy. Method of Detecting a Fictitious Company on the Machine Learning Base. In: Hu Z., Petoukhov S., Dychka I., He M. (eds) *Advances in Computer Science for Engineering and Education IV. ICCSEE 2021. Lecture Notes on Data Engineering and Communications Technologies*, vol 83, pp. 138-146. Springer, Cham. [https://doi.org/10.1007/978-3-030-80472-5\\_12](https://doi.org/10.1007/978-3-030-80472-5_12).
- [Publ 14]. S. Rippa, A. Sachenko, M. Rippa, O. Chereshnyuk, O. Sachenko, T. Lendyuk. Neurogenetic Tools for Fintech. *Proceedings of the Modern Machine Learning Technologies and Data Science Workshop. Proc. 3rd International Workshop (MoML&T&DS 2021). Volume I: Main Conference. Lviv-Shatsk, Ukraine, June 5-6, 2021.* <http://ceur-ws.org/Vol-2917/paper47.pdf>
- [Publ 15]. Sergii K. Chernov, Sergey D. Titov, Ludmila S. Chernova, Lubava S. Chernova, Diana Zahorodnia, Taras Lendiuk. The Methods and Means of Efficiency Increasing the Linear Optimization Problems Solving in Project Management. *Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications September 22-25, 2021, Cracow, Poland, vol. 1, pp. 60-63.*
- [Publ 16]. Dmytro Uhryn, Vasyl Lytvyn, Taras Lendiuk. Method of Selecting and Determining the Free Parameters of Swarm Intelligent Algorithms for Optimizing Solutions in GIS. *Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications September 22-25, 2021, Cracow, Poland, vol. 1, pp. 86-93.*
- [Publ 17]. Drozd O, Nowakowski G, Sachenko A, Antoniuk V, Kochan V, Drozd M. Power-Oriented Monitoring of Clock Signals in FPGA Systems for Critical Applications. *Sensors*. 2021; 21(3):792. <https://doi.org/10.3390/s21030792>
- [Publ 18]. Turchenko, V., Kit, I., Osolinskiy, O., Zahorodnia, D., Bykovyy, P., Sachenko, A. IoT Based Modular Grow Box System Using the AR. *Proceedings of the 2020 IEEE International Conference on Problems of Infocommunications Science and Technology, PIC S and T 2020 - Proceedings, 2021, pp. 741–746, 9467949*
- [Publ 19]. Dombrowski, M., Sachenko, A., Sachenko, O., Dombrowski, Z. Project management time-cost balancing model for smart cities transformation. *2021 IEEE European Technology and Engineering Management Summit, E-TEMS 2021 - Conference Proceedings, 2021, pp. 106–109.*
- [Publ 20]. Lutsiv, N., Maksymyuk, T., Beshley, M., Sachenko, A, Vokorokos, L., Gazda, J. Deep semisupervised learning-based network anomaly detection in heterogeneous information systems. *Computers, Materials and Continua*, 2021, 70(1), pp. 413–431.
- [Publ 21]. Kravets, P., Lytvyn, V., Dobrotvor, I., Vysotska, V., Sachenko, A. Matrix Stochastic Game with Q-learning for Multi-agent System. *Lecture Notes on Data Engineering and Communications Technologies*, 2021, 83, pp. 304–314.
- [Publ 22]. Drozd, O., Zashcholkin, K., Dobrowolski, M., Sachenko, A., Ivanova, O., Drozd, J. Evaluating real checkability for FPGA-based components of safety-related systems. *CEUR Workshop Proceedings*, 2021, 2870, pp. 1832–1842.
- [Publ 23]. Osolinskiy, O., Kolodiichuk, L., Lipyana-Goncharenko, H., Sachenko, A., Kochan, V., Zahorodnia, D. Conceptual model of IoT-based laboratory for studying the electrical engineering and electronics. *CEUR Workshop Proceedings*, 2021, 2864, pp. 344–355.
- [Publ 24]. Oleksandr Drozd, Anatoliy Sachenko, Volodymyr Kochan, Myroslav Drozd, Maciej Dobrowolski and Jun Su. Concept of Active Wireless Sensor Network in Checkability Aspect. *Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 70-74.*
- [Publ 25]. Valentyn Domanskyi, Carsten Wolff, Anatoliy Sachenko and Anna Badasian. A Hybrid Method for Managing Agile Teams in a Distributed Environment. *Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing*

- Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 247-250.
- [Publ 26]. Antonina Kashtalian, Oleg Savenko and Anatoliy Sachenko. Agglomerative Clustering of Data Collected by Honeypots. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 504-509.
- [Publ 27]. Oleksandr Drozd, Anatoliy Sachenko, Robert Hiromoto, Kostiantyn Zashcholkin and Myroslav Drozd. Particularities of Sync Monitoring in FPGA Components of Safety-Related Systems. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 979-983.
- [Publ 28]. Oleksandr Martynyuk, Oleksandr Drozd, Anatoliy Sachenko, Hanna Stepova, Dmitry Martynyuk, Luyudmila Sugak and Iryna Turchenko. Verification Model for Agent Coordination of Distributed Information Systems. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 984-989.
- [Publ 29]. Oleksandr Drozd, Adam Ustynowicz, Andrzej Rucinski, Anatoliy Sachenko and Julia Drozd. Evolution of Models and Methods in the Field of Resilient Computing. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 1180-1185.
- [Publ 30]. Yury Kolokolov, Anna Monovskaya, Kondo Adjallah and Anatoliy Sachenko. On Visualization of Regulatory and Evolutionary Processes Towards Climate Changes. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 1186-1189.
- [Publ 31]. Michael Dombrowski, Zbyshek Dombrowski, Jacek Wołoszyn, Anatoliy Sachenko, Oleg Sachenko and Inna Melnychuk. Adaptive Management of Digitalization Projects for Efficiency Increasing. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, 1195-1199.
- [Publ 32]. Andriy Krysovaty, Hrystyna Lipyanina-Goncharenko, Svitlana Sachenko and Oksana Desyatnyuk. Economic Crime Detection Using Support Vector Machine Classification. Modern Machine Learning Technologies and Data Science Workshop. Proc. 3rd International Workshop (MoMLeT&DS 2021). Volume I: Main Conference. Lviv-Shatsk, Ukraine, June 5-6, 2021. pp 830-840
- [Publ 33]. Viktor Koziuk, Hrystyna Lipyanina-Goncharenko. Intelligent Method of Predicting the Discount Rate Trend. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, pp. 1132-1142.
- [Publ 34]. Igor Yakymenko, Mykhailo Kasianchuk, Vasyl Yatskiv, Ruslan Shevchuk, Vasyl Koval, Solomiya Yatskiv. Sustainability and time complexity estimation of cryptographic algorithms main operations on elliptic curves. 2021 11th International Conference on Advanced Computer Information Technologies, Deggendorf, GERMANY, 15-17 September 2021, pp 494-498 (Scopus)
- [Publ 35]. Oleksandr Osolinskyi, Volodymyr Kochan, Liubomyr Kolodiichuk, Grygoriy Sapozhnyk, Agnieszka Molga. The Hybrid Research Stand based on LabVIEW within IoT. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, pp. 990-996.
- [Publ 36]. Galina Shcherbakova, Viktor Krylov, Bohdan Rusyn, Anatoliy Sachenko, Pavlo Bykovyy, Diana Zahorodnia, Lukasz Kopania. Optimization Methods on the Wavelet Transformation Base for Technical Diagnostic Information Systems. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced

- Computing Systems: Technology and Applications (IDAACS'2021), September 22-25, 2021, Cracow, Poland, pp. 767-773.
- [Publ 37]. Vasylykiv N., Dubchak L., Sachenko A. Fuzzy controller of IT project management. Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021), Slavsko, Lviv region, Ukraine, February 16-18, 2021. CEUR Workshop Proceedings, 2021, Vol. 2851, pp. 411–421.
- [Publ 38]. H. Lipyana, O. Sachenko, T. Lendyuk, A. Sachenko, N. Vasylykiv. Intelligent Method of Forming the HR Management Short-Term Project. Shakhovska N., Medykovskyy M. O. (eds) International Conference on Computer Science and Information Technologies, CSIT 2020. Advances in Intelligent Systems and Computing V (AICS), Springer, Cham, vol. 1293, pp. 1045–1055, 2021. [https://doi.org/10.1007/978-3-030-63270-0\\_71](https://doi.org/10.1007/978-3-030-63270-0_71).
- [Publ 39]. Bodnar D., Bilanyk I. Parabolic Convergence Regions of Branched Continued Fractions of the Special Form. Carpathian Math. Publ. 2021, 13 (3), 619-630.
- [Publ 40]. M. Dyvak, A. Rot, R. Pasichnyk, V. Tymchyshyn, N. Huliiev, Y. Maslyiak. Monitoring and mathematical modeling of soil and groundwater contamination by harmful emissions of nitrogen dioxide from motor vehicles, Sustainability, 13 (5), 2768, 2021.
- [Publ 41]. A. M. Melnyk, M. P. Dyvak, R. M. Pasichnik. The method of detecting irrelevant information in service-oriented corporate systems on the example of soil quality assessment systems, Information Technologies and Computer Engineering 50 (1), 45-54, 2021.
- [Publ 42]. M. Dyvak, R. Pasichnyk, I. Voytyuk. Mathematical Model of Soil and Groundwater Contamination by Nitrogen Dioxide Taking Into Account the Factors Influencing the Diffusion Coefficient, Proceedings of the 2021 11th International Conference on Advanced Computer Information Technologies (ACIT), 2021, 121-125.
- [Publ 43]. K. Zashcholkin, O. Drozd, O. Ivanova, R. Shaporin, M. Kuznetsov. An Approach to Stego-Container Organization in FPGA Systems for Approximate Data Processing. Proceedings of the International Conference IntelITSIS, 2021, pp. 527-536.
- [Publ 44]. K. Zashcholkin, O. Drozd, S. Antoshchuk, O. Ivanova, O. Sachenko. Steganographic Resources of FPGA-based Systems for Approximate Data Processing. Proceedings of the International Conference CMIS, 2021, pp. 324-333.
- [Publ 45]. O. Drozd, K. Zashcholkin, A. Sachenko, O. Martynyuk, O. Ivanova, J. Drozd. Checkable FPGA-Based Components of Safety-Related Systems. Proceedings of the ICTERI 2021 Workshops: ITER, MROL, RMSEBT, TheRMIT, UNLP 2021, Kherson, Ukraine, September 28–October 2, 2021, pp. 425-441.
- [Publ 46]. O. Drozd, O. Ivanova, K. Zashcholkin, V. A Romankevich, J. Drozd. Checkability Important for Fail-Safety of FPGA-based Components in Critical Systems. Proceedings of the International Conference IntelITSIS, 2021, pp. 471-480.
- [Publ 47]. O. V. Drozd, A. Rusinsky, K. V. Zashcholkin, M. O. Drozd, Yu. Yu. Sulima. Improving FPGA components of critical systems based on natural version redundancy. Applied aspects of information technologies. 4 (2), c. 168-177, 2021.
- [Publ 48]. O. Drozd, A. Rucinski, K. Zashcholkin, O. Martynyuk, J. Drozd. Resilient Development of Models and Methods in Computing Space. Proceedings of the International Conference 2021 IEEE East-West Design & Test Symposium (EWDTS), 2021, pp. 1-6.
- [Publ 49]. O. Ivanova, O. Drozd, K. Zashcholkin, Y. Sulima. Combined Use of Equivalent and Non-Equivalent Transformations of FPGA Program Code to Embedding Additional Security Data. Proceedings of the International Conference 2021 IEEE East-West Design & Test Symposium (EWDTS), 2021, pp. 1-5.
- [Publ 50]. S. Bushuyev, V. Bushuieva, H. Tanaka, Modeling Agile-Transformation Organizational Development Project Portfolio. Scientific Journal of Astana IT University, 2021, vol. 11, pp. 32-41.
- [Publ 51]. S. Bushuyev, S. Murzabekova, M. Khussainova. Competence Approach in Agile Transformation of Education Establishment. Scientific Journal of Astana IT University, 2021, vol. 7, pp. 52-62.

- [Publ 52]. Bushuyev, S., & Trach, R. (2021). Knowledge-based construction technology development management. *International Scientific Journal "Transfer of Innovative Technologies"*, 4(1), 88–91. <https://doi.org/10.32347/tit2141.0302>
- [Publ 53]. S. Bushuyev, S. Onyshchenko, D. Bushuyev, V. Bushuyeva, N. Bushuyeva. Dynamics and Impact of Digital Footprint on Project Success. *Scientific Journal of Astana IT University*, 2021 vol. 10, pp. 15-22.
- [Publ 54]. Bushuev, S., Bushuev, D., Bushueva, V., & Bushueva, N. (2021). Conceptual Model of the Digital Track of Projects in the Conditions of Digitization of Society. *Complex Systems Development Management*, (46), 12–18. <https://doi.org/10.32347/2412-9933.2021.46.12-18>
- [Publ 55]. S. Bushuyev, N. Bushuyeva, D. Bushuiev, I. Babayev and J. Babayev, "Modeling Leadership for developing information technologies based on Agile methodology," 2021 IEEE International Conference on Smart Information Systems and Technologies (SIST), Nur-Sultan, Kazakhstan, 2021, pp. 1-5, doi: 10.1109/SIST50301.2021.9465910.
- [Publ 56]. S. Bushuyev, S. Murzabekova and M. Khusainova, "Strategic audit based on the competence approach in Agile transformation of Education Establishment," 2021 IEEE International Conference on Smart Information Systems and Technologies (SIST), Nur-Sultan, Kazakhstan, 2021, pp. 1-8, doi: 10.1109/SIST50301.2021.9465987.
- [Publ 57]. S. Bushuyev, I. Babayev, V. Bushuieva, N. Bushuyeva, J. Babayev and D. Bushuiev, "Managing Project Success with "Infodemic" vs "Pandemic" Environment on the COVID – 19 Pandemic Case," 2021 IEEE International Conference on Smart Information Systems and Technologies (SIST), Nur-Sultan, Kazakhstan, 2021, pp. 1-7, doi: 10.1109/SIST50301.2021.9465939.
- [Publ 58]. S. Bushuyev, D. Bushuiev and V. Bushuieva, "'Infodemia vs. Pandemia, COVID 2019" management projects with critical thinking," 2021 IEEE International Conference on Smart Information Systems and Technologies (SIST), Nur-Sultan, Kazakhstan, 2021, pp. 1-9, doi: 10.1109/SIST50301.2021.9465942.
- [Publ 59]. B. Alla, B. Natalija, B. Sergey and O. Svitlana, "Modelling of creation organizations energy-entropy," 2021 IEEE International Conference on Smart Information Systems and Technologies (SIST), Nur-Sultan, Kazakhstan, 2021, pp. 1-6, doi: 10.1109/SIST50301.2021.9465911.
- [Publ 60]. N. I. Rusan, S. D. Bushuev. Applying Empathy and Emotional Intelligence to Different Kinds of Teams in a Pandemic. *Bulletin of the National Technical University "KhPI". Series: Strategic management, management of portfolios, programs and projects.* 2021. No. 1(3) 3-8
- [Publ 61]. Bushuev, S., Bushuev, D., Bushueva, V., & Verenich, O. (2021). Project management in the conditions of the transition to a circular economy. *Complex Systems Development Management*, (45), 21–26. <https://doi.org/10.32347/2412-9933.2021.45.21-26>
- [Publ 62]. S. Bushuyev, S. Onyshchenko, N. Bushuyeva and A. Bondar, "Modelling projects portfolio structure dynamics of the organization development with a resistance of information entropy," *Proceedings of the International Conference 2021 IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT)*, LVIV, Ukraine, 2021, pp. 293-298, doi: 10.1109/CSIT52700.2021.9648713.
- [Publ 63]. S. Bushuyev, V. Bushuieva, N. Bushuyeva and D. Bushuiev, "Conceptual model of project digital footprint," *Proceedings of the International Conference 2021 IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT)*, LVIV, Ukraine, 2021, pp. 327-332, doi: 10.1109/CSIT52700.2021.9648662.
- [Publ 64]. S. Bushuyev, N. Gaydukova, N. Bushuyeva and I. Achkasov, "Evaluation of the investment projects portfolio efficiency," *Proceedings of the International Conference 2021 IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT)*, LVIV, Ukraine, 2021, pp. 351-354, doi: 10.1109/CSIT52700.2021.9648798.
- [Publ 65]. S. Bushuyev and A. Puziichuk, "Development organizational structure for value-oriented reengineering project of construction enterprises," *Proceedings of the International Conference 2021 IEEE 16th International Conference on Computer Sciences and*

- Information Technologies (CSIT), LVIV, Ukraine, 2021, pp . 367-370, doi: 10.1109/CSIT52700.2021.9648758.
- [Publ 66]. C. Wolff, S. Bushuyev, S. Recker, O. Verenych, G. Tabunshchyyk and A. Badasian, "International Educational Project: ELearning Results Assessment (Case Study)," Proceedings of the International Conference 2021 IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT), LVIV, Ukraine, 2021, pp. 445-448, doi: 10.1109/CSIT52700.2021.9648734.
- [Publ 67]. S. Bushuyev, V. Bushuieva, S. Onyshchenko, A. Bondar. Modeling the Dynamics of Information Panic in Society. COVID-19 case. Proceedings of The Fourth International Workshop on Computer Modeling and Intelligent Systems (CMIS-2021), Zaporizhzhia, Ukraine, April 27, 2021. Pp. 400-408. <https://ceur-ws.org/Vol-2864/paper35.pdf>
- [Publ 68]. Dobrotvor, I.G., Stukhlyak, P.D., Mykytyshyn, A.G., Stukhlyak, D.P. Influence of Thickness and Dispersed Impurities on Residual Stresses in Epoxy Composite Coatings. *Strength of Materials*, 2021, 53(2), pp. 283–290
- [Publ 69]. Sapronov, O.O., Buketov, A.V., Yakushchenko, S.V., ...Sieliverstov, I.A., Dobrotvor, I.H. Application of Synthesized Iron/Titanium Carbide Mixture for Restoration of Water Transport Parts by Epoxy Composites. *Composites: Mechanics, Computations, Applications*, 2021, 12(4), pp. 23–35.
- [Publ 70]. Stadnyk, I., Piddubnyi, P.D.V., Beyko, L., ...Sabadosh, G., Hushtan, T. Formation of Heat and Mass Transfer Bonds when Mixing Components in a Suspended State. *Potravinarstvo Slovak Journal of Food Sciences*, 2021, 15, pp. 810–823.
- [Publ 71]. Golovko, V., Kroshchanka, A., Mikhno, E., Komar, M., Sachenko, A. (2021). Deep Convolutional Neural Network for Detection of Solar Panels. In: Radivilova, T., Ageyev, D., Kryvinska, N. (eds) *Data-Centric Business and Applications. Lecture Notes on Data Engineering and Communications Technologies*, vol 48. Springer, Cham. [https://doi.org/10.1007/978-3-030-43070-2\\_17](https://doi.org/10.1007/978-3-030-43070-2_17)
- [Publ 72]. Golovko, V.A., Kroshchanka, A.A. & Mikhno, E.V. Deep Neural Networks: Selected Aspects of Learning and Application. *Pattern Recognize. Image Anal.* 31, 132–143 (2021). <https://doi.org/10.1134/S1054661821010090>
- [Publ 73]. A. Kroshchanka and V. Golovko, "The Reduction of Fully Connected Neural Network Parameters Using the Pre-training Technique," 2021 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS), Cracow, Poland, 2021, pp. 937-941, doi: 10.1109/IDAACS53288.2021.9661015.
- [Publ 74]. Bleja, J., Wiewelhove, D., Kruger, T., Grossmann, U. Achieving life in smart cities: Chances and challenges for a holistic care platform. 2021 IEEE European Technology and Engineering Management Summit, E-TEMS 2021 - Conference Proceedings, 2021, pp. 72–75
- [Publ 75]. Bleja, J., Wiewelhove, D., Kruger, T., Grossmann, U. Networking in smart cities: Qualitative analysis for the demand-oriented development of a care platform. 2021 IEEE European Technology and Engineering Management Summit, E-TEMS 2021 - Conference Proceedings, 2021, pp. 122–126.
- [Publ 76]. Bleja, J., Engelmann, L., Wiewelhove, D., Grossmann, U. Smart Care in Smart Cities - Scenario Analysis for an Innovative Care Platform. Proceedings of the 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, IDAACS 2021, 2021, 2, pp. 657–662
- [Publ 77]. Kasianchuk, M., Yakymenko, I., Yatskiv, V., Ivasiev, S., Sverstiuk, A. Same bit-size moduli formation of residue number system for application in asymmetric cryptography. *CEUR Workshop Proceedings*, 2021, 2853, pp. 301–308
- [Publ 78]. Kovalchuk, O.; Karpinski, M.; Banakh, S.; Kasianchuk, M.; Shevchuk, R.; Zagorodna, N. Prediction Machine Learning Models on Propensity of Convicts to Criminal Recidivism. *Information* 2023, 14, 161. <https://doi.org/10.3390/info14030161>
- [Publ 79]. Yesin, V.; Karpinski, M.; Yesina, M.; Vilihura, V.; Rajba, S.A. Technique for Evaluating the Security of Relational Databases Based on the Enhanced Clements–Hoffman Model. *Appl. Sci.* 2021, 11, 11175. <https://doi.org/10.3390/app112311175>

- [Publ 80]. Maksymovych, V.; Harasymchuk, O.; Karpinski, M.; Shabatura, M.; Jancarczyk, D.; Kajstura, K. A New Approach to the Development of Additive Fibonacci Generators Based on Prime Numbers. *Electronics* 2021, 10, 2912. <https://doi.org/10.3390/electronics10232912>
- [Publ 81]. Marek Aleksander, Mikolaj Karpinski. Information Security Measures in Homogeneous Wireless Sensor Networks. *Procedia Computer Science*, Volume 192, 2021, pp. 2699-2708. <https://doi.org/10.1016/j.procs.2021.09.040>.
- [Publ 82]. N. Kazakova, M. Karpinski, A. Sokolov, T. Gancarczyk. Nonlinearity of Many-Valued Logic Component Functions of Modern Cryptographic Algorithms S-boxes. *Procedia Computer Science*, Volume 192, 2021, pp. 2731-2741. <https://doi.org/10.1016/j.procs.2021.09.043>.
- [Publ 83]. Karpinski, M.; Kovalchuk, L.; Kochan, R.; Oliynykov, R.; Rodinko, M.; Wieclaw, L. Blockchain Technologies: Probability of Double-Spend Attack on a Proof-of-Stake Consensus. *Sensors* 2021, 21, 6408. <https://doi.org/10.3390/s21196408>
- [Publ 84]. Yesin, V.; Karpinski, M.; Yesina, M.; Vilihura, V.; Warwas, K. Ensuring Data Integrity in Databases with the Universal Basis of Relations. *Appl. Sci.* 2021, 11, 8781. <https://doi.org/10.3390/app11188781>
- [Publ 85]. Proskurnina, N., Karpinski, M., Rayevnyeva, O., Kochan, R. (2021). Digital Maturity of Retail Enterprises in Ukraine: Technology of Definition and Directions of Improvement. In: Wrycza, S., Maślankowski, J. (eds) *Digital Transformation. PLAIS EuroSymposium 2021. Lecture Notes in Business Information Processing*, vol 429. Springer, Cham. [https://doi.org/10.1007/978-3-030-85893-3\\_1](https://doi.org/10.1007/978-3-030-85893-3_1)
- [Publ 86]. Rayevnyeva, O., Karpinski, M., Brovko, O., Falat, P., Aksonova, I. (2021). The Diagnostic Model for Assessing the State of Stability of an Industrial Enterprise. In: Wrycza, S., Maślankowski, J. (eds) *Digital Transformation. PLAIS EuroSymposium 2021. Lecture Notes in Business Information Processing*, vol 429. Springer, Cham. [https://doi.org/10.1007/978-3-030-85893-3\\_4](https://doi.org/10.1007/978-3-030-85893-3_4)
- [Publ 87]. Kochan, O.; Chornodolskyy, Y.; Selech, J.; Karnaushenko, V.; Przystupa, K.; Kotlov, A.; Demkiv, T.; Vistovskyy, V.; Stryhanyuk, H.; Rodnyi, P.; Gektin, A.; Voloshinovskii, A. Energy Structure and Luminescence of CeF<sub>3</sub> Crystals. *Materials* 2021, 14, 4243. <https://doi.org/10.3390/ma14154243>
- [Publ 88]. Xiong, G.; Przystupa, K.; Teng, Y.; Xue, W.; Huan, W.; Feng, Z.; Qiong, X.; Wang, C.; Skowron, M.; Kochan, O.; Beshley, M. Online Measurement Error Detection for the Electronic Transformer in a Smart Grid. *Energies* 2021, 14, 3551. <https://doi.org/10.3390/en14123551>
- [Publ 89]. Fang, M.-t.; Chen, Z.-j.; Przystupa, K.; Li, T.; Majka, M.; Kochan, O. Examination of Abnormal Behavior Detection Based on Improved YOLOv3. *Electronics* 2021, 10, 197. <https://doi.org/10.3390/electronics10020197>
- [Publ 90]. Proskurnina, N., Karpinski, M., Rayevnyeva, O., Kochan, R. (2021). Digital Maturity of Retail Enterprises in Ukraine: Technology of Definition and Directions of Improvement. In: Wrycza, S., Maślankowski, J. (eds) *Digital Transformation. PLAIS EuroSymposium 2021. Lecture Notes in Business Information Processing*, vol 429. Springer, Cham. [https://doi.org/10.1007/978-3-030-85893-3\\_1](https://doi.org/10.1007/978-3-030-85893-3_1)
- [Publ 91]. Lytvyn, V., Vysotska, V., Bublyk, M., Grudowski, P., Matseliukh, Y., Nanivskyi, R. (2021). Developing Methods for Building Intelligent Systems of Information Resources Processing Using an Ontological Approach. In: Shakhovska, N., Medykovskyy, M.O. (eds) *Advances in Intelligent Systems and Computing V. CSIT 2020. Advances in Intelligent Systems and Computing*, vol 1293. Springer, Cham. [https://doi.org/10.1007/978-3-030-63270-0\\_23](https://doi.org/10.1007/978-3-030-63270-0_23)
- [Publ 92]. Kravets, P., Lytvyn, V., Vysotska, V., Ryshkovets, Y., Vyshemyrska, S., Smailova, S. (2021). Dynamic Coordination of Strategies for Multi-agent Systems. In: Babichev, S., Lytvynenko, V., Wójcik, W., Vyshemyrskaya, S. (eds) *Lecture Notes in Computational Intelligence and Decision Making. ISDMCI 2020. Advances in Intelligent Systems and Computing*, vol 1246. Springer, Cham. [https://doi.org/10.1007/978-3-030-54215-3\\_42](https://doi.org/10.1007/978-3-030-54215-3_42)

- [Publ 93]. Bisikalo, O., Vysotska, V., Lytvyn, V., Brodyak, O., Vyshemyrska, S., Rozov, Y. (2021). Experimental Investigation of Significant Keywords Search in Ukrainian Content. In: Shakhovska, N., Medykovskyy, M.O. (eds) *Advances in Intelligent Systems and Computing V. CSIT 2020. Advances in Intelligent Systems and Computing*, vol 1293. Springer, Cham. [https://doi.org/10.1007/978-3-030-63270-0\\_1](https://doi.org/10.1007/978-3-030-63270-0_1)
- [Publ 94]. Vysotska, V. et al. (2021). Information Resource Management Technology Based on Fuzzy Logic. In: Babichev, S., Lytvynenko, V., Wójcik, W., Vyshemyrskaya, S. (eds) *Lecture Notes in Computational Intelligence and Decision Making. ISDMCI 2020. Advances in Intelligent Systems and Computing*, vol 1246. Springer, Cham. [https://doi.org/10.1007/978-3-030-54215-3\\_11](https://doi.org/10.1007/978-3-030-54215-3_11)
- [Publ 95]. Kravets, P., Lytvyn, V., Dobrotvor, I., Sachenko, O., Vysotska, V., Sachenko, A. (2021). Matrix Stochastic Game with Q-learning for Multi-agent Systems. In: Hu, Z., Petoukhov, S., Dychka, I., He, M. (eds) *Advances in Computer Science for Engineering and Education IV. ICCSEE 2021. Lecture Notes on Data Engineering and Communications Technologies*, vol 83. Springer, Cham. [https://doi.org/10.1007/978-3-030-80472-5\\_26](https://doi.org/10.1007/978-3-030-80472-5_26)
- [Publ 96]. Lytvyn, V., Peleshchak, R., Peleshchak, I., Cherniak, O., & Demkiv, L. (2021). Building a mathematical model and an algorithm for training a neural network with sparse dipole synaptic connections for image recognition. *Eastern-European Journal of Enterprise Technologies*, 6(4 (114), 21–27. <https://doi.org/10.15587/1729-4061.2021.245010>
- [Publ 97]. Bihun, R., Lytvyn, V. ., & Oleksiv, N. (2021). Mathematical modeling and analysis of the development of territorial communities. *Technology Audit and Production Reserves*, 3(2(59), 6–12. <https://doi.org/10.15587/2706-5448.2021.232788>
- [Publ 98]. D. Horváth, J. Gazda, E. Šlapak, T. Maksymyuk, M. Dohler. Evolutionary coverage optimization for a self-organizing UAV-based wireless communication system. *IEEE Access*, vol. 9, pp. 145066-145082.
- [Publ 99]. L. Han, J. Zhao, X. Bao, G. Liu, Y. Liu, T. Maksymyuk. An Adaptive Video Transmission Mechanism over MEC-Based Content-Centric Networks. *Wireless Communications and Mobile Computing* 2021, 1-10.
- [Publ 100]. A. Luntovskyy, B. Shubyn, T. Maksymyuk, M. Klymash. 5G slicing and handover scenarios: compulsoriness and machine learning. *Current Trends in Communication and Information Technologies*, 223-255.
- [Publ 101]. E. Šlapak, J. Gazda, W. Guo, T. Maksymyuk, M. Dohler. Cost-effective resource allocation for multitier mobile edge computing in 5G mobile networks. *IEEE access*, vol. 9, 28658-28672.
- [Publ 102]. N. Lutsiv, T. Maksymyuk, M. Beshley, O. Lavriv, V. Andrushchak, A. Sachenko. Deep semisupervised learning-based network anomaly detection in heterogeneous information systems. *Computers, Materials and Continua*, 70 (1), 413-431.
- [Publ 103]. B. P. Rusyn, O. A. Lutsyk, R. Ya. Kosarevych, Yu. V. Obukh. Recognition of Damaged Forest with the Help of Convolutional Models in Remote Sensing. *UJIT 2021, Volume 3, Number 1*, pp. 1-7. <https://doi.org/10.23939/ujit2021.03.001>
- [Publ 104]. Kosarevych R.Ya., Alokhhina O.V., Rusyn B.P., Lutsyk O.A., Pits N.A., Ivchenko D.V. Analysis of remote sensing images by methods of convolutional neural networks and marked random point fields. *Information Extraction and Processing*. 2021, 49(125), 45-51. DOI:<https://doi.org/10.15407/vidbir2021.49.045>
- [Publ 105]. Shakhovska, N., Dronyuk, I., Shpak, Z., Klapchuk, M. (2021). An Empirical Investigation of Pandemic Impact on IT Students' Educational Schedule. In: Byrski, A., Czachórski, T., Gelenbe, E., Grochla, K., Murayama, Y. (eds) *Computer Science Protecting Human Society Against Epidemics. ANTICOVID 2021. IFIP Advances in Information and Communication Technology*, vol 616. Springer, Cham. [https://doi.org/10.1007/978-3-030-86582-5\\_4](https://doi.org/10.1007/978-3-030-86582-5_4)
- [Publ 106]. Shakhovska, N., Yakovyna, V. (2021). Feature Selection and Software Defect Prediction by Different Ensemble Classifiers. In: Strauss, C., Kotsis, G., Tjoa, A.M., Khalil, I. (eds) *Database and Expert Systems Applications. DEXA 2021. Lecture Notes in Computer Science()*, vol 12923. Springer, Cham. [https://doi.org/10.1007/978-3-030-86472-9\\_28](https://doi.org/10.1007/978-3-030-86472-9_28)

- [Publ 107]. Chukhray, N., Shakhovska, N., Mrykhina, O. (2021). Method for Estimation of R&D Products Cost Taking into Account Their Technological Readiness. In: Shakhovska, N., Medykovskyy, M.O. (eds) *Advances in Intelligent Systems and Computing V. CSIT 2020. Advances in Intelligent Systems and Computing*, vol 1293. Springer, Cham. [https://doi.org/10.1007/978-3-030-63270-0\\_62](https://doi.org/10.1007/978-3-030-63270-0_62)
- [Publ 108]. Shakhovska, N., Melnykova, N., Melnykov, V., Mahlovanyj, V., Hrabovska, N. (2021). The Novel Approach to Modeling the Spread of Viral Infections. In: Shakhovska, N., Medykovskyy, M.O. (eds) *Advances in Intelligent Systems and Computing V. CSIT 2020. Advances in Intelligent Systems and Computing*, vol 1293. Springer, Cham. [https://doi.org/10.1007/978-3-030-63270-0\\_16](https://doi.org/10.1007/978-3-030-63270-0_16)
- [Publ 109]. Chernukha, O.; Bilushchak, Y.; Shakhovska, N.; Kulhánek, R. A Numerical Method for Computing Double Integrals with Variable Upper Limits. *Mathematics* 2022, 10, 108. <https://doi.org/10.3390/math10010108>
- [Publ 110]. Tolstyak, Y.; Zhuk, R.; Yakovlev, I.; Shakhovska, N.; Gregus ml, M.; Chopyak, V.; Melnykova, N. The Ensembles of Machine Learning Methods for Survival Predicting after Kidney Transplantation. *Appl. Sci.* 2021, 11, 10380. <https://doi.org/10.3390/app112110380>
- [Publ 111]. Kaminskiy, R.; Shakhovska, N.; Kajanová, J.; Kryvenchuk, Y. Method of Distinguishing Styles by Fractal and Statistical Indicators of the Text as a Sequence of the Number of Letters in Its Words. *Mathematics* 2021, 9, 2410. <https://doi.org/10.3390/math9192410>
- [Publ 112]. N. Shakhovska and A. Natiahlyi, "The System for Eliminating Blurring of Text Images Using Convolutional Neural Networks," 2021 IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT), LVIV, Ukraine, 2021, pp. 93-96, doi: 10.1109/CSIT52700.2021.9648586.
- [Publ 113]. Melnykova, N.; Shakhovska, N.; Melnykov, V.; Melnykova, K.; Lishchuk-Yakymovych, K. Personalized Data Analysis Approach for Assessing Necessary Hospital Bed-Days Built on Condition Space and Hierarchical Predictor. *Big Data Cogn. Comput.* 2021, 5, 37. <https://doi.org/10.3390/bdcc5030037>
- [Publ 114]. R. Kaminsky, N. Shakhovska, N. Kryvinska, M. Younas. Dendrograms-based disclosure method for evaluating cluster analysis in the IoT domain. *Computers & Industrial Engineering*, Volume 158, 2021, 107402, <https://doi.org/10.1016/j.cie.2021.107402>.
- [Publ 115]. Izonin, I.; Tkachenko, R.; Shakhovska, N.; Lotoshynska, N. The Additive Input-Doubling Method Based on the SVR with Nonlinear Kernels: Small Data Approach. *Symmetry* 2021, 13, 612. <https://doi.org/10.3390/sym13040612>
- [Publ 116]. Grytsenko, O.; Pukach, P.; Suberlyak, O.; Shakhovska, N.; Karovič Jr., V. Usage of Mathematical Modeling and Optimization in Development of Hydrogel Medical Dressings Production. *Electronics* 2021, 10, 620. <https://doi.org/10.3390/electronics10050620>
- [Publ 117]. Shakhovska, N.; Izonin, I.; Melnykova, N. The Hierarchical Classifier for COVID-19 Resistance Evaluation. *Data* 2021, 6, 6. <https://doi.org/10.3390/data6010006>
- [Publ 118]. A. Borisov, J. Sieck, E. Thielen. OrchestraBox: RFID Music Box for Musical Education at Schools. *Proceedings of the International Conference 2021 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*, 2021, vol. 1, pp. 236-240.
- [Publ 119]. S. Schauer, J. Letellier, J. Sieck. Augmentation of Printed Content with Web-based Technologies. *Proceedings of the International Conference 2021 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*, 2021, vol. 1, pp. 252-256.
- [Publ 120]. Y. Nykolaychuk, N. Vozna, B. Krulikovskyy, A. Sydor, I. Pitukh, L. Nykolaychuk. Special-Purpose Processors for Determining the Hamming Distance between Signals: Theoretical Basis, Methods, and Structures. *Proceedings of the International Conference 2021 11th International Conference on Advanced Computer Information Technologies (ACIT)*, 2021, pp. 676-681.
- [Publ 121]. Y. Nykolaychuk, N. Vozna, A. Davletova, I. Pitukh, O. Zastavnyy, V. Hryha. Microelectronic Structures of Arithmetic Logic Unit Components. *Proceedings of the*

- International Conference 2021 11th International Conference on Advanced Computer Information Technologies (ACIT), 2021, pp. 682-685.
- [Publ 122]. N. Vozna, Y. Nykolaychuk, A. Davletova. Methods of improving the structures of multi-bit multiplying devices of the matrix type. *Physico-mathematical modeling and information technologies*, issue 32, c. 80-85.
- [Publ 123]. I. R. Pitukh, N. Ya. Vozna. Ways of organizing the movement of monitoring, interactive and dialogue data in the structures of distributed computer systems. *Scientific bulletin of NLTU of Ukraine*, Vol. 31, Issue 3, pp. 101-108.
- [Publ 124]. I. Yakymenko, M. Kasianchuk, V. Yatskiv, R. Shevchuk, V. Koval, S. Yatskiv. Sustainability and Time Complexity Estimation of Cryptographic Algorithms Main Operations on Elliptic Curves. *Proceedings of the International Conference 2021 11th International Conference on Advanced Computer Information Technologies (ACIT)*, 2021, pp. 494-498.
- [Publ 125]. H. Lipyanina, S. Sachenko, T. Lendyuk, V. Brych, V. Yatskiv, O. Osolinskiy. Method of Detecting a Fictitious Company on the Machine Learning Base. *Proceedings of the International Conference International Conference on Computer Science, Engineering and Education Applications*, pp. 138-146.
- [Publ 126]. M. Kasianchuk, I. Yakymenko, V. Yatskiv, S. Ivasiev, A. Sverstiuk. Same bit-size moduli formation of residue number system for application in asymmetric cryptography. *CEUR Workshop Proceedings*, 2021, pp. 301-308.
- [Publ 127]. V. Yatskiv, O. Osolinskiy. Method of Detecting a Fictitious Company on the Machine Learning Base. Springer Nature. *Advances in Computer Science for Engineering and Education IV*, 2021, vol. 83, pp. 138.
- [Publ 128]. Y. Nykolaychuk, N. Vozna, A. Davletova, I. Pitukh, O. Zastavnyy and V. Hryha, "Microelectronic Structures of Arithmetic Logic Unit Components," 2021 11th International Conference on Advanced Computer Information Technologies (ACIT), Deggendorf, Germany, 2021, pp. 682-685, doi: 10.1109/ACIT52158.2021.9548512.

### Conference Proceedings

- [Publ 129]. H. Lipianina-Goncharenko, I. Anisimova. Review of scientific studies on the formation of a training sample for the segmentation of tender organizers based on machine learning. *Actual problems of natural sciences and humanities in the research of young scientists "Rain - 2021" / XXII All-Ukrainian scientific conference of young scientists. – Cherkasy: CHNU named after B. Khmelnytskyi, 2021. – pp. 538-539.*
- [Publ 130]. Lipianina-Honcharenko H., Anisimova I. "The structure of training sample formation for the segmentation of tender organizers based on machine learning". *Actual problems of modern education: realities and prospects. Materials of the 3rd All-Ukrainian conference of students and teachers of educational institutions. Abstracts of reports of conference participants. Volume 2 - Mariupol: VSP "Mariupol Vocational College of Higher Education Institution "Priazov State Technical University", 2021 - 227 p.*
- [Publ 131]. Lendyuk T.V., Dutkevich T. Comparative analysis of distance and traditional learning structures. *International Scientific Internet Conference "Information Society: Technological, Economic and Technical Aspects of Formation (Issue 61)" / Collection of Paper Abstracts: Issue 61 (Ternopil, September 15, 2021). - Ternopil. – 2021. – P. 27-29.*
- [Publ 132]. Dutkevich T., Lendyuk T. V. Scheme of interaction of the training management system and the training module. *Technologies, tools and strategies for the implementation of scientific research: materials of the II International Scientific Conference (Vol. 1), Lviv, September 24, 2021 / International Center for Scientific Research. — Vinnytsia: European Scientific Platform, 2021. – P. 141-142.*
- [Publ 133]. Vasylykiv N.M., Rozhko K.A., Zhuravel S.I., Pavlat V.E. IT project management in conditions of risks Modern movement of science: theses add. *XII International Scientific and Practical Internet Conference, April 1-2, 2021 - Dnipro, Ukraine, 2021. - Volume 1. - 493 p. - C. 323-324.*

- [Publ 134]. Koval M.P., Melyanchuk A.V., Koval V.S. A model for improving the efficiency of time planning and task management. Abstracts of the 5th Scientific and Practical Conference of Young Scientists and Students "Intelligent Computer Systems and Networks". – Ternopil, WUNU, December 2, 2021 – P. 42.
- [Publ 135]. Melyanchuk A.V., Koval M.P., Koval V.S. A method of recognizing voice commands using artificial neural networks. V scientific and practical conference of young scientists and students "Intelligent computer systems and networks". – Ternopil, WUNU, December 2, 2021 – P. 43.

### Patents

- [Publ 136]. Y. M. Nikolaychuk, N. Ya. Vozna, V. M. Griga, O. I. Volynskyi. Adder with accelerated carry. 2021, SE "Ukrainian Institute of Intellectual Property".
- [Publ 137]. Y. M. Nikolaychuk, N. Ya. Vozna, V. M. Hryga, I. R. Pitukh, A. Ya. Davletova, L. P. Hryga. Accumulating binary adder. 2021, SE "Ukrainian Institute of Intellectual Property".
- [Publ 138]. N. Ya. Vozna, V. M. Griga, Ya. M. Nikolaychuk. Matrix multiplier. 2021, National Intellectual Property Authority.
- [Publ 139]. Ya. M. Nikolaychuk, N. Ya. Vozna, A. Ya. Davletova. Logic element "Exclusive OR" with paraphase outputs. 2021, National Intellectual Property Authority.
- [Publ 140]. T. I. Pastukh, L. M. Nikolaychuk, N. Ya. Vozna, A. R. Voronych, A. I. Segin. Device for determining entropy. 2021, National Intellectual Property Authority.
- [Publ 141]. T. M. Grynchysyn, V. V. Yatskiv. The method of bi-signal transmission of optical signals. 2021, SE "Ukrainian Institute of Intellectual Property".

## 7. PARTICIPATION IN CONFERENCES, SYMPOSIUMS AND WORKSHOPS, AND RESEARCH VISITS

### Conferences

- [Visit 1] **The 2nd International Workshop IT Project Management (ITPM-2021), February 16-18, 2021, Slavske, Ukraine**
- Oleksandr Osolinskiy
  - Ivan Kit
  - Nadiia Vasylykiv
- [Visit 2] **IEEE European Technology and Engineering Management Summit (E-TEMS 2021), March 18-20, 2021, Dortmund, Germany**
- Anatoliy Sachenko
  - Mykhailo Dombrovskyi
  - Uwe Grossman
- [Visit 3] **2nd International Workshop on Intelligent Information Technologies & Systems of Information Security (IntellITSIS-2021), March 24-26, 2021, Khmelnytskyi, Ukraine**
- Khrystyna Lipianina-Honcharenko
  - Konstantin Zashcholkin
  - Taras Landyuk
  - Anatoliy Sachenko
- [Visit 4] **5th International Conference on Computational Linguistics and Intelligent Systems (COLINS 2021), April 22-23, 2021, Lviv, Ukraine**
- Anatoliy Sachenko
  - Taras Landyuk
- [Visit 5] **4th International Workshop on Computer Modeling and Intelligent Systems (CMIS-2021), April 27, 2021, Zaporizhzhia, Ukraine**
- Konstantin Zashcholkin
- [Visit 6] **IEEE International Conference on Smart Information Systems and Technologies (SIST-2021), April 28-30, 2021, Nur-Sultan, Kazakhstan**
- Serhiy Bushuev
- [Visit 7] **International Workshop on Modern Machine Learning Technologies and Data Science (MoML&T&DS'2021), June 4-6, 2021, Shatsk, Ukraine**
- Sergey Rippa
  - Taras Landyuk
  - Khrystyna Lipianina-Honcharenko
- [Visit 8] **11th International Conference on Advanced Computer Information Technologies (ACIT'2021), September 15-17, 2021, Deggendorf, Germany**
- Andriy Melnyk
  - Vasyl Yatskiv
  - Vasyl Koval
  - Roman Pasichnyk
- [Visit 9] **11th IEEE International Conference on Wireless Systems within the IEEE International Conferences on Intelligent Data Acquisition and Advanced Computing Systems" (IDAACS-2021), September 22-25, 2021, Krakow, Poland**
- Anatoly Sachenko
  - Volodymyr Kochan
  - Pavlo Bykovy
  - Oleksandr Osolinskyi
  - Taras Landyuk
  - Orest Kochan
  - Vasyl Yatskiv
  - Ivan Kit

**[Visit 10] XVIth IEEE International Conference "Computer Science and Information Technologies" (CSIT'2021), September 22-25, 2021, Lviv, Ukraine**

- Carsten Wolff
- Shakhovska
- Serhiy Bushuev

**[Visit 11] 17th IEEE International Conference "Information and Communication Technologies in Education, Research and Industrial Applications" (ICTERI-2021), September 28 - October 2, 2021, Kherson, Ukraine**

- Konstantin Zashcholkin
- Anatoly Sachenko

## 8. AWARDS

- [Award 1]. **Anatoliy Sachenko, Mykhailo Dombrovskiy**, students **Semen Kovalskiy** and **Aziz Sepa** received a grant to participate from September 10 to 15 in the Odessa Summer School 2021 on the topic "Augmented Reality: IT and Culture", initiated by prof. Jürgen Zick under the auspices of the German Academic Exchange Agency (DAAD).
- [Award 2]. **Anatoliy Sachenko, Pavlo Bykovy, Khrystyna Lipianina-Honcharenko, Mykhailo Dombrovskiy, Hryhoriy Gladiy** on November 15-19, 2021 took part in the Training week for Teachers as part of the VIMacS and WORK4CE international projects. And Denys Khlopetskyi, a student of KN-42 group, received a grant to participate in the Dortmund International Winter School 2021. The training covered the topics of artificial intelligence and data analysis, business analytics and decision-making, and cloud data processing systems.

## 9. STATISTICAL DATA

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of Senior Researches	9	15	18	19	20	22	27	30	34	39	40	39	45	46	60	<b>60</b>
Number of Junior Researches	14	17	15	18	18	15	13	11	14	16	12	10	8	8	6	<b>5</b>
Number of Active Research Projects	9	7	7	8	4	2	2	3	3	3	3	2	4	4	4	<b>3</b>
Publications	26	58	57	72	77	104	109	126	127	113	131	115	163	114	187	<b>141</b>
Patents and applications for the invention	more than 150 invention certificates of the former USSR and 39 Ukrainian patents										9	10	8	2	8	<b>6</b>
Participation in Conferences, Symposia and Workshops	13	18	19	21	36	29	33	28	23	33	24	32	33	21	7	<b>11</b>
Number of Defended PhD and DrSc Theses	–	3	3	2	–	3	3	3	3	7	7	6	4	3	0	<b>3</b>
Number of Defended Master Theses	1	10	7	20	23	22	39	22	48	60	12	54	88	87	82	<b>49</b>
Number of Received Awards	1	2	5	7	5	3	2	3	2	5	6	5	7	4	4	<b>2</b>

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