



# INTERNATIONAL CONFERENCE ON ELECTRONICS, COMMUNICATIONS AND COMPUTING ECCO 2024

17-18 OCTOBER, 2024, CHIȘINĂU

**Technical University of Moldova**

The 13<sup>th</sup> International Conference on Electronics,  
Communications and Computing (IC ECCO-2024):  
The conference program and abstract book

*Conference organized by*

**Technical University of Moldova**

**Computer, Informatics and Microelectronics Faculty  
Electronics and Telecommunications Faculty**

*in cooperation with*

Academy of Science of Moldova

Information Society Development Institute

National Institute of Innovations in Cybersecurity "Cybercor"

**Chisinau, Moldova**

**October 17-18, 2024**



Published by: Technical University of Moldova

Editors: Associate Professor, Dr. Dumitru CIORBA  
Associate Professor, Dr. Nicolai ABABII  
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Graphic designer: Associate Professor, Dr. Dumitru CIORBA

**DESCRIEREA CIP A CAMEREI NAȚIONALE A CĂRȚII DIN RM**

**"Electronics, Communications and Computing (IC ECCO-2024)", international conference (13; 2024; Chișinău).** The 13<sup>th</sup> International Conference on Electronics, Communications and Computing (IC ECCO-2024): The conference program and abstract book, Chisinau, October 17-18, 2024 / editors: Dumitru Ciorba [et al.]; chairman: Dumitru Ciorba, Lilia Sava.

– [Chișinău]: Tehnica-UTM, 2024. – 225 p.: fig. color, tab.

Cerințe de sistem: PDF Reader.

Antetit.: Technical University of Moldova, Computer, Informatics and Microelectronics Faculty, Electronics and Telecommunications Faculty in cooperation with Academy of Science of Moldova, Information Society Development Institute, National Institute of Innovations in Cybersecurity "Cybercor".

– Referințe bibliogr. la sfârșitul art. – Sponsori: Allied Testing [et al.].

Bun de tipar 02.12.24.

Forma electronica.

Comanda nr. 128

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MD-2004, Chișinău, bd. Ștefan cel Mare și Sfânt, 168, UTM

MD-2045, Chișinău, str. Studenților, 9/9, Editura „Tehnica-UTM”

The program contains the timetable for the 13<sup>th</sup> International Conference on Electronics, Communications and Computing's plenary and conference sessions.



**CYBERCOR**

Institutul Național de Inovații  
în Securitatea Cibernetică



## About IC ECCO

The conference aims to bring together scientists and engineers involved in fundamental and applied research to report on the latest results and achievements in the fields involved.

The Technical University of Moldova organizes the conference in cooperation with the Academy of Sciences of Moldova, the Information Society Development Institute and the National Institute of Innovations in Cybersecurity "Cybercor"

The IC ECCO 2024 program consists of invited and contributed papers. The presentation should not exceed 15 minutes (contributed papers) or 30 minutes (plenary papers). The official language of the conference is English.



*The Polytechnic Institute, which later became the Technical University of Moldova, was established in 1964. As such, we warmly welcome all our esteemed colleagues to join us in celebrating our 60<sup>th</sup> anniversary during this conference edition.*

## CONFERENCE CHAIRMEN

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Dean of Computers, Informatics  
and Microelectronics Faculty

**Lilia Sava, assoc. prof., dr.**  
Dean of Electronics and  
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**Ion Tighineanu,**  
**acad., professor, dr. hab.**

*President of the Academy of  
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## CONFERENCE SPONSORS



## Cybersecurity practices workshop sponsor



## Topic sponsors



## CONFERENCE TRACKS

### DAY 1 - 17 October

#### Plenary talks Aula Magna

#### BIOMEDICAL ENGINEERING

1-100

12 Speakers

#### COMPUTER SCIENCE 1

Aula Magna

11 Speakers

#### COMPUTER ENGINEERING

1-101

7 Speakers

#### INFRASTRUCTURE AND SECURITY OF COMMUNICATIONS

1-321

6 Speakers

### DAY 2 - 18 October

#### ELECTRONICS AND MATERIALS SCIENCE 1

3-604

13 Speakers

#### ELECTRONICS AND MATERIALS SCIENCE 2

3-607

10 Speakers

#### SOFTWARE ENGINEERING AND CYBERSECURITY

3-614

14 Speakers

#### COMPUTER SCIENCE 2

3-623

12 Speakers

#### COMPUTER SCIENCE 3

3-609

11 Speakers

#### CYBERSECURITY PRACTICES (w)

3-628

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## OPENING CEREMONY

Technical University of Moldova, Aula Magna, Cybercor  
Bd. Ștefan cel Mare 168

09:00	Speaker	08:00 - Registration	OPENING CEREMONY
	Viorel Bostan	Rector, Technical University of Moldova, <i>professor, dr. hab.</i>	
	Ion Tighineanu	President Academy of Sciences of Moldova, <i>acad., professor, dr. hab.</i>	
	Vasile Tronciu	Vice-Rector, Technical University of Moldova, <i>professor, dr. hab.</i>	
	Mihai Lupașcu	Director, Cybersecurity Agency	
	Irina Strajescu	Executive Director of the Moldcell Foundation	
	Evghenii Galamaga	Director, Allied Testing	

## Venues

**Day 1** Chisinău, Ștefan cel Mare bd. 168, TUM Cybercor

**Day 2** Chisinău, Studenților str. 9/7, TUM building nr. 3, 6<sup>th</sup> floor

**PLENARY SESSION**[HTTPS://ECCO.UTM.MD/](https://ECCO.UTM.MD/)**DAY 1****Session chairmen****17 OCTOBER 2024**

prof., dr. hab., Oleg Lupan  
 assoc. prof., dr. Dumitru Ciorbă

	Speaker	PLENARY SESSION
09:30	Ion Tighineanu	Development of nanotechnologies at the Technical University of Moldova between 2001-2024
10:00	Reiner Adelung	From Hydrogen Detection to Energy Harvesting: Advances in Self-Sustaining Sensing Technologies from a Materials perspective
10:30	<i>COFFEE BREAK</i>	
11:00	Oleg Lupan	Hybrid Nano-Materials for Sensors in Biomedical, Environmental And Industrial Applications
11:30	Anatolie Sidorenko	Superconducting base elements for brain-like artificial neural network
12:00	Viorel Bostan Nicolae Secrieru	International projects with new missions of the Technical University of Moldova National Space Technologies Center
12:30	Ion Țurcanu	Time-Sensitive Networking: From Theory to Practice

**DAY 1: BIOMEDICAL ENGINEERING**[HTTPS://ECCO.UTM.MD/ECCO24-BME/](https://ECCO.UTM.MD/ECCO24-BME/)**Room 1-100****Domain**

Biomaterials for medical applications; Biomedical instrumentation; Biomedical imaging and image processing; Biomedical engineering education; Nuclear and radiation safety and security.

**Session chairman**

prof. dr. Victor Şontea

assoc. prof. dr. hab. Artur Buzdugan

**Program Committee members**

prof. dr. Călin Corciova (România)

	Speaker	BIOMEDICAL ENGINEERING
14:00	Victor Moraru	Analysis of Cloud Biomedical Healthcare Systems Security Based on Matrix Rewriting SRNs With Fuzzy Parameters
14:15	Veaceslav Sprincean	Micro- and nano-structured oxides based on Cd- and Sn-doped InSe for volatile organic compound sensors applications
14:30	Victor Iapăscuță	Modeling the Human Circulatory System Using System Dynamics: Possibilities, Benefits, and Practical Applications
14:45	Octavian Cordun	Analyze of Quality Assurance (QA) of brachytherapy evolution from GammaMedplus to Bravos System
15:00	Emilian Guțuleac	Biomedical Systems Sensing Layer Technologies and Networking
15:15	COFFEE BREAK	

	Speaker	BIOMEDICAL ENGINEERING
15:30	Vladislav Ghenea	Photoluminescence Properties of Eu doped ZnO Films under Thermal Treatment
15:45	Mihai Brinza	Health Safety Sensors Based On Doped Metal-Oxide Gas Sensing Structures For Formaldehyde Detection
16:00	Olga Shikimaka	Microstructure and Mechanical Properties of Nanocrystalline Zr1.0Nb Alloy Obtained by Equal Channel Angular Pressing
16:15	Maria Lupu	Preparation of ZnFe <sub>2</sub> O <sub>4</sub> /ZnO:Ga/SnO <sub>2</sub> Heterostructure with Peroxidase-Like Activity for the Detection of Hydrogen Peroxide
16:30	Victor Iapăscuță	Semifinal Results of a Research Project Involving Algorithmic Complexity Estimation and Machine Learning
16:45	Tatiana Gutsul	Catalase-like activity properties of Fe <sub>3</sub> O <sub>4</sub> / PVP nanoparticles in the study of Sorghum seed germination processes
17:00	Constantin-Daniel Oancea	Interface Adaptation Design for Extracellular Recordings from Excitable Tissue

**DAY 1: COMPUTER SCIENCE**[HTTPS://ECCO.UTM.MD/ECCO24-CS1/](https://ecco.utm.md/ecco24-cs1/)**Room 1-205****Domain**

Mathematical Modelling and Applications; Algorithms and Computing Theory; Data Science/Engineering; Artificial Intelligence; Bioinformatics.

**Session chairman**

prof. dr. Alexei Leahu

**Program Committee members**

prof. univ. dr. Radu-Daniel Vatavu (Romania)

assoc. prof. dr. Valeriy Frataevchan (Ukraine)

assoc. prof. dr. Vasile Moraru

assoc. prof. dr. Victoria Bobicev

	Speaker	COMPUTER SCIENCE
14:00	Alexei Leahu	The likelihood function based on uncensored/censored statistical data for Min-PSD(Max-PSD) and Max-PSD(Min-PSD) as lifetime distributions in network reliability
14:15	Mihai Ivanovici	In Situ Measurements for the Validation of Sentinel-2 Data
14:30	Nicolae Secrieru	Implementation of Artificial Intelligence in engineering teaching and learning
14:45	Ion Fiodorov	Synthesis of the control system of the manipulator robot
15:00	Viorel Munteanu	Entropy-based Kullback-Leibler Taxonomic Classification of Biological Sequences
15:15	COFFEE BREAK	

	Speaker	COMPUTER SCIENCE
15:30	Rodica Cujba	Leveraging Data Science for Effective Research Management in the Field of Scientometrics
15:45	Yaroslav Drin	Analysis of Non-Classical Heat Conduction Models
16:00	Mario Lefebvre	An Optimal Landing Problem for a Bessel Process
16:15	Diana Marusic	TinyLlama-Powered AI Chatbot: Transforming Medical Education for Patients
16:30	Rodica Braniște	Modeling the behavior of pollutants on the Dniester River in Olănești region
16:45	Alexandra-Petronela Alexa	Assessing the Usability of Software Applications: a Case Study

**DAY 1: COMPUTER ENGINEERING**[HTTPS://ECCO.UTM.MD/ECCO24-CE/](https://ECCO.UTM.MD/ECCO24-CE/)**Room 1-101****Domain**

Computer design; Automatic Control; Robotics and mechatronics.

**Session chairwoman**assoc. prof. dr. Viorica  
Sudacevschi**Program Committee members**prof. dr. hab. Emilian Guțuleac (Moldova),  
prof. univ. dr. Ștefan-Gheorghe Pentiuc (România)  
assoc. prof. dr. Ion Fiodorov

	Speaker	COMPUTER ENGINEERING
14:00	Ion Bolun	Necessary capacities of computer networks` core components
14:15	Victor Besliu	Stability Conditions of Linear Discrete-Time Systems by Characteristic Equation Coefficients
14:30	Bartolomeu Izvoreanu	Tuning the Controller for Object Models with One-Four Poles Using the Polynomial Method
14:45	Irina Cojuhari	Control-Relevant Identification of the First-Order Inertial Systems with Time-Delay
15:00	Rodica Braniște	Edge Computing System for Monitoring of the Aquatic Ecosystems
15:15	COFFEE BREAK	
15:30	Irina Cojuhari	Closed-Loop Identification of the First Order Inertial System with Astatism and Time Delay
15:45	Dumitrita Sandu	Sensorless control of permanent magnet synchronous machine

**DAY 1: INFRASTRUCTURE AND SECURITY OF COMMUNICATIONS**[HTTPS://ECCO.UTM.MD/ECCO24-ISC/](https://ecco.utm.md/ecco24-isc/)**Room 1-215****Domain**

Telecommunications: Technology, Networks and Software; Electronics and Telecommunications: Operations, Administration and Maintenance; IoT Technologies: Software, Hardware and Connectivity; IT Infrastructure and Cloud Computing.

**Session chairman**

assoc. prof. dr. Andrian  
Prisăcaru

**Program Committee members**

prof. dr. ing. Dan Laurentiu Milici  
(România)  
dr. Mircea Popescu (Romania)  
dr. Andrei Dorogan

	Speaker	INFRASTRUCTURE AND SECURITY OF COMMUNICATIONS
14:00	Serghei Istrati	GFRP application in the modern Telecommunication Infrastructure
14:15	<i>Mircea Elpujan*</i>	<i>Special topic on communications technologies</i>
14:30	Adrian Prisacaru	Cyber security professional development within CYBERCOR
14:45	Mircea Popescu	Aspects regarding TEMPEST protection measures of IT equipment using electromagnetic shielding enclosures
15:00	Larisa Dunai	Advancements in Sensor Technology for Autonomous Walker
15:15	<i>COFFEE BREAK</i>	
15.30	Alisa Maşnic	Vegetation and Water Body Inspection and Monitoring Using Multispectral Drone Imagery
15:45	Andrei Dorogan	Real-time irrigation planning system
16:00	Vladimir Mirovski	The role of 5G technology in fostering sustainable economic development

\* *extra-program presentation*



**DAY 2: ELECTRONICS AND MATERIALS SCIENCE**[HTTPS://ECCO.UTM.MD/ECCO24-EMS1/](https://ecco.utm.md/ecco24-ems1/)**Room 3-604****Domain**

Applied Electronics and Embedded Systems;  
Micro & Nano-electronics.

**Session chairman**

prof. dr. hab. Oleg Lupan

**Program Committee members**

prof. dr. hab. HDR Thierry Pauporté (France)  
assoc. prof. dr. Serghei Railean

	Speaker	ELECTRONICS AND MATERIALS SCIENCE
9:00	Cătălin Creciunel	Design and Implementation of a Low-Cost Electrospinning Setup for Nanofibers Fabrication
9:15	Tetiana Barlas	Surface excitations in nanocomposites based on porous III-V semiconductors
9:30	Silvia Andronic	Exploring the Potential of Quasi-One-Dimensional Organic Crystals of $\text{TTT}_2\text{I}_3$ for Thermoelectric Applications
9:45	Cristian Lupan	Morphological, chemical and structural characterization of $\text{ZnO}/\text{ZnAl}_2\text{O}_4$ micro-nanostructures
10:00	Rajat Nagpal	t-ZnO based sensor for optical and gas sensing applications
10:15	Ecaterina Cristea	Determination of refractive indices of layered GaSe by help of wavelength modulation spectroscopy
10:30	Nicolae Magariu	Sensors for detecting different types of gases: VOCs and battery
10:45	Bîrnaz Adrian	Al-doped CdS used as light detector
11:00	COFFEE BREAK	

	Speaker	ELECTRONICS AND MATERIALS SCIENCE
11:30	Maxim Chiriac	Semiconducting oxide nanostructures for wideband optical detectors
11:45	Dinu Litra	Selectivity control of Ni-doped copper oxide at high operating temperatures
12:00	Simon Busuioc	Growth of ZnO Nanowire Arrays on Various Substrates for Enhanced Glucose Sensing
12:15	Fatim Ezzahra Merfouk	Synthesis of nanosized zeolites for VOCs detection

**DAY 2: ELECTRONICS AND MATERIALS SCIENCE**[HTTPS://ECCO.UTM.MD/ECCO24-EMS2/](https://ecco.utm.md/ecco24-ems2/)**Room 3-607****Domain**

Applied Electronics and Embedded Systems;  
Micro & Nano-electronics.

**Session chairman**

assoc. prof. dr. Vasiliu Crețu

**Program Committee members**

prof. dr. hab. HDR Thierry Pauporté (France)  
assoc. prof. dr. Serghei Railean

	Speaker	ELECTRONICS AND MATERIALS SCIENCE
9:00	Stefan Popa	The architecture of nanosatellite module for FPGA-based cosmic radiation sensing with artificial intelligence
9:15	Ionel Sanduleac	Picosecond pulse generation by a gain – switched DFB lasers
9:30	Vladimir Melnic	Technological verification of the satellite module for precise determination of the position of satellites in orbit
9:45	Irina Vasiliev	Linear and Non-Linear Voltage-to-Frequency Multi-Zone Control of Synchronously Modulated Power Electronic Inverters
10:00	Veronica Dobrovolschi	Picosecond pulse generation in InGaN blue lasers with saturable absorber
10:15	Valentin Oleschuk	Flexible Synchronous Regulation of Power Electronic Blocks of Transformer-Based Photovoltaic Stations
10:30	Tatiana Maslova	Nodes for sensor networks

	Speaker	ELECTRONICS AND MATERIALS SCIENCE
10:45	Sergiu Pascari	The Impact of Three-Phase Smart Gate Drivers on the Performance and Safety of PMSM and BLDC Motor Drives
11:00	COFFEE BREAK	
11:15	Eduard C. Popovici	Virtual Prototyping and Validation of a System for Flood and Fire Risk Mitigation in Wetlands
11:30	Ionica-Marcela Pletea	Design and Partitioning Across 2 Strata in 3D IC architectures

**DAY 2: SOFTWARE ENGINEERING AND CYBERSECURITY**[HTTPS://ECCO.UTM.MD/ECCO24-SEC/](https://ecco.utm.md/ecco24-sec/)**Room 3-614****Domain**

Methods and Tools of Software Engineering; Information Systems and Applications; Software Engineering; Computer Security and Cryptography; Security and Privacy in Computing.

**Session chairman**

prof. dr. hab. Ion Bolun  
dr. Arina Alexei

**Program Committee members**

prof. dr. Panayotis Yannakopoulos (Greece)  
prof. dr. Victor Beşliu

	Speaker	SOFTWARE ENGINEERING AND CYBERSECURITY
9:00	Ion Bolun	Approaches to secure biomedical informatics systems and networks
9:15	Dinu Țurcanu	Reducing cyber risk through a human-centered approach
9:30	Arina Alexei	Cybersecurity in Healthcare: Mitigating Risks in Medical Technologies
9:45	Alexandru-Laurențiu Bolocan	The Digital Tool for Assuring the Documents Submission - Receiving Process for the State Tax Service
10:00	Bianca Liana Bercea	A construction of Reed-Muller codes from Boolean functions
10:15	Ana Țurcan	Assessing the Adoption of HTTP Security Headers
10:30	Stefan-Gheorghe Pentiu	Advanced AI Techniques for Analyzing Consumer Survey Responses
10:45	Svetlana Cojocar	Challenges and solutions on the use of Artificial Intelligence in Internet of Things network security

	Speaker	SOFTWARE ENGINEERING AND CYBERSECURITY
11:00	COFFEE BREAK	
11:30	Alexandru Cozlovski	The Classification Module Intended to Be Used in The Didactic Assessment
11:45	Dorin Gribincea	Systemic framework for security auditing and compliance verification of institutional information systems
12:00	Ana Șarapova	A Structured Analysis of Security and Privacy Threats in Large Language Models
12:15	Oksana Kyrychenko	Real-time communication tools for web applications in a cloud environment
12:30	Yevhen Kyrychenko	Leveraging AWS EMR for Scalable and Efficient Neural Network Deployment in Cloud Computing
12:45	Victor Moraru	Cybersecurity Risks and Mitigation Strategies for SMEs: A Focus on the Republic of Moldova

**DAY 2: COMPUTER SCIENCE**[HTTPS://ECCO.UTM.MD/ECCO24-CS2/](https://ecco.utm.md/ecco24-cs2/)**Room 3-623****Domain**

Mathematical Modelling and Applications; Algorithms and Computing Theory;  
Data Science/Engineering; Artificial Intelligence; Bioinformatics.

**Session chairwoman**

assoc. prof. dr. Irina Cojuhari

**Program Committee members**

prof. univ. dr. Radu-Daniel Vatavu (Romania)  
assoc. prof. dr. Valeriy Fratavchan (Ukraine)  
assoc. prof. dr. Vasile Moraru  
assoc. prof. dr. Victoria Bobicev

	Speaker	COMPUTER SCIENCE
9:00	Victor Iapăscuță	Integration of a Proprietary Software Application and a Multimodal LLM for Enhanced Nutritional Guidance
9:15	Ion Geru	Quantum computing for multi-qubit systems using Schwinger's paired bosons representation of angular momentum
9:30	Victor Ababii	Spatial-Temporal Modeling of Critical Infrastructure Systems
9:45	Maria Gutu	Advanced Drone-Based Monitoring of Agricultural, Forestry, and Aquatic Ecosystems: Technical Framework
10:00	Evghenia Morozova	Demagoguery and its Automatic Recognition in Texts
10:15	Vadim Struna	Method for Knowledge Acquisition Based on Image Processing for Decision-Making Systems

	Speaker	COMPUTER SCIENCE
10:30	Eugeniu Catlabuga	Rare Events Detection and Forecasting in Dynamic Systems
10:45	Ludmila Duca	ERP system implementation in companies
11:00	<i>COFFEE BREAK</i>	
11:30	Marin Guțu	Correlation of the CubeSat TestPod vibration test results with finite element analysis
11:45	Dumitru Moraru	Cascade Control Algorithm of the Servomotor Drive of Robotic Arm
12:00	Raluca Vernic	Mixed Sum-Product and Convolutional Networks for Classification Problems



**DAY 2: COMPUTER SCIENCE**[HTTPS://ECCO.UTM.MD/ECCO24-CS3/](https://ecco.utm.md/ecco24-cs3/)**Room 3-609****Domain**

Mathematical Modelling and Applications; Algorithms and Computing Theory; Data Science/Engineering; Artificial Intelligence; Bioinformatics.

**Session chairwoman**

assoc. prof. dr. Victoria  
Bobicev

**Program Committee members**

prof. univ. dr. Radu-Daniel Vatavu (Romania)  
assoc. prof. dr. Valeriy Fratacvchan (Ukraine)  
assoc. prof. dr. Vasile Moraru

	Speaker	COMPUTER SCIENCE
9:00	Victoria Bobicev	Fake News detection in Moldova's Information Space
9:15	Daniela Istrati	Development of an employee scheduling application under consecutive days-off constraints
9:30	Veronica Andrievschi-Bagrin	Comparative Analysis of Serial-Parallel and Parallel Network Reliability for different distributions with Monte Carlo Simulations
9:45	Nicolae Drabcinski	The reusability of public omics data across 5 million research publications
10:00	Victoria Alexei	Managing and Monitoring the Flow of Ads on Selling Platforms
10:15	Inga Lisnic	Holistic Optimization through Reinforced Unified Synergy: A Novel Approach for Agent-based Modeling
10:30	Sergiu Scrob	Harmonized Abstract Color Knowledge: A Novel Approach for Enhancing Image Segmentation

	Speaker	COMPUTER SCIENCE
10:45	Nicolae Muntean	Effectiveness of Artificial Intelligence Integration in ERP Systems for Fitness Centers
11:00	<i>COFFEE BREAK</i>	
11:30	Victoria Alexei	Automatic Simplification of Drug Descriptions
11:45	Valerii Fratavchan	About a Pseudo-Genetic Algorithm and Some Features of its Practical Application
12:00	Andreea-Elena Baias	Special elements in octonions algebra over $\mathbb{Z}_p$
12:15	Radu Melnic	Assessment of Student Pass Rate Based on Correlation and Regression Models

DAY 2: CYBERSECURITY PRACTICES

[HTTPS://ECCO.UTM.MD/ECCO24-CPW/](https://ecco.utm.md/ecco24-cpw/)

Room 3-628

WORKSHOP

This workshop explores key cybersecurity challenges in decentralized applications, threat detection, and IoT systems. Sessions will cover smart contract vulnerabilities and mitigation methods, honeypot deployment for threat monitoring, and IoT security practices for protecting devices against common exploits. Participants will gain essential insights into advanced threat detection and security resilience techniques.

Session chairman  
Marius Dumitraşcu

9:00	Special guests	CYBERSECURITY PRACTICES
	Emil Cebotaros, Senior Cyber Security Analyst CODWER	Smart Contracts Vulnerabilities. A deep dive into smart contracts, exploring different vulnerabilities, analyzing the discovery and the patching processes.
	Ciprian Zariciuc, CSIRT Engineer ASC	Honeypots: A how-to guide. A practical guide on setting up honeypots for cybersecurity, detailing the steps for deployment, configuration, and effective monitoring to identify and analyze cyber threats.
	Alexandru Tocan, Software Engineer CODWER	Exploitation techniques in IoT. IoT vulnerabilities like weak authentication, insecure firmware, and poor encryption. How attackers exploit these weaknesses to gain control or access networks and best practices for securing IoT devices, including strong authentication and secure firmware updates.

## PLENARY SESSION

## Development of nanotechnologies at the Technical University of Moldova between 2001-2024

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**Keywords:** NCMST, TUM, nanotechnologies, research infrastructure, young researchers, international collaborations

**Abstract.** The New Nanotechnology Initiative promoted in the USA at the very beginning of the XXI Century had a strong impact on the development of nanotechnologies in the whole world. Being in 2001 at the University of Michigan in Ann Arbor, I witnessed the process of launching the new initiative. Moreover, in autumn 2002 I attended the Conference organized by the European Commission to launch the EU 6th Framework Programme which had nanotechnologies as an important component. Being impressed by the decision of the authorities in the USA and the European Commission to invest in the development of nanotechnologies, we decided to create a nanotechnological infrastructure at the Technical University of Moldova. We started with the purchase of a Scanning Electron Microscope, an Atomic Force Microscope, equipment for the deposition of thin layers by sputtering as well as of equipment for electrochemical etching and deposition of electronic materials. The nanotechnological infrastructure served as the basis for the creation of the National Center for Materials Study and Testing (NCMST) (<https://ncmst.utm.md/en>). The first collaborators of the NCMST were graduates Veaceslav Popa and Eduard Monaico who contributed much to the successful realization of the first projects on nanotechnologies and nanomaterials. In 2005 our research group got an Award of Excellence at an International Exhibition on New Technologies and Products held in Pittsburgh, USA, for the invention of the so-called *Surface Charge Lithography* which enabled one to create various nanostructures and ultrathin membranes based on GaN and other binary semiconductor compounds. Subsequently we succeeded in the fabrication of

single crystals of pores, membranes consisting of networks of ordered nanotubes, two-dimensional metal-semiconductor photonic crystals etc. *Hopping electrodeposition* developed at the NCMST allowed one to cover complicated surfaces of semiconductor materials by a monolayer of metal nanodots. Later on, our research group succeeded in developing hollow nanoparticles and three-dimensional nanoarchitectures based on GaN for multifunctional applications, including applications in microfluidics and biomedicine. The first artificial material exhibiting dual hydrophobic-hydrophilic properties has been invented, a fascinating result highlighted by Physics World (<https://physicsworld.com/a/hydrophobic-or-hydrophilic-aero-gallium-nitride-is-both/>). Over the years, we implemented important projects, including ones financially supported by the European Commission under the 7<sup>th</sup> EU Framework Programme and Horizon-2020 Programme. In the frame of these projects, many dozens of students have been trained at the NCMST as well as in a number of prestigious foreign research institutes and partner universities, including Royal Institute of Technology (Stockholm, Sweden), Joint Research Centre (Ispra, Italy), Bristol University (UK), Kiel University (Germany) etc. The infrastructure of the NCMST enabled 12 young researchers to defend their PhD theses in the field of nanotechnologies and nanomaterials, while one of them succeeded in defending the Doctor habilitate thesis as well. In the presentation, there will also be highlighted the achievements of other research groups of the Technical University implementing projects related to the field of nanotechnology.

## From Hydrogen Detection to Energy Harvesting: Advances in Self-Sustaining Sensing Technologies from a Materials perspective

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**Keywords:** gas sensing, light- scattering, self-powered magnetoelectric sensors

**Abstract.** The integration of energy supply with sensing technologies is enabling a new generation of autonomous sensors that address challenges in environmental, biomedical, and industrial applications. Recent basic research ideas in self-powered sensors are highlighted, focusing on innovative material systems and energy harvesting strategies that combine detection ideas for sustainable energy systems like fuel cells, electrical systems or living matter.

Ultra-selective hydrogen detection is achieved through core-shell structures featuring tetrapodal zinc oxide (t-ZnO) with a crystalline copper oxide (CuO) coating, which enhances sensitivity at low operational temperatures [1]. This advanced heterostructure demonstrates how surface engineering can improve sensor performance, particularly for environmental monitoring applications.

Building on these innovations, multifunctional t-ZnO-based sensors capable of detecting ultraviolet radiation and volatile organic compounds (VOCs) exhibit robust response and recovery characteristics over a wide temperature range [2]. Such versatility positions these sensors as promising solutions for biomedical applications where multifunctional sensing is crucial. Further extending the scope of functional materials, hybrid CsPbBr<sub>3</sub>/SiO<sub>2</sub> aeroframeworks are presented for efficient light conversion and thermal management in high-intensity laser illumination systems [3]. These functional light diffusers enable uniform light distribution and improved thermal stability,

providing a pathway for integrating light detection and conversion functionalities e.g. for gas sensor technology, see Fig.1.

In addition, self-powered magnetoelectric sensors utilize resonant cantilevers and permanent magnets for magnetic field detection without the need for external power supplies [4]. This approach not only facilitates highly sensitive magnetic field detection for biomedical applications but also enables efficient energy harvesting from ambient magnetic fields.

These advancements demonstrate the synergy between material innovation and energy systems detection and autonomy, offering a pathway to versatile, sensing technologies that meet the needs of future smart systems.

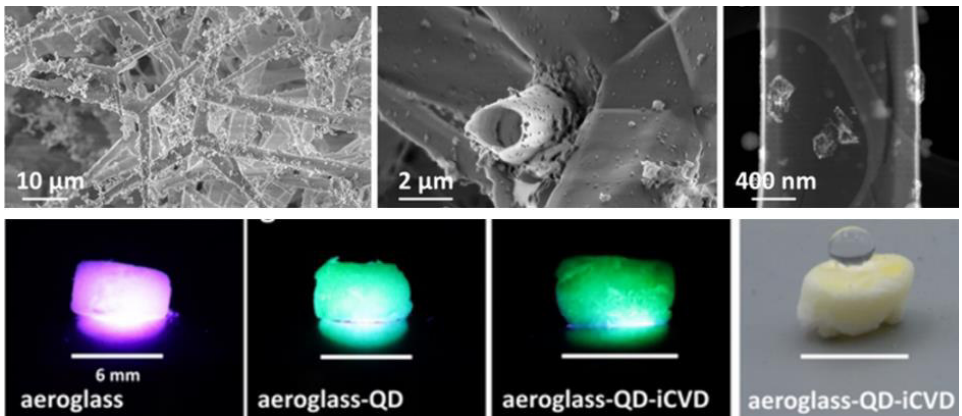


Fig.1. SEM images and photographs of qd-functionalized aeroglass, from [3]

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## Hybrid Nano-Materials for Sensors in Biomedical, Environmental And Industrial Applications

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**Keywords:** Hybrid materials, gas sensor, polymer, biomarker, safety

**Abstract.** Technological advances create opportunities for further research, applications and breakthroughs. Medical, environmental and industrial requirements call for accurate gas sensors with high sensitivity to certain gases and even water resistance. Potentially, sensors based on different methods using metal oxide-based materials as gas sensing structures and tailoring their properties by different techniques, such as nanoparticle doping and coating with different polymers, tend to meet the requirements of the demanding fields.

Fortunately, the possibilities are limitless, as different materials offer unique results. In a recent study TiO<sub>2</sub> coated with V4D4 polymer shows

selectivity towards 2-propanol gas vapor with a response stated as 225% at a relative high operating temperature of 400 °C [1], while Teflon (PTFE) coated TiO<sub>2</sub> shows selectivity towards 2-propanol at 350 °C operating temperature with a response value of 45% [2]. Thus, this shows potential in detecting lung cancer. Another sample of TiO<sub>2</sub> pre-annealed at 610 °C doped with Ag and Pt nanoparticles and coated with V4D4 polymer showed an a selectivity towards H<sub>2</sub> at operating temperatures such as 250, 300 and 350 °C with the highest response of 709% in the last case [3]. Using different techniques such as pre-annealing TiO<sub>2</sub> at 610 °C and coating it with V4D4 polymer, a response of 52% to 100 ppm of ammonia vapor at room temperature and 100% response to H<sub>2</sub> at relative higher operating temperature of 300 °C [4], thus obtaining a sensor that can be used for food quality assessment and as kidney failure biomarker.

**Acknowledgments.** This work was partially supported by the State Program LIFE TECH No. 020404 and No. 020401 at the Technical University of Moldova.

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## Superconducting base elements for brain-like artificial neural network

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**Abstract.** Increasing energy consumption of computers with von-Neumann architecture rose the necessity of energy efficiency and the radical reduction of the power consumption as a crucial parameter constraining the advance of supercomputers. The promising solution is development of the non-von Neumann computers with brain-like architecture – the Artificial Neural Networks (ANN) based on superconducting elements with two main parts: nonlinear switch similar to the neuron, and linear connecting elements similar to synapse [1]. We present results of design and investigation of artificial neurons, based on superconducting spin valves, and superconducting synapses, based on layered hybrid nanostructures superconductor-ferromagnet.

The superlattices Nb/Co demonstrate change of the superconducting order parameter in thin niobium films due to switching from the parallel to the antiparallel alignment of neighboring ferromagnetic layers. We argue that such superlattices can be used as suitable base elements for superconducting spintronics for ANN engineering [2]. Design of the ANN using that two base elements, artificial neurons and artificial synapses, allows construction of the computer with several orders of magnitude lower energy consumption in comparison with the existing computers based on semiconducting elements.

The study was supported by the project of the Moldova State Program «Functional nanostructures and nanomaterials for industry and agriculture» no. 20.80009.5007.11.

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## International projects with new missions of the Technical University of Moldova National Space Technologies Center

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**Keywords:** United Nations Office for Outer Space Affairs (UNOOSA), access to Space for all, satellite development track.

**Abstract.** Nowadays, space solutions are essential to ensure sustainable development and the peaceful use and exploration of outer space. The multitude of space applications such as remote sensing of the Earth, telecommunications and global navigation enhance economic growth and promote technological progress and it is the interest of all countries to have access to them and to obtain the benefits. Access to Space for All is a joint initiative of UNOOSA and space agencies, research institutions and industry that are involved in the development of technical knowledge, engineering processes and infrastructure of the United Nations member states in the fields of hyper- and micro-gravity, satellite development and space exploration [1].

Access to Space for All provides research and orbiting opportunities member states to have access to space and ensure that the benefits of space, in particular, for sustainable development. Space technologies, data and applications already play a key integral role in sustainable development, and their importance becomes even stronger in the coming years, underlining the importance of efforts such as Access to Space for All [1].

UNOOSA and Japan Aerospace Exploration Agency (JAXA) announces annual competition for the United Nations/Japan Cooperation KiboCUBE Programme on nanosatellite deployment from the International Space Station (ISS) using the Kibo Japanese Experiment Module. The National Centre for Space Technologies (NCST) of TUM submitted in 2019 year the nanosatellite project "TUMnanoSAT" to the competition for the 4th round and on August 12, 2022, at 12:45 pm, TUM made history when Moldova's first nanosatellite was deployed into Earth orbit. It is a historic first for the Republic of Moldova, marking the success of the efforts of a group of young researchers from TUM, supported in this ambitious project by development partners UNOOSA and JAXA. This project aimed to stimulate young minds by familiarizing them with aerospace technologies and to provide students with the skills and experiences needed to build pico- and nano-satellites.

NCST participated with project proposal "TUM's Payload Hosting Initiative - 2024" in the framework of The 2nd Announcement of UNOOSA and Mohammed Bin Rashid Space Centre for All initiative United Nations for Cooperation Programme on Payload Hosting Initiative, 2024. This project proposal goals are to verify the asset of two technology demonstration missions, which are of great interest both locally and internationally: assessing the feasibility of using the one COTS GNSS receiver payload module for accurately determining the positioning of satellites in orbit [2] and assessing the feasibility and performance testing of hetero-structures of a set of nano-sensors under space radiation conditions, which can be applied in many fields, including on board the ISS.

Recently, NCST participated with the project proposal "TUM's Payload J-CUBE - 2024" to the J-CUBE Project's International Collaborative Partner-Matching System. JAXA and the University Space Engineering Consortium (UNISEC) have announced CubeSat deployment opportunity from the ISS - JEM Small Satellite Orbital Deployer (J-SSOD) for Japanese universities called "Comprehensive collaboration agreement on CubeSat release from ISS Kibo

module for academic research and capacity building”. As a result of discussions with JAXA and UNISEC NCST has been selected as a partner on The Laboratory of Lean Satellite Enterprises and In-Orbit Experiments of the Kyushi Institute of Technology (Kyutech) from Japan. Recently, discussions on mission determination and the development of a joint CubeSat 2U nanosatellite have been ongoing, which will result in the conclusion with the collaboration contract between NCST and Kyutech.

**Acknowledgment.** This paper is funded by the Moldavian Ministry of Education and Research project ”Satellite systems and platform for monitoring plantations and aquatic surfaces using space and drone technologies”, code 020401.

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## Time-Sensitive Networking: From Theory to Practice

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**Keywords:** Time-Sensitive Networking, Time-Aware Shaper, Credit-Based Shaper, Simulation, Performance Evaluation, Wi-Fi 7, 5G.

**Abstract.** Time-critical communication is emerging as a cornerstone of next-generation networked systems, poised to revolutionize a variety of vertical industries, including industrial automation, autonomous driving, aerospace, healthcare, professional audio/video, and smart grids. These applications demand ultra-reliable communication with stringent requirements such as bounded latency, high reliability, and minimal packet loss. The need to meet these demands has led to the development of IEEE 802.1 Time-Sensitive Networking (TSN), a family of standards that equips Ethernet-based networks with tools and mechanisms to ensure time-sensitive communication [1].

*Challenges.* While TSN has originally been designed for wired Ethernet environments, extending its capabilities to the wireless domain is gaining momentum. Wireless TSN promises to enable more flexible and scalable communication infrastructures, which can either complement or replace traditional wired systems. This evolution opens up exciting possibilities for a wider range of applications, especially in environments where mobility and flexibility are crucial. However, integrating wireless capabilities into TSN introduces several technical challenges, such as maintaining precise time synchronization, overcoming unreliable wireless channels, mitigating latency, and dealing with interference.

Given the complexity of these hybrid wired-wireless systems, there is a growing need for rapid, realistic, and accurate evaluations of TSN-based systems [3].

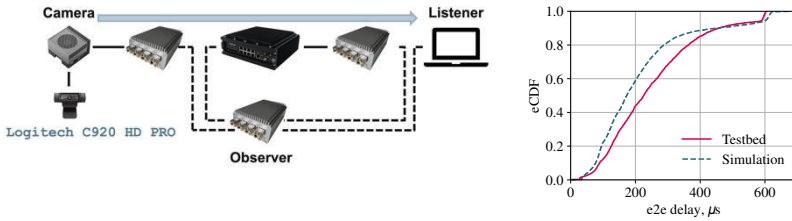


Figure 1: TSN network topology (on the left). Cross validation of TSN simulation and experimental results (on the right).

These evaluations are essential to understand the performance and scalability of TSN mechanisms, supporting their integration into future standards and deployments. Moreover, comprehensive evaluation frameworks are critical for fostering the adoption of TSN across various industries.

**Contribution.** This paper makes several key contributions to this area of research: (i) It provides an overview of the core features and mechanisms of TSN, offering insights into the main TSN profiles; (ii) It explores how TSN features are being extended to the wireless domain, focusing on the integration of TSN mechanisms into emerging wireless technologies like IEEE 802.11be (Wi-Fi 7) and 5G New Radio (NR); (iii) It describes a simulation framework and a real testbed for TSN experimentation and validation (see Figure 1).

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## BIOMEDICAL ENGINEERING

## Analysis of Cloud Biomedical Healthcare Systems Security Based on Matrix Rewriting SRNs With Fuzzy Parameters

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**Keywords:** — cloud biomedical healthcare systems security, fuzzy numbers, moving target defense, performability modeling, rewriting rules, stochastic Petri nets

**Abstract.** Cloud-based Biomedical and Healthcare Systems (CBHS) play an important role in providing access to services for solving widespread problems related to biomedical complications [1]. The sensitive nature of data in CBHS presents considerable challenges regarding its security and privacy, at the same time, CBHS are more susceptible to cyber-attacks compared to conventional computer systems. One of the key functions of the CHBS is the centralized data processing using cloud computing technologies. The aims of this article are the modelling and analyzing of the defense process against cyber-attacks in CBHS.

To address this issue, recently are proposed an emerging proactive defense approach, the Moving Target Defense (MTD) techniques, that aims to thwart attacks by dynamically changing the attack surface and disrupts the attacker's exploration phase [3], leading to complexity and unpredictability, thus confusing attackers by creating asymmetric uncertainties in favor of the defenders, thus reducing the probability of the success of an attack. However, migration services from one cloud Virtual Machines (VMs) to another in the CBHS takes a finite time that delays the service execution and leads to the degradation of its performances. So, we need to evaluate and analyze the impact of using an MTD technique for CBHS defense under uncertainty. We used as mathematical formalism the Stochastic Reward Nets (SRNs) [4], a variant of stochastic Petri nets, because it is conceptually easy to understand

due to its graphical nature and it is well supported by the theory, as well by a large number of existing software tools.

Nevertheless, in this type of models, the fuzzy epistemic uncertainties of the attacker's behavior are not taken into account. So, it is necessary to enhance the SRN in order to fully represent more compactly and flexibly the models that describe complex processes of CBHS and also to evaluate the impact of MTD migration policies in terms of performability.

In this paper we propose the Matrix Rewriting SRNs (MRSRN) with Fuzzy parameters (FMRSRN) for properly uncertainty performability modeling and analysis of CBHS that are enhanced with time-based MTD techniques. One of the key advantages of utilizing FMRSRN for CBHS modeling is that these models have a compact structure, making them flexible for reconfiguration and modification of quantitative parameters during runtime.

The implementation of the suggested FMRSRN method is illustrated through a performability modeling and numerical case study analysis of a specific CBHS.

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## Modeling the Human Circulatory System Using System Dynamics: Possibilities, Benefits, and Practical Applications

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**Keywords:** system dynamics modeling, circulatory system, myocardial infarction, integrated development environment.

**Abstract.** System dynamics is a robust methodology for understanding the behavior of complex systems over time. Employing feedback loops, stocks, flows, and time delays provides a framework for simulating and analyzing dynamic systems. Applying system dynamics to the human circulatory system offers numerous possibilities, benefits, and practical applications that can significantly enhance our understanding and management of cardiovascular health. This article presents experimental results of modeling myocardial infarction conditions based on system dynamics with a six-compartment model built using NetLogo integrated development environment, including BehaviorSpace as part of this environment for simulations. For the analysis of the results, specialized packages in R programming language, Python environment, and Wolfram Mathematica were used. The results show promising fidelity when compared with data described in the literature, as well as real-time patient data.

Fig.1 below presents the user interface for the created system dynamics model, which can be personalized for a specific patient.

Table 1 represents the numerical output of an experiment using the model to simulate the myocardial infarction conditions. The table illustrates the dynamics of six physiological circulatory parameters over time.

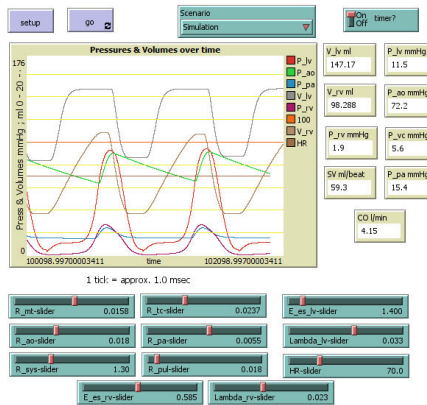


Fig.1. The appearance of the model's user interface.

Table 1. A small portion of the simulation results

Left ventric. press.	Left ventric. output	Right ventric. output	Right ventric. volume	Aortic press.	Vena Cava press.
(mmHg)	(L/min)	(L/min)	(mL)	(mmHg)	(mmHg)
69.24	4.14	4.14	96.68	91.25	4.81
70.32	4.14	4.14	96.54	91.20	4.81
71.42	4.14	4.14	96.36	91.16	4.81
72.52	4.14	4.14	96.13	91.11	4.81
73.65	4.14	4.14	95.87	91.07	4.81
74.78	4.14	4.14	95.58	91.02	4.81
75.93	4.14	4.14	95.26	90.97	4.81
77.09	4.14	4.14	94.92	90.93	4.81
78.26	4.14	4.14	94.54	90.88	4.82
79.45	4.14	4.14	94.15	90.84	4.82

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## Analyze of Quality Assurance (QA) of brachytherapy evolution from GammaMedplus to Bravos System ★

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**Keywords:** Brachytherapy, Bravos, Quality Assurance, high-dose-rate, Iridium-192.

**Abstract:** In this work, we analyze the differences between the QA of operated old GammaMedplus brachytherapy system and the recent implemented lasted model equipment (Bravos), including new dosimetric equipment and facility that is used in treatment at the moment in Moldovan Oncological Institute [1, 2].

*Methods:* The new QA implementation includes introduction of CamScale System (built-in), used for daily measurements of dummy and source cable, elaboration and update of the daily and quarterly (or every source change) protocols.

*Results:* The daily QA with CamScale show an ascending error growth of both source and dummy cable (0.11 mm maximum), but that does not exceed the nominal threshold (0.2 mm). In case of outs of limits or necessity for calibration process is quick and not need special additional equipment.

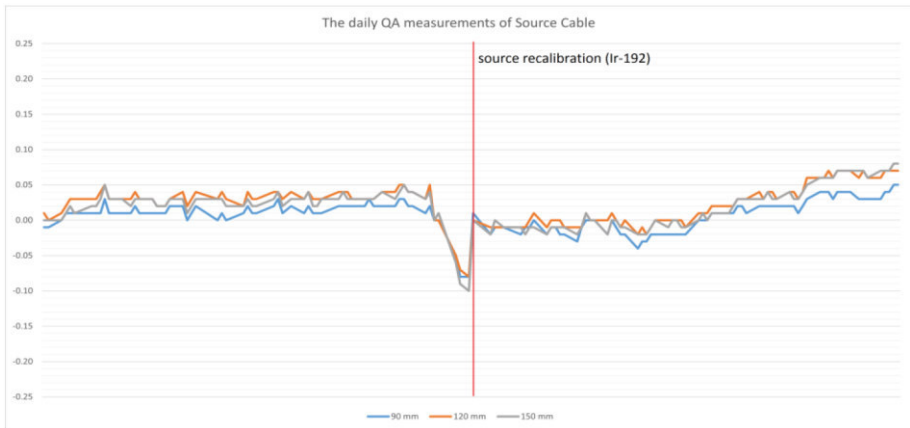


Fig.1. The daily QA measurements of Source Cable.

**Conclusions:** The implementation of the new QA program has improved the precision of source positioning in brachytherapy treatments, thereby enhancing patient safety and optimizing treatment efficacy. This advancement has contributed to a higher overall standard of care in brachytherapy nationwide.

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## Micro- and nano-structured oxides based on Cd- and Sn-doped InSe for volatile organic compound sensors applications

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**Keywords:** photoluminescent, heat treatment, nanowires, nanobelts.

**Abstract.** Indium oxide ( $\text{In}_2\text{O}_3$ ) is a material widely used in electronic devices as electrodes with high electrical conductivity and optical transparency [1]. The properties of this material extend with the transition from monocrystalline and polycrystalline thin layers to nanostructured films (nanowires, nanobelts, nanoparticles, etc.) [2]. In the nanostructured  $\text{In}_2\text{O}_3$  material, together with the characteristic properties of the  $\text{In}_2\text{O}_3$  compound, an intense luminescence in the visible range of the spectrum is emphasized, with maximum intensity in the blue region. In this work, micro and nanostructured  $\text{In}_2\text{O}_3$  and  $\text{In}_2\text{O}_3$ -InSe (Cd, Sn) layers and micro and nanostructures were fabricated by heat treatment (TT) in atmosphere of undoped InSe single-crystalline wafers doped with Cd and Sn in concentrations ranging from 0.25 at.% and 1.5 at.%. X-ray diffraction (XRD) studies, EDX plots and Raman spectra demonstrated that the layer formed on the surface of InSe (Cd, Sn) plates corresponds to the  $\text{In}_2\text{O}_3$  compound. Depending on the thermal annealing temperature, nanowires and nanobelts are obtained from  $\text{In}_2\text{O}_3$  microcrystallites with cubic and hexagonal lattice. The  $\text{In}_2\text{O}_3$  oxide formation process takes place in two steps. At a certain temperature the phase transformation  $\text{InSe} \rightarrow \text{In}_2\text{Se}_3$  and at the second stage  $\text{In}_2\text{Se}_3 \rightarrow \text{In}_2\text{O}_3$  takes place. The surface and edge defects of InSe lamellae serve as initiation centers for  $\text{In}_2\text{O}_3$  nanoforms. The forbidden band edge of the  $\text{In}_2\text{O}_3$  (Cd, Sn) layer is



formed by direct (3.6 eV) and indirect ( $\sim 2.6$  eV) optical transitions [3]. The nanostructured  $\text{In}_2\text{O}_3$  layers formed on the surface of InSe (Sn) and InSe (Cd) nanocrystals upon radiation excitation near the edge of the optical absorption band ( $\lambda=340$  nm) emit a photoluminescent radiation band (PL) covering the visible band (400÷700) nm range, with a well pronounced maximum in the 465÷475 nm region. The PL intensity in the maximum band as well as the PL band contour depend on several factors, such as excitation wavelength, excited beam intensity, temperature and time, and dopant concentration. In this paper, the influence of vapors of volatile organic compounds (benzol, acetone) on the peak intensity of the PL band was examined, from which it was determined that acetone vapors lead to the decrease of the PL intensity. The relaxation process of the PL intensity tends to saturation and is reached in  $\sim 25\div 30$  s and depends on the level of Cd and Sn doping of the primary InSe crystals from which the  $\text{In}_2\text{O}_3$  nanowire arrays were obtained. The ratio of the maximum PL band intensity of the  $\text{In}_2\text{O}_3$  nanowire layer in the initial not-annealed layer with vapor and its stationary PL intensity in vapor environment can serve as a criterion of the time and concentration of vapors, especially acetone vapors. This research was funded by the Ministry of Education and Research of the Republic of Moldova within the subprogramme no. 011210, "Advanced physical methods and UAV-based technologies for complex monitoring, evaluation and modeling" and the international project within the NATO Science for Peace and Security (SPS) program "Advanced technologies for physical resilience of critical infrastructures" (APRIORI), no. SPS MYP G6140.

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## Health Safety Sensors Based on Doped Metal-Oxide Gas Sensing Structures for Formaldehyde Detection

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**Keywords:** Formaldehyde, gas sensor, metal oxide, doped, health safety

**Abstract.** Although known as a toxic and carcinogenic compound, formaldehyde is still used in different industries and occupational settings due to its properties [1] such as sea-food industry [2] and medical human anatomy laboratories [1]. Recent studies [3,4] shows that formaldehyde pollution event at low concentration poses a threat to human health and it may reach even higher concentration values in indoor air of building that in open air. It enters body through the respiratory tract and can be cause of sick building syndrome, can cause asthma in both children and adults as well as some brain diseases, being also associated with the cause of nasopharyngeal cavity cancer and leukemia [3].

Thus, a motivation is growing toward researching and manufacturing acquirable methods and technologies for fast detection of different concentrations of formaldehyde in different industries and conditions which may be metal-oxide based sensor, as they showed a good potential in other works [5]. In this regards, in this paper different structures of copper oxide and zinc oxide doped with different particles have been studied and compared to show the potential of using such sensors and further research.

Measurements resulted in interesting data which showed a relative good response of the studied nanostructures at relative higher operating temperatures such as 300 °C and 400 °C, especially for zinc oxide doped with tin. Also the obtained data showed that at this operating temperatures sensors tend to respond only to gas, escaping the influence of water vapors.

**Acknowledgments.** This work was partially supported by the State Program LIFETECH No. 020404 at the Technical University of Moldova.

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## Photoluminescence Properties of Eu doped ZnO Films under Thermal Treatment

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**Keywords:** Photoluminescence; ZnO films; Europium(III)

**Abstract:** ZnO is a well-established semiconductor, widely used for applications such as biomedical applications due to its wide bandgap and high excitation binding energy. However, challenges such as high operating temperatures and poor selectivity limit its potential. In order to optimize optical properties of this material researchers often explore a dual modification strategy: doping with europium (Eu) [1]. In this paper we present preliminary results on ZnO:Eu<sup>3+</sup> emission spectra related to their technological treatment.

*Experimental methods:* The films were synthesized via a chemical solution approach, followed by thermal annealing [1]. Photoluminescence spectra were recorded at room temperature using as an excitation source a laser diode at 375 nm (Thorlabs, USA). The measurement setup was described elsewhere [2].

*Results:* The PL spectrum of the ZnO:Eu<sup>3+</sup> films measured under laser excitation 375 nm (Fig. 1) display a broad emission band that extends between 450 and 720 nm with a maximum at around 500 nm.

One can distinguish a number of emission bands, that can be attributed to intra-configurational 4f–4f transitions of the Eu<sup>3+</sup> ion. These bands are related to radiative transitions of the Eu<sup>3+</sup> ion <sup>5</sup>D<sub>0</sub>–<sup>7</sup>F<sub>J</sub> (J=0-4), with the barycenter at about ~610 nm (<sup>5</sup>D<sub>0</sub>–<sup>7</sup>F<sub>2</sub>), ~650 nm (<sup>5</sup>D<sub>0</sub>–<sup>7</sup>F<sub>3</sub>), and ~700 nm (<sup>5</sup>D<sub>0</sub>–<sup>7</sup>F<sub>4</sub>). The wide band between 450 and 600 nm can be assigned, as accepted by

most of the researchers, to various defects, and specifically to oxygen vacancies  $V_O$  [3]. When the samples are treated at 550 or 650 °C there is a remarkable change of the emission spectrum with diminishing of the band intensity as well as of the band spectral character. It appears that thermal treatment diminishes the contribution of the radiative centers related to 500-700 nm range. On the other side thermal treatment at 550 °C and 650 °C clearly reveals the vacancies related band at  $\sim 505$  nm, as well as the  $\text{Eu}^{3+}$  related band  ${}^5\text{D}_0\text{-}{}^7\text{F}_4$  at  $\sim 700$  nm.

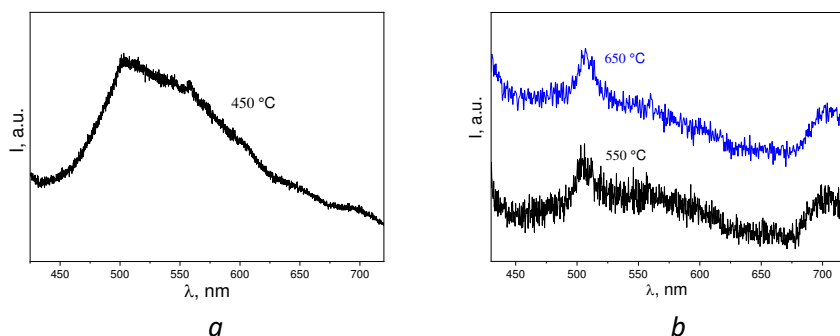


Fig. 1. PL emission spectrum of  $\text{ZnO:Eu}^{3+}$  film treated at different temperatures (450, 550 and 650 °C).  $\lambda_{\text{exc}} = 375$  nm.  $\text{P}_{\text{LD}} = 7$  mW.

**Conclusions:** It was found that variation of annealing temperature of  $\text{ZnO:Eu}^{3+}$  films from 450 to 750 °C alters the character of emission spectrum. On the one side, it reduces the PL emission related to the visible range about 510 – 675 nm, and, on the other side, reveals two distinctive bands at  $\sim 505$  nm, and at  $\sim 700$  nm.

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## Biomedical Systems Sensing Layer Technologies and Networking

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**Keywords:** biomedical system, sensor layer, Internet of Medical Things, biomedical sensors, sensor layer networking

**Abstract.** Biomedical systems use engineering ideas and design in medicine and biology to enhance healthcare results. This area aims to link engineering with medicine by combining the creative and analytical skills of engineering with medical and biological knowledge, leading to better methods for diagnosing, monitoring, and treating patients.

The Internet of Medical Things (IoMT), as a tool for biomedical implementing, refers to a network of connected medical devices, applications, and services that are designed to enable real-time health monitoring and management through the use of internet-connected technology. It combines the capabilities of the Internet of Things (IoT) in the healthcare domain [1], offering significant opportunities to improve patient care, enhance clinical workflows, and facilitate data-driven decision-making for healthcare providers. Overall, IoMT represents a transformative approach in healthcare, emphasizing proactive and personalized care while addressing the challenges of security and patient privacy.

The sensing layer plays a crucial role in the process of collecting and organizing information from various physical devices, it is particularly important in the context of the IoMT, where it interacts directly with medical devices and sensors. In this environment, the sensing layer gathers data from devices such as heart rate monitors, glucose meters, and other wearable technology. This sensing layer serves as a vital connection between the

physical world of medical devices and the digital environment where data are processed and analyzed.

This article aims to review the main approaches and organization of IoMT sensing layer: medical devices and intelligent sensors, biomedical sensors, wireless technologies, communication protocols, reliability and security challenges [2]. The few points that have to be considered especially in IoMT network design: body movements, temperature change, energy efficiency, range of transmission, heterogeneous environment, Quality of Service for real-time applications and security.

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## Microstructure and Mechanical Properties of Nanocrystalline Zr1.0Nb Alloy Obtained by Equal Channel Angular Pressing

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**Keywords:** Zr1.0Nb alloy, microstructure, grain refinement, tensile strength, microhardness

**Abstract.** Recently Zirconium (Zr) alloys obtained new applications as a material for dental and orthopedic implants [1, 2]. Mechanical properties as functional ones are very important for such applications. The changes of microstructure and mechanical properties of Zr1.0Nb alloy processed by Equal Channel Angular Pressing (ECAP) was investigated in this work. ECAP is known to induce the grain refinement of metals and metallic alloys, which in turn improves their mechanical characteristics [3].

*Experimental.* The analysis of the microstructure, dislocation structure and grain size of Zr1.0Nb alloy before and after ECAP was performed by means of transmission electron microscopy (TEM). The mechanical properties were investigated by using the uniaxial static and cyclic tension and microindentation tests. The fractography analysis was applied to study the fracture mechanisms.

*Results.* The TEM results showed the initial grains size of Zr1.0Nb alloy, before ECAP, to be 1.1-2.4  $\mu\text{m}$ , which decreased to 70-280 nm after ECAP processing. Three types of grains were identified depending on their



dislocation structure. The microhardness values exhibit an increase from 1.4 to 1.93 GPa induced by ECAP. The yield and ultimate tensile strength increased as well from 324 to 397 MPa and from 420 to 588 MPa, respectively; at the same time the elongation at failure decreased from 20.2% to 10.8%. Fatigue strength did not show substantial changes for high stresses and demonstrated a drop from 225 to 150 MPa for low stresses. Zr1.0Nb alloy demonstrated mostly ductile fracture mechanism for both before and after ECAP. A transition to quasi-brittle fracture was noticed for low stresses cyclic tension test for ECAP Zr1.0Nb alloy.

**Conclusions.** The ECAP processing of Zr1.0Nb alloy demonstrated a grain refinement up to nanometer size. The obtained nanocrystalline structure led to the improvement of mechanical properties manifested in higher strength and hardness and the same time in rather high fatigue and fracture resistance.

**Acknowledgments.** This study was fulfilled in the frame of the research Subprogram **011201** of the Institute of Applied Physics, Moldova State University.

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## Preparation of ZnFe<sub>2</sub>O<sub>4</sub>/ZnO:Ga/SnO<sub>2</sub> Heterostructure with Peroxidase-Like Activity for the Detection of Hydrogen Peroxide

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**Keywords:** Nanocatalyst, peroxidase activity, magnetron sputtering, thin films

**Abstract.** The study is devoted to the creation of effective nanocatalysts based on semiconductor heterostructures with the property of peroxidase mimetic enzymes. These substances can be used in the colorimetric determination of hydrogen peroxide, participate in various catalytic processes, and also be used in photodestructive reactions of harmful and toxic organic water pollutants (dyes of the textile industry, pesticides, antibiotics and other pharmaceuticals).

New heterostructures of the ZnFe<sub>2</sub>O<sub>4</sub>/ZnO:Ga/SnO<sub>2</sub> composition were obtained by magnetron sputtering [1]. The ZnFe<sub>2</sub>O<sub>4</sub>/ZnO:Ga/SnO<sub>2</sub>/glass film heterostructure was studied in accordance with the standards [2]. Gallium-doped zinc oxide (ZnO:Ga) films were grown on SnO<sub>2</sub> substrates by a similar magnetron sputtering method at direct current using a target and a substrate temperature of 200°C. The magnetron power was 1.2 W. The target (consisting of pressed ZnFe<sub>2</sub>O<sub>4</sub> nanoparticles) was sputtered discretely at a supply voltage frequency of 13.56 MHz and a magnetron power in the range of 40-100 W.

At the second stage, at a substrate temperature of 200°C, ZnFe<sub>2</sub>O<sub>4</sub> films were formed, and the temperature in the sputtering (erosion) zone reached 700°C. The obtained ZnFe<sub>2</sub>O<sub>4</sub>/ZnO:Ga/SnO<sub>2</sub>/glass layers were studied and characterized by such physico-chemical methods as SEM, EDX, AFM, XRD, UV-VIS. The chemical composition was determined using X-ray spectroscopy (EDX), which made it possible to detect the main elements of the structure (O, Fe, Zn, Ga, Sn). The study of the morphology of the layers made it possible to reveal the formation of flexible chain and ring-shaped aggregates with a ribbed structure.

This structure leads to the creation of a developed surface with a roughness level of 15 nm. This in turn leads to an increase in the area of the active contact surface, which leads to an increase in catalytic activity. It is shown that the resulting film heterostructure ZnFe<sub>2</sub>O<sub>4</sub>/ZnO:Ga/SnO<sub>2</sub>/glass has the property of a mimetic peroxidase enzyme and participates in catalytic processes.

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## Semifinal Results of a Research Project Involving Algorithmic Complexity Estimation and Machine Learning

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**Keywords:** Kolmogorov-Chaitin complexity, machine learning, sepsis, epilepsy

**Abstract.** In recent years, the intersection of algorithmic complexity and machine learning has opened new avenues for analyzing continuous biomedical data. This paper presents the semifinal results of a research project focused on estimating Kolmogorov-Chaitin Complexity (KCC) using the Block Decomposition Method. KCC serves as a core feature for machine learning models aimed at predicting sepsis and epileptic seizures. The results highlight the efficacy of these models, with promising performance metrics, and underscore the utility of algorithmic complexity measures in enhancing machine learning models for biomedical applications. By leveraging the inherent complexity in biomedical signals, these models achieve superior predictive performance.

*Methodology.* Kolmogorov-Chaitin Complexity (KCC) [1] is a measure of the randomness or information content of a data sequence. Estimating KCC for continuous biomedical signals involves the Block Decomposition Method, which breaks down data into manageable blocks to approximate complexity.

The KCC values derived from biomedical data are used as primary features in various machine learning models. The objective is to predict medical conditions—specifically, sepsis with a 4-hour horizon and epileptic seizures.

*Data and Experimentation.* Real-world biomedical data were sourced from international competitions, including time-series data relevant to sepsis

and epilepsy. These datasets provided a robust foundation for training and testing machine learning models.

Several models, including neural networks, gradient boosting machines, generalized linear models, and others, were trained using the KCC features.

### Results

Table 1. The machine learning models with the highest performance [2].

Data set	ML model	Performance by AUC
Epileptic EEG set	Word2Vec	96.8%
Sepsis set	Gradient Boosting Machine	95.3%

Note: AUC – area under the ROC curve

*Discussion.* The results underscore the utility of algorithmic complexity measures in enhancing machine learning models for biomedical applications. By leveraging the inherent complexity in biomedical signals, these models achieve superior predictive performance.

*Conclusion.* This research project demonstrates the effectiveness of combining algorithmic complexity estimation with machine learning to predict sepsis and epileptic seizures. With AUC scores of 95.3% and 96.8%, respectively, the models show significant promise for real-world medical applications. Further refinement and validation could enhance their utility in clinical practice.

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## Catalase-like activity properties of Fe<sub>3</sub>O<sub>4</sub>/PVP nanoparticles in the study of Sorghum seed germination processes

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**Keywords:** magnetite nanoparticles, catalase-like enzyme activity

**Abstract.** Since the discovery of the effect of the behavior of ferromagnetic (Fe<sub>3</sub>O<sub>4</sub>) nanoparticles in 2007 by a group of researchers, nanoparticles have shown their own peroxidase-like and catalase-like activity. A cycle of articles, dedicated to similar properties for other nanoparticles, have appeared: CeO<sub>2</sub>, Ru, Pd, NiO [1].

However, nanomaterials with catalase-like activity have rarely been studied. In particular, depending on the acidity of the medium, magnetite nanoparticles as enzyme mimetics can exhibit both peroxidase and catalase properties.

Earlier, we studied the catalase activity of the soil when growing sorghum treated with colloidal solutions of Fe<sub>3</sub>O<sub>4</sub>/PVP nanoparticles. *Sorghum vulgare* was chosen as a test object. The test response is the length of the roots and shoots. The catalase activity was determined by the Galstyan method based on the evolving of oxygen [2].

According to the results of the research, the question of studying the processes associated with seed germination in the first stages, when oxygen plays a decisive role, has appeared. The process of germination of *Sorghum vulgare* seed was simulated. In the presence of Fe<sub>3</sub>O<sub>4</sub>/PVP nanoparticles,

incubated with  $\text{H}_2\text{O}_2$  as the only substrate, oxygen evolving and oxygen production were controlled by an oxygraph (Clark electrode). It has been shown that the amount of evolved oxygen (i.e. catalase activity) depends on the time and concentration of magnetite nanoparticles.

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## Interface Adaptation Design for Extracellular Recordings from Excitable Tissue

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**Keywords:** Tissue, Recording, Conditioning, Instrumentation Amplifier

**Abstract.** For a clear perspective and almost exhaustive regarding physiology life organism, it is important to have the best method to gather this kind of signal and to processing them correctly and do not affect information content. Thus, the method must ensure a good sensibility and a better selectivity. Along this papers it is develop an application how to get physiological signals and how can-do processing of it. On circuit design the main component will be instrumentation amplifier, which fulfill these requests. It was presented an amplifier which is fit for high quality recording of extracellular signals from muscular tissue and nerve. In particular case, it has a gain and bandwidth for a proper action potential, a common mode rejection rate, filtering and internal noise. Input impedance is high and a low consumption are the main key feature of this device. Additional, component costs are very low and have a very compact design. Because of high input impedance of amplifier, is not necessary a specified input impedance. Final experimental results show the viability of the solution chosen by design.

*Design.* To design this kind of device, must looking to basic three function of any biopotential amplifier: amplifier gain, signal filtering, and, which is important when is used to live organisms, protection regarding dangerous potentials. This method can be used as an invasive or non-invasive method. An example of biopotential measurement systems is presented in Fig. 1. Main components are electrodes, amplifier, oscilloscope, interface and conversion to connect to a computer. As seen on Fig 1 the performance of this measurement system depends by amplifier.



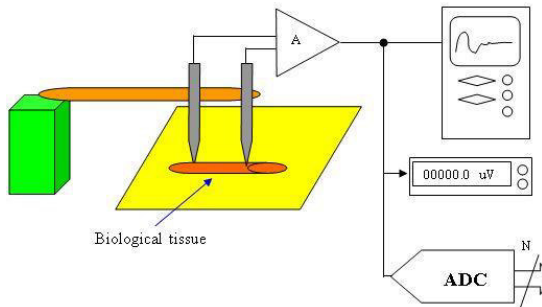


Fig. 1. Measurement system for physiological pulses

Signals can be different types starting with extracellular signals, neuro-physiological signals and brain signals or from muscular activities.

Proposed device is a combination of amplifiers-filters, that main purpose is to adapt physiological signal to easy follow by classical measurement methods. This is important when want to connect this device to a data acquisition system for post processing and memorize them. Only condition of conversion stage is to work at a frequency (which compliant sampling theorem) correlated with cut frequency of low pass frequency, to avoid spectrum aliasing.

For experimental purposes, were design two different schematics, but with the same structure: first use bipolar power supply and inverted amplifier stage and the second use unipolar power supply and non-inverted amplifier stage. Experiments are done using rat sciatic nerve.

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## **ELECTRONICS AND MATERIALS SCIENCE**

## Design and Implementation of a Low-Cost Electrospinning Setup for Nanofibers Fabrication ★

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0000-0003-3293-8645

**Keywords:** Electrospinning, High-voltage control, Material synthesis, Microcontroller-based system, Nanofiber production

**Abstract.** This paper presents an advanced electrospinning device designed for novel nanomaterials production, focusing on its innovative software architecture and open-source approach. The system, built around an Arduino Mega microcontroller, utilizes FreeRTOS for efficient task management and real-time control (see. Figure 1). Developed using PlatformIO, the entire codebase is hosted in an open GitHub repository, promoting collaboration and customization. Key hardware features include a high-voltage source with precise output measurement, an LCD interface for parameter adjustment, and accurate motor control for the syringe pump. The implementation of GitHub Actions ensures cross-device compatibility and streamlines the development process. Custom-written code enhances voltage reading and motor control, adapting to various research requirements. This open-source, real-time operating system-based approach represents a significant advancement in electrospinning technology, potentially accelerating the development of new nanomaterials with tailored properties for applications in tissue engineering, filtration, energy storage etc.

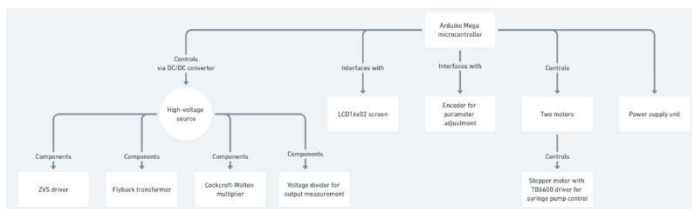


Fig.1. Schematic representation of the custom electrospinning setup

This open-source electrospinning device represents a significant advancement in accessible materials research. Its key advantages include:

- **Cost-effectiveness:** Utilizing readily available components reduces overall expenses.
- **Reproducibility:** Open-source nature and GitHub integration ensure easy replication across labs.
- **Customizability:** FreeRTOS implementation allows for flexible adaptation to various research needs.
- **Real-time control:** Precise parameter adjustment enhances experimental accuracy.

Compared to commercial alternatives, the elaborated device offers comparable performance at a fraction of the cost. The open-source approach also encourages collaborative improvement, potentially accelerating innovation in nanofiber production.

This work was supported by the institutional subprogram #02.04.02 „Development of technologies and investigation of the properties of layered semiconductor compounds, hybrid nanostructures and laser sources” and by the “Young Researchers” project #24.80012.5007.12TC.

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★ award-winning abstract

## Surface excitations in nanocomposites based on porous III-V semiconductors

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**Keywords:** porous semiconductors, nanocomposite, III-V semiconductors, surface polariton, effective medium approximation

**Abstract.** In this work, we investigated porous layers obtained by electrochemical etching of n-type GaAs, InP, and GaP single crystals [1,2]. Electrochemical etching techniques provide wide possibilities for formation layers with different morphology, in particular quasi-ordered array of pore with possibility to control pore shape and size. Far-infrared spectral region is very attractive for the characterization of porous polar semiconductors because, unlike well-studied por-Si for polar semiconductor compounds, the specific region of the Reststrahlen band and also mixed plasmon-phonon mode in doped materials exist. For our samples, we investigated specular reflection that is traditionally enough and attenuated total reflection (ATR) in Otto geometry, with consideration of phonon and plasmon-phonon surface polariton excitation.

The ATR spectra are changed more significantly due to the porosity, and also their fitting curves are more sensitive to the changes in fitting parameters. The results of the fitting made in the isotropic Bruggeman model show that frequencies of longitudinal and transverse optical phonons don't change. Also, they prove the depletion of porous layers by free carriers. Reasonable and correlating porosity values were obtained. Most interesting is that the phonon damping values were changed not so much and we can say that the skeleton

is a good monocrystal. Surface polariton (SP) spectroscopy shows much promise for porous composite medium characterization since SPs are very sensitive to the essential parameters of porous semiconductor layers such as porosity, symmetry, free carrier concentration, thickness, etc. The usage of these porous layers as a skeleton to create composites with organic and inorganic components seems perspective [3].

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## Exploring the Potential of Quasi-One-Dimensional Organic Crystals of $\text{TTT}_2\text{I}_3$ for Thermoelectric Applications

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**Keywords:** Nanostructured Organic Crystals, Interchain Interaction, Thermoelectric Figure of Merit, Renormalized Phonon Spectrum, Peierls Structural Transition

**Abstract.** This paper estimates the potential of using quasi-one-dimensional organic crystals of  $\text{TTT}_2\text{I}_3$  (tetrathiotetracene-iodide) as prospective thermoelectric converters. A comprehensive physical model of the crystal was developed and numerical calculations were performed based on the derived analytical expressions. Along with the free hole and phonon energies and the impurity scattering term, the main Hamiltonian of the physical model incorporates two types of hole-phonon interactions: the first interaction involves the deformation potential and the second interaction characterized by polaron effects. Charge transport along the TTT chains is of band-type, while charge transport between the neighboring molecules in different molecular chains is of the hopping type. The electrical conductivity, Seebeck coefficient, thermal conductivity, thermoelectric power factor and figure of merit were calculated as functions of charge carrier concentrations, temperature and impurity concentration. A detailed analysis of the charge-lattice interaction, including the investigation of the Peierls structural transition in the TTT molecular chains of  $\text{TTT}_2\text{I}_3$ , was carried out, leading to the

determination of the critical transition temperature. Additionally, considering the random phase approximation, the dispersion law of renormalized phonons was examined at different temperatures for two cases: one including interaction between TTT chains, and another where this interaction is neglected.

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## Morphological, chemical and structural characterization of ZnO/ZnAl<sub>2</sub>O<sub>4</sub> micro-nanostructures

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**Keywords:** ZnO; ZnAl<sub>2</sub>O<sub>4</sub>; ternary; spinel type; micro-nanostructures.

**Abstract.** In this work we present a method of obtaining ZnO/ZnAl<sub>2</sub>O<sub>4</sub> micro-nanostructures and their properties. ZnAl<sub>2</sub>O<sub>4</sub> (bandgap ~3.8 eV) is a promising material for use in different applications, as catalyst, optoelectronic, etc., due to its thermal stability, electronic and chemical properties [1–3]. ZnO micro-nanostructures obtained using flame transport synthesis were covered with ZnAl<sub>2</sub>O<sub>4</sub> nanodots using chemical method. At the end the nanostructures were thermal annealed at 1000°C for 3 hours. Morphological, chemical and structural properties have been investigated using SEM, EDX and XRD, respectively. SEM investigation shows the formation of micro-nanostructures with different morphology, namely tetrapods and nanowires, covered with small nanodots (Fig. 1). EDX study presented the chemical composition of the micro-nanostructures, confirming the presence of Al (Fig. 1). XRD pattern of the investigated micro-nanostructures shows presence of ZnO and ZnAl<sub>2</sub>O<sub>4</sub> in the material. Further integration and investigation of sensing properties of devices based on this material is necessary and will be presented in future work.

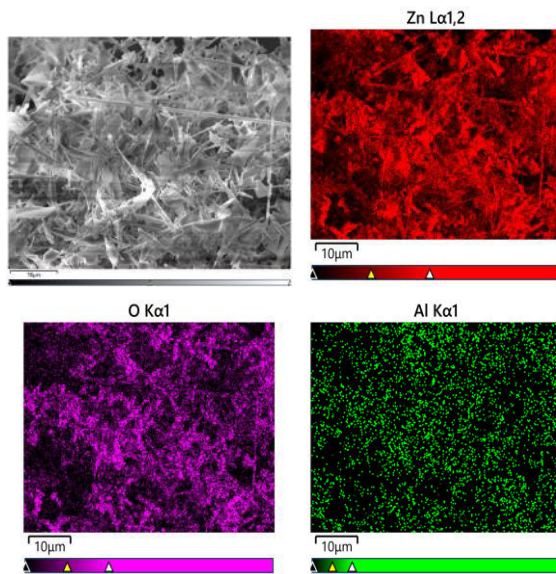


Fig.1. EDX mapping of ZnO/ZnAl<sub>2</sub>O<sub>4</sub> micro-nanostructures annealed at 1000 °C for 3h

**Acknowledgment.** This paper was supported by project code 24.80012.5007.15TC by National Agency for Research and Development of Moldova at Technical University of Moldova.

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## t-ZnO based sensor for optical and gas sensing applications

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**Keywords:** t-ZnO, VOC, UV, mechanism

**Abstract.** This paper investigates the synthesis, structural characterization, and multifunctional sensing applications of tetrapodal zinc oxide (t-ZnO) networks, grown using the flame transport synthesis (FTS) method. SEM images reveal an interconnected network of ZnO tetrapod with crystalline cores, which provide structural stability and enhance electrical contact for sensing applications. XRD analysis confirms the crystallinity and purity of the ZnO networks.

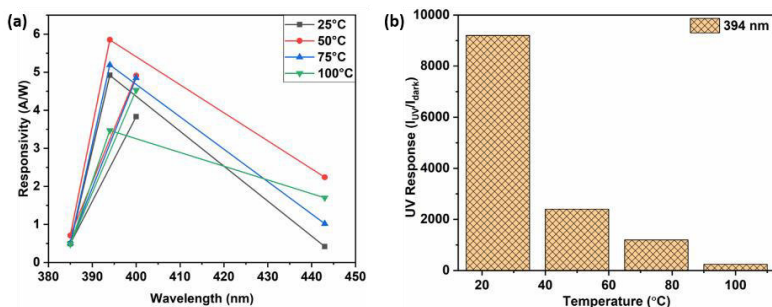


Fig.1. (a) The photo responsivity of t-ZnO networks at different tested wavelengths. (b) The UV response at different operating temperatures.

The photodetection capabilities of t-ZnO were studied under UV and visible light at various temperatures and bias voltages. The highest photo responsivity of 5.85 A/W and external quantum efficiency (EQE) of 1841.1

were achieved at 50°C under 394 nm UV illumination (Fig.1(a)) [1]. The UV response declined with increasing temperature (Fig.1(b)) [1], attributed to bandgap narrowing and increased dark current due to surface oxygen desorption. The paper also explores the gas-sensing capabilities of t-ZnO networks, with selective detection of volatile organic compounds (VOCs) such as n-butanol (Fig.2) [1].

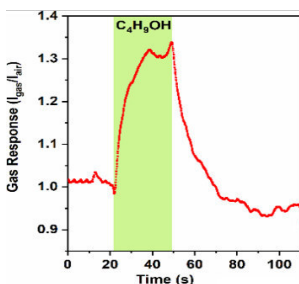


Fig.2. (a) The dynamic gas sensing response of n-butanol at 350 °C for 100 ppm concentration.

The sensing mechanism relies on oxygen adsorption-desorption dynamics [2]. Overall, the study highlights the potential of t-ZnO networks for UV photodetection, and gas detection applications, supported by robust structural and electrical properties.

**Acknowledgments.** This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101072845.

Rajat gratefully acknowledges Kiel University, Germany, Department of Materials Science, Chair of Functional Nanomaterials, and Technical University of Moldova for constant support.

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## Determination of refractive indices of layered GaSe by help of wavelength modulation spectroscopy

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**Keywords:** Interference, refractive index, layered semiconductor, wavelength modulation spectroscopy

**Abstract.** After obtaining graphene [1], the study of layered materials received a second breath. As with other layered 2D structures like graphene, adjacent GaSe layers are bound by the weak van der Waals force [2]. This makes it possible to peel the structure by mechanical or liquid exfoliation [3]. The resultant ultra-thin few or single layer 2D gallium selenide nanosheets or nanoparticles have well-known nonlinear optical properties and a range of applications in areas including integrated optics, optical information communications and biology [4]. Weak Van der Waals bonds of this material allow obtaining samples of various thicknesses. One of the fundamental optical constants of any material is the dielectrical permittivity, and in particular its real part called the refractive index. One of the methods for obtaining this constant is its calculation from the interference fringes at a known sample thickness [5].

The wavelength modulation spectroscopy is a powerful instrument for recognizing of very weak signals [6]. In our case it was used a self-made equipment on the base of high aperture monochromator MDR-2. The samples

of different thicknesses were exfoliated by adhesive tape, and its thicknesses was measured by help of optical or SEM microscopes.

This paper examines the possibility of obtaining interference spectra by measuring wavelength-modulated transmission spectra to obtain a more contrasting interference fringes. It is shown that modulation spectroscopy can be used to more accurately determine the positions of the extrema of interference maxima and minima.

The work was supported by the institutional subprogram 02.04.02 no. 4/FI «Development of technologies and investigation of the properties of layered semiconductor compounds, hybrid nanostructures and laser sources».

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## Sensors for detecting different types of gases: VOCs and battery

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**Keywords:** AlO<sub>x</sub>, ZnO, gas sensor, structures

**Abstract.** In the given work is presented the fabrication of sensors based on AlO<sub>x</sub> on columnar zinc oxide structures utilizing cost-effective methods for gas sensor development.

To obtain the sensors based on AlO<sub>x</sub> on columnar zinc oxide structures, the chemical synthesis from solution (SCS) method was used to obtain the nanostructured columnar ZnO film and atomic layer deposition (ALD) was used to deposit different thicknesses of AlO<sub>x</sub>.

In the same way, AlO<sub>x</sub> can be deposited over CuO nanostructured films [1].

Different types of heat treatments were used to improve the morphological, structural, chemical and sensory properties.

After studying the sensory properties, it was observed that the AlO<sub>x</sub>/ZnO based structures are selective and stable over time to different types of gases. It was demonstrated that the use of 19 nm thickness of AlO<sub>x</sub> on columnar zinc oxide was obtained a sensor for the detection of n-Butanol vapors. Thus, a sensor with a high response to n-Butanol reaching the value of ~ 300 % was obtained (Fig.1). The use of smaller thicknesses of AlO<sub>x</sub> allowed to obtain stable sensors for the detection of 2-Propanol molecules [2].

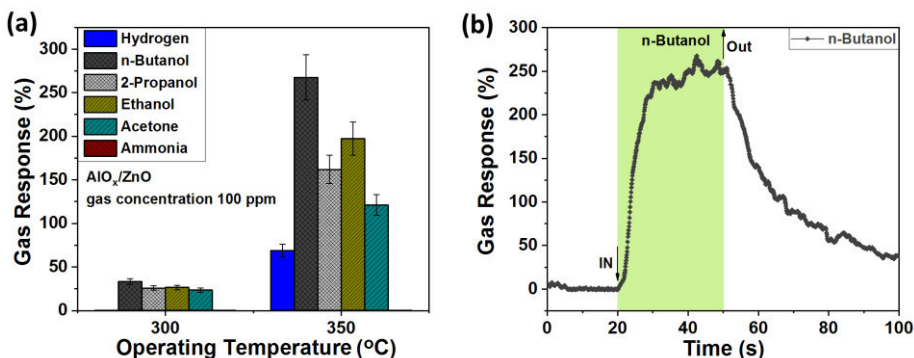


Fig.1. (a) The response of oxide structures to different gases. (b) The dynamic response to n-Butanol molecules.

At the same time, the  $\text{AlO}_x$  structures were also tested with the vapors that are part of the electric batteries. Thus, it was demonstrated that the use of the thickness of 10 nm allowed inding a sensor for  $\text{C}_3\text{H}_6\text{O}_2$  sensing. It has been demonstrated that the given sensor can detect small concentrations of  $\text{C}_3\text{H}_6\text{O}_2$  [3].

### Acknowledgments

This work was partially supported by the State Program and 020401 at the Technical University of Moldova.

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## Al-doped CdS used as light detector

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**Keywords:** cadmium sulphide, sensor, ultraviolet

**Abstract.** Solar radiation, particularly ultraviolet light, can have both positive and negative effects in different fields. Cadmium sulphide is a sensitive material commonly used in the manufacturing of solar panels. This material has potential for usage as light sensors due to its ability to convert solar energy into electricity.

This article examines a CdS doped with Al sample, that was acquired using the chemical bath deposition. EDS-SEM was used to assess the sample's chemical composition. The sample's morphology was examined using SEM. The wavelengths at which the response to light was examined were 280, 370, and 443 nm. These were chosen so that the R2 would be as near to 1 as possible, enabling an accurate comparison of the sample reaction at various wavelengths. At every wavelength under investigation, the sample displayed a noticeable current response.

*Introduction.* Cadmium sulphide is a group II-IV semiconductor with the forbidden band 2.42eV. Cadmium sulfide is widely used in the fabrication of solar panels due to its good absorption of solar energy and subsequent conversion to electricity [1].

The use of a material for doping CdS can help to improve the electro-optical properties and as an expected result it will be possible to use these samples in detectors with fast response to external excitons such as UV radiation [2]. In previously published work is characterized some samples that have been doped with Al, to obtain in result decrease in electrical resistance,

increase in charge carrier density and sensitization of the sample, which could in the perspective could beneficially influence the sample for further use as UV sensor [3, 4].

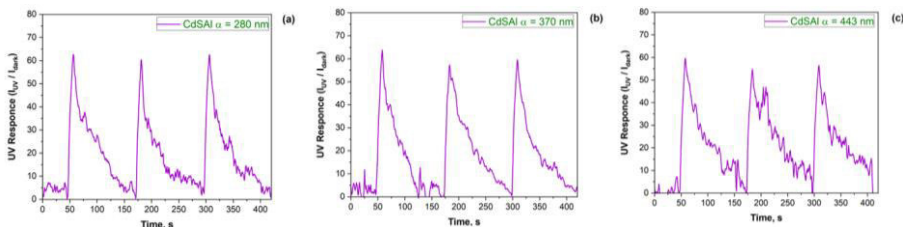


Fig. 2. Response of Al-doped CdS sample at 280, 370 and 443 nm.

For this research, 3 light sources are used, mainly in the ultraviolet range, with wavelengths equal to 280, 370 and 443 nm respectively. Figure 2 provides pronounced responses at all wavelengths.

**Acknowledgments.** The study was supported by the by State Program LIFETECH «Innovations in Biomedical Engineering: Advanced Technologies and Applications for Data Acquisition, Processing and Analysis» No. 020404 at Technical University of Moldova.

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## Semiconducting oxide nanostructures for wideband optical detectors

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**Keywords:** sensor, ultraviolet, heterostructure

**Abstract.** The aim of the research in this work was the determination of selective nanostructures at different wavelengths in the ultraviolet spectrum, used as broadband detectors. The ultraviolet spectrum is used in the industrial field to manufacture integrated circuits, in food to pasteurize food products, in agriculture to enhance plant growth and in the medical field to decontaminate surfaces and in tooth restoration procedures [1, 2].

At the same time, excessive exposure to ultraviolet radiation can cause adverse effects ranging from skin burns to skin cancer [3]. The study allowed to conclude nanostructures based on semiconducting metal oxides that respond to different wavelengths at room temperature. Room-temperature functional wideband detectors allow their integration into low power consumption devices, increasing the lifetime of the device during use.

One principle of using radiation from the UV spectrum is to replace the wireless communication technology widely used today. The advantage of

using this technology consists in the type of omnidirectional communication and the low noise of the emitted signal [4].

**Acknowledgments.** The research was supported by the young researchers Project No. 24.80012.5007.15TC funded by the National Agency for Research and Development and by the Technical University of Moldova.

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## Selectivity control of Ni-doped copper oxide at high operating temperatures

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**Keywords:** nanostructures, doped, sensor, hydrogen

**Abstract.** Gas sensors are of major importance in today's industrial, chemical, agricultural, energy and household fields, and their development for general consumer use is an area of growing interest [1, 2].

This study explores the development and hydrogen sensing performance of CuO nanostructures synthesized via a cost-effective chemical solution method. The nanostructures, composed of copper oxide granules uniformly coated with nickel nanoparticles, were deposited on a glass substrate and thermally treated using rapid thermal annealing (RTA) to minimize defects.

Figure 1 shows the response to several investigated gases, where a high sensitivity to hydrogen can be observed, with responses of 60-70% at high temperatures of 300°C and 350°C. The uniform deposition of Ni on CuO played a critical role in enhancing both sensitivity and selectivity towards hydrogen, while minimizing interference from other gases such as acetone, methane, and ammonia.

The sensor also demonstrated rapid response and recovery times, further confirming its potential for efficient hydrogen detection. These findings suggest that CuO nanostructures offer a promising, cost-effective solution for hydrogen sensing applications, particularly in safety-critical environments where hydrogen leaks need to be rapidly detected.

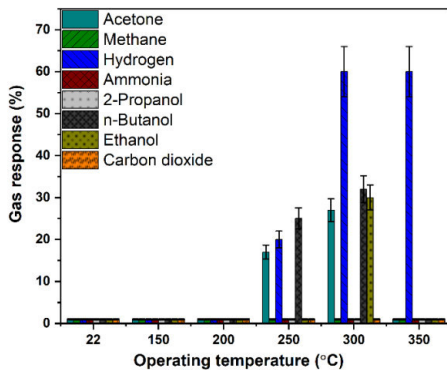


Figure 1. The response of CuO:Ni nanostructures to different gases with concentration of 100 ppm at the different operating temperatures.

The following formula was used to determine the sensor signal [3]:

$$S = \frac{R_{gas} - R_{air}}{R_{air}} \times 100\% \quad (1)$$

The study was supported by the by State Program LIFETECH « Innovations in Biomedical Engineering: Advanced Technologies and Applications for Data Acquisition, Processing and Analysis » No. 020404 at Technical University of Moldova.

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## Growth of ZnO Nanowire Arrays on Various Substrates for Enhanced Glucose Sensing

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**Keywords:** semiconductor nanowires, zinc oxide, gallium arsenide, glucose sensor

**Abstract.** This study explores the potential of zinc oxide (ZnO) nanowires grown on various substrates for glucose sensing applications. The primary aim is to evaluate the electrochemical performance of these nanowires for non-enzymatic glucose detection, focusing on optimizing sensitivity, reproducibility, and selectivity. Initial experiments using a phosphate-buffered saline (PBS) solution demonstrated that the ZnO nanowire-based system can detect glucose.

Substrate selection plays a critical role in determining the morphology and alignment of ZnO nanowires, which directly impacts sensor performance.

Recent studies have demonstrated the advantages of using silicon (Si) substrates for the growth of ZnO nanowire arrays, where the high-density nanostructures significantly enhance the electroactive surface area, improving sensitivity for glucose detection [1,2].

Substrates like indium tin oxide (ITO) showed promise by delivering more ordered nanowire arrays, while gallium arsenide (GaAs) produced more complex growth morphologies [3,4], with potential applications in other analytical areas. GaAs bulk substrates, including GaAs nanowire arrays, offer advanced properties such as higher electron mobility and unique surface chemistry. GaAs substrates allow for more complex growth of nanowires and improved electronic properties, suggesting potential for even greater

performance improvements in glucose sensing compared to conventional Si substrates.

Further work is needed to refine the sensing capabilities and achieve greater selectivity for glucose in complex biological environments, building on previous studies on the influence of nanowire morphology on electrochemical performance, such as those on porous semiconductor compounds [5]. Additional studies will focus on improving system performance and exploring new methods to enhance glucose detection.

The work was partially supported by the institutional subprogram 02.04.02 no. 4/FI «Development of technologies and investigation of the properties of layered semiconductor compounds, hybrid nanostructures and laser sources».

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## Synthesis of nanosized zeolites for VOCs detection

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**Keywords:** Nanozeolites, VOC detection, sensors, acetone, *in situ* IR study

**Abstract.** Detection of volatile organic compounds (VOCs) is essential in many areas such as environmental monitoring, industrial safety and healthcare [1]. Zeolites have recently emerged as promising microporous materials for gas sensing due to their unique properties including different pore sizes, shapes, large surface area, high adsorption capacity, excellent selectivity, and hydrophilic/hydrophobic characteristics [2]. Our previous work has successfully demonstrated the deposition of zeolites onto sensor devices, followed by testing their reactivity on ethanol adsorption [3].

In that context, this work aims at using MFI zeolites structure for VOC detection, addressing challenges of selectivity and sensitivity in real-world conditions. Two different MFI-type nanozeolites, one as pure silica and the other Mo-containing with different particle sizes were synthesized and subjected to further characterizations.

In order to develop a better understanding of their physico-chemical properties and evaluate their behaviour towards acetone detection, the zeolite samples were characterized thoroughly by XRD, SEM, FTIR and *in situ* IR spectroscopy. The zeolites with particle sizes of 100, 200 and 2000 nm are shown in Fig. 1a-c. *In situ* IR revealed that Mo-containing MFI zeolites exhibit lower silanol (-Si-OH) content compared to pure silica MFI, leading to high physisorption capacity for acetone (Fig. 1d-f). Furthermore, acetone was

found to interact more strongly with the silanols of the pure silica zeolite (Si-MFI) than with those on Mo-containing MFI under the same conditions. These findings confirm the potential of MFI type nanozeolites for detection of VOCs.

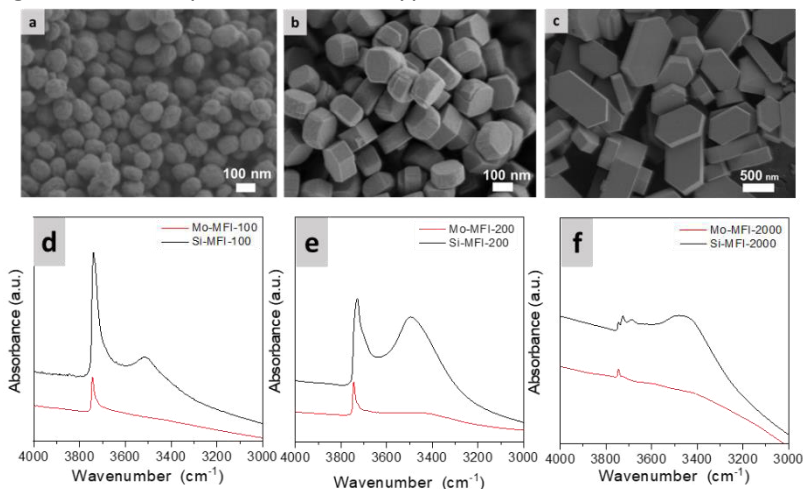


Fig 1. (a-c) SEM images of pure silica MFI zeolites: (a) Si-MFI-100, (b) Si-MFI-200, (c) Si-MFI-2000, (d-f) Corresponding FTIR Spectra of silanol groups.

**Acknowledgment:** The financial support of the MARIE SKŁODOWSKA-CURIE ACTIONS Doctoral Networks project, HORIZON-MSCA-DN-2021 SENNET's acknowledged.

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## The architecture of nanosatellite module for FPGA-based cosmic radiation sensing with artificial intelligence

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**Keywords:** cosmic radiation sensor; FPGA; satellite module; artificial intelligence

**Abstract.** This paper is devoted to the study of cosmic radiation and its effects on electronics, as well as ways to measure it in order to help the idealization of the proposed cosmic radiation sensing satellite module architecture depicted in Fig.1. This module contains two types of standard radiation sensors, an FPGA device and several individual semiconductor memories. The FPGA device contains arrays of radiation sensing elements based on its internal memories while the external memories complement/extend this capability. The module includes an AI model for the classification and real-time analysis of the cosmic radiation-induced fault patterns. This intelligent module could be employed for adjusting and optimizing the radiation tolerance of satellite electronic systems.

The cosmic radiation environment represents radiation risk to all electronic components of Earth-orbiting satellites. The radiating particles in this environment consist mainly of high-energy electrons, protons, alpha particles and cosmic rays [1]. The development of cosmic radiation sensor based on artificial intelligence would give the possibility to more adequately assess the

state of space weather and will give the possibility to mitigate its negative effects.

The architecture of a prototype satellite module is proposed, the objectives being to verify the value of a demonstration mission to assess the feasibility of using a radiation sensor based on artificial intelligence and realized on COTS components. At the core of this module is an FPGA-type circuit [2-4], in which several SEU detector arrays are embedded uniformly placed on the silicon area of the FPGA circuit, in a matrix configuration.

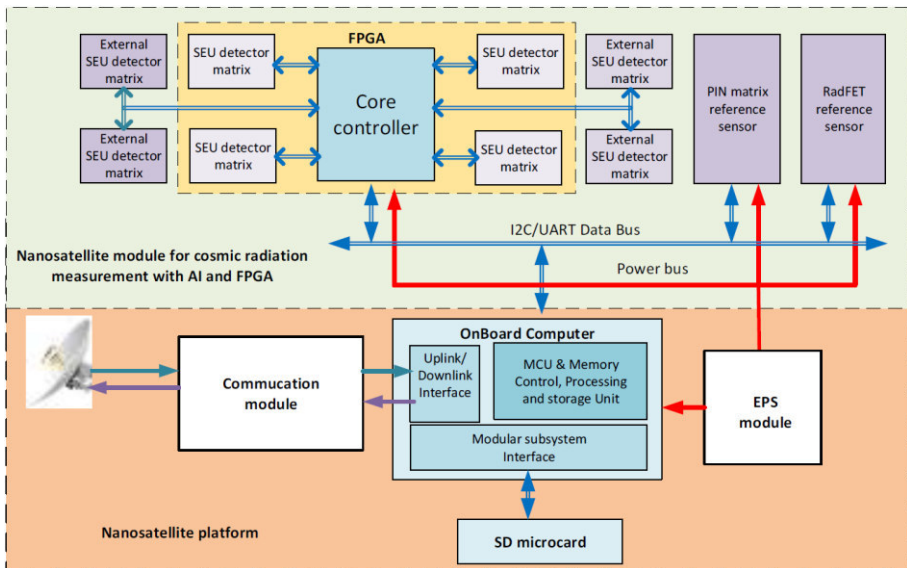


Figure 1. The diagram of the satellite module of cosmic radiation sensors for classification and real-time analysis of cosmic radiation.

The FPGA device will be configured with a custom design aimed at detecting SEUs and then clustering and classifying the patterns using an AI model. The device will be hosted on an auxiliary printed circuit board (PCB) interfaced to the OBC main board through a connector. The four objectives of the AI-based hardware Cosmic Radiation Sensor (AICoRS) system are: i) evaluating the feasibility of using an FPGA device as a cosmic radiation sensor,

ii) measuring and classifying the cosmic radiation patterns, iii) evaluating the effectiveness of SEU mitigating mechanisms (e.g. TMR, ECC) and iv) evaluating the feasibility of using such a modern, low-cost general-purpose FPGA device for space applications.

**Acknowledgment.** This work was funded by the Romanian Ministry of Research, Innovation and Digitalization, project PN-IV-P8-8.3-ROMD-2023-0068 entitled "Artificial Intelligence-enabled Hardware Cosmic Radiation Sensor for Space Applications (AlCoRS)", contract no. 2ROMD/01.06.2024.

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## Picosecond pulse generation by a gain – switched DFB lasers

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**Keywords:** picosecond pulses, DFB lasers, gain-switching, residual Fabry-Perot mode, Bragg mode

**Abstract.** This paper reports on picosecond pulse generation in a gain – switched DFB lasers, modeled by rate equation model. We study numerically the influence of material and geometrical parameters on pulse characteristics.

Recently, picoseconds optical pulses find applications in different fields like free-space communications, bio-analytics, sensing, distance measurements, material processing, and spectroscopy. Such short pulses, can be generated by diode lasers. In addition, the diode lasers connected with other types of lasers, as solid state and fibre lasers can improve the pulse energy and peak power of pulses. Therefore, the theoretical and experimental efforts have been performed to improve the performance (shape, magnitude, etc.) of pulsed generated by diode lasers [1]-[3]. With this in mind, we consider in this paper the generation of picosecond pulses by gain-switching of distributed feedback ridge-waveguide laser diode shown in Fig. 1.

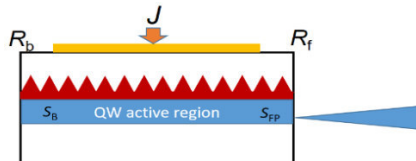


Fig.1. Schematic DFB laser.  $R_b=0.95$ ,  $R_f=10^{-4}$ . Other parameters are as in [4].

The model investigated in this paper aims to simulate the mode competition between the Bragg-mode and the residual Fabry-Pérot modes during switch-on of a DFB laser [4]. The rate equation model for Fabry-Perot

modes *FP* and Bragg mode *B* are treated separately coupled with one equation for charge carriers *n*

$$\begin{aligned} \frac{dS_B}{dt} &= \frac{g_B(n)\Gamma S_B}{1 + \varepsilon S_B} - \frac{S_B}{\tau_{S_B}} + K_B n^2, & \frac{dS_{FP}}{dt} &= \frac{g_{FP}(n)\Gamma S_{FP}}{1 + \varepsilon S_{FP}} - \frac{S_{FP}}{\tau_{S_{FP}}} + K_{FP} n^2, \\ \frac{dn}{dt} &= J - R - \frac{g_B(n)S_B}{1 + \varepsilon S_B} + \frac{g_{FP}(n)S_{FP}}{1 + \varepsilon S_{FP}} \end{aligned} \quad (1)$$

We integrate numerically the equations (1) by studying the influence of different parameters on shape and energy of pulses, under pulse current (red line in Fig. 2). Figure 2 shows also the temporal behavior (black line) of the optical power at the front facet for different thickness and width of laser. One can see the almost symmetric shape and higher peak for small width of active region (Fig.2a). An increase of width leads to a deformation of pulse and lower peak, as well lower pulse energy (see Fig. 2b). We believe that our work provides a good basis for future experimental study of ps pulses generated by gain – switched DFB lasers.

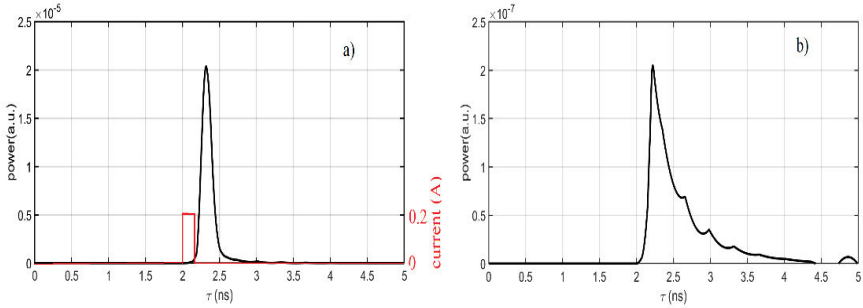


Fig. 2 Pulse generation. a) laser width-4.1  $\mu\text{m}$ , laser thickness -20 nm  
b) laser width-5.1  $\mu\text{m}$ , laser thickness -27 nm.

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## Technological verification of the satellite module for precise determination of the position of satellites in orbit

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**Keywords:** global navigation satellite systems; precise point positioning (PPP), low earth orbits (LEO); artificial neural network (ANN)

**Abstract.** Today, nanosatellite constellations are increasingly used in various missions. Given the complexity of these missions, more precise positioning and maneuvering is required for all constellation components. Recently positioning solutions are based on Global Navigation Satellite Systems (GNSS), such as the Global Positioning System (GPS), the European GALILEO system, which have complied the stringent requirements of satellite constellations.

This paper proposes the development of a low-cost, COTS, point-precise positioning (PPP), multi-constellation, multi-frequency GNSS satellite receiver module for technology verification, enabling positioning accuracy of the order of cm on low earth orbits (LEO). In addition, this satellite module will integrate orbit determination algorithms and positioning modes, which would provide low power consumption, an accurate orbit propagator and an embedded artificial neural network (ANN).

The objectives of the current proposal are to verify the technology demonstration mission, which is of great interest both regionally and internationally: to assess the feasibility of using a GNSS COTS receiver payload module for accurate positioning determination of satellites in LEO orbit. It will be verified that these features increase positioning accuracy when PPP corrections are not available or when lower power consumption is required.



The novelty of this mission also consists in the development of the ANN architecture, which is designed to better exploit information from both an orbit propagator (OP) and GNSS measurements. GNSS measurements alone are typically not accurate enough to allow complex orbital maneuvers such as inspection and formation controlled flight, providing only approximations of the satellite's true position and velocity. The OP's idea is to estimate the position and velocity of the Earth-orbiting satellite at any time in LEO orbits.

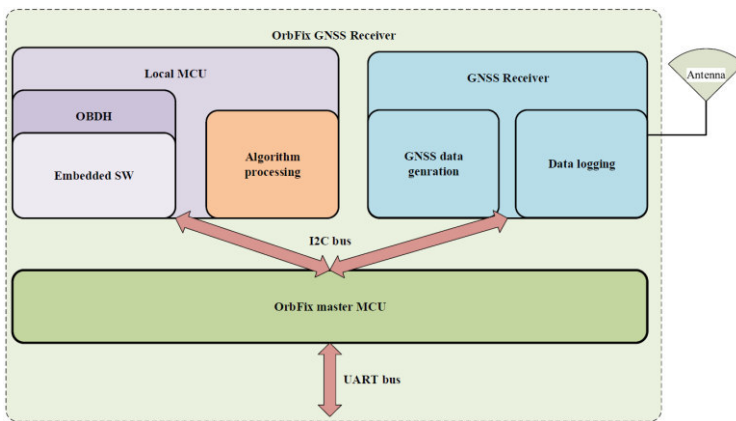


Figure 1. GNSS payload diagram.

**Acknowledgment.** This paper is funded by the Moldavian Ministry of Education and Research project "Satellite systems and platform for monitoring plantations and aquatic surfaces using space and drone technologies", code 020401.

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## Linear and Non-Linear Voltage-to-Frequency Multi-Zone Control of Synchronously Modulated Power Electronic Inverters

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**Keywords:** voltage source inverter, pulsewidth modulation, variable-voltage variable-frequency drive, voltage spectra

**Abstract.** The publication presents a brief analysis of the results of a study of power electronic converters of parameters of electrical energy based on voltage source inverters (VSIs) and neutral-point-clamped inverters (NPCIs) with scalar control modes realizable by algorithms of synchronous multi-zone pulsewidth modulation (SMZ PWM) that can provide both linear and required nonlinear dependences between the output voltage and fundamental frequency of inverters (*Voltage/Frequency (V/F)*). Simulation results showed a behavior of variable speed drives based on inverters regulated in accordance with schemes of SMZ PWM. Thus, correspondingly modified techniques of SMZ PWM applied for adjustment of inverters of variable-voltage variable-frequency drives with both linear and non-linear  $V/F$  scalar control, assure continuous synchronization and symmetry of the phase and line voltages in power conversion installations over the entire control range.

## Picosecond Pulse Generation in InGaN Blue Lasers with Saturable Absorber

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**Abstract.** In this paper we report the results of theoretical investigations of generation of ps-pulses by blue InGaN with saturable absorber. We study numerically, using the single mode rate equations, the influence of wavelength of laser, and the length of saturable absorber on the features of output pulses. We investigate also, the impact of different material and laser parameters on properties of pulses. The mechanism belong to pulse generation is also presented. Finally, we discuss the applications of ps-pulses in distant measurements, free-space communications, material processing and spectroscopy.

Figure 1 shows an analytical model of investigated setup. It consists of an InGaN active layer and a saturable absorber (SA). The active layer is composed by six QWs, and the emitting wavelength is 405 nm. Lasers with different cavity length and wavelengths have been investigated theoretically.

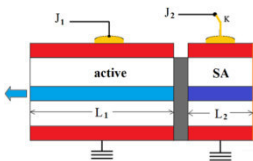


Fig.1. Setup of InGaN laser.

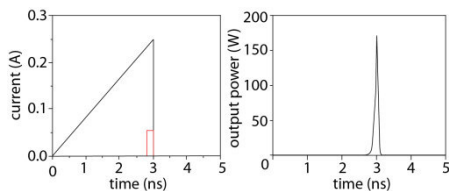


Fig. 2. Principle of pulse generation. a) injected current into active (black line) and SA (red line) sections. b) Generated output pulse.

To simulate the generation of pulses in an InGaN lasers we use the single mode model [1], which is given by the following rate equations for photon number  $S$  and injected carrier number  $n_1$  in active region and  $n_2$  in the saturable absorber

$$\frac{dn_1}{d\tau} = -(n_1 - n_{g1})S - \frac{n_1}{\tau_{s1}} + J_1, \quad \frac{dn_2}{d\tau} = -(n_2 - n_{g2})S - \frac{n_2}{\tau_{s2}} + J_2,$$

$$\frac{dS}{d\tau} = (n_1 - n_{g1} + n_2 - n_{g2})S - B_C(n_1 - n_{g1})S - GS + M(n_1 + n_2).$$

We integrate numerically this set of equations by studying the features of pulses in dependence of laser wavelength and length of SA. Figure 3 shows the dependence of pulse energy and maximum of output pulse on the laser wavelength. One can see that a large wavelength implies a low maximum of pulses, as well as a decrease of their energy. Figures 3 c) and d) shows the dependence of the same pulse features on length of SA. Large SA length lead to low energy and peak of pulse due to the increase of losses in SA. We believe that our work provides a good basis for future experimental study of pico-seconds pulses generated by blue InGaN laser with saturable absorber.

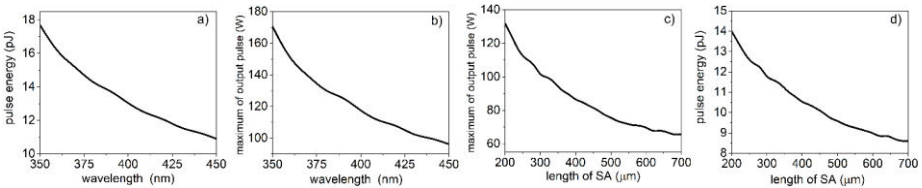


Fig. 3 Dependences of pulse features (energy and peak) on the laser parameters.

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## Flexible Synchronous Regulation of Power Electronic Blocks of Transformer-Based Photovoltaic Stations

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**Keywords:** voltage source inverter, photovoltaic station, pulsewidth modulation (PWM), voltage synchronization, spectral analysis

**Abstract.** Photovoltaic (PV) systems are very popular sources of renewable electrical energy [1]. Voltage source inverters (VSI) are the main workhorses of PV installations, providing controlled conversion of dc voltage from PV strings into the required ac voltage for energy consumers [2]. To ensure synchronization and symmetry of basic voltages of PV inverters at increased power levels, an original strategy and scheme of synchronous modulation have been developed for regulation of inverters of some promising structures of systems [3, 4].

*Basic conception.* Modification of algorithms of synchronous modulation of signals of dual VSIs of the corresponding configurations of transformer-based PV systems, based on smooth regulation of switching frequency of VSIs, subject to equivalence of switching losses in each VSI, improves the spectral composition of winding voltage of the power transformer.

Fig. 1 presents dual-inverter-based PV installation supplied by two strings of PV panels with the operating dc voltages  $V_L$  (lower voltage) and  $V_H$  (higher voltage) [2]. So, to assure equal switching losses in two VSIs, the VSI feeding by the lower voltage  $V_L$  should be functioning at higher switching frequency  $F_{sw-higher}$ , and VSI feeding by the higher voltage  $V_H$  should be functioning at lower switching frequency  $F_{sw-lower}$ :

$$V_L F_{sw-higher} = V_H F_{sw-lower} \quad (1)$$

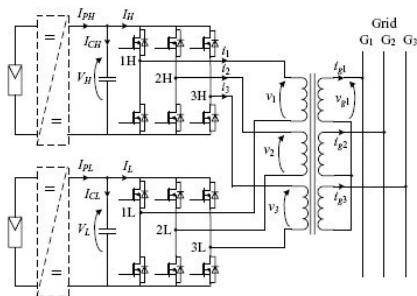


Fig. 1. Two-VSI-based topology of grid-tied PV system with power transformer

*Simulation results and conclusion.* Table presents results of calculation of *Total Harmonic Distortion (THD)* factor ( $THD = (1/V_{11}) \sqrt{\sum_{k=2}^{100} V_{1k}^2}$ ) of the winding voltage  $V_1$  of system as function of modulation index  $m$  of VSIs for two PWM schemes ( $V_L = 0.8V_H$ ,  $F_{sw-lower}=1.2kHz$ ,  $F_{sw-higher} = 1.5kHz$ ), which shows advantage of the using of discontinuous synchronous PWM (DPWM) for PV system, if  $m>0.5$ .

Table. *THD* factor of the winding voltage  $V_1$

$m_L=m_H$	0.3	0.4	0.5	0.6	0.7	0.8	0.9
CPWM	0.15	0.17	0.20	0.23	0.27	0.31	0.35
DPWM	0.24	0.22	0.20	0.18	0.17	0.17	0.18

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## Nodes for sensor networks

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**Keywords:** Nodes, sensors, sensor networks, IoT

**Abstract.** The theoretical aspects of nodes in sensor networks are examined in this article, with a focus on their use in Internet of Things (IoT) applications. Sensor nodes are essential parts that make data processing, communication, and acquisition possible in a variety of settings. The paper examines several sensor network node layouts, communication protocols, and energy-efficient designs [1]. Among the methodologies covered are networking methods and an investigation of low-power wireless communication technologies like MQTT and BLE [2,3]. The theoretical approach assesses the trade-offs between data throughput, communication range, and power consumption among node design characteristics. According to the research, enhancing sensor node performance is essential for increasing network lifespan and enhancing data dependability in Internet of Things systems.

**Acknowledgement.** This paper was supported by project code 24.80012.5007.15TC by National Agency for Research and Development of Moldova at Technical University of Moldova.

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## The Impact of Three-Phase Smart Gate Drivers on the Performance and Safety of PMSM and BLDC Motor Drives

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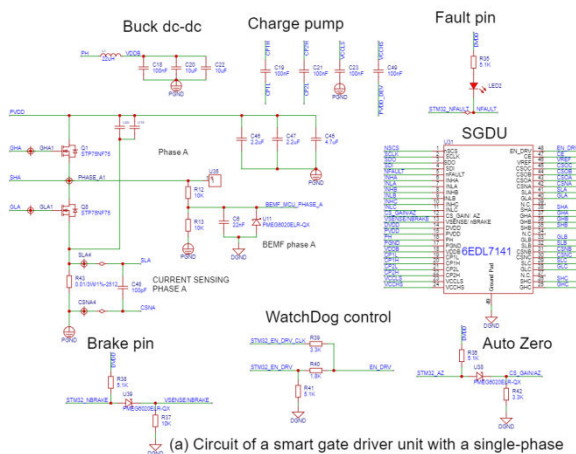
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**Keywords:** smart gate driver, slew rate control, integrated protection, motor control

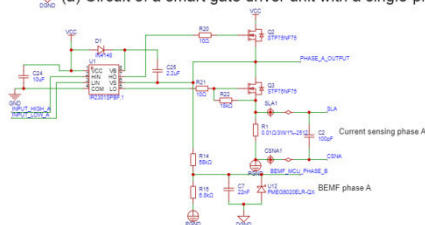
**Abstract.** Three-phase smart gate drivers (SGDs) have revolutionized the control of high-performance permanent magnet synchronous motors (PMSMs) and brushless direct current (BLDC) motors. [1] Smart Gate Drive offers an intelligent solution for driving and protecting the exterior Power MOSFETs. This feature allows system designers to adjust MOSFET slew rate, optimize switching and electromagnetic interference (EMI) performance, reduce bill of materials (BOM) numbers, automatically generate dead times, and provide additional protection for external power MOSFETs and the drive system. This makes them highly effective for use in demanding environments where motor performance and safety are critical and are widely used in industrial automation, automotive systems, drones and robotics.

**Introduction.** This article examines the impact of the three-phase smart gate driver on motor performance and safety. Key advantages over traditional gate drivers will be discussed, including reduced switching loss and increased fault tolerance. For comparison, Infineon's [2] MOTIX™ 6EDL7141 IC, which is a gate driver IC for three-phase BLDC or PMSM applications, and a [3] IR2104(S) which is a high-voltage MOSFET and IGBT, power great. driver with dependent high and low reference output channels. Figure 1 gives the difference between the wiring of an SGD unit and a regular gate driver or three-phase configuration, the former in turn can offer a wide range of settings and built-in protections, and the latter only gate control.





(a) Circuit of a smart gate driver unit with a single-phase



(b) Single phase circuit with common gate drive unit

Fig.1. Circuit comparison of (a) a smart gate driver with additional safety wiring and (b) a conventional single-phase gate driver

The study was supported by the by State Program LIFETECH « Innovations in Biomedical Engineering: Advanced Technologies and Applications for Data Acquisition, Processing and Analysis » No. 020404 at Technical University of Moldova.

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## Virtual Prototyping and Validation of a System for Flood and Fire Risk Mitigation in Wetlands ★

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**Keywords:** wetlands, ecological actions, modular solution, sensors, pilot project

**Abstract.** Our paper presents the virtual prototyping, and the experimental validation of a hardware and software system aimed to use two novel fire and flood sensors based on miniature sensing technology, to process the real-time acquired data using business intelligence tools to provide input for detection of sudden increase in temperature and water level, to generate visual alerts to wetland administering authorities for better crisis assessment and early response to wetland threats. At the end of the project, which was successful from the point of view of the KPIs too, we prepared the system so that potential users could find it on the hosting platform, test and hopefully want to use our solution, docker based and including all the components developed in virtual machines. The simulator was adapted to better match the real sensors.

In this context, a pilot project [1], FF-RIWER (*Flood and Fire Risk Mitigation in Wetlands Using MicroWire Sensing*), was implemented to build and validate a TRL4 prototype of our future *Delta ProEco* platform, through an "experiment" specified and executed [1,2]. The paper describes the FF-RIWER pilot project, where a model of miniature sensors that we needed to monitor temperature and humidity in the Danube Delta was integrated with a software solution.

FF-RIWER had two phases, one to prepare and the second to realize and validate the “experiment”. In the second phase, we did the overall evaluation after the integration with the real sensors. We also prepared the system so that other SMEs could find it on a virtual collaboration (HUBCAP) platform [2,3], test and hopefully want to use our solution, as a dockerized version including all the components developed in the first stage in virtual machines. The experiment carried out was virtualized, with the aim that potential users can download our work and, in a guided way, be able to redo it (as presented in [1]).

At the end, we have a virtualized version of the modular solution, in a docker, the visualizations of the execution results of the dockerized virtual machines that includes all the virtual machines mentioned in [1], and KPIs fulfilled 100% (information published in [1]). We look forward to developing more modules monitoring and eco actions in the Danube Delta, targeting other threats like fish and bird populations dangers, vegetation issues, pollution sources.

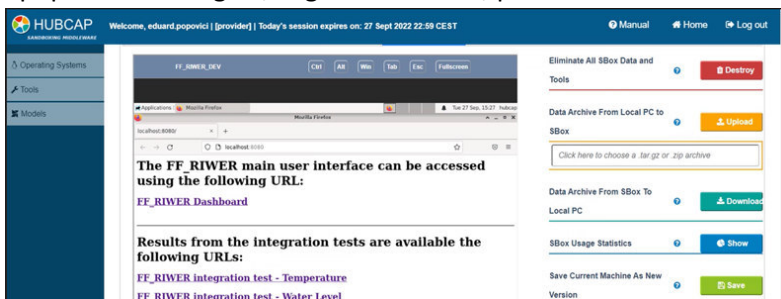


Fig.1. FF\_RIWER experiment in the virtual collaboration platform [3]

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award-winning abstract

## Design and Partitioning Across 2 Strata in 3D IC architectures

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**Keywords:** strata, partitioning, 3D, integration, memories

**Abstract.** The 2D tools used for producing integrated circuits can be adapted for de 3D integration taking into consideration the design, technological files and methodology used for implementation [1,2]. A suitable design for 3D integration using 2D instruments should have about half memory area and half standard cells area, memories going to the 2<sup>nd</sup> stratum and standard cells remaining on the 1<sup>st</sup> stratum [3]. Usually these 2 strata will have different placement utilization, but anyhow much smaller than 100% (this is very depended by design size and shape as well as by memories' size, shape and number). There are custom memories witch allow abutment ("touching each other") on 3 sides and such memories will allow abutment on all 4 sides in 3D placement and, in some cases, this can drive to 100% utilization on 2<sup>nd</sup> stratum. A different category of memories are the small ones which can remain on the 1<sup>st</sup> stratum along with standard cells [4]. The last to categories of memories are exception and depending on the blocks of memory used in the design there can appear more particular scenarios that need to be treated in a specific way [5].

"This research was funded by Ministry of Education and Research from the Republic of Moldova, institutional subprogram #02.04.02 „Development of

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## **SOFTWARE ENGINEERING AND CYBERSECURITY**

## Approaches to secure biomedical informatics systems and networks

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**Keywords:** sensitive information; cyber-attack; impact; healthcare; medical devices

**Abstract.** A significant part of medical information, but especially that related to patient records, is very sensitive confidential information. A health care facility is at risk of becoming completely unable to activate as needed if data from patient i-records are altered or can no longer be accessed. Unfortunately, in 2023, according to [1], the healthcare sector bears the brunt of cybercrime activity, accounting for 14.2% off all attacks targeting critical infrastructure.

The cyber security peculiarities of biomedical informatics systems (HISs) and networks (HINs) are systematized. Based on these particularities and on some statistical data, the acuteness of HISs/HINs' security is estimated. Cyber security standards [2] in the field, briefly described in the paper, facilitate the orientation in the multitude of aspects and requirements of cyber security in various practical situations. Also, some specific solutions [3] for securing HISs/HINs are described. They can serve to define cyber security modalities in concrete cases. The requirements of cyber security and, respectively, the implementation of the respective informatics means in informatics applications, systems and biomedical networks to comply with them depend on each specific case.

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## Reducing cyber risk through a human-centered approach

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**Keywords:** artificial intelligence, cybersecurity, „Golden Circle” method, security culture, educational programs, risk prediction.

**Abstract:** this paper investigates the complex challenges faced by professionals in managing cyber risks during the implementation of human risk management programs. Emphasizing the crucial role of human behavior in effectively mitigating cyber risks, the paper highlights the transformative impact of utilizing the „Golden Circle” methodology. This methodology, which is based on a people-centered approach, initiates conversations starting with „WHY”, articulating the core purpose of the human risk management process and advocating for an „inside-out” approach. By fostering a sense of responsibility and belief in the mission among participants, this approach promotes the sustainability of human risk management practices.

Additionally, the integration of Artificial Intelligence (AI) is explored as a vital component in enhancing human risk management. AI's ability to analyze behavioral patterns, predict potential risks, and automate responses provides an advanced level of security. However, the paper also addresses the drawbacks and risks presented by AI, such as the proliferation of sophisticated



phishing attacks, deepfakes, and other AI-driven threats that exploit human vulnerabilities.

By combining AI with the „Golden Circle” methodology, organizations can achieve a more robust and proactive risk management strategy while remaining vigilant about the potential risks introduced by AI. The paper illustrates the integration of the „Golden Circle” methodology and AI into a human risk management program, offering tips and recommendations for evolving and sustaining the methodology over time to ensure its continued effectiveness in the dynamic landscape of cybersecurity.

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## Cybersecurity in Healthcare: Mitigating Risks in Medical Technologies ★

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**Keywords:** cybersecurity, healthcare, risk, threat.

**Abstract.** The digitization of the healthcare sector is unavoidable and emerging in the 21st century, when society is transitioning from an industrial approach to a knowledge-based economy [1]. The widespread use of Electronic Medical Records (ERM), Internet of Medical Things (IoMT) devices, interconnected devices in anaesthesia and Intensive Care departments has brought major benefits [2]. With the digital transformation of healthcare, cybersecurity has become crucial, based on the following: patient medical data is of major interest to attackers; it has already been demonstrated that devices in the Intensive Care and anaesthesia department such as: ventilators, infusion pumps, anaesthesia devices can be hacked and their configurations can be changed, without the physician knowing [2]; the disruption of medical services has a high impact, with an average loss of \$1.3 million per incident [3]. However, the implementation of cyber security in this area is new and requires a holistic approach [4], as data is collected from a wide variety of devices connected to different networks, wireless and wired. The purpose of the article is to present the threats to the security of the technologies used in healthcare, to highlight the vulnerability of the technologies and to present recommendations for their mitigation.

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## The Digital Tool for Assuring the Documents Submission - Receiving Process for the State Tax Service

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**Keywords:** Submission-Receiving Process, State Tax Service Digital Tool, Financial Documents Processing

**Abstract.** Digitization has become essential in modern society, transforming the way we live, work, and interact. The state institutions, including those in the Republic of Moldova, are no exception to this process, being faced with the need to adapt and transform to meet new technological requirements and rigors. The Republic of Moldova has developed digitization plans to support this modernization process, ensuring an efficient and effective transition to a digital environment.

However, some challenges and issues still need to be addressed, including within the State Tax Service. Among them is the need to improve and optimize the process of submitting and receiving applications, thus reducing the processing time and facilitating the interaction between the institution and taxpayers. The present research describes some aspects of the development of a digital tool for solving the aforementioned problem within STS.

The field in which the present research is related to the engineering sciences, in particular: computer science, information and communication technologies, software engineering, the development and implementation of software products, and the development of software modules able to support the activity of public services in various state institutions.

## A construction of Reed-Muller codes from Boolean functions

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**Keywords:** Boolean functions, Reed-Muller codes, cryptography

**Abstract.** Boolean functions have important applications in cryptography and coding theory. A famous class of binary codes derived from Boolean functions are the Reed-Muller (RM) codes. These were defined by Reed, and Muller built the way of decoding and implicitly detecting and correcting errors. One of these codes (RM(1,5)) was used in 1969 by the Mariner probe to transmit images from the Moon. Each pixel in the image was assigned one of  $2^6 = 64$  degrees of shade, and the six bits of information were encoded in a word of length 32. The RM(1,5) code can correct up to 7 independent errors.

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## Assessing the Adoption of HTTP Security Headers

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**Keywords:** Web security, Security assessment, HTTP headers

**Abstract.** Recent cybersecurity evaluations reveal that many user vulnerabilities are linked to web technologies, mainly stemming from inadequate or improper usage of HTTP headers. [1]

Security headers in HTTP responses provide an essential layer of protection against common web vulnerabilities such as cross-site scripting (XSS), clickjacking, and MIME-type sniffing attacks. These headers, including Content-Security-Policy, X-Content-Type-Options, Strict-Transport-Security, and X-Frame-Options, among others, serve as safeguards by enforcing stricter communication policies between web servers and browsers. [2]

The availability of various tools indicates the increasing significance of using HTTP headers. [3] Although they provide valuable analyses, they are either overly complex and inaccessible, or the simplistic approach lacks comprehensiveness in various aspects of web security.

Therefore, this paper proposes a complex methodology to provide a balanced framework for assessing a website's security. This framework encompasses both traditional web security practices and modern cross-origin protections.

The Web Security Index (WSI) scoring methodology evaluates website security with 150 points. Core HTTP security headers (CSP, HSTS, X-Frame-Options, etc.) contribute 65 points, emphasizing foundational protections.

Cross-origin protections are heavily weighted (40 points) to combat data theft, while HTTP/2 standards account for 20 points. Additional features, including cookies and DNSSEC, add 25 points, reflecting modern security needs.

The research aimed to identify the presence of security headers and calculate the WSI score for specific European nations within the subregions of Europe according to the UN geoscheme. The countries were selected based on a combined index proposed by the ITU, the Global Cybers Security Index 2024 [1], and the evaluation score for each country according to the National Cyber Security Index (NCSI) [4].

The analysis of WSI scores reveals that lower-performing websites universally lack essential security headers, highlighting their inadequate security configurations and susceptibility to various cyber threats. Among the subregions, Northern Europe excels in adopting modern security practices, while Eastern Europe exhibits the most significant deficiencies in security implementations.

This context reinforces the relevance of HTTP security headers in providing a robust shield for users against the pervasive threats that proliferate across the web.

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## Advanced AI Techniques for Analyzing Consumer Survey Responses

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**Keywords:** Consumer survey analysis, Artificial intelligence, Machine learning  
Natural language processing, Ensemble learning

**Abstract.** The paper investigates the application of advanced artificial intelligence (AI) techniques for analyzing consumer survey responses, aiming to predict customer preferences, sentiment, and the likelihood of future product usage. The research integrates methods from pattern recognition, machine learning, and data mining to extract valuable information from company surveys. Natural language processing (NLP) tools are used for linguistic tasks such as morphology, parsing, and semantics. The study explores ensemble learning algorithms, including bagging, boosting, and stacking, to improve classification accuracy. A case study on television services employs a cross-sectional, quantitative survey using self-reported questionnaires distributed online via GoogleForms. Statistical models like Principal Component Analysis (PCA) are applied to the analysis of survey responses, while linguistic models are customized for processing open-text responses. The study also updates the previously developed Clasask algorithm, ensuring its compatibility with scikit-learn's estimator modules, enhancing its performance in ensemble machine learning methods. This approach demonstrates the potential of AI to support NLP tasks and improve decision-making in analyzing consumer behavior.



## Challenges and solutions on the use of Artificial Intelligence in Internet of Things network security

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**Keywords:** artificial intelligence, cyber security, Internet of Things networks, anomaly detection, cyber-attacks, machine learning

**Abstract.** The article is an analysis of how artificial intelligence can be used for the security of Internet of Things networks, emphasizing its use in the detection and prevention of cyber-attacks.

The article focuses on new advances in the use of artificial intelligence for: anomaly detection through machine learning algorithms; automating response processes by reducing incident response time by isolating compromised devices; detecting suspicious activity by strengthening protection against attacks.

Recent research results showing the effectiveness of Artificial Intelligence in securing the Internet of Things have been analyzed: the use of machine learning algorithms to detect DDoS attacks on Internet of Things devices, the implementation of autoencoding for botnet detection, the highlighting of vulnerabilities of unsecured Internet of Things devices and the integration of Artificial Intelligence in security, the development of an intrusion detection system based on recurrent neural networks for Internet of Things networks.

The analysis shows that Artificial Intelligence implementation offers solutions for detecting and preventing cyber-attacks, but there are also challenges related to data quality, detection errors and implementation complexity.

To overcome these, new research directions are recommended: development of algorithms to reduce false alarms, Artificial Intelligence assisted security, data protection by training Artificial Intelligence models directly on Internet of Things devices, use of deep learning to identify and neutralize unknown threats.

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## The Classification Module Intended to Be Used in The Didactic Assessment

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**Keywords:** modular classifier component, labels classifier, supervised learning, educational program product

**Abstract.** The present paper describes one of the modular components of an eventual and complex system that will allow the generation of items to be evaluated in didactic evaluation tests with a pronounced adaptive character. The respective component will be one with the potential to integrate into various Learning Management System (LMS) platforms, such as Moodle , and can be applied by a wide spectrum of users: from teachers and pupils/students/learners enrolled in various forms and/or levels of education to administrators of LSM platforms and LMS-type systems component developers. From the technical perspective, this component is a classifier that turns out to be a fragment of a program product, which interacts with the database (DB), but especially with the LMS system bank question, created by the course developer, in order to satisfy the perspective functions of the software product in the specific aspects regarding the teacher and learner needs [8] during the didactic assessment. The classifier, developed and described in the current material, works based on the labels , and the degree of use of Artificial Intelligence (AI) And Machine Learning (ML) at the implementation level includes it in the category of supervised learning program products. The given work is included in fields such as applied informatics, software engineering, and artificial intelligence and aligns with the national and international trends regarding digitization of the educational system.

## Systemic framework for security auditing and compliance verification of institutional information systems

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**Keywords:** compliance verification, security policies, preventive measures, periodic assessment, risk management

**Abstract.** The current digital ecosystem requires the adoption of robust security policies, aligned with the highest standards and regulations in the field. The efficiency and consistency of preventive measures are essential to ensure the integrity, confidentiality and availability of sensitive information. Cyber security must be integrated into the overall strategy of organizations, especially within institutions with complex and interconnected information systems [1]. This article proposes a systemic framework for security auditing and compliance verification in institutional information systems, based on the premise that security is a continuous process and not a finished product.

In an increasingly complex digital landscape, cybersecurity cannot be considered just a technology issue. Its integration into the global strategy of organizations is essential, given that they operate with interconnected and complex information systems [2]. The implementation of advanced technical measures must be complemented by the periodic evaluation of their effectiveness, according to the relevant standards and regulations. The present research aims to develop a systemic framework for security auditing and compliance verification in institutional information systems. The goal is to provide a comprehensive tool for evaluating, optimizing and constantly monitoring the state of security in organizations. In this endeavor, an integrated approach will be used that includes theoretical analysis and the

development of a systemic model. The research methodology will involve case studies, benchmarking and evaluations of existing security measures [3]. There will be an emphasis on rapid adaptation and evolution beyond conventional solutions, given the increasing cyber attacks on institutions. The implementation of the proposed framework will contribute to the development of an effective security policy, which is not just a static document, but a dynamic and adaptable tool to changes in the cyber landscape. Through this research, it is hoped that significant contributions will be made to the evolution of the field of cyber security and to the strengthening of a more secure and resilient digital environment within institutions.

Cyber security is a continuous and integrated process, and robust security policies are necessary to ensure effective and sustainable protection. The proposed systemic framework for security auditing and compliance verification aims to provide organizations with a tool to assess and manage cyber risks, thus responding to fundamental challenges in the field.

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## A Structured Analysis of Security and Privacy Threats in Large Language Models

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**Keywords:** Large Language Models, Security Threats, Data Privacy

**Abstract.** Large Language Models (LLMs), such as ChatGPT, have rapidly become integrated into daily life, often without a full understanding of their security and privacy implications. As these models grow more influential, two key groups have emerged: one advocating for the shutdown of LLMs due to their numerous risks, and the other calling for the development of ethical guidelines and security protocols [1]. Most of the research literature categorizes the threats posed by LLMs into four major pillars: security, privacy, trust, and ethical considerations [2]. Despite their seamless integration, LLMs present vulnerabilities that can indirectly lead to malicious attacks, placing users and organizations at risk. The exponential advancements in LLM technology have outpaced security measures, leaving critical issues unresolved. This paper aims to analyze these challenges at a broad level, identifying root causes and exploring potential remedies. The goal is to provide an understanding of LLM risks and promote responsible usage through informed guidelines.

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## Real-time communication tools for web applications in a cloud environment

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**Keywords:** cloud computing, analytical research, cloud, cloud technologies, serverless architecture, AWS (Amazon Web Services), load testing, web application, web service

**Abstract.** This research analyzes AWS AppSync's effectiveness in enabling scalable, real-time communication between web applications. It highlights the benefits of serverless models in resource efficiency and cost. A comparison between AWS AppSync and WebSockets via API Gateway is performed, with load testing to assess performance. Despite some limitations like GraphQL constraints and connection caps, AppSync proves efficient for complex, interactive applications. The study outlines key selection criteria, including scalability, integration, security, and cost, concluding that the choice depends on the application's specific architecture and needs.

*Outline of the main material.* Cloud computing, with benefits like cost reduction, flexibility, high availability, and robust data security, has become essential for modern businesses. Alongside this, real-time communication has emerged as a critical technology for immediate information exchange, enhancing decision-making speed, customer support, and operational productivity [1].

A separate area within cloud technologies is serverless computing, a cloud model where resources are dynamically allocated by the platform without needing a fixed infrastructure. Serverless solutions automatically scale resources according to demand, making them ideal for real-time communication applications that need to handle varying user loads [2].

In our research, we compare two serverless technologies for RTC in web applications: AWS AppSync [3] and WebSockets through API Gateway [4, 5]. Both provide real-time, low-latency communication capabilities, ensuring that updates are promptly delivered to users. AWS AppSync, which uses GraphQL, allows efficient querying and manipulation of data in real time, while WebSockets through API Gateway provide a more traditional, lightweight messaging protocol for low-latency updates.

*Conclusions.* The comparative analysis of the testing results indicates that AWS AppSync is a competitive option for building real-time communication systems in a cloud environment. AWS AppSync offers seamless integration with other AWS services and robust security features, making it a strong choice for developers building secure, scalable, real-time applications. However, constraints such as connection caps and performance limitations with large datasets need consideration. The cost-effectiveness of these technologies, especially for complex queries, highlights serverless computing as an optimal solution for many modern web applications requiring real-time communication.

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## Leveraging AWS EMR for Scalable and Efficient Neural Network Deployment in Cloud Computing

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**Keywords:** cloud computing, analytical research, cloud, cloud technologies, serverless architecture, AWS (Amazon Web Services), Elastic MapReduce, neural networks, web service

**Abstract.** This research investigates the potential of AWS Elastic MapReduce (EMR) as a cloud-based solution for building and deploying neural networks, focusing on its performance, scalability, and flexibility compared to traditional on-premises systems. The study offers a comparative analysis of stochastic neural networks deployed using AWS EMR Serverless, with financial data from Google Finance used to assess model performance through the Root Mean Square Error (RMSE) metric. The results highlight the advantages of cloud-based machine learning, particularly in handling large-scale datasets.

*Outline of the main material.* Cloud computing's ability to dynamically scale computational resources is very crucial for training large neural networks that require significant processing power. AWS EMR provides access to advanced hardware, such as GPUs and TPUs, which accelerates the training process and reduces the time to results. This capability makes cloud platforms like AWS EMR attractive for complex machine learning tasks where traditional infrastructure falls short [1].

Large datasets require robust computational resources, and AWS EMR Serverless offers a scalable infrastructure that automatically allocates and releases resources based on demand. By distributing loads across processors or GPUs, AWS EMR efficiently handles parallel processing, making it ideal for high-performance machine learning projects [2].

In this study, financial data from Google Finance is used to train neural networks for predicting stock price fluctuations [3]. The architecture features a Flask web server that interacts with the EMR cluster, along with Amazon S3 for storing models and data. AWS EMR Serverless optimizes resource allocation, preventing over- or under-allocation, and supports open-source tools like Hive and Spark [4].

Though AWS EMR Serverless excels in large-scale data processing, it may be less efficient for smaller datasets that can be managed on a single machine. Nonetheless, its ability to manage vast datasets and complex models makes it well-suited for large-scale machine learning tasks.

*Conclusions.* In conclusion, combining neural networks with AWS EMR opens new possibilities for researchers and developers by offering a scalable, efficient, and flexible environment for AI projects. As cloud technologies evolve, their role in supporting large-scale machine learning will grow, making them critical tools for modern AI development. This study provides insights into the effective use of cloud infrastructure for machine learning, offering guidance for future deployment strategies.

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## Cybersecurity Risks and Mitigation Strategies for SMEs: A Focus on the Republic of Moldova

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**Keywords:** information system, security, SME

**Abstract.** The digitization of small and medium-sized enterprises (SME) is taking place at a rapid pace in recent years. SMEs carry out different business processes that are based on information systems [1]. ENISA's 2021 report reflected a major increase in the dependence of activities carried out by SMEs on IT technologies [2].

Technological progress adds competitiveness and can help increase the annual revenue of businesses, but it also causes cyber risks. The World Economic Forum assessed in 2021, that the failure of cyber security in SMEs is assessed as the 4th major global risk [3]. Carrying out a gap analysis of various scientific studies carried out in Great Britain, Australia, the European Union, Malaysia and the USA, it was determined that the main threats to information security in SMEs are: social engineering, DoS/DDoS attacks and MitM attacks [4].

In the article, the factors influencing the limitation of the implementation of a security framework/model/standard in SMEs were determined. Recommendations adapted to micro-organizations and the context of the

Republic of Moldova were formulated. It was determined that there are no decisions or laws at the state level, recommendations were made to mitigate the highlighted problems.

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## COMPUTER SCIENCE

## The likelihood function based on uncensored/censored statistical data for Min-PSD(Max-PSD) and Max-PSD(Min-PSD) as lifetime distributions in network reliability

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**Keywords:** lifetime distributions, Power Series Distribution, serial-parallel and parallel-serial networks, likelihood function, maximum likelihood estimator.

**Abstract.** In our paper general formulas for the likelihood function are derived in the case when uncensored/censored statistical data refer to the lifetime of serial-parallel and parallel-serial type networks when the lifetimes of the system units are independent, identically distributed random variables and the number of subsystems and the number of units in each subsystem are random variables with power series type distribution. The formulas can be applied to obtain maximum likelihood estimators for the parameters of the lifetime distribution of the mentioned networks. The results are illustrated by examples of concrete probabilistic models.

The problem of obtaining maximum likelihood estimators for the lifetime distribution parameters of serial-parallel and parallel-serial networks described in [1], first requires knowledge of the likelihood function based on both uncensored or uncensored statistical data. Since dynamic probabilistic models have already been launched and researched for the mentioned networks, following which the most general analytical formulas were obtained [2,3], it is natural that they have a similar continuity in the case of the likelihood function.

The general formulas that serve as the source for calculating the Likelihood Function which represents the cumulative distribution functions (c.d.f.) of the lifetimes of the networks, respectively, of serial-parallel type and

parallel-serial type [2,3]. Using them, we show how the Likelihood Function looks both in the case of uncensored data and in the case of censored data according to the methodology described in [4].

Finally, our conclusions are the following:

General formulas for determining c.d.f. of lifetimes is a large source of dynamic probabilistic models for serial-parallel or parallel-serial networks, but also a basis for writing the Likelihood Function, when the data are uncensored or censored. Writing the likelihood function for censored data becomes simpler, because it does not depend on the type of lifetime as r.v. (discrete or continuous), using only c.d.f.. The examples given show that finding the maximum likelihood estimators becomes a maximization problem that can be solved, as a rule, by numerical methods, implemented, in particular, in the Mathematica System.

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## In Situ Measurements for the Validation of Sentinel-2 Data

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**Keywords:** remote sensing, Sentinel-2 data, NDVI, entropy, agricultural crops

**Abstract.** Validation of remotely-sensed data is crucial for the massive adoption of applications fostering remote sensing data. In the framework of the Copernicus program, the Sentinel-2 data are an invaluable source of information for agriculture. In this abstract we perform two types of in situ measurements for the validation of Sentinel-2 data: (i) by using an FieldScout NDVI meter – which is a portable device capable of instantly measuring the Normalized Difference Vegetation Index [1] widely used for assessing the status of vegetation, and (ii) by using hyperspectral images acquired with the SPECIM IQ – which is a portable camera within the VISNIR (visible and near infra-red) domain (400-1000 nm). From the hyperspectral images acquired in situ we computed the entropy for each spectral band corresponding the Sentinel-2 multi-spectral instrument (MSI), as entropy is often use for the evaluation of grassland quality [2]. We show experimental results from two typers of agricultural crops – common spring wheat and grassland. We notice that the in situ NDVI measurements usually exhibit larger values compared to the NDVI values computed based on the Sentinel-2 data, while the entropy values are usually larger for the satellite data.

*Experimental results.* In Figure 1 we show the validation of NDVI measurements based on the Sentinel-2 data using the in-situ measurements performed with an NDVI portable meter. The validation is performed for a parcel on which common spring wheat was grown in 2023. On September 22, 2023, 15 ground-based NDVI measurements were taken and shown as a box



plot over the NDVI time series computed on Sentinel-2 data. The NDVI values measured in the field ranged from 0.29 to 0.32, with an average of 0.31. The average of the NDVI values computed from Sentinel-2 data between the closest dates (12 and 27 September 2023) is 0.23. One may notice a difference of 0.08 between the average of the values measured in the field and the average of the values calculated using Sentinel-2 images. The entropy values are shown in Table 1.

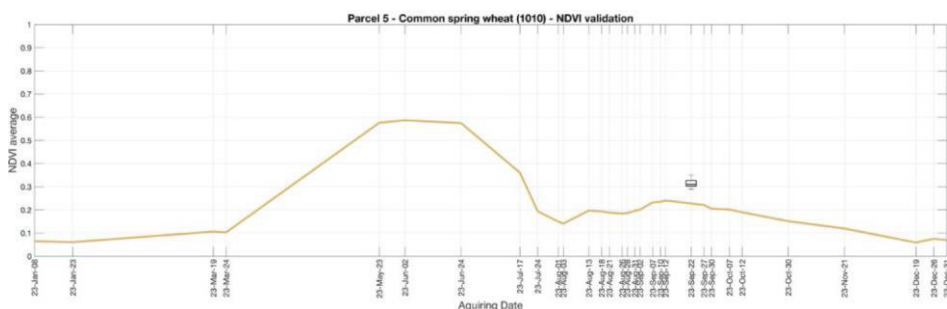


Fig. 1. Graph with validation of NDVI values. The average NDVI values over the year 2023 and a *box plot* of NDVI values measured in situ.

Table 1. Entropy values computed based on the hyper-spectral images acquired in situ ( $H_{in-situ}$ ) and based on Sentinel-2 data ( $H_{S2}$ ) for 10 spectral bands of Sentinel-2 MSI.

band	B1	B2	B3	B4	B5	B6	B7	B8	B8A	B9
$H_{in-situ}$	4.108	4.125	4.093	4.030	4.125	4.132	4.102	4.064	4.093	3.819
$H_{S2}$	4.187	4.160	4.179	4.142	4.229	4.195	4.191	4.243	4.257	4.184
$\Delta H$	0.081	0.035	0.086	0.112	0.104	0.063	0.089	0.179	0.164	0.364

**Conclusions.** In our experiments, the Sentinel-2 data lead to more pessimistic NDVI measurements compared against the in-situ validation data. From an application point of view, this may leave to a false positive alarm which is preferably over a false negative alarm. The difference can be explained by various factors, as every involved equipment (i.e. Sentinel-2 MSI, FieldScout NDVI Meter) has its own characteristics and performance. In addition, the

atmosphere and the associated correction for the satellite data can affect the remote sensing measurements. The slight disagreement in the NDVI measurements can be mitigated [3]. For the entropy, the Sentinel-2 data showed larger values, confirming the larger spread of the data and consequently indicating more optimistic values which can be erroneously interpreted as higher quality grassland. On average, there was a difference in entropy of 0.1277.

**Acknowledgment.** Funded by the European Union (EU). The AI4AGRI project entitled *Romanian Excellence Center in Artificial Intelligence on Earth Observation Data for Agriculture* received funding from the EU's Horizon Europe research and innovation program under grant agreement no. 101079136.

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## Implementation of Artificial Intelligence in engineering teaching and learning

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**Keywords:** engineering teaching; artificial intelligence; tutorial-type teaching; personalized study tasks; knowledge estimation

**Abstract.** This paper is concerned with increasing the efficiency of teaching and learning in engineering by applying artificial intelligence (AI) techniques and technologies. An approach to realize the personalized intelligent tutorial system (ITS) is proposed, which would be more oriented to the specifics of engineering teaching. The key-idea is to create a subsystem for generating personalized tasks to students in the form of a decision module based on binary and fuzzy logic rules. Intelligent tutoring systems are characterized by storing three types of knowledge base [1-3]: a) domain knowledge, b) learner knowledge, and c) pedagogical knowledge. It is these types of knowledge that also determine the three main parts of the ITS architecture: a) domain knowledge creation/development applications, learner knowledge assessment modules and pedagogical knowledge creation/development modules. The scheme of an ITS with the information flow in this system is proposed (see Fig. 1), in which the key component of the ITS is the intelligent generator of personalized tasks for each student. This module is a dedicated tool that generates recommended tasks for each student on what they need

to do next. The ITS recommends topics and learning resources based on previous long-term performance and the student's psychological profile. The

ITS must possess three main capabilities:

a) Estimates of the student's learning model; b) personalized tasks and recommendations for learning to be achieved; c) the ability to store, retrieve and modify a calendar that schedules both subjects and individual learning tasks.

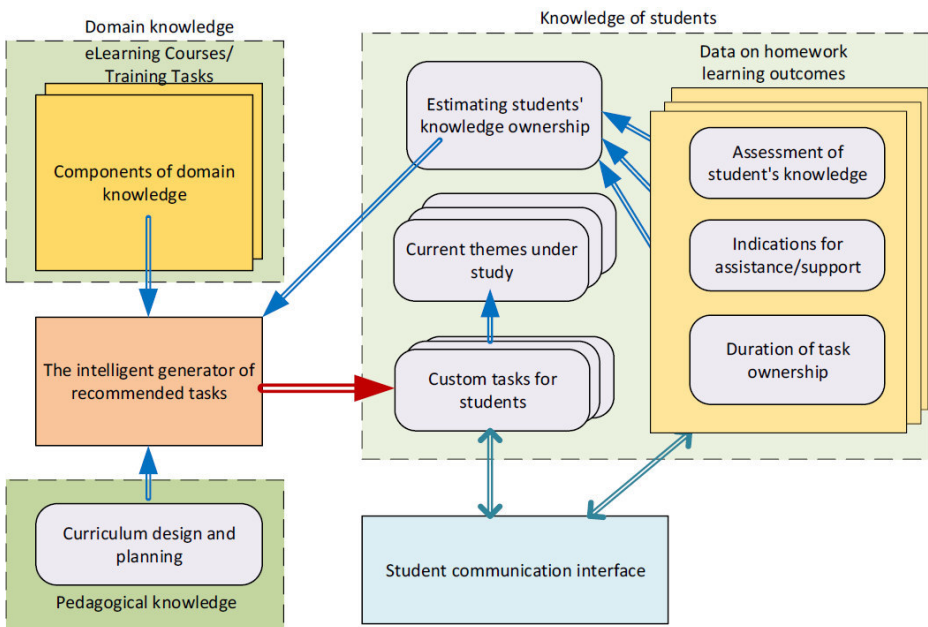


Figure 1. Data/information flow in the AI-based tutorial system.

These capabilities provide three ways in which a student can consider a learning task: a) the overview pane that lists all available tasks, b) the currently recommended resources; and c) the resource appropriation calendar. We propose that the task generator is realized as a decision system with a mixed rule base (with binary and fuzzy logic). As input information are the knowledge components of domain and the estimation of knowledge possession of each student. The output will be the list of personalized tasks for each student at a

concrete stage of the study process. The mode of forming individual tasks for students presents a heuristic algorithm managed by decision rules. These rules are created and dynamically developed/modified by the credentialed teachers for ITS development.

The proposed vision refers to the case of self-regulated study, (more typical for the engineering university environment), where tasks and recommendations have a more central role, helping students to go through the material efficiently but under their own control.

**Acknowledgment.** This paper is funded by the Moldavian Ministry of Education and Research project "Satellite systems and platform for monitoring plantations and aquatic surfaces using space and drone technologies", code 020401.

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## Synthesis of the control system of the manipulator robot

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**Keywords:** mathematical model, control algorithm, PID controller, stability degree

**Abstract.** The manipulator robot is composed of a series of subsystems: actuators (DC motors); mechanical transmissions (gear reducers); articulated bars connected by rotational couplings (mechanical structure). According to the control strategy of sequential positioning of the robot's individual joints, the controlled elements are the DC motors in each coupling, while the mechanical structure subsystem becomes a source of disturbances.

In this case, the control problem with the manipulator is reduced to the determination of the mathematical model of the DC motor and the synthesis of the control algorithm (PID controller) that ensures the imposed performance of the system.

The mathematical model of the selected DC motor CЛ-361 has been determined analytically and is represented by the transfer function

$$H_m(s) = \frac{\Theta_m(s)}{U_a(s)} = \frac{3027.2}{s^3 + 223.52s^2 + 12133.14s}, \quad (1)$$

where  $U_a$  is the voltage applied to the rotor (control value);  $\theta_m$  – rotor position (the control parameter, in radians).

Analyzing the transfer function (1), it is observed that the control object contains astatism. The presence of astatism leads to zero steady-state error for the unperturbed closed-loop system. It follows that it is sufficient to use a proportional P controller to achieve a zero steady-state error.

In accordance with [1, 2], for industrial robots performance indices, are required that lead to a critically damped response and it is recommended the overshoot  $\sigma < 5\%$  and settling time  $t_s < 1s$ .

For synthesis of the P controller, the Maximum Stability Degree method is proposed, which provides the designed systems with aperiodic processes and a short settling time [3]

$$J = \sqrt[r]{\frac{a_{r-1}}{ra_0}} = \sqrt{\frac{a_2}{3a_0}} = \sqrt{\frac{12133.14}{3}} = 63.6; \quad (2)$$

$$k_p = \frac{1}{k} [a_0 J^r + a_r] = \frac{1}{k} [a_0 J^3 + a_3] = \frac{63.6^3}{3027.2} = 84.98, \quad (3)$$

where  $J$  is the maximum stability degree;  $k_p$  - the tuning parameter of the controller;  $a_i, i = (0, \dots, r)$  - the coefficients of the transfer function (1);  $r$  - the order of the transfer function of the control object.

However, as a result of the simulation in Matlab Simulink of the designed control system, it was found that the use of a proportional controller does not eliminate the steady-state error in the case of the disturbed system.

To solve this problem, a disturbance compensation circuit was implemented

$$H_c(s) = \frac{H_T(s)}{H_R(s)H_m(s)} = 0,00567s + 0,44. \quad (4)$$

As a result, disturbances of constant character, caused by resistive moments in the couplings, are eliminated, the steady-state error becomes zero, and the transient process of the disturbed system is critically damped, with a settling time  $t_s = 0,11s$  ( $\epsilon_{st} = \pm 2\%$ ) that is almost identical to that of the undisturbed system.

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## Entropy-based Kullback-Leibler Taxonomic Classification of Biological Sequences

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**Keywords:** alignment-free method, Kullback-Leibler divergence, phylogeny

**Abstract.** Accurate classification of biological sequences is fundamental for understanding their functional, structural, and evolutionary significance. Traditional alignment-based methods often face challenges when applied to large, highly diverse datasets, especially when sequences have low identity or are distantly related [1]. Alignment-free methods, an established category in computational biology, have emerged as powerful alternatives to traditional alignment approaches, offering solutions for these challenges. Here we present an efficient alignment-free method for sequence similarity measure and taxonomic classification that relies on  $k$ -mer frequency distribution using Kullback-Leibler (KL) divergence between two probability distributions [2]:

$$D_{KL}(P||Q) = \sum_{x \in X} P(x) \log \left( \frac{P(x)}{Q(x)} \right), \quad (1)$$

where  $P(x)$  and  $Q(x)$  represents the probability of observing  $k$ -mer  $x$  in the first and second sequence, respectively. This measure is asymmetric,  $D_{KL}(P||Q) \neq D_{KL}(Q||P)$ , correspondingly don't satisfy the proprieties of a true distance metric, such as symmetry and the triangle inequality. To account for this asymmetry, we compute the symmetric KL divergence, which averages the KL divergence in both directions:

$$D_{KL}^s(P, Q) = \frac{1}{2} (D_{KL}(P||Q) + D_{KL}(Q||P)) \quad (2)$$



Our preliminary results show that the  $D_{KL}^S$ -based method for sequence comparison and taxonomic classification performs with high accuracy, closely matching traditional alignment-based methods (Fig.1)[3].

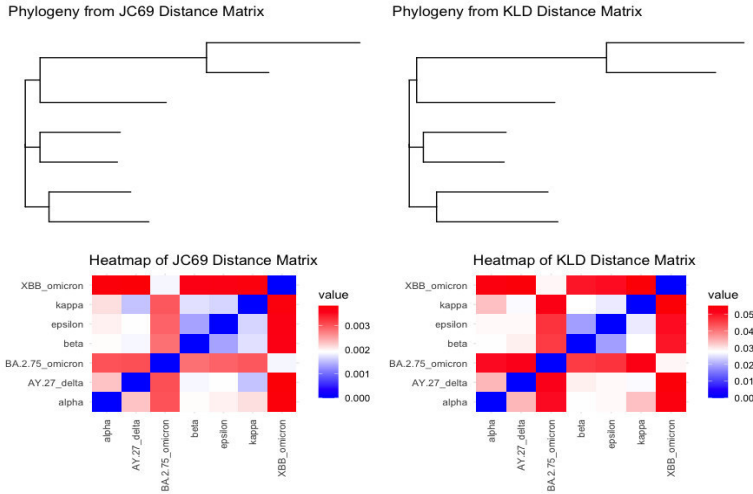


Fig 1. Both the traditional JC69 (left) and the  $D_{KL}^S$  metric (right) produce consistent phylogenetic trees and similar distances (heatmaps) across both methods (here  $k$ -mer length is 10bp).

**Acknowledgments.** This work was partially supported by the State Program LIFETECH No. 020404 at the Technical University of Moldova.

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## Leveraging Data Science for Effective Research Management in the Field of Scientometrics

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**Keywords:** Data Science, Research Management, Scientometrics, Predictive Analytics, Data Visualization, Research Insights

**Abstract.** In today's rapidly evolving world, research and development have become increasingly complex, necessitating innovative management approaches. The exponential growth in research outputs—ranging from scholarly articles to conference proceedings—has made managing this wealth of information overwhelming. Data science has emerged as a powerful tool for managing research activities, particularly in the field of scientometrics. Mingers & Leydesdorff [1] review the theoretical frameworks and practical applications of scientometrics, emphasizing how data science techniques can be utilized to analyze and manage scientific research.

One of the primary ways in which data science is transforming research management is through its capacity to extract valuable insights from extensive datasets.

Moreover, data science empowers research managers to make informed decisions by providing predictive analytics capabilities. By leveraging historical research data and utilizing advanced predictive modeling algorithms, research managers can forecast future research trends, anticipate potential breakthroughs, and allocate resources more effectively. Ding et al. [2] provide a comprehensive overview of the methods used in scientometric analysis, emphasizing the role of data science in measuring research impact, analyzing large datasets, and offering insights for research management.

Additionally, data science provides robust visualization tools that enhance the communication of complex research insights to stakeholders. These visualization techniques allow stakeholders to understand the significance of research outcomes, thereby fostering greater engagement and support for research initiatives. Several studies [3, 4] describe how traditional scientometric methods are integrated with advanced computational techniques to analyze and visualize scholarly data on a large scale.

In conclusion, data science has emerged as an indispensable asset in managing research and development activities, particularly within the field of scientometrics. By leveraging the capabilities of data science, research managers can unlock the full potential of research data, gain deeper insights, and facilitate informed decision-making. As the volume and complexity of research data continue to increase, the integration of data science into research management practices will certainly be vital in influencing the future of scientific exploration and innovation.

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## Analysis of Non-Classical Heat Conduction Models

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**Keywords:** heat conduction process, classical and generalized boundary value problems, computer modeling, numerical method

**Abstract.** Let  $t > 0$  be the time variable,  $x$  – the spatial variable where  $0 \leq x \leq l$  and  $f, \varphi, \mu_1, \mu_2$  be known function of their arguments. Let  $u(x, t)$  be unknown function representing temperature of a rod positioned along the  $Ox$  axis, where  $0 \leq x \leq l$ . Using computer modeling, the following heat conduction problems have been investigated:

- the first boundary value problem:

$$\frac{\partial u(x, t)}{\partial t} = a^2 \frac{\partial^2 u(x, t)}{\partial x^2} + f(x, t), \quad (1)$$

$$u(x, 0) = \varphi(x), \quad (2)$$

$$u(0, t) = \mu_1(t), \quad (3)$$

$$u(l, t) = \mu_2(t), \quad (4)$$

- the generalized first boundary value problem: (1)-(3),

$$\frac{\partial u(l, t)}{\partial x} = \mu_2(t). \quad (4')$$

Analytical and numerical solutions for these problems have been obtained. Graphs have been constructed for them (Fig. 1 and Fig. 2 respectively) with the known  $\varphi(x), \mu_1, \mu_2$  in [1], [2], [3]

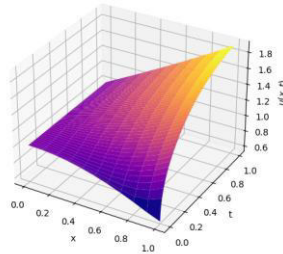


Fig. 1

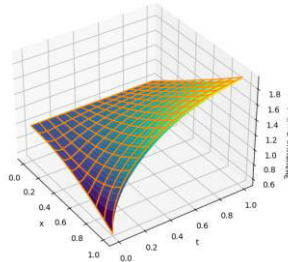


Fig. 2

The graphs of the numerical and analytical solutions coincide over the entire range of investigated time and space values.

Further improvements in the accuracy of the numerical solution can be achieved by adjusting grid parameters – reducing spatial step size and increasing the number of computational iterations.

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## An Optimal Landing Problem for a Bessel Process

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**Keywords:** Stochastic control, homing problem, first-passage time, dynamic programming, risk parameter

**Abstract.** We consider the one-dimensional controlled diffusion process  $\{X(t), t \geq 0\}$  defined by the stochastic differential equation

$$dX(t) = b_0 \theta u[X(t)]dt + \frac{(\alpha - 1)}{2X(t)}dt + \sigma dB(t), \quad (1)$$

where  $b_0$ ,  $\theta$ ,  $\alpha$  and  $\sigma$  are non-negative constants, the continuous function  $u(\cdot)$  is the control variable and  $\{B(t), t \geq 0\}$  is a standard Brownian motion. The uncontrolled process  $\{X_0(t), t \geq 0\}$  is a Bessel process of dimension  $\alpha$  (if  $\sigma=1$ ).

Let  $T(x)$  be the *first-passage time* defined by

$$T(x) = \inf \{t > 0 : X(t) = d \mid X(0) = x > d \geq 0\}. \quad (2)$$

The aim is to find the control  $u^*[X(t)]$  that minimizes the expected value of the cost function

$$J(x) = \int_0^{T(x)} \left\{ \frac{1}{2} q_0 g(\theta) u^2[X(t)] X^2(t) + \lambda \right\} dt, \quad (3)$$

where  $q_0$  and  $\lambda$  are positive constants.

This type of problem, in which the optimizer controls a stochastic process until a certain event occurs, is known as a *homing problem*; see [1]-[3]. The above problem can be interpreted as an optimal landing problem, with  $d$  representing ground level. Because the parameter  $\lambda$  is positive, the optimizer tries to reach  $d$  as soon as possible, while taking the control costs into account. Therefore, the optimal control  $u^*[X(t)]$  should in general be negative. Moreover,  $\theta$  is a risk parameter. If  $\theta < 1$  (respectively,  $\theta > 1$ ) the optimizer is risk-averse (resp., risk-seeking) and does not want to land too rapidly (resp., wants to land rapidly). The case when  $\theta = 1$  is the risk-neutral case.

Using dynamic programming, the equation satisfied by the value function

$$F(x) := \inf_{\substack{u|X(t) \\ 0 \leq t < T(x)}} E[J(x)] \quad (4)$$

is derived. This equation is a non-linear second-order ordinary differential equation. We find that  $F(x)$  is actually of the form

$$F(x) = k(x - d)^2, \quad (5)$$

where  $k$  is a constant that depends on the various parameters in the model. From the value function, the optimal control is obtained explicitly.

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## TinyLlama-Powered AI Chatbot: Transforming Medical Education for Patients ★

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**Keywords:** Large Language Models (LLMs), Small Language Models (SLMs), healthcare, education, TinyLlama, Artificial Intelligence (AI)

**Abstract.** In the last two years, the rise of Large Language Models (LLMs) and Small Language Models (SLMs) has driven advancements in fields such as industry, education, and healthcare. For obvious reasons, medical practitioners will never be replaced by these language models; however, LLMs and SLMs can assist in ways such as aiding in diagnosing conditions, providing medical literature reviews and supporting patient communication and understanding of medical terms [1].

This paper presents an innovative AI-driven chatbot based on TinyLlama [2, 3] as a tool for delivering precise, contextually relevant, and safe educational content in the healthcare field, in order to help patients better understand the medical terms, diagnosis and treatment options. Designed for efficiency, TinyLlama operates on personal computers without GPUs, being environmentally friendly.

In particular for the English language, the experiments demonstrated performance in delivering contextually appropriate responses to medical queries, assisting users in understanding diagnosis, treatments, and medical terms.



In conclusion, this paper presents an educational chatbot for patients, adapted specifically for answering questions in the medical field. The promising results observed with English-language interactions showcase TinyLlama's potential impact, while the identified limitations for languages such as Romanian and German highlight areas for future enhancement, including better prompting and fine-tuning.

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## Modeling the behavior of pollutants on the Dniester River in Olănești region

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**Keywords:** ANSYS CFD, mathematical modeling, computer simulation, pollution, prediction, water quality

**Abstract.** Effective prediction and monitoring of pollutants in river-type aquatic systems is critical for protecting aquatic ecosystems and public health. This study presents a comprehensive methodology for simulating and analyzing pollutant behavior in river-type water environments using ANSYS CFD software. By integrating hydrodynamic modeling and transport mechanisms, ANSYS enables the prediction of pollutant dispersion patterns under various environmental conditions. The study focuses on pollutants that exceeded the MAC (maximum admissible concentration) for the period of 2019-2023.

The paper presents a monitoring strategy that uses ANSYS simulations to provide useful information on pollutant concentration, enabling timely interventions in the event of calamities. The results demonstrate the potential of ANSYS in supporting sustainable water quality management practices by improving pollutant prediction and monitoring capabilities in dynamic river environments.

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## Assessing the Usability of Software Applications: a Case Study

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**Keywords:** software testing, usability, SUS.

**Abstract.** Usability is a critical factor in determining the success of a software application and user satisfaction with respect to it. It tackles how effectively, efficiently and satisfactorily the users interact with a system. This paper explores existing methods used to quantify the usability evaluation of software applications, focusing on standardized questionnaires, which capture user feedback in a structured manner, thus aiding in evaluating and improving system design. We present a case study of an educational management platform widely used in Romanian schools, to demonstrate how these questionnaires can be applied in a real-world scenario. Our findings contribute to the literature focused on refining user experience evaluation in educational technologies.

## Integration of a Proprietary Software Application and a Multimodal LLM for Enhanced Nutritional Guidance ★

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**Keywords:** software application; nutrition; artificial intelligence; large language model

**Abstract.** In the realm of health and wellness, the integration of data-driven technology and artificial intelligence (AI) has opened up new possibilities for personalized and data-driven approaches. HN-Assistant, a software application designed to analyze an individual's nutritional state and provide tailored recommendations, offers a powerful tool for promoting healthy eating habits. The HN-Assistant can also analyze how good a food product is at covering the estimated nutrient requirements. However, when combined with the capabilities of advanced AI assistants based on LLMs, the potential for comprehensive and insightful nutritional guidance is taken to new heights. This paper describes an attempt at integrating the proprietary software application HN-Assistant with GPT-4o to empower final users to make better nutritional decisions. The application was built in R programming language using the Shiny package, and the interaction between HN-Assistant and GPT-4o is based on an API in Python.

## Quantum computing for multi-qubit systems using Schwinger's paired bosons representation of angular momentum

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**Keywords:** paired bosons, multi-qubit system, effective spin, quantum harmonic oscillator

**Abstract.** The fundamental difference between calculations performed using quantum and classical computers is that, unlike a bit, a quantum bit (qubit) is a linear combination of quantum states  $|1/2, 1/2\rangle$  and  $|1/2, -1/2\rangle$  of effective spin  $S = 1/2$ . The states of an N-qubit system can be characterized by spin wave functions  $|S, M_S\rangle$  ( $M_S = S, S-1, S-2, \dots, 2-S, 1-S, -S$ ) of effective spin  $S = 2^{N-1} - 1/2$  [1]. These  $2S+1$  spin wave functions, given traditionally in the spinor representation, can also be written using the paired bosons representation proposed by J. Schwinger [2]:

$$|S, M_S\rangle = [(S+M_S)!(S-M_S)!]^{-\frac{1}{2}} (a_1^+)^{S+M_S} (a_2^+)^{S-M_S} |0\rangle = |S+M_S\rangle_1 \cdot |S-M_S\rangle_2, \quad (1)$$

where  $a_i^+$  and  $a_i$  ( $i = 1, 2$ ) denote the operators of creation and annihilation of bosons related to quantum oscillators 1 and 2,  $|0\rangle = |0\rangle_1 \cdot |0\rangle_2$ ,  $|0\rangle_1$  and  $|0\rangle_2$  are the vacuum states of the quantum harmonic oscillators 1 and 2. According to (1), the  $2S+1$  spin wave functions related to the effective spin  $S$  are expressed in the Schwinger paired bosons representation through boson wave functions corresponding to the lowest  $2S+1$  energy levels of each of the harmonic oscillators 1 and 2. The spin projection operators  $S_x$ ,  $S_y$  and  $S_z$  in the Schwinger paired bosons representation have the form:

$$S_x = \frac{1}{2} (a_1^+ a_2 + a_2^+ a_1), \quad S_y = \frac{1}{2i} (a_1^+ a_2 - a_2^+ a_1), \quad S_z = \frac{1}{2} (a_1^+ a_1 - a_2^+ a_2). \quad (2)$$

The explicit form of operators  $S_x$ ,  $S_y$  and  $S_z$  from (2) does not depend on the spin  $S$  value, in contrast to the spinor representation, when the dimensions and forms of the matrices of these operators depend on the value of  $S$ . Using formulas (2), all logical elements of quantum circuits of a  $N$ -qubit system can be expressed in the Schwinger representation of paired bosons by means of operators  $a_i^+$  and  $a_i$  ( $i = 1, 2$ ). With an increase in the number of qubits  $N$ , there is a sharp increase in the number of boson states of each of the quantum harmonic oscillators 1 and 2 participating in the two-boson representation of  $2S+1$  spin states  $|S, M_S\rangle$  ( $M_S = S, \dots, -S$ ). Particularly, for  $N = 70$  we obtain  $2S+1 = 2^{70} = 1.2 \times 10^{21}$ . Therefore, at  $N \geq 70$  the number of boson states  $2S+1 \simeq 10^{21}$  of each of the quantum harmonic oscillators 1 and 2 participating to the paired bosons representation of spin states can be approximately considered equal to infinity. In this case, the methods of quantum field theory [3] can be used to perform quantum computations. This is another advantage of the two-boson representation of effective spin states when performing quantum computations in the case of multi-qubit systems.

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## Spatial-Temporal Modeling of Critical Infrastructure Systems

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**Keywords:** Spatio-temporal modeling, Critical infrastructure, Critical Services, Multi-Agent System, Timed Petri nets

**Abstract.** The application of timed Petri nets for the spatio-temporal modelling of critical infrastructure systems is essential for the effective assessment and management of the risks associated with their operation. Critical infrastructures, such as energy, transport, telecommunications and water networks, health and insurance systems, production, distribution and food security, environmental monitoring and management systems, and financial and banking services, are of strategic importance, and their disruption can have serious consequences for society and the economy. This paper proposes an approach in applied spatio-temporal modeling to understand the dynamics and interdependencies of these complex systems in space and time. The use of advanced modeling techniques and data analysis provides a detailed insight into critical infrastructure vulnerabilities, as well as the possibilities for preventing and responding to major incidents. At the same time, by applying partial differential equation models, disruption and recovery scenarios can be analyzed, in order to optimize the resilience of systems and ensure operational continuity in the face of natural and anthropogenic threats.

The model of operation and interaction of systems with critical infrastructure is defined by the system of equations, which provides for the search for the optimal solution in space and time:



$$Q(t) = \text{opt} [f(E(t), W(t), Tr(t), CI(t), H(t), F(t), B(t), G(t), En(t), P(t), X)], \quad (1)$$

where:  $Q(t)$  - the quality of services offered by the system with critical infrastructure at the moment of time  $t$ ;  $E(t)$  - the energy system with energy and transport resources;  $W(t)$  - the drinking water supply, sewerage, and wastewater treatment system;  $Tr(t)$  - the road, rail, air, and public transport system;  $CI(t)$  - the communication and information assurance system;  $H(t)$  - the public health system and medical services;  $F(t)$  - the food system and food safety;  $B(t)$  - the financial and banking system;  $G(t)$  - defence, public services, and emergency services;  $En(t)$  - the environmental monitoring and management system;  $P(t)$  - the health, life, and property insurance system;  $X \in R^N$  - the work environment with  $N$  status variables;  $f(\dots)$  - space- and time-derived functions that ensure the evaluation of the relationship between the components of critical infrastructure systems.

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## Advanced Drone-Based Monitoring of Agricultural, Forestry, and Aquatic Ecosystems: Technical Framework

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**Keywords:** Drone-based monitoring system, Ecosystem management, Drone-based acquisition, AI-driven analytics

**Abstract.** The rapid advancement of drone technology has significantly transformed environmental monitoring by enhancing capabilities for observing and managing agricultural, forestry, and aquatic ecosystems. This paper presents a comprehensive technical framework for implementing advanced drone-based systems into ecosystem monitoring, focusing on the integration of high-resolution sensors, data processing, and AI analytics. The proposed framework incorporates modern technologies, including DJI or FPV drones equipped with metric cameras, which facilitate aerial photogrammetry. These drones can be further enhanced with multispectral and LiDAR sensors, allowing real-time data collection and analysis [1].

Furthermore, the Proxmox Virtual Environment is used as the core of the system's architecture [2], hence increasing effective virtualization and deployment. Core data processing technologies include Python scripts, QGIS and Pix4D, which are employed for advanced image analysis [3]. The system also integrates Elasticsearch for database management [4], ensuring the efficient acquisition, storage and retrieval of large volumes of environmental data. Additionally, Kibana is utilized to provide interactive data visualization through customizable dashboards, offering stakeholders the ability to make informed, evidence-based decisions.

Designed with a service-oriented architecture (SOA), the system's modularity allows it to easily integrate new tools and methodologies concerning photogrammetry and image processing [5]. The framework will be validated in real-world environments, demonstrating its efficacy in overcoming the challenges of ecosystem management, especially in remote or inaccessible areas. This approach offers a comprehensive and adaptive technical framework for sustainable ecosystem management, contributing to improved decision-making processes and the long-term health of the environmental system.

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## Demagoguery and its Automatic Recognition in Texts

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**Keywords:** Natural Language Processing, demagoguery, corpus creation, text analysis, machine learning methods

**Abstract.** The work is devoted to automatic text analysis in order to detect the demagoguery. The demagoguery is used to play with the hopes and fears, and especially the hatred, of the people, betraying their true interests for the sake of one's own political popularity and power [1]. Automatic detection of demagoguery in texts will help people to stay aware of their real goals and avoid such publications.

Theoretical aspects of demagoguery such as types of demagoguery, its subjects and objects, areas of application and basic techniques are exhaustively studied and described in the theoretical part of the work.

The practical part describes the work of the dataset collection and annotation. The texts with various types of demagoguery and without it had been collected from various news sources in Russian language. The task of demagoguery detection and classification was a difficult one even for human annotators. Several persons evaluated the collected texts, then the consistency of evaluation had been calculated using Cohen's Kappa [2]. The resulting correlations depended on the annotator's experience and ranged from 0.44, that is considered moderate agreement for the Cohen scale, to 0.84, that is almost perfect agreement.

Initially, five types of demagoguery have been defined; the total number of six classes used for annotation included five types of demagoguery and texts without demagoguery. Table 1 presents statistics for the collected dataset. It is clear that some classes were presented by a very small number of texts; such a small number was definitely not enough to train any machine learning

classifier. Thus, for machine learning experiments, a decision had been made to transform the annotation into binary one: 0 – no demagoguery, 1 – demagoguery is present.

Table 1. Class rates for multi-label classification

markers	Type of demagoguery	Number of texts	% percent of the whole set
0	Without any kind of demagoguery	211	42.3
1	Appeal to the obvious	49	9.8
2	Appeal to the individual	127	25.5
3	Appeal to authority	44	8.8
4	Appeal to the majority	29	5.8
5	False dilemma	39	7.8

By merging all types of demagoguery in one class, an almost balanced dataset was obtained with 52.1% of text without any kind of demagoguery and 47.9% of texts with presence of demagoguery.

Several methods of machine learning had been tested for demagoguery classification. Among the classical ones, Logistics regression, Naïve Bayes and KNN had been selected [3]. In the experiments with all 6 classes, traditional models could detect with acceptable accuracy only large classes, 0 and 2. In binary classification, however, they demonstrated rather good results: F-measure was in the range of 0.86–0.89.

In the final set of experiments, all these models were tested on a separate list of 20 texts of different styles. Actual accuracy varied from 60% to 100% depending on the model and studied class.

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## Method for Knowledge Acquisition Based on Image Processing for Decision-Making Systems

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**Keywords:** Decision Making Systems, Knowledge Acquisition, Knowledge model, Artificial Intelligence, Stratified Morse Theory, Image Processing

**Abstract.** This work proposes a method of acquiring and updating knowledge based on image processing with application in modern decision-making systems. At the basis of the research carried out is the behavioral model of human beings, which serves as a source of inspiration for the development of the algorithm for acquiring, interpreting, classifying and presenting knowledge. To this end, an empirical analysis of methods and models of knowledge presentation in artificial intelligence systems was carried out [1]. The extraction of new knowledge provides for the acquisition and processing of images based on the stratified Morse Theory, which allows the identification and classification of objects, their placement in depth, in order to update the knowledge specified as real or hidden. The knowledge model is presented in object format compatible with object-oriented programming languages.

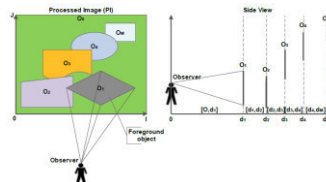
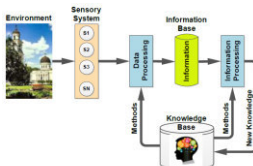


Figure 1. Knowledge extraction and update diagram.

Figure 2. Image acquisition and knowledge identification and classification.

- *Observer* – observation point or video camera for image acquisition;
- *Processed Image (PI)* – the space of the image acquired by the video camera, with the set of objects  $O_1, O_2, O_3, O_4, O_M$ , and the background image  $OO$  (the observer is focused on the object  $O_1$ );

- *Side View* – side view of the acquisition system and the depth distance of the objects in the PI image;
- *O* – origin of the coordinate system; *I* – pixel coordinate in image horizontally; *J* – pixel coordinate in the image vertically; *d*<sub>1</sub>, *d*<sub>2</sub>, *d*<sub>3</sub>, *d*<sub>4</sub>, *d*<sub>M</sub> – distance points in depth, to the objects in the image;
- [*d*<sub>1</sub>, *d*<sub>2</sub>] – The distance between objects *O*<sub>1</sub> and *O*<sub>2</sub>.
- According to Morse Theory, any video image can be layered, resulting in discrete objects placed at depth with each other. The condition for identifying the objects in the image is defined by the expression (1):

$$x(t)[j, i] \in O_m \left| \left( \frac{\partial x(t)}{\partial j} = 0, \frac{\partial x(t)}{\partial i} = 0 \right), \forall m = \overline{1, M}, j = \overline{1, J}, i = \overline{1, I} \quad (1) \right.$$

Where: pixel  $x(t)$  with the coordinates  $j, i \forall j = \overline{1, J}, i = \overline{1, I}$ , belongs to the object  $O_m, m = \overline{1, M}$ , if the conditions are met:  $\frac{\partial x(t)}{\partial j} = 0$  - which means that the variation of the pixel coordinate vertically does not lead to a change in the  $x(t)$ , and  $\frac{\partial x(t)}{\partial i} = 0$  - which means that the variation of the pixel coordinate horizontally does not lead to a change in the  $x(t)$ .

**Conclusion.** In the development of modern decision-making [2] systems based on image processing, an important role is played by the method of acquiring, interpreting, classifying and presenting knowledge. At the basis of the research carried out in the paper is the behavioral model of human beings, which serves as a source of inspiration for the development of decision systems based on artificial intelligence, with image processing at the conscious and subconscious level. To this end, an empirical analysis [3] of methods and models of knowledge presentation in artificial intelligence systems was carried out. As a result, the object-oriented method of knowledge presentation was selected, which is successfully used in object-oriented programming languages.

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## Rare Events Detection and Forecasting in Dynamic Systems

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**Keywords:** Rare events detection, dynamic systems, SVM kernels, Predictive models, Banking system, Forecasting

**Abstract.** Rare events, such as financial crises, banking failures and epidemics outbreaks can significantly impact economies and people's lives [1]. Early detection in the banking sector is crucial for mitigating financial losses and maintaining operational stability. Traditional models often fail to predict these events due to their unpredictable nature and complex dynamics. Existing systems based on methods like decision trees and neural networks struggle with scalability and accuracy, limited by specific resources of information systems and real datasets. This work aims to develop and evaluate a machine learning-based software pipeline for detecting and forecasting rare events in dynamic systems, using heterogeneous data sources such as Loghub from the banking system, which contains operations logs, transaction data, and system performance metrics [2]. The pipeline employs advanced feature selection techniques, including Wavelet Transform for multi-scale analysis and Fenchel Transform to extract meaningful patterns. We utilize Support Vector Machines (SVMs) equipped with linear, polynomial, radial basis function (RBF), and sigmoid kernels to capture diverse data characteristics [3]. To ensure training on balanced data and mitigate overfitting, we integrate oversampling (SMOTE) with undersampling strategies. Hyperparameters are refined via grid search and cross-validation, enhancing the SVM classifier's ability to adapt to the unique features of the data. The probabilistic outputs from these models are



further processed using a Binary Logistic Regression, which obtains the final prediction for each event.

The pipeline was tested in the context of banking systems, which involve server-based environments and logs from operating systems, databases, and applications. The study specifically utilizes publicly available logs from Loghub, sourced from lab servers, to validate the model's effectiveness in identifying rare events in complex real-world scenarios. The results demonstrate the pipeline's efficiency, achieving a precision of 94%, recall of 92%, and a low MSE of 0.03, indicating its robustness in predicting rare events [4]. Furthermore, the model achieved an overall accuracy of 96% in classifying and forecasting rare events, highlighting its strong predictive performance in dynamic systems.

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## ERP system implementation in companies

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**Keywords:** ERP, processes, modules, functionality

**Abstract.** This paper presents an review on the Enterprise Resource Planning (ERP), which are software systems that help run businesses, supporting automation and processes in human resources, procurement, finance, supply chain, services, manufacturing, and more. ERP helps to efficiently manage all the core business processes needed to run a company and provides the automation, integration, and intelligence that is essential to efficiently run all day-to-day business operations. Top management needs instant visibility into the company's performance to make timely decisions.

The company that implemented the ERP system has only to gain both financially and the time of data processing and making important decisions. An ERP system is made up of integrated modules or business applications that talk to each other and share common a database. ERP systems can accept some of the company's requirements either in terms of the basic functionality of the system or different extensions depending on the company's needs.

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## Correlation of the CubeSat TestPod vibration test results with finite element analysis

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**Keywords:** TestPod, vibration test, modal analysis, numerical model

**Abstract.** One of the important verification steps before the launch of the nanosatellite developed at TUM (TUMnanoSAT) was vibration testing of the real model. These tests were carried out according to the requirements submitted by the Japan Aerospace Exploration Agency (JAXA) in collaboration with which the launch of our nanosatellite was possible [1]. Thus, in order to validate the structural integrity of CubeSat nanosatellites under launch loads, a 1U TestPod was designed and manufactured.

This work presents hands on experience of the vibration testing of the developed TestPod, the simulation of the modal analysis and the correlation of the obtained results. The testing facilities were provided by the Space Science Institute from Bucharest. Our test pod mounted on the test Jig is presented in figure 1, *a*. The attached accelerometer generates a voltage signal that corresponds to the amount of vibration and the frequency of vibration the machine is producing. Before the nanosatellite test, according to the requirements, the empty TestPod was tested on the Y and Z axes (for the X axis the nanosatellite can be repositioned inside the Pod). Acceleration data measured by modal survey are illustrated in figure 2. The blue line graph shows the response of the acceleration sensor.

The numerical calculation model was elaborated in ANSYS Workbench [2]. The meshed model in over 122800 elements is depicted in figure 1, *b*. The modal simulation results include the first 6 modes and contain values higher than the critical frequency of 140 Hz, reaching the level of 2000 Hz. The first

modes for the each axis are compared in the table 1. Results correlation is obvious.

Table 1. Experimental and numerical modal test results comparison.

Axis	1 <sup>st</sup> mode test freq., Hz	1 <sup>st</sup> mode simulation freq., Hz	Difference, %
Y	325	328	0,9
Z	255	246	3,5

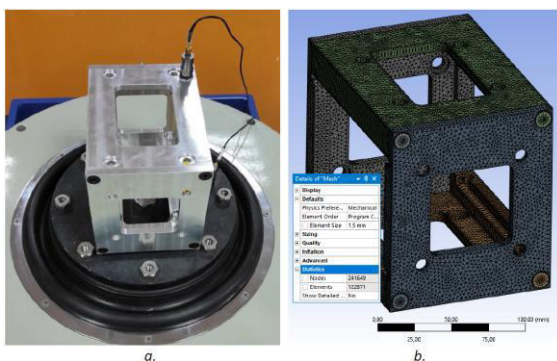


Fig. 1. CubeSat TestPod: a) real model; b) numerical calculation model.

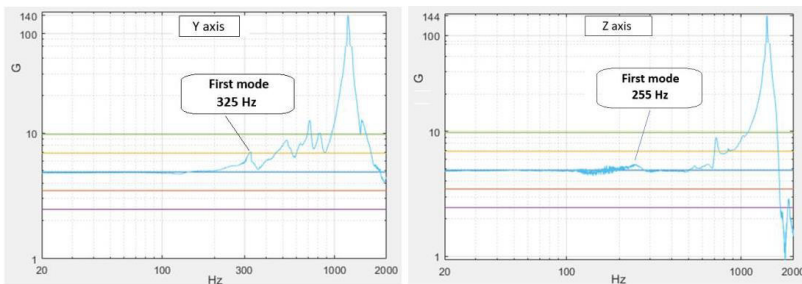


Fig. 2. Modal testing results.

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## Cascade Control Algorithm of the Servomotor Drive of Robotic Arm

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**Keywords:** Maximum stability degree method with iterations, PID controller, automatic control system, cascade control systems

**Abstract.** In this paper is synthesized the control algorithms in cascade control systems. The control object is the robotic arm which is actuated by a servo motor presented as a cascade control system which is consisting of two loops. The use of multiple loops is justified by the fact that with a single loop, only one parameter of the servo motor is controlled, which leads to a decrease in the reliability of the automatic system.

It is considered given the mathematical model of a servo DC motor with permanent magnets, which is described by the second order with astatism transfer function:

$$H_M(s) = \frac{k}{s(T_m T_e s^2 + T_m s + 1)}, \quad (1)$$

where  $k$  is the transfer coefficient,  $T_m$  – electromechanical time constant,  $T_e$  – electrical time constant.

Cascade control structures are used for control fast and slow processes with or without time delay. The presence of a big number of time constants in the transfer function of the fixed part makes it difficult to use some typical control algorithms imposing the compensation of these time constants, by the control algorithms that are containing several first degree binomials. The structural block diagram of the automatic control

system for the servo motor angle with two loops is shown in Figure 1 [1], [2].

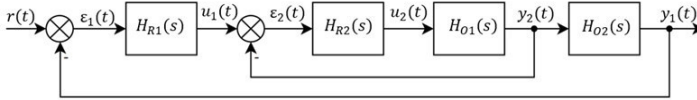


Fig. 1. Structural block diagram of the two-loop automatic control system

According to the structural block scheme of the DC motor with permanent magnets, the expressions for the parts  $H_{01}(s)$  and  $H_{02}(s)$  of the control object are following:

$$H_{01}(s) = \frac{k_1}{Ls + R}, \quad (2)$$

$$H_{02}(s) = \frac{\frac{1}{Js}}{1 + \frac{1}{Js}k_2} \cdot \frac{1}{s} = \frac{1}{Js^2 + k_2s}. \quad (3)$$

To tune the controllers in the inner and outer contour, the maximum stability degree method with iterations, polynomial method and the Ziegler-Nichols method are used. For the inner loop, the coil current was chosen as the control parameter, and for the outer loop, the angular displacement of the servo motor shaft [2].

The best results were obtained for the case with a PI controller in the inner loop (rise time 0.024 s, settling time 0.026 s), and a P (rise time 0.278 s, settling time 0.299 s) or PD controller (rise time 0.039 s, settling time 0.046 s) in the outer loop. It is not recommended to use a controller with an integrative component in the outer loop, as this will lead to overshoot.

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## Mixed Sum-Product and Convolutional Networks for Classification Problems

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**Keywords:** Sum-Product Networks, Convolutional Networks, Classification Problems, Probabilistic Inference

**Abstract.** In this work, we propose a joint Sum-Product (SPN) and Convolutional (CNN) Network for classification problems, namely image classification performed on several real-life benchmark datasets. These mixed networks represent an original development within the probabilistic graphical models domain that outperform the traditional CNNs results.

After recalling the structural properties of SPNs with their theoretical foundations, we present the performance metrics (F1 score, Brier score, precision, recall and accuracy) obtained for four different datasets: the MNIST dataset, the Fashion MNIST dataset, the Fast, Furious and Insured dataset, and the Garbage Classification dataset, respectively. The results obtained for the last two datasets outperformed the results obtained by the classical deep learning methods.

The mixed networks proposed in this paper contribute to the understanding of SPN applications emphasizing possible further areas of study within the field.

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## Fake News detection in Moldova's Information Space

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**Keywords:** natural language processing, automatic fake news detection, corpus of annotated news, machine learning

**Abstract.** The described research is dedicated to the development of an automatic fake news detection system. Fake news, also known as disinformation or misinformation, poses a significant threat to society. Fake news can erode trust in traditional media outlets, leading people to question credible sources, they can also undermine trust in government institutions and democratic processes. Emotionally written fake news can exacerbate social divisions by spreading false or misleading information to reinforce existing prejudices [1]. Disinformation can damage the reputation of individuals, organizations, and even entire countries; they can influence elections by spreading false or misleading information about candidates or policies disrupting democratic processes by sowing confusion and distrust.

To combat the problem of fake news, it is essential to promote critical thinking, media literacy, and fact-checking. Additionally, platforms and governments need to work together to address the spread of misinformation and disinformation.

Despite the existence of similar research, there is no adequate system for detecting fake news in Russian for the Republic of Moldova and neighboring regions. The complexity of developing such a system lies in the need to create a representative dataset, which involves identifying reliable sources that do not publish fake news and finding the fake news itself. The creation of such a dataset is included in this work [2].

The sites specializing in fact-checking in Russian were selected as sources of fake news: [stopfals.md](http://stopfals.md), [stopfake.org](http://stopfake.org), [factcheck.kz](http://factcheck.kz), [veridica.ro](http://veridica.ro),

provereno.media, factcheck.kg, stopfake.kz. As a result, a dataset was formed containing 2108 news articles, of which 614 are fake and 1494 are reliable.

A balanced collection of 614 fake and 614 reliable news articles has been used in the machine learning experiments. The texts were cleaned, tokenized, vectorized and split in train-test parts in proportion 70%-30%. Several algorithms have been tested including Naive Bayes classifier, logistic regression, the k-nearest neighbors method, the support vector machine, and the random forest.

The technologies used in the experiments included various machine learning algorithms such as the naive Bayes classifier, logistic regression, the k-nearest neighbors method, the support vector machine, and the random forest, ensuring high accuracy in fake news detection [3].

The support vector machine and random forest algorithms showed the best results, achieving an accuracy of 90% and 91%, respectively. The error analysis allowed us to study and correct common classification improving the quality and robustness of the models.

The developed system helps protect society from disinformation, which is especially important in the modern world, where information warfare and political manipulation have become commonplace.

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## Development of an Employee Scheduling Application Under Consecutive Days-off Constraints

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**Keywords:** Human-machine Interfaces, Human Resources Scheduling, Web Application

**Abstract.** This paper presents a model of an application for monitoring the scheduling of a company's human resources, which was developed taking into consideration the two important factors: matching the required number of employees on a particular day (request) and the number of employees available on that day (offer), as well as identifying trends that may affect the required number of employees on a given day in the subsequent period. This application offers the following services: access through a main screen of the interface for monitoring the human resource flow and displaying employee categories and a list of them, including a summary of each employee's status. It offers the possibility of adapting the quadratic optimization module for accessing web resources specialized in performing the calculations related to human resource planning and scheduling. The application is accessible and portable and brings an essential advantage to the managers and employees of the company, where it could be used.

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## Comparative Analysis of Serial-Parallel and Parallel Network Reliability for different distributions with Monte Carlo Simulations

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**Keywords:** reliability, dynamic mathematical models, independent random variables, survival function, cumulative distribution function, lifetime distribution

**Abstract.** This paper is about the reliability of some networks with serial-parallel and parallel-serial architectures. It compares the dynamic mathematical models of both types of networks. The unit's lifetimes of the networks are independent and identically distributed random variables, with cumulative distribution functions having a uniform or exponential distribution. The model of the lifetime of each network's unit is a nonnegative random variable. The network's reliability is represented by the survival function, which is the tail of the cumulative distribution function of the network's lifetime. It was used Analytical and empirical methods and formulas which were established in earlier studies, to obtain the formulas for the reliability of both mentioned networks. Monte Carlo simulations are used for empirical verification, using Python Programmer Language. Through examples, we compare the reliability of two different architecture networks, where the number of subnets and units in each subnet remain constant.

It provided graphical representations and calculations for each case, offering valuable insights into the impact of network architecture on reliability under dynamic conditions, and providing a foundation for further exploration of complex network systems under real-world dynamic conditions.

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## The reusability of public omics data across 5 million research publications

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**Keywords:** Reproducibility, public omics data, data reuse, secondary analysis

**Abstract.** Publicly accessible omics data are a vital resource for the scientific community, enabling re-analysis, experiments, and meta-analyses that promote reproducibility and fuel new discoveries [1]. Despite their importance, the patterns and extent of secondary data reuse are not well understood. In this comprehensive study, we analyzed over five million open-access publications from 2001 to 2024, identifying 400,000 papers focused on omics data [2]. Among these, 58% of the publications reused publicly available datasets. Notably, from 2016 to 2024, there was a significant 30% increase in publications utilizing reused gene expression data [3], surpassing the number of studies using newly generated data. For the study, we collected 5,547,235 open-access publications from PubMed Central (PMC), spanning the years 2001 to 2024. We identified 276,642 publications that mentioned omics datasets, such as those from the Sequence Read Archive (SRA) and Gene Expression Omnibus (GEO), using text mining and regular expressions. The publications were classified as either primary or secondary analyses based on the dataset release date. Our validation process, based on a curated dataset, achieved high accuracy: 97.6% for primary analyses and 97.4% for secondary analyses, with misclassifications primarily occurring in incomplete texts or pre-print journals [4]. Our findings show that datasets requiring minimal

computational resources or more advanced analytical methods had higher rates of reuse. We introduced the normalized reusability index (NRI), which revealed that over 16% of omics datasets are reused at least ten times annually, while at least 56% of datasets are reused at least once. This analysis provides critical insights into trends in omics data reuse and highlights methodological inconsistencies in the field.

**Acknowledgments.** This work was partially supported by the State Program LIFETECH No. 020404 at the Technical University of Moldova.

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## Managing and Monitoring the Flow of Ads on Selling Platforms

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**Keywords:** flow of ads, ad platforms, optimize the performance, competitive analysis

**Abstract.** Online advertising platforms are an essential component of global marketing. With millions of users browsing daily, these platforms provide a dynamic environment for businesses of all sizes to promote their products and services. However, effectively managing and monitoring ad flow is becoming increasingly challenging in an environment characterized by competition and rapid change. The need and complexity of ad management on selling platforms stems from and focuses on efforts to optimize the processes involved in creating, publishing and monitoring online ads. Online ad platforms play a vital role in the marketing strategies of companies worldwide. With an ever-increasing number of users and competition, effective online ad management is becoming crucial to the success of a business. This topic is therefore highly topical and of considerable interest to researchers, practitioners and businesses [1]. The absence of specialized applications for managing and monitoring the flow of online advertisements in the Republic of Moldova represents an opportunity for the development of tools adapted to the local context. The implementation of such applications would support online sellers in optimizing their activities, contributing to increased performance and strengthening Moldova's presence in the global e-commerce market.

A dedicated online ad management app would allow sellers to optimize the performance of their ads, conduct detailed competitive analysis and make quick adjustments to market changes.

Puppeteer is used to automate and streamline front-end development and testing respectively. Using Puppeteer, it is possible to browse web pages, extract data and interact with elements on the page. This approach allows

gathering information from external websites for use in the application. Through Puppeteer, it is possible to create and run automated tests to verify application functionality and performance [2].

The "Scrappy" app is an innovative solution for managing and monitoring ads on various online selling platforms. The app specializes in collecting and organizing ads by categories, including cars, tech equipment, phones and laptops. With a modern and intuitive design, users have easy access to the basic tools needed to navigate and interact with ads efficiently. The data collection and organization process is handled automatically, without requiring constant human intervention. This provides users with a hassle-free experience with up-to-date and relevant information in real time. Through its advanced functionalities, "Scrappy" enables users to monitor prices, receive real-time notifications and make informed buying and selling decisions. These features add value to the user experience, facilitating decision-making and optimizing results.

This application is a useful and necessary tool in the context of the online classifieds market in the Republic of Moldova, contributing to streamlining the process of managing and monitoring the ads, as well as optimizing the sales and purchase activities on these platforms.

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## Holistic Optimization through Reinforced Unified Synergy: A Novel Approach for Agent-based Modeling

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**Keywords:** agent-based modeling, reinforcement learning, reinforced unified synergy, holistic optimization, decision-making approach

**Abstract.** The paper proposes a new approach for agent-based modeling and reinforcement learning, using a coordinated system of four specialized neural networks – Imagination, Stimulation, Strategy and Intuition. These models act as individual agents, each performing a specific subtask while collectively contributing to a broader and more complex decision-making process. By decomposing complex problems into smaller and manageable components, this approach enables faster generalization and more efficient problem-solving, unlike traditional reinforcement learning methods that require extensive iterations and large amount of data with large number of trials. Each neural model focuses on its specific domain, allowing for more efficient reflection and insight generation. By leveraging the synergy between these models, the proposed approach achieves holistic optimization and optimal results with fewer steps while improving decision-making accuracy. This approach demonstrates a significant advancement in agent-based modeling for complex tasks and the potential for enhanced performance across diverse scenarios, providing a more efficient path to optimization in agent-based environments.

## Harmonized Abstract Color Knowledge: A Novel Approach for Enhancing Image Segmentation ★

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**Keywords:** image segmentation, color knowledge, color enrichment, abstract color model, perceptual color model, perceptive color nexus, color perception, latent space representation, variational autoencoder

**Abstract.** The paper proposes a new approach for image segmentation using abstract color modeling derived from the latent space of a Variational Autoencoder (VAE) model. By training the VAE to compress and reconstruct multi-class color features while simultaneously correlating the latent space with the RGB color model, we introduce a robust perceptual color model that aligns machine vision with human perception by achieving a perceptive color nexus. Unlike traditional RGB-based segmentation methods that are limited by the constraints of three-dimensional color space, which does not capture the full range of human perceptual experiences, the proposed approach leverages an enriched abstract color model that classifies RGB pixels using a diverse set of objective and subjective color criteria into higher dimensional representation. This approach allows for a more comprehensive understanding of color attributes and their relationships, leading to more precise and meaningful segmentations.



## Effectiveness of Artificial Intelligence Integration in ERP Systems for Fitness Centers

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**Keywords:** Artificial Intelligence, ERP, processes, solution, management

**Abstract.** In the competitive and dynamic context of the fitness industry, fitness centers must optimize internal operations and provide personalized experiences to attract and retain customers. Integrating Artificial Intelligence (AI) into enterprise resource planning (ERP) systems offers an innovative solution to these challenges. For this reason there is a trend of implementing AI in ERP, focusing on process automation, service customization, predictive analysis and decision optimization.

Fitness centers are no longer just places where people exercise; they have become providers of services that include personalized training, nutritional counseling, and personal exercise programs. In such a competitive environment, these centers must maximize operational efficiency and provide personalized service to remain attractive.

Enterprise Resource Planning (ERP) systems are critical to effectively managing these centers, centralizing and optimizing workflows, resources and information. Technological evolution, especially in the field of Artificial Intelligence, opens new horizons for improving ERP functionalities, offering

opportunities for automation, customization and optimization of processes at an unprecedented level.

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## Automatic Simplification of Drug Descriptions

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**Keywords:** automatic text simplification, drug description

**Abstract.** Automatic simplification of drug descriptions and medical texts is a very important task, it helps people with low medical literacy to understand complex drug descriptions and medical texts. Automatic text simplification is the process of converting source text into another text that conveys the information of the source text but is easier to understand and read [3]. This process usually involves replacing complex or unknown phrases or words with simple equivalents and converting long and syntactically complex sentences into shorter and less complex ones [1].

Automatic text simplification usually focuses on two methods of simplification, lexical and syntactic. Lexical text simplification seeks to replace words so that they are easier to understand, or to add appropriate definitions to a sentence. For example, “The book was great” would become “The book was excellent” or “The boy had tuberculosis” would become “The boy had tuberculosis, a lung disease.” Changing words in context is not a trivial task because the original meaning of the text can very easily be lost or misinterpreted [2].

Syntactic simplification aims at identifying syntactic phenomena in sentences that may make readability and comprehension difficult, with the aim of possibly transforming the found sentences into more readable and understandable equivalents. For example: “The festival was held in New Orleans, which was recovering from Hurricane Katrina” is converted in two simpler sentences: “The festival was held in New Orleans. New Orleans was recovering from Hurricane Katrina”.

Experiments of this work fell into three main categories:

1. Experiments without the use of large language models used data such as word frequency and dictionaries to find compound words and their definitions.

2. Experiments with exclusive application of large language models to simplify a given drug description [3].

3. Combined experiments that solved certain problems with large language models while others without them. For example, we defined a word difficult to understand using a large language model and then inserted its definition from a dictionary.

In conclusion, both methods are useful for the simplification: the wordfreq library identifies complex words as well as ChatGPT3.5 but ChatGPT is better at simplifying text due to good corpora training, while dictionary parsing is a very unreliable method that is also difficult to verify for correctness.

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## About a Pseudo-Genetic Algorithm and Some Features of its Practical Application

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**Keywords:** genetic algorithm, computational complexity, optimization task, hybrid method of clustering

**Abstract.** The paper describes some of the difficulties of using the classical genetic algorithm in a multidimensional numerical space. An optimization algorithm is proposed, which functions according to the principle of the genetic algorithm, but works with numerical arguments and has a simpler implementation. Examples of the use of the pseudo-genetic algorithm for solving certain non-standard optimization problems and for conducting hybrid procedures for clustering sets of multidimensional points are demonstrated.

The Genetic Algorithm (GA) is used to solve optimization problems of the following form:

$$\begin{aligned} E(W) &\rightarrow \text{extr}, \\ W &\in D, \end{aligned} \tag{1}$$

Provided:  $E(W)$  is the objective function (fitness function) of the optimization problem; and  $W$  – is the composite vector of arguments of the optimization problem (chromosome) in the space of optimization parameters.

The proposed pseudo-genetic algorithm is a somewhat simplified model of the classical genetic algorithm, adapted for solving non-standard optimization problems in multidimensional numerical spaces. With this approach, the mathematical model of the problem can be easily adapted to the needs and specifics of the subject area, the need for data transformation

for the implementation of the genetic algorithm is significantly reduced, the procedure for checking the validity of the data when forming the initial population of the genetic algorithm and forming new generations is simplified. Overall, the software implementation of optimization tasks is significantly simplified, particularly when integrating the genetic algorithm into other software packages, where the use of library resources is limited, and there is a need for the direct implementation of such algorithms.

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## Special elements in octonions algebra over $\mathbb{Z}_p$

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**Keywords:** Octonion Algebra, Idempotent Elements, Nilpotent Elements, Finite Fields

**Abstract.** This paper explores the properties of idempotent and nilpotent elements in octonion algebras over finite fields, specifically  $\mathbb{Z}_p$ , where  $p$  is a prime number. Octonion algebras, which extend quaternion algebras, are characterized by their non-associative structure and their dimension of 8. The study begins by defining idempotent elements, where  $\sigma^2 = \sigma$ , and nilpotent elements, where  $\sigma^z = 0$  for some nonzero integer  $z$ . These elements are of particular interest due to their relevance in the algebraic structures of both quaternion and octonion algebras. The paper presents examples and theorems to illustrate the conditions under which elements in octonion algebras retain idempotent or nilpotent properties. Special attention is given to the implications of these findings for the structure of the algebra  $O/\mathbb{Z}_p$ , with potential applications in fields such as coding theory and cryptography. The results demonstrate how algebraic structures like octonions behave under finite fields and their differences from associative algebras, such as quaternions.

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## Assessment of Student Pass Rate Based on Correlation and Regression Models

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**Keywords:** evaluation, correlation, regression, promotion, admission performance, graduation rate, graduation performance

**Abstract.** This paper presents a case study exploring the use of correlation and regression models to evaluate and predict the promotion rate of students at the Technical University of Moldova, a public higher education institution in the Republic of Moldova. Static correlation models are used to examine the relationships between academic performance and results achieved throughout the years of study. While linear and logistic regression models are applied to estimate the prediction of student promotion and successful graduation. The paper highlights the importance of these tools in identifying relevant factors influencing academic success and in developing effective educational strategies to improve promotion rates and reduce the risk of university dropout.

Evaluating and predicting student promotion rates is an important process for higher education institutions, as it provides valuable insights about academic performance, the quality of the educational process, and the factors influencing student success. Correlation and regression models are statistical tools that help identify key factors affecting promotion rates and contribute to the development of effective strategies for improving academic performance.

The research objectives are to identify key factors influencing student promotion (e.g., demographic data, prior academic performance, academic engagement), develop and apply regression models to predict

promotion probability, and accurately interpret correlation coefficients to gain relevant data and insights.

The correlation models examined include admission performance vs. promotion rate and academic engagement vs. promotion and graduation rates.

The regression models studied are linear regression and logistic regression.

These correlation and regression models were applied to historical datasets containing information on students' admission performance, academic engagement, and achievements throughout their studies.

As a result, the following valuable insights were gained for optimizing the study process:

- Key factors with the most significant impact on the promotion rate were identified;
- Logistic regression was used to estimate the probability of student promotion based on their academic history.

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## COMPUTER ENGINEERING

## Necessary capacities of computer networks` core components

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**Keywords:** channel, router, server, cost, response time.

**Abstract.** The creation and development of computer networks and data centers [1] involves considerable expenses. Minimizing these expenses is important. In this paper, the backbone subnet and server set of wide area computer networks are examined to determine the necessary capacities of their channels, routers and servers, considering the linear dependence of their costs on their capacity. The proposed in this aim queuing network model is an extension of the respective model for channels proposed by L. Kleinrock [2] based on Jackson's theorem [3].

With this model, two optimization problems are considered: (a) minimizing the average time in the network of user's data processing requests; (b) minimizing the summary cost of the network's servers, channels and routers. For both problems, analytical solutions regarding the necessary capacities of channels, routers and servers are obtained. They can be useful for the preliminary estimation of basic characteristics of common core components of a concrete computer network. Also, if necessary, two algorithms to adjust the analytical solutions to the allowed capacities of the network components in question are proposed.

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## Stability Conditions of Linear Discrete-Time Systems by Characteristic Equation Coefficients

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**Keywords:** discrete-time systems, stability, transfer function, characteristic equation

**Abstract.** A linear discrete-time system (LDTS) is deemed stable if the poles of its transfer function are located within the unit circle in the complex  $z$ -plane. To verify pole locations, techniques such as the Schur-Cohn criterion or the Jury test can be employed. Alternatively, an indirect approach involves mapping the interior of the unit circle to the left half-plane of the complex  $w$ -plane using the bilinear transformation, which allows for the application of stability criteria designed for continuous-time systems. However, both direct and indirect methods become increasingly complex as the system's order increases, complicating the synthesis process. Given that modern automatic control systems, especially those involving dynamic objects, are often high-dimensional, there is a significant need for simplified stability criteria to facilitate the synthesis process.

In this work, simplified stability conditions for LTDS have been identified, conditions expressed as relationships among the coefficients of the characteristic equation in the  $z$ -plane,  $w$ -plane, or  $\zeta$ -plane:

1. For a LDTS with the characteristic equation

$$z^n + a_{n-1}z^{n-1} + a_{n-2}z^{n-2} + \dots + a_2z^2 + a_1z + a_0 = 0,$$

a necessary condition for stability is that the inequality  $|a_i| < C(n, i)$  holds, where  $C(n, i)$  are the binomial coefficients ( $i = 0, 1, \dots, n-1$ ).

2. For a LDTS with the characteristic equation in the  $\zeta$ -plane [1]

$$\zeta^n + b_{n-1}\zeta^{n-1} + b_{n-2}\zeta^{n-2} + \dots + b_2\zeta^2 + b_1\zeta + b_0 = 0,$$

the inequality  $\lambda_i < b_{i-1}b_{i+2}/(b_ib_{i+1}) < 1$ , holds ( $i = 1, 2, \dots, n-2$ ),.



If any of these inequalities are violated, the system is unstable.

For example, consider the LDTS with the characteristic equation

$$z^3 + z^2 + z + 2 = 0$$

The bilinear transformation, the Stodola criterion, and Routh's table, show that the system is unstable [2]. Applying Condition 1, the same conclusion can be drawn without further calculation, because  $a_0 = 2 > C(3,3) = 1$ .

Transitioning from the  $z$ -plane to the  $w$ -plane using the bilinear transformation  $z = (w + 1)/(w - 1)$  enables the extension of methods proposed in [3] for the synthesis of discrete systems, as follows:

3. For the stability of a LDTS with the characteristic equation

$$w^n + c_{n-1}w^{n-1} + c_{n-2}w^{n-2} + \dots + c_2w^2 + c_1w + c_0 = 0,$$

it is sufficient to satisfy one of the following conditions:

$$\lambda_i < c_{i-1}c_{i+2}/(c_i c_{i+1}) < 0,465 \quad i = 1, 2, \dots, n-2; \quad (1)$$

$$\lambda_i + \lambda_{i+1} < 0,89 \quad i = 1, 2, \dots, n-3; \quad (2)$$

$$\lambda_i + \lambda_{i+1} + \lambda_{i+2} < 1 \quad i = 1, 2, \dots, n-4. \quad (3)$$

Satisfying any of these conditions guarantees the stability of the system. In this case the synthesis of a stable LDTS involves the following steps:

1. Applying the bilinear transformation  $z = (w + 1)/(w - 1)$  to obtain the characteristic equation in the  $w$ -plane.
2. Using 3 to calculate the coefficients of the characteristic equation.
3. Transforming back to the  $z$ -plane to complete the determination of the stable system's characteristic equation coefficients.

The proposed stability conditions not only simplify the evaluation of LDTS stability, but, more importantly, significantly facilitate the synthesis of high-dimensional discrete control systems.

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## Tuning the Controller for Object Models with One-Four Poles Using the Polynomial Method

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**Keywords:** object models with one-four poles, transfer function, controller, controller tuning methods, system response, performance, and robustness

**Abstract:** The paper describes the procedure for tuning the controller for models of control objects with first to fourth order inertia and astatism, using the polynomial method with the imposition of damping ratio and settling time of the synthesized system. In the automation of various technical objects, industrial, and technological processes that require automatic control [1, 2], whose dynamics approximate mathematical models described by transfer functions with constant parameters and inertia degrees 1-4 and astatism of the form:

$$H_1(s) = \frac{b_0}{s(a_0s + a_1)} = \frac{B(s)}{A(s)}, \quad (1)$$

$$H_2(s) = \frac{b_0}{s(a_0s^2 + a_1s + a_2)} = \frac{B(s)}{A(s)}, \quad (2)$$

$$H_3(s) = \frac{b_0}{s(a_0s^3 + a_1s^2 + a_2s + a_3)} = \frac{B(s)}{A(s)}, \quad (3)$$

$$H_4(s) = \frac{b_0}{s(a_0s^4 + a_1s^3 + a_2s^2 + a_3s + a_4)} = \frac{B(s)}{A(s)}, \quad (4)$$

where  $b_0, a_0, a_1, a_2, a_3, a_4$  are the coefficients of the transfer function.

For models (1)-(4), there are methods for tuning the controller such as the pole-zero method, frequency methods, integral criteria method, etc. However, using these methods is accompanied by complex calculations to achieve the desired performance [1, 2].

In the study, the synthesis procedure of the control algorithm for models (1)-(4) using the polynomial method is described, aiming for the synthesized system to exhibit high performance and good robustness.

The transfer functions of the objects (1)-(4) are described in factored form according to the zeros in the left and right half-planes of the complex plane. Based on the required performance specifications for the system, the characteristic polynomial is constructed with two dominant poles and, if necessary, additional real poles allocated as far as possible from the dominant poles to meet the performance criteria of the synthesized system.

Based on the order of the object's model and the conditions for solving the system of algebraic equations, the physical feasibility of the controller and the robustness of the system, the desired characteristic polynomial of the synthesized system is constructed. This polynomial contains two polynomials with unknown coefficients, and the degrees and the unknown polynomials, as well as the degree of the desired polynomial, are calculated. The desired polynomial is equated with the polynomial containing the dominant poles. By equating the coefficients of the same powers of the variable  $s$  on both sides of the equality, an algebraic system of equations is obtained, from which the unknown coefficients and polynomials are determined. Based on the stable components of the object's model and the unknown polynomials, the transfer function of the control algorithm is constructed.

The study analyzes the synthesis of the control algorithm for models (1)-(4) using the polynomial method, aiming for the synthesized system to exhibit high performance and good robustness. By examining the results of the controller synthesis for examples of models (1)-(4) with the imposed performance specifications—a damping ratio of 0.707 and a settling time of one second—it is found that:

1. The synthesis of the controller for these types of models is straightforward and involves a low computational effort.
2. The step responses of the systems are aperiodic with high performance and good robustness, and the performance decreases slowly with the increasing order of the model.

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## Control-Relevant Identification of the First-Order Inertial Systems with Time-Delay

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**Keywords:** control-relevant identification; PID control algorithm; first order inertial systems; time-delay; closed-loop system identification

**Abstract.** In this paper is proposed an approach of control-relevant identification of the inertial systems with time delay. The experimental identification is performed in the closed-loop and the control object is proposed to be approximated with transfer function with inertia first order and time delay:

$$H(s) = \frac{ke^{-\tau s}}{(Ts + 1)} = \frac{B(s)}{A(s)},$$

where  $T$  is time constant,  $k$  is transfer coefficient,  $\tau$  is time delay.

This study contributes in enhancing of the understanding the closed-loop experimental identification process of the inertial systems with time delay, and provides effective strategies for synthesizing the PID control algorithm. According to the proposed approach of the closed-loop identification and synthesis the PID control algorithm, it is presented an algorithm for control-relevant identification:

1. Preliminary information gathering.
2. Ensuring the feedback control system with P controller.
3. Variation of the proportional tuning parameter  $k_p > 0$  till it is achieved the undamped step response of the closed-loop system.
4. From the undamped step response of the closed-loop system determination the period of oscillations –  $T_{cr}$  and time delay -  $\tau$ .
5. Calculation the value of natural frequency.

6. Estimation the parameters of the transfer function in conformity with expression:

$$T = \frac{k_{cr} k \sin(\tau \omega_n)}{\omega_n}.$$

7. Tuning the PID controller in conformity with expressions (14)-(15) and (17).

$$k_p = 2 \cdot k_d \cdot \frac{(\tau + 6a_0)}{2\tau a_0}; k_i = \frac{e^{-\tau J}}{2k} \cdot \frac{\tau^2 - 36a_0^2}{4\tau^2 a_0} + \frac{k_p^2}{4k_d}; k_d = \frac{e^{-\tau J}}{2k} \cdot \frac{\tau^2 + 8a_0^2}{8a_0}.$$

The obtained results are verified by computer simulation using software package MATLAB. The results demonstrate that the proposed control identification approach of first order inertial systems offers good results in model estimation and the control algorithm ensures good system performances.

**Acknowledgment.** This work was supported by the project 23.70105.5007.13T Research and synthesis of efficient attitude control algorithms for nanosatellites.

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## Edge Computing System for Monitoring of the Aquatic Ecosystems ★

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**Keywords:** edge computing, aquatic ecosystems, environmental monitoring, IoT, real-time data analysis, water quality, drone, Wi-Fi

**Abstract.** Rapid advances in the development of IoT and edge computing technologies have led to innovative solutions for environmental monitoring. In this paper is presented an edge computing system designed for real-time monitoring of aquatic ecosystems, which addresses the need for efficient processing of environmental state data. The system uses a swarm of mobile edge computing nodes, deployed on drone platforms, to monitor strategic areas in the aquatic environment, collecting, processing and analyzing data on-site, thereby reducing reliance on data transport infrastructure and the cloud centralized. Real-time data analysis enables early detection of environmental anomalies or threats, enabling their location and rapid interventions to protect aquatic life and ecosystems. The system architecture ensures scalability, reliability and algorithmic efficiency, making it a promising solution for various application domains.

*Solved problems in the design and research process:*

- Stabilization of the drone flight in relation to the interaction of the drone in flight and water, which involves multiple phenomena and specific challenges, due to the unique characteristics of the aquatic environment (unstable surface with waves and noise, air stream and

- turbulence, etc.) and the reflection of radio waves or navigation and control signals (GPS, WiFi, GSM, GPRS);
- Orientation, navigation, take-off and landing of the drone from/on the water surface in exceptional cases;
  - Protection of the drone against the aquatic environment, expressed through the use of water-resistant models, which avoid damage caused by splashes or condensation;
  - Evaluation of the performance characteristics of the set of sensors (ultrasonic and optical) applied for spatial positioning and in-flight navigation of the drone.

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## Closed-Loop Identification of the First Order Inertial System with Astatism and Time Delay

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**Keywords:** experimental identification, first order inertial system with astatism, time-delay, closed-loop system identification

**Abstract.** The mathematical model that accurately represents the dynamics of the industrial process is crucial for the efficient synthesis of control algorithm in industrial applications [1]. The mathematical model can be obtained using identification procedures, either in an open-loop or closed-loop configuration of the automatic control system. Identification methods in open-loop configuration are well known and typically yield accurate approximations of the process dynamics. However, in the closed-loop configuration, the presence of feedback in the system makes impossible to apply open-loop identification techniques directly. As a result, there are required specialized techniques and methods to accurately mathematical model estimation under closed-loop conditions [2-3].

This paper proposes an approach for closed-loop experimental identification, which involves approximating the process with model of object with inertia first order, time delay and astatism:

$$H(s) = \frac{ke^{-\tau s}}{s(Ts + 1)} = \frac{B(s)}{A(s)},$$

where  $T$  is time constant,  $k$  is transfer coefficient,  $\tau$  is time delay.

he value of time constant  $T$  is calculated based on: the critical transfer coefficient -  $k_{cr}$ , time delay –  $\tau$ , natural frequency -  $\omega_n$  and oscillations period



$T_{cr}$  of the underdamped step response of the closed-loop system with P controller, when system achieves the limit of stability:

$$T = f(\tau, \omega_n, k_{cr}, k).$$

Value of natural frequency is calculated according to the expression:

$$\omega_n = \frac{2\pi}{T_{cr}}.$$

According to the identification procedure presented in [4], the following expression is obtained for calculating the value of the time constant:

$$T = \frac{k_{cr}k \cos(\tau\omega_n)}{\omega_n^2}.$$

The obtained results are verified by computer simulation using software package MATLAB. The results demonstrate that the proposed control identification approach of first order inertial system with time delay and astatism offer good results in model estimation.

**Acknowledgment.** This work was supported by the project 23.70105.5007.13T Research and synthesis of efficient attitude control algorithms for nanosatellites.

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## Sensorless control of permanent magnet synchronous machine

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**Keywords:** permanent magnet synchronous motor, sensorless control, position estimation method.

**Abstract.** Permanent magnet synchronous motors (PMSMs) are widely utilized in the aerospace sector, serving as actuators for flight surface control in aircraft and as driving units for satellite attitude control. These applications benefit significantly from the high dynamics and energy efficiency inherent to PMSM drives. This paper focuses on the development of sensorless control methods for PMSMs, which enhance reliability and reduce costs by eliminating mechanical speed and position sensors. Sensorless control techniques rely on estimating the motor's speed and rotational angle, which can be categorized into two primary approaches: high-frequency signal injection methods, effective at low speeds, and back electromotive force (back-EMF) estimation methods, which excel at higher speeds. The objective of this study is to investigate a back-EMF-based sensorless control method through simulations using MATLAB/Simulink, followed by experimental validation with a dSPACE1104 board. The proposed control strategy is implemented on a three-phase synchronous permanent magnet motor, enabling phase excitation without the need for rotary or linear position sensors. This approach mitigates energy loss due to heat dissipation and minimizes potential sensor wear and maintenance requirements. The implementation utilizes an Extended Luenberger Observer (ELO) for sensorless control, coupled with a Phase-Locked Loop (PLL) rotor position tracker. The synergy between ELO and PLL enhances estimation accuracy, robustness against disturbances, and overall

system responsiveness, making it a powerful solution for practical applications. The performance of this system is evaluated using the dSPACE1104 platform, demonstrating its effectiveness in real-world scenarios.

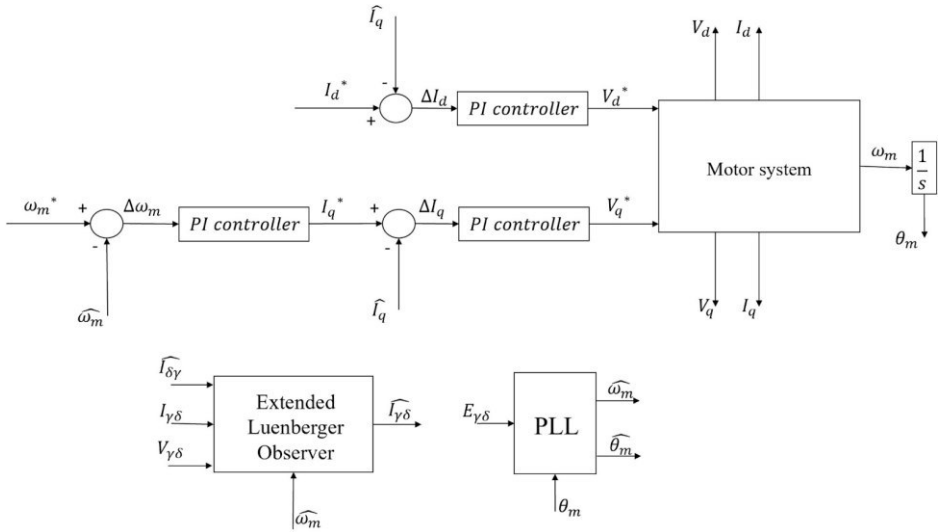


Fig.1 Sensorless control system using ELO and PLL

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## **INFRASTRUCTURE AND SECURITY OF COMMUNICATIONS**

## Cyber security professional development within CYBERCOR

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**Keywords:** cybersecurity, personal development, training programs, professional development, cybersecurity training exercises

**Abstract:** One of the main development challenges facing the Republic of Moldova is its vulnerability to state security threats and risks. In the context of the objectives for developing the digital economy and digitalizing public services, measures to counter cyber threats and risks become imperative. Law No. 48/2023 on cyber security stipulates the implementation of requirements, measures, and mechanisms to ensure a sufficiently high level of security for networks and information systems in the Republic of Moldova, capable of guaranteeing the protection of the vital interests of individuals and legal entities, society, and the state, as well as the national interests of the Republic of Moldova. In this regard, the human resources' preparation level plays a primary role and is a priority. Developing cybersecurity skills among staff is an indispensable part of the process of ensuring the cybersecurity of systems and information resources. The creation of the National Institute for Cybersecurity

Innovation „CYBERCOR” aims ultimately to ensure the necessary level of cybersecurity competencies among personnel, strengthening the security of networks and information systems. The appropriate professional development of public authority staff at any level and employees of other legal entities, public or private, will enable the prevention and counteraction of cyber threats and risks.

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## GFRP application in the modern Telecommunication Infrastructure

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**Keywords:** GFRP, Telecom civil infrastructure, Cost reduction, Tower rollout speedup

**Abstract.** Together with the implementation of 5G technology in the mobile networks the construction of telecom civil infrastructure has received new challenges due to the increased load and static requirements on mobile towers.

One of the innovative solutions in reducing these costs and complexity is to use the GFRP which is a new trend in the telecom civil infrastructure.

GFRP (Glass Fiber Reinforced Plastics) is a composite material with glass fiber as reinforcement material and synthetic resin as matrix material and is designed following CEN/TS 19101, complies with European Union regulations.

The GFRP is widely used since long time in the wind power industry, bridge construction, civil building and other domains. But its usage in the telecom civil infrastructure is not widely spread.

It has several advantages comparing to the steel which are important for the production and construction of mobile tower sites. Here are several of them:

**Cost:** depend on the particular tower design the GFRP solution it can save up to 30% costs compared to the steel.

**Crane:** the costs for the Crane and the road block are saved. The GFRP tower has a modular design, it's constructed of elements with the length less than 3 meters and permits manual lifting by stairs or by house elevator and mounted together on the roof top using steel elements and steel bolts.

**Weight:** for the identical tower design and function GFRP has 35% to 50% less weight than the steel. This avoids static rejection in many cases.

Strong: GFRP material is 2x times stronger comparing to the steel.

Insulation: has excellent insulation and very good wave transmission, it has no electrical conductivity and assure a better lightning protection.

Faster: with GFRP solution less footprint is needed, as result companies have easier site acquisition process. Also the crane free solution saves the time.

Climate: it has low thermal conductivity, and can be used in different climatic zones such as south regions with high temperature and in the Nordic regions.

Green: no galvanization, no harmful gas and pollutions during production.

The application scenarios in most of the cases can be: Antenna pole, roof top pole, roof top tower, light greenfield tower.

In the future the tower solution based on Glass Fiber Reinforced Plastic will prove its sustainability and innovative value for the telecom civil infrastructure and will bring benefits for the whole telecommunication community including each of us as end mobile users.

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## Aspects regarding TEMPEST protection measures of IT equipment using electromagnetic shielding enclosures

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**Keywords:** TEMPEST, electromagnetic shielding

**Abstract.** The need for shielding has become critical because of the tremendous growth of electronic devices in home, office and factory. Today, shielding against electromagnetic interferences (EMI) is being practiced by government, military, private industry, medical facility and R&D laboratories. Shielding serves two basic functions: that of preventing interference and preventing electronic eavesdropping. Electronic equipment can emit unintentional signals that allow eavesdroppers to reconstruct processed data at a distance. The document presents aspects of shielding of compromising electromagnetic emissions (TEMPEST) to ensure information security in information and communication systems - ICS. Thus, the authors analyze the minimum level of effectiveness of the electromagnetic shielding enclosures, in which IT equipment is installed. To describe this electromagnetic attenuation, a mathematical model was developed, numerical simulations were carried out, and tests were carried out with signals that simulated compromising emissions.

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## Real-time irrigation planning system

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**Keywords:** automated irrigation, crop optimization, water conservation, irrigation planning

**Abstract.** Irrigation is a crucial agricultural practice, directly impacting crop yield and resource utilization [1]. Traditional irrigation methods often rely on manual scheduling, leading to potential inefficiencies in water usage and potential crop stress due to under or overwatering [2, 3]. Recent advancements in agricultural technology have paved the way for the development of automated irrigation systems that leverage real-time data and software-based planning [4].

This paper presents the development and implementation of a software system designed to optimize irrigation practices for various field crops. By leveraging real-time data on soil moisture, crop type, rainfall, and temperature, it ensures the efficient utilization of water and energy resources.

The system operates by collecting soil moisture data from strategically placed sensors throughout the field and incorporating weather forecasts for the specific geographical location. This information is then processed to calculate and plan the irrigation system's schedule, aiming to minimize water consumption while maintaining optimal soil moisture levels.

Key features of the system include:

- *Real-time data integration:* The system seamlessly incorporates real-time weather forecasts and soil moisture measurements, enabling dynamic irrigation planning.

- *Crop-specific optimization*: The software is tailored to accommodate a variety of crops, allowing for customized irrigation schedules based on individual plant water requirements.
- *User-friendly interface*: The system provides an intuitive interface that facilitates easy data visualization.
- *Flexibility and adaptability*: The software can be adapted to different irrigation systems and field conditions, ensuring its applicability in diverse agricultural settings.

The development of such software has the potential to significantly enhance agricultural productivity and sustainability by reducing water wastage and optimizing irrigation practices. By providing farmers with a reliable and efficient tool for irrigation management, the software system can contribute to more resilient and environmentally friendly agricultural systems.

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## Advancements in Sensor Technology for Autonomous Walker ★

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**Keywords:** rollator, sensors, IMU, TOF, LiDAR

**Abstract.** By 2050, the global population will experience significant aging, with the proportion of individuals aged 65 and older increasing from 10% in 2022 to 16% [1], and the number of people aged 80 and above tripling [2,3]. This demographic shift has driven interest in technologies that improve quality of life and autonomy for older adults. Walkers, essential for mobility and independence, require enhancements in usability and automation [4]. This paper outlines the design of a motorized smart walker, integrating user feedback and focusing on affordability, with the goal of improving safety and mobility through sensor-equipped systems. Key steps in the development process include:

- Conducting user surveys to identify desired enhancements for existing walkers.
- Sourcing cost-efficient components such as sensors and batteries based on user feedback.
- Modifying a commercial walker by designing and installing prototypical supports for batteries, screens, and regulators.
- Designing and integrating an electronic board equipped with various sensors.

Implementing a data collection system to monitor performance, tracking movement speed, applied force, and user interactions for ongoing prototype refinement. Design the electronic board

This approach seeks to improve mobility for the aging population and enhance walker integration in public spaces.

Prototype development: The components were designed using Autodesk Inventor® software and fabricated through 3D printing processes utilizing PLA (polylactic acid) and resin materials as can be seen in Figure 1.



Fig.1 Sketches: a) for the batterie, b) controller and c) position in the walker

*Design the electronic board.* The electronic board has been designed to accommodate both the current and future components, ensuring scalability. The board's optimized layout allows for seamless integration into the walker, utilizing a low-power ESP32 microcontroller with multiple communication interfaces and a 32-bit processor for real-time sensor data processing (Figure 2). The prototype incorporates various sensors, including IMU, Time of Flight (ToF), and LiDAR, to collect precise data on movement, distance, and environmental mapping. Initial tests have shown high reliability, effectively tracking gait, balance, and walking intent, enabling future integration of AI for enhanced data analysis and user safety.

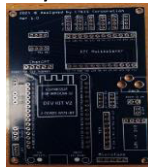


Fig.2. Figure of the design board

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award-winning abstract

## **Vegetation and Water Body Inspection and Monitoring Using Multispectral Drone Imagery**

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8475, 0000-0002-7267-1239, 0000-0002-6788-1856

**Keywords:** Multispectral images, vegetation indices, pseudo-image histogram

**Abstract:** The continuous crop condition monitoring at a regional scale is critical especially for private investors which should apply land reclamations measures regarding the soil degradation and modern methods of irrigation for optimizing the water use efficiency and crop yield production. Multispectral images have numerous applications in agriculture, in the calculation of vegetation indices in precision agriculture, whose interpretation is useful in the analysis of the state of vegetation or health of crops and the estimation of production near red. Any plant condition, such as stress caused by lack of water or the presence of pests, is reflected in the plant's ability to carry out photosynthesis.

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## The role of 5G technology in fostering sustainable economic development

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**Abstract.** This paper analyzes the evolution of mobile communication technologies, focusing on the progress from the early mobile networks to the sophisticated 5G network. Since the inception of wireless communications by Guglielmo Marconi in 1895, this research highlights how each generation of mobile networks has contributed to the radical transformation of communication, transitioning from simple voice calls to advanced data services.

2G networks revolutionized communication by introducing digital voice services, followed by 3G, which paved the way for mobile internet. The 4G network significantly improved data transfer speeds, integrating services such as VoLTE (Voice over LTE). The latest innovation, 5G, offers extremely fast speeds, low latency, and the ability to simultaneously connect millions of devices, facilitating the development of IoT, AR, and VR applications.

An essential aspect of this paper is the analysis of the impact of 5G technologies on the sustainable economy. These advanced networks contribute to optimizing resource consumption and reducing carbon emissions, being fundamental in implementing smart grid solutions in the energy sector. In transportation, 5G plays a crucial role in the development of autonomous vehicles and smart infrastructure, improving traffic efficiency and reducing pollution.

In agriculture, 5G technology facilitates the use of precision technologies, promising more sustainable resource management. We conclude that the implementation of 5G networks not only redefines mobile communication but

also has a profound impact on sustainable economic development, contributing to innovation and efficiency across multiple industrial sectors. Thus, 5G networks are essential for achieving global sustainable development goals.

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The EU Horizon SENNET project, titled "**Porous Networks for Gas Sensing**," involves a network of 12 recruited PhD researchers (Aleksandra Hernik, Ajay Padunnappattu, Aparajita Ghosh, Barnika Chakraborty, Rajat Nagpal, Fatim Ezzahra, Masaya Sugihara, Iago Maye, Laura Ramio, Kavosh Karami, Divya Rajagopal, Sabrina Grigoletto) working on cutting-edge sensor technology to detect volatile organic compounds (VOCs) under the supervision of Prof. Rob Ameloot (KU Leuven), Prof. Guillaume Maurin (Université de Montpellier), Prof. Norbert Stock (Kiel University), Prof. Rainer Adelung (Kiel University), Veronique Van Speybroeck (Ghent University), Prof. Louis Vanduyfhuys (Ghent University), Prof. Joeri Denayer (VUB), Prof. Izabela Naydenova (TU Dublin), Prof. Matthias Thommes (FAU), Prof. Svetlana Mintova (ENSICAEN), Prof. Oleg Lupan (UTM), Prof. Michael Kraft (KU Leuven), Prof. Agustin Gutierrez Galvez (University of Barcelona). These researchers are developing advanced materials like metal-organic frameworks (MOFs) and zeolites, crucial for improving the sensitivity and selectivity of gas sensors. Each PhD candidate is enrolled in joint doctoral programs across European universities, engaging in interdisciplinary research that combines chemistry, materials science, and engineering.

<b>The beneficiaries of the SENNET project are some of the leading academic and research institutions in Europe, including:</b>	<b>The project collaborates with several associated partners, including academic and industry leaders. These partners contribute expertise in sensor technology, product development, and large-scale fabrication. Key associated companies include:</b>
<ul style="list-style-type: none"><li>- KU Leuven (Belgium)</li><li>- Christian-Albrechts-Universität zu Kiel (Germany)</li><li>- Centre National De La Recherche Scientifique (CNRS) (France)</li><li>- Vrije Universiteit Brussel (VUB) (Belgium)</li><li>- Friedrich-Alexander University Erlangen-Nürnberg (Germany)</li><li>- Ghent University (Belgium)</li><li>- Technological University Dublin (Ireland)</li><li>- Technical University of Moldova (Moldova)</li><li>- University of Barcelona (Spain)</li></ul>	<ul style="list-style-type: none"><li>- Airsense Analytics (Germany)</li><li>- Analog Devices (Ireland)</li><li>- Hiden Isochema (UK)</li><li>- ProfMOF (Norway)</li><li>- Voxdale (Belgium)</li><li>- Software for Chemistry and Materials, SCM (Netherlands)</li><li>- STARNAV (France)</li><li>- VITO (Belgium)</li><li>- UNICAEN (France)</li><li>- Université de Montpellier (France)</li></ul>

This collaboration between academic institutions and industry partners ensures that the research is well-rounded and has real-world applications in improving air quality monitoring and sensor integration.

*Next edition: 15-16 October 2026*