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UNIVERSITY  
OF CLUJ-NAPOCA  
ROMANIA



Faculty of Electronics,  
Telecommunications and  
Information Technology

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2025

**May 23, 2025**

# **Student Symposium on Electronics and Telecommunications**

**20th edition**

**NOVICE INSIGHTS IN ELECTRONICS AND  
TELECOMMUNICATIONS**

# SSET 2025

## **Student Symposium on Electronics and Telecommunications**

**20th edition**

**May 23, 2025  
Cluj-Napoca**

**NOVICE INSIGHTS IN ELECTRONICS AND  
TELECOMMUNICATIONS**

# **SSET 2025**

## **Student Symposium on Electronics and Telecommunications**

**20th edition**

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Lorant SZOLGA  
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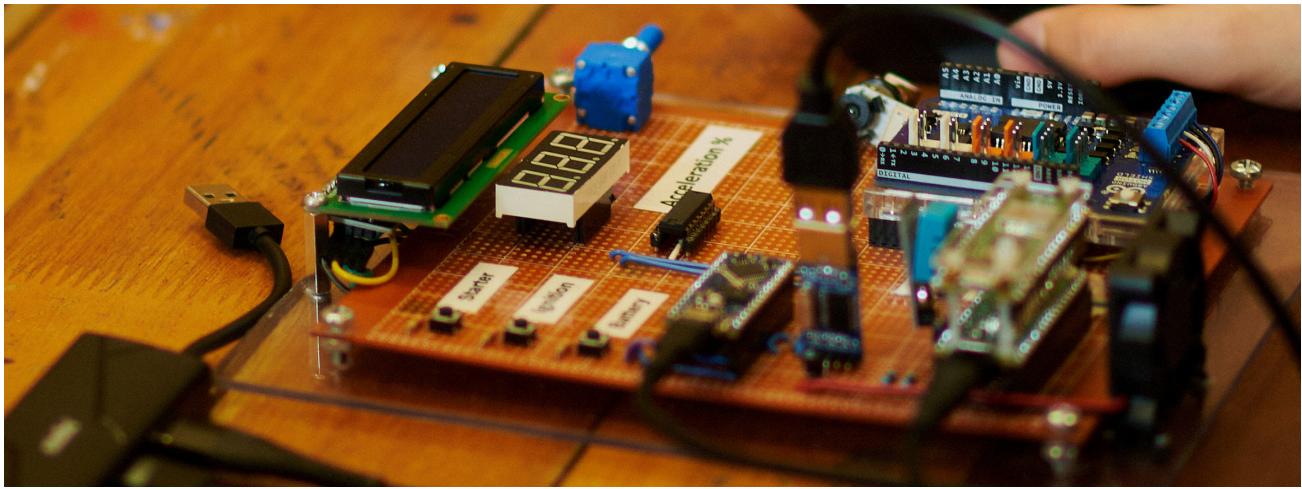
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# Foreword

It is our pleasure to welcome you to the **20th edition of the Student Symposium on Electronics and Telecommunications (SSET)**, a distinguished event hosted by the *Faculty of Electronics, Telecommunications, and Information Technology*. For two decades, SSET has served as a bridge between aspiring engineers, academic mentors, and industry leaders, creating an environment of knowledge exchange and collaborative growth.

This year's symposium is a celebration of student ingenuity and perseverance, providing them with a stage to communicate their technical insights and innovative solutions. Beyond mere presentations, SSET is a space where participants enhance their public speaking abilities and engage in meaningful dialogues with seasoned professionals.

The 20th edition is set to deliver a dynamic program, featuring diverse subjects: from advanced communication technologies to pioneering research in artificial intelligence and semiconductor design. Attendees will gain fresh perspectives, explore groundbreaking ideas, and establish valuable professional connections.

Our institution remains unwavering in its mission to nurture talent in electronics, telecommunications, and information technology. SSET is a vital component of this mission, as it directly contributes to the professional growth of our students and the overall enhancement of the educational process, empowering students to refine their technical expertise and broaden their horizons.

We extend our heartfelt appreciation to the organizing committee, our industry partners, and the dedicated faculty members who have made this event possible. Their continuous support ensures that the 20th edition of SSET will be a memorable and enriching experience.

Thank you for joining us, and we hope this symposium inspires you and enhances your professional journey.

**Prof. Ovidiu POP, PhD**  
**Dean of ETTI**

# Bachelor, Master and PhD Programs at ETTI



The **Faculty of Electronics, Telecommunications and Information Technology** offers educational programs at three levels:

## **Bachelor programs (4 years, 240 ECTS):**

- Applied Electronics (in Romanian and English)
- Telecommunications Technologies and Systems (in Romanian and English)
- Microelectronics, Optoelectronics and Nanotechnologies (in Romanian)
- Economic Engineering in the Electric, Electronic and Energetic Field (in Romanian)

## **Master programs (2 years, 120 ECTS):**

- Integrated Circuits and Systems (in Romanian)
- Electronics Engineering (in Romanian)
- Artificial Intelligence and Signal Processing in Electronics and Telecommunications (in English)
- Traitement du Signal et des Images (in French)
- Integrated Communications Systems with Special Applications (in Romanian)
- Multimedia Technologies (in Romanian)
- Technologies, Systems and Applications for e-Activities (in Romanian)
- Telecommunications (in Romanian)

## **PhD program (4 years):**

- Electronics, Telecommunications and Information Technologies



<https://etti.utcluj.ro/planuri-de-invatamant.html>



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Semiconductors are crucial to solve the energy challenges of our time and shape the digital transformation. This is why Infineon is committed to actively driving decarbonization and digitalization. As a global semiconductor leader in power systems and IoT, we enable game-changing solutions for green and efficient energy, clean and safe mobility, as well as smart and secure IoT.

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Semiconductors developed by Infineon in Romania help to address the global need for decarbonization and digitalization and are used in automotive, security, IoT and consumer applications.

With now more than 550 engineers, Infineon is the strongest semiconductor company in Romania, having ownership and all competencies along the development lifecycle of semiconductor chips.





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and digital world towards  
breakthrough innovation. Be part  
of the future.**



## OPPORTUNITIES



### FULL TIME POSITIONS

- Hardware
- Embedded software
- Digital design/FPGA
- Software applications



### INTERNSHIP POSITIONS

Internships in all the departments

- part time: 4h/day
- up to 1 year period



### SUMMER INTERNSHIP

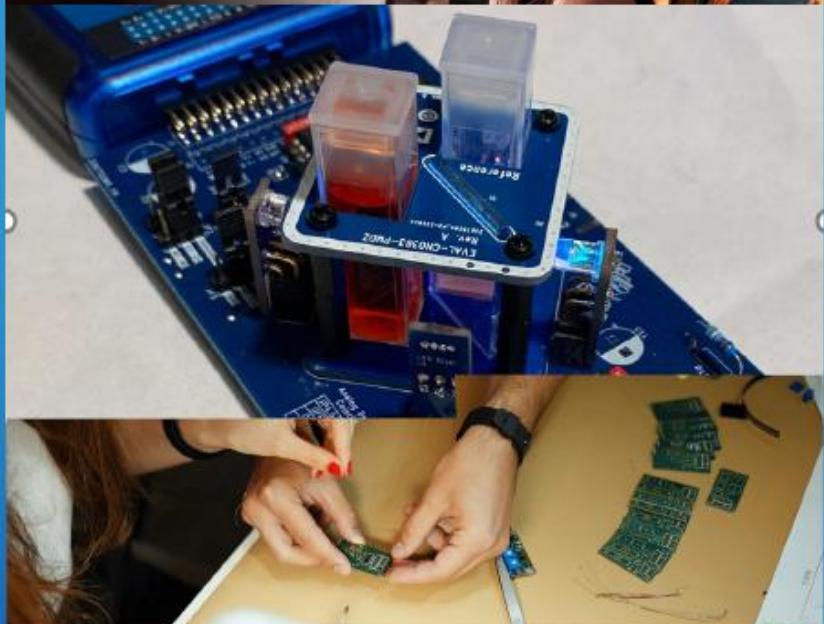
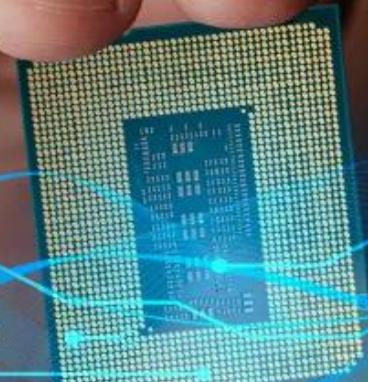
- 6-week program
- 8h/day
- 10 positions available
- project based and instructors led program
- students develop a fully functional device from scratch

**OPEN JOBS**





# INNOVATING AT THE INTELLIGENT EDGE



WHERE **WHAT IF** BECOMES **WHAT IS**.



Tehnică pentru o viață



## Centrul de Inginerie Bosch din Cluj

De la înființarea sa în anul 2013, Centrul de Inginerie Bosch din Cluj joacă un rol esențial în marea transformare a sectorului mobilității. Prin expertiza amplă în ingineria software, hardware & mecanică și ingineria fiabilității, dar și în planificarea vânzărilor, centrul contribuie la dezvoltarea unor produse și servicii inovatoare bazate pe inteligență artificială (IA) aplicate în domeniile conducerii automatizate, mobilității electrică și conectate.

Fie că este vorba de sisteme avansate pentru asistența șoferului, sisteme de direcție asistată electric, sisteme de propulsie tradiționale și electrice, diferite servicii pentru industria auto - avem experiență vastă în dezvoltarea unor soluții software și hardware inovatoare. De asemenea, suntem lider principal în domeniul tehnologiei inteligenței artificiale din industria auto cu cea mai mare echipă de specialiști IA din România.

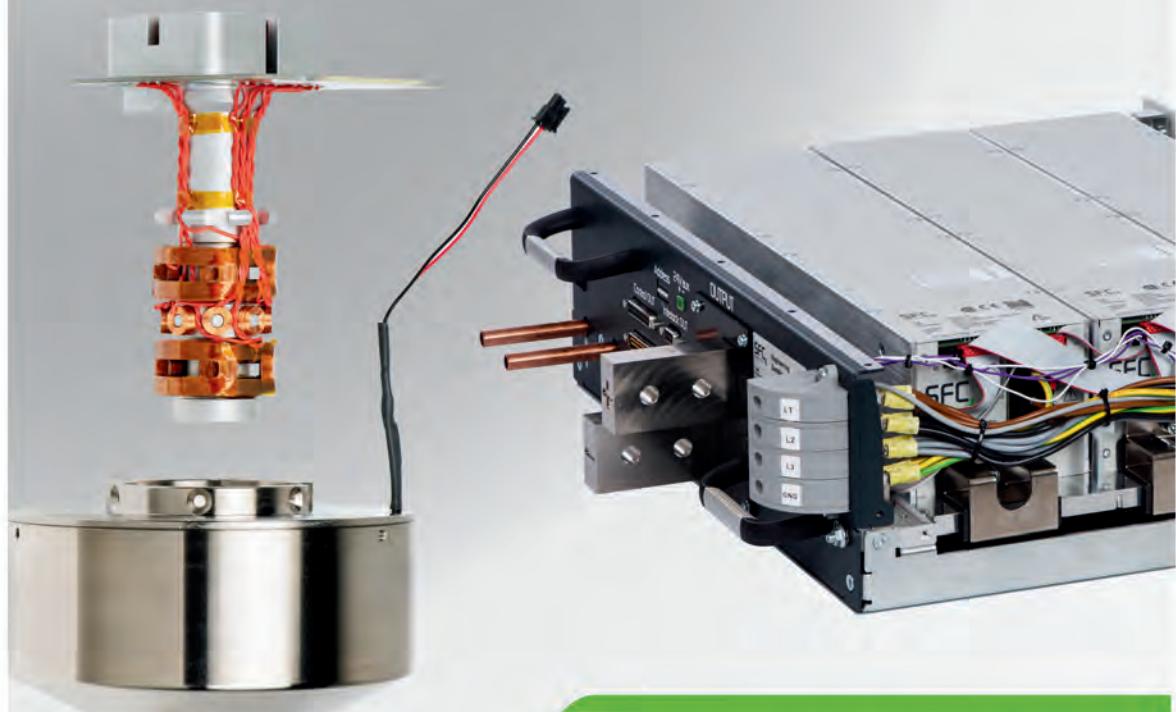
Datorită proiectelor tehnice complexe, contribuției noastre la dezvoltarea produselor Bosch inovatoare, oportunităților de dezvoltare profesională și personală pentru colegi, modului de lucru flexibil, birourilor și laboratoarelor moderne din Cluj-Napoca și Jucu, suntem unul dintre cei mai doriti angajatori în rândul inginerilor și specialiștilor IT în România.

Promisiunea noastră față de colegi este una fermă: ne dezvoltăm împreună, ne bucurăm de munca noastră și ne inspirăm unii pe ceilalți.



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The new R&D center in Cluj-Napoca, Eberspächer Controls Ro, is focused on design and development for e-mobility projects, like the new generation of control units for electrical heating solutions and energy management systems for both batteries and super-capacitors. Over the last 4 years the team in Romania reached 51 colleagues, most of which engineers, covering several core competence areas such as Basic Software and Infrastructure, Algorithms/Model Based Development, and Functional Testing. Recently our 12 V Battery Management System won the first prize automotive "Product of the Year 2025" by the prestigious Elektronik magazine from Germany.

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# SSET 2024 Awards

## Student TST

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### 1st Prize - Raluca-Andreea TRANDAFIR, Assist.prof. Ioana ILEA

"Polarimetric Synthetic Aperture Radar Image Classification based on Improved Local Quinary Patterns"

### 2nd Prize - Andrei AXENTE, Prof. Mircea GIURGIU

"An End-to-End Pipeline for Handwritten Text Recognition using Word Segmentation and Attention-based DNN"

### 3rd Prize - Tiberiu SERBĂNOIU, Assoc.prof. Nicolae CRIŞAN

"Prototyping a Solar Tracking System"

### 1st Special Award - Roxana CHEJAN, Assoc.prof. Mihaela GORDAN

"Facial Microexpression Recognition Using Local Spatial-Temporal Binary Pattern Descriptors"

### 2nd Special Award - David OROIAN, Prof. Virgil DOBROTĂ

"First Steps in Telecommunications Traffic Classification with Machine Learning"

### 3rd Special Award - Sebastian-Adrian BABICIU, Assist.prof. Iustin IVANCIU

"The Implementation of a CI/CD Pipeline Using AWS and Terraform"

### 4th Special Award - Alex BULZAN, Assist. Robert BOTEZ

"Implementing Blockchain-as-a-Service: Deployment of a Private Hyperledger Network on Kubernetes"

### 5th Special Award - Vladimir GIUSTACCHINI, Assoc.prof. Anca APATEAN

"Generating identity document photos using Python and a Raspberry Pi-based cloud service"

## Student EA-IM

---

### 1st Prize - Vlad VELICIU, Assoc.prof. Liviu VIMAN

"System for Automatic Greenhouse"

### 2nd Prize - Petru-Rares MOLDOVAN, George-Gabriel SIMEON, Assist.prof. Raul ONEȚ

"Feedback Buffer Architectures for LDO Voltage Regulators"

### 3rd Prize - Victorina LUPOI, Tomina Fabiola SĂLĂJAN, Assist.prof. Raul ONEȚ

"Current Recycling-Based LDO for Large Load Applications"

### 1st Special Award - Vlad-Andrei CRISTESCU, Assoc.prof. Liviu VIMAN

"PCB temperature controller for automated soldering"

### 2nd Special Award - Octavian-Constantin AXINTE, Assist.prof. Mihai DĂRĂBAN

"Signal Integrity Analysis on eMMC Interface"

### 3rd Special Award - Emanuel POP, Assist.prof. Iustin IVANCIU

"Mobile Android Application for Organising Airsoft Games"

### 4th Special Award - Marian-Nicolae CAP, Assist.prof. Iustin IVANCIU

"Automatic Deployment of a Java Application in AWS Using Jenkins"

### 5th Special Award - Lucas Stefan MANCIU, Assist.prof. Toma PĂTĂRĂU

"Development of Single Phase Modular Inverter"

### 6th Special Award - David-Gabriel COMBEI, Assoc.prof. Adriana STAN

"Multimodal emotion recognition using pretrained self-supervised text and speech models"

## Master-Doctor

---

### 1st Prize - Emilia GHEORGHIȚĂ, Iulian CÂMPANU, Assist.prof. Raul ONEȚ

"Innovative automated approach for sizing essential basic building blocks in CMOS submicronic nodes"

### 2nd Prize - Mihnea-Antoniu COVACI, Prof. Ramona GĂLĂTUS, Assoc.prof. Lorant SZOLGA

"Micro-adjustable Pulsed Laser Cavity Prototype for Electromagnetic Propagation Mode Study"

### 3rd Prize - Sergiu-Andrei PARFENOV, Iulian CÂMPANU, Assist.prof. Raul ONEȚ

"An automatic approach on sizing current limitation circuitry for linear regulators used in PMICs"

### 1st Special Award - Alexandru OPREA, Assoc.prof. Botond KIREI

"Method to Expand Spectrum Analyzer Range"

## Special Awards

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Analog Devices - Vlad-Andrei CRISTESCU, Octavian-Constantin AXINTE (Student EA-IM)  
Alexandru OPREA (Master-Doctor)

# SSET 2025

## Program at a glance

Event	Section, time, location		
	Student TST-IM	Student EA	Master-Doctor
Opening ceremony		8.00 - 8.10 room 359	
Presentations	8.15 - 10.00 room 368	8.15 - 10.00 room 359	8.30 - 9.45 room BT 2.04
Coffee break		10.00 - 10.15	9.45 - 10.00
Presentations	10.00 - 12.15	10.00 - 12.00	10.00 - 11.00
Partners presentations and awards ceremony		12.15 - 13.30 room 359	



# SSET 2025

## Committees

### Scientific committees

#### Section 1 - Student TST-IM

**Chairman:** Prof. Virgil DOBROTĂ, PhD

**Members:** Prof. Petre POP, PhD

Prof. Emanuel PUŞCHIȚĂ, PhD

Assoc.prof. Raul MĂLUȚAN, PhD

Assist.prof. Camelia FLOREA, PhD

#### Section 2 - Student EA

**Chairman:** Prof. Dorin PETREUȘ, PhD

**Members:** Assoc.prof. Marius NEAG, PhD

Assoc.prof. Albert FAZAKAS, PhD

Assoc.prof. Liviu VIMAN, PhD

Assist.prof. Călin FĂRCAȘ, PhD

#### Section 3 - Master-Doctor

**Chairman:** Prof. Corneliu RUSU, PhD

**Members:** Prof. Romulus TEREBEȘ, PhD

Prof. Ramona GĂLĂTUȘ, PhD

Assoc.prof. Gabriel CHINDRIȘ, PhD

Assoc.prof. Botond KIREI, PhD

### Organizing committee:

Assoc.prof. Anca APATEAN, PhD

Assoc.prof. Lorant SZOLGA, PhD

Assist.prof. Rajmond JÁNÓ, PhD

Assoc.prof. Laura IVANCIU, PhD

**Chairman (coordinator):** Prof. Ovidiu POP, PhD

**Co-chairman:** Prof. Emanuel PUŞCHIȚĂ, PhD

**Financial officer:** Eng. Angela RUSU

# SSET 2025

## Detailed program

### Section 1 - Student TST-IM - room 368

**8:15 – 8:30:** Sebastian-Iulius HOMEI, Assist.prof. Iustin IVANCIU – “High Availability Network Infrastructure Using Cisco Packet Tracer”

**8:30 – 8:45:** Ioana-Alexandra BOTĂ, Assist.prof. Iustin IVANCIU – “Automated Threat Detection and Notification System using AWS GuardDuty”

**8:45 – 9:00:** Vasile-Alexandru IVAN, Assist.prof. Ioana ILEA – “Target Recognition Algorithm, using Synthetic Aperture Radar Imaging”

**9:00 – 9:15:** Andrei AXENTE, Prof. Mircea GIURGIU – “Robust Audio Deepfake Detection Using Deep Neural Networks and Pipeline Optimization”

**9:15 – 9:30:** Anda TĂTAR, Assoc.prof. Mihaela GORDAN – “A Comparison of ORB and LBP Descriptors for Face Expression Recognition”

**9:30 – 9:45:** Anda CSEH, Assoc.prof. Bogdan ORZA – “A Machine Learning Based Painting Genre Classification System from Face Appearance”

**9:45 – 10:00:** Daiana-Alexandra HORVATH, Assoc.prof. Cosmin STRILEȚCHI – “A classical vs. AI comparative approach to image segmentation”

#### 10:00 – 10:15 Coffee break

**10:15 – 10:30:** Adelina-Nicoleta PÎRJOL, Assist. Robert BOTEZ – “A Kubernetes-Based Architecture for Tier-Aware Multimedia Streaming with Quality-of-Service Management”

**10:30 – 10:45:** Tudor-Gabriel FURDUI, Prof. Virgil DOBROTĂ – “Overview of 5G KPI Analysis: Cloud versus Legacy Implementations”

**10:45 – 11:00:** Denis-Andrei TODORUȚ, Assist.prof. Ioana ILEA – “Fire Risk Assessment Based on Texture and Color Information from Remote Sensing Images”

**11:00 – 11:15:** Sara-Damaris BORODI, Assist.prof. Iustin IVANCIU – “Automatic Application Deployment System Using GitHub Actions and Azure”

**11:15 – 11:30:** Ștefan-Darian CÎRNAT, Prof. Virgil DOBROTĂ – “Isolation Forest Anomaly Detection and Long Short-Term Memory Traffic Prediction”

**11:30 – 11:45:** David-George HIDEГ, Assist.prof. Iustin IVANCIU – “Inter-Cluster Communication in Kubernetes Using Istio Service Mesh”

**11:45 – 12:00:** Mihai-Cristian FUFEZAN, Assist. Robert BOTEZ – “Enhancing Student Learning with a Retrieval-Augmented Generation Chatbot”

**12:00 – 12:15:** Dan CUCIUREANU, Assist. Robert BOTEZ – “Monitoring-based Horizontal Autoscaling of Virtual Machines in Private Cloud Infrastructures”

# SSET 2025

## Detailed program

### Section 2 - Student EA - room 359

**8:15 – 8:30:** Alexandro VIDICAN, Assoc.prof. Mihaela CÎRLUGEA – “Sound Sculpting Synthesizer using MatLab”

**8:30 – 8:45:** Andra SIMEDRONI, Assoc.prof. Lorant SZOLGA – “Mole Analyzer Based on ESP32-CAM”

**8:45 – 9:00:** Alexandru Andrei ALEXA, Assoc.prof. Lorant SZOLGA – “DVD Player Conversion into a Laser Confocal Scanning Microscope”

**9:00 – 9:15:** Raul-George HORGOS, Assoc.prof. Liviu VIMAN – “Thermal Sensing Camera”

**9:15 – 9:30:** Maria MIHAI, Assoc.prof. Mihaela GORDAN – “A CT Scan-Based Multi-Slice Nodule Detection System with Volumetric Features and SVMs”

**9:30 – 9:45:** Cristian Valentin CHIRIAC, Prof. Dorin PETREUŞ – “Digitally Controlled High Performance DC Bench Power Supply”

**9:45 – 10:00:** David-Sorin ROȘCA, Prof. Sorin HINTEA, Paul Gabriel POP, Assist. Claudia CORDOȘ – “Seismic activity measurement system based on FPGAs using SPI Engine”

#### **10:00 – 10:15 Coffee break**

**10:15 – 10:30:** Major-Norbert APAI, Esteban FORESI, Valeria GÂRLEANU, Ovidiu Aurelian CIUPE, Assist.prof. Ligia CHIOREAN – “Website for optimizing stock monitoring and measurements in Tenaris Silcotub company”

**10:30 – 10:45:** Mihai-Cătălin ILIE, Assist.prof. Ionel BACIU – “Parking assistance system based on sensors and wireless remote control using the ESP-NOW network protocol”

**10:45 – 11:00:** Radu Bogdan SABĂU, Assist.prof. Radu ETZ – “Speed Control of a Permanent Magnet Synchronous Machine”

**11:00 – 11:15:** Adina Mariana BODEA, Assoc.prof. Mihaela GORDAN – “Traditional Vs. Deep Learning Models for Carotid Segmentation in Ultrasound Images”

**11:15 – 11:30:** Andrei VASIU, Assoc.prof. Liviu VIMAN - “Smart Autonomous Robot for Fire Detection and Suppression”

**11:30 – 11:45:** Laurențiu-Vlad BOBOCEA, Assist.prof. Toma PĂTĂRĂU – “Smart Chess Board Using AI”

**11:45 – 12:00:** Andrei NEGREA, Assoc.prof. Cristian FĂRCĂȘ – “Automatic parking barrier opening system using a Beacon”

# SSET 2025

## Detailed program

### Section 3 - Master-Doctor - room BT 2.04

**8:30 – 8:45:** Elena-Andreea MARIAN, Assoc.prof. Marius NEAG – “Design methodology for a low-power IC relaxation oscillator”

**8:45 – 9:00:** Maria-Zoița ANDRICA, Prof. Sorin HINTEA – “Performance analysis of the multiplier implemented with Booth's algorithm using integration samples with the VHDL language and Basys 3 FPGA board”

**9:00 – 9:15:** Raluca-Cosmina-Maria ARDELEAN, Assoc.prof. Laura IVANCIU – “Novel method for UCF101 dataset division for HAR and hybrid CNN and LSTM architecture”

**9:15 – 9:30:** Iulian-Teodor GOIA, Marius PETREUŞ, Assist.prof. Raul ONEȚ – “Area-Efficient Active Low-Pass Filter for Noise Reduction in Integrated Voltage References”

**9:30 – 9:45:** Valentin-Dimitrie POPESCU, Prof. Mircea GIURGIU – “Quantized Residual CNN Edge Node for Real-Time Vibration Classification and Secure OTA Updates”

#### **9:45 – 10:00 Coffee break**

**10:00 – 10:15:** Cătălin-Ionuț OPRITA, Octavian-Constantin AXINTE, Assoc.prof. Mihai DĂRĂBAN – “Signal Integrity Analysis on a RGMIv2.0 Interface”

**10:15 – 10:30:** Sebastian-Adrian BABICIU, Assist.prof. Iustin IVANCIU – “GitOps-Driven Approach for Automating Cloud Infrastructure on GCP with Terraform”

**10:30 – 10:45:** Orlando Sebastian BUHAIU, Assoc.prof. Raul MĂLŪTAN – “AlidoUP Invoice: Fast and secure e-invoicing platform on AWS with Azure DevOps CI/CD”

**10:45 – 11:00:** Petru-Rareș MOLDOVAN, Cosmin-Sorin PLEŞA, George-Gabriel SIMEON, Assoc.prof. Marius NEAG – “Stability Analysis of Multi-Loop Voltage Regulators using Signal Flow Graphs and Driving Point Impedance: A Dual-Loop Case Study”



# Paper abstracts

## Section 1 – Student TST-IM

### 1: Sebastian-Iulius HOMEI, Assist.prof. Iustin IVANCIU - *High Availability Network Infrastructure Using Cisco Packet Tracer*

*Abstract*—This paper presents the design and implementation of a redundant and scalable network infrastructure using Cisco Packet Tracer. The network integrates multiple technologies and protocols such as Virtual LANs, Rapid Spanning Tree Protocol, Hot Standby Router Protocol and Open Shortest Path First routing protocol. The goal is to simulate an enterprise environment where high availability and dynamic routing are critical.

*Keywords*—Cisco Packet Tracer, HSRP, Layer 3 Switching, OSPF, RSTP, VLAN.

### 2: Ioana-Alexandra BOTĂ, Assist.prof. Iustin IVANCIU - *Automated Threat Detection and Notification System using AWS GuardDuty*

*Abstract*—This paper presents the implementation of an automated threat detection and notification system using AWS GuardDuty. The solution leverages Amazon EventBridge to monitor GuardDuty findings in real time and routes critical alerts to subscribed users via Amazon SNS. Additionally, a custom threat simulation tool is configured and used to safely trigger GuardDuty detections, enabling consistent and automated testing of the alert pipeline. This project demonstrates how AWS-native services can be combined to build a cost-effective, scalable, and testable security alerting system for cloud environments.

*Keywords*—AWS, EventBridge GuardDuty, SNS, Threat Detection.

### 3: Vasile-Alexandru IVAN, Assist.prof. Ioana ILEA - *Target Recognition Algorithm, using Synthetic Aperture Radar Imaging*

*Abstract*—This paper presents a target recognition algorithm, designed to identify objects in imagery captured by synthetic aperture radar (SAR) systems. The proposed algorithm uses a stacked autoencoder and feature fusion techniques, in order to obtain highly discriminative features, which enhance the classification accuracy on the Moving and Stationary Target Acquisition and Recognition (MSTAR) dataset.

*Keywords*—target recognition, SAR systems, feature fusion, stacked autoencoder, MSTAR.

**4: Andrei AXENTE, Prof. Mircea GIURGIU - Robust Audio Deepfake Detection Using Deep Neural Networks and Pipeline Optimization**

*Abstract*—This research presents a robust deepfake audio detection system that combines a denoising U-Net front-end and a ResNet18 classifier back-end, trained jointly on Log Mel-Spectrograms representations of audio files. The proposed architecture aims to improve the classification F1 score and EER on noisy audio samples. Additionally, we implement and benchmark a series of training loop optimizations using PyTorch and NVIDIA tools. These contributions highlight the importance of both model architecture design and training pipeline optimization in building scalable, real-world deepfake detection systems.

**5: Anda TĂTAR, Assoc.prof. Mihaela GORDAN - A Comparison of ORB and LBP Descriptors for Face Expression Recognition**

*Abstract*—A key element of emotional computing is facial expression recognition (FER), which allows machines to interpret human emotions. This paper examines the relative effectiveness of two types of descriptors for static facial emotion recognition: Local Binary Patterns (LBP) and Oriented FAST and Rotated BRIEF (ORB). Features are extracted from aligned face images after the face region selection based on landmarks. Afterwards the expression recognition is performed in the resulting feature spaces using support vector machine (SVM) classifiers with polynomial kernel. The performance of the proposed system is assessed on the peak expression frames from the extended Cohn-Kanade (CK+) dataset. The purpose of this comparison is to evaluate how well each descriptor captures relevant information from facial expressions. Global ORB processes the face as a whole, while block-based ORB extracts local facial features from predefined regions. LBP, on the other hand, analyses local texture patterns through histograms computed from overlapping blocks. As compared to other previous works on the same dataset, we use much fewer images (only one peak frame per video sequence), and the accuracy is comparable to existing classical machine learning systems (and even superior in the case of the block-based ORB).

*Keywords*—facial expression recognition, LBP, ORB, SVM, block-based ORB, CK+.

**6: Anda CSEH, Assoc.prof. Bogdan ORZA - A Machine Learning Based Painting Genre Classification System from Face Appearance**

*Abstract*—Painting classification based on their genre is a nontrivial task, currently benefiting from researchers' attention. A particularly interesting approach is to analyze the style in which the faces are represented, because this can distinguish between the art movements better than the general overall features of the painting (e.g. global color palette, stroke style or texture). In this paper we propose, implement and validate on a public painting dataset such an image processing and analysis system, using color-based and texture-based features extracted from painted faces in conjunction with SVM classifiers. The system is trained to recognize four painting genres: Renaissance, Impressionism, Ukiyo and Rococo. The performance for the first three exceeds 80%, which is slightly superior to the state-of-the-art, and this validates the usefulness of this approach for the automatic classification of the paintings. The implementation is done in Python (Jupyter Notebook), using available public libraries.

*Keywords*—painting genre, painting face style, image analysis, color distance, LBP, SVM.

**7: Daiana-Alexandra HORVATH, Assoc.prof. Cosmin STRILEȚCHI - A classical vs. AI comparative approach to image segmentation**

*Abstract*—In almost all the computer vision tasks, such as object detection, scene understanding, and image editing, image segmentation is an important process step. In the current work, we address and analyze two different approaches to segmentation using deep neural networks and classical algorithms. We concentrate on a practical and visually meaningful use case—segmenting artwork for paint-by-number applications. A U-Net architecture with a ResNet50 encoder is trained on a dataset of artistic images and then evaluated against classical segmentation techniques, including SLIC superpixels. Alongside qualitative visual comparisons, quantitative results such as inference time are also provided.

*Keywords*—SLIC, U-Net, ResNet50, segmentation, inference time.

**8: Adelina-Nicoleta PÎRJOL, Assist. Robert BOTEZ - A Kubernetes-Based Architecture for Tier-Aware Multimedia Streaming with Quality-of-Service Management**

*Abstract*—This paper introduces a Kubernetes-based multimedia streaming application with microservices. It separates free and premium users through dedicated services and bandwidth control using Kube-OVN. Monitoring is done via Prometheus and Grafana. The system is cloud-native and deployable locally, demonstrating effective Quality-of-Service.

*Keywords*—cloud-native, Kubernetes, microservices, Quality-of-Service, Prometheus.

**9: Tudor-Gabriel FURDUI, Prof. Virgil DOBROTĂ - Overview of 5G KPI Analysis: Cloud versus Legacy Implementations**

*Abstract*—Cloudification has an important role in modernizing mobile network infrastructures to meet the demands of the fast-paced growth of data throughput and number of connected devices required for the next-generation connectivity. In this paper, we analyze the performance of cloud 5G deployment compared to legacy implementations. We describe the network implementation and administration methods based on dedicated software. The evaluation confirms the improvements that cloudification brings to 5G networks based on key performance indicators (KPIs) analysis in three main categories 5G Standalone, Non-standalone and Voice over New Radio. This work contributes to the overall understanding of cloudification's role in 5G evolution and highlights the importance of KPI monitoring and legacy system management in achieving optimal network performance.

*Keywords*—cloud, cloudification, Key Performance Indicators, 5G.

**10: Denis-Andrei TODORUȚ, Assist.prof. Ioana ILEA - Fire Risk Assessment Based on Texture and Color Information from Remote Sensing Images**

*Abstract*—This work involves the early detection of areas with a high probability of fires, using texture and color features extracted from multiple color spaces. Using the Multiple Channels Local Binary Pattern descriptor extracted from RGB space, and, at the same time, the color histogram along with statistical moments from the HSV space, the model achieves promising results in the assessing the fire risk in various areas.

*Keywords*—fire risk assessment, color features, texture information, MCLBP, k-NN, remote sensing images.

**11: Sara-Damaris BORODI, Assist.prof. Iustin IVANCIU - Automatic Application Deployment System Using GitHub Actions and Azure**

*Abstract*—This paper presents a system for the automatic deployment of a Dockerized web application in Microsoft Azure. One virtual machine hosts the GitHub Actions Runner, while another one runs the application and the monitoring stack, composed of Prometheus and Grafana. The CI/CD process, triggered by a webhook on code push, is automated using GitHub Actions, including building the Docker image and deploying it in Azure.

*Keywords*—Azure, Docker, GitHub Actions, Grafana, Prometheus.

**12: Ștefan-Darian CÎRNAT, Prof. Virgil DOBROTĂ - Isolation Forest Anomaly Detection and Long Short-Term Memory Traffic Prediction**

*Abstract*—The integration of Artificial Intelligence (AI) with network traffic analysis offers a new approach to monitor and to predict network behavior. By leveraging Grafana, Prometheus and Node Exporter for real-time data collection and visualization, the system enhances traditional monitoring methods. These tools play a crucial role in improving network management: Prometheus collects and stores network data, while Node exporter delivers detailed metrics on endpoint devices and Grafana comes with an advanced visual interface, enabling efficient traffic analysis and monitoring. Machine Learning models were used for anomaly detection and traffic forecasting to identify potential issues and to predict the network conditions. By combining these technologies, the system enabled real-time monitoring, while also supporting anomaly detection and traffic prediction, thereby improving network performance and optimizing resource allocation.

*Keywords*—artificial intelligence, Grafana, machine learning network traffic analysis, Prometheus.

**13: David-George HIDEG, Assist.prof. Iustin IVANCIU - Inter-Cluster Communication in Kubernetes Using Istio Service Mesh**

*Abstract*—This paper presents a system designed to enable communication among services running on two distinct Kubernetes clusters using Istio. One of the clusters runs on Minikube, while the other runs on Docker Desktop. The configuration includes both Istio ingress and egress gateways as well as VirtualService and ServiceEntry resources, along with DNS resolution. The connection between the clusters is validated through curl-based testing from within pods. The entire setup is managed by Kubernetes manifests and Terraform scripts.

*Keywords*—Docker Desktop, Istio, Kubernetes, Minikube, Terraform, ServiceEntry, VirtualService.

**14: Mihai-Cristian FUFEZAN, Assist. Robert BOTEZ - Enhancing Student Learning with a Retrieval-Augmented Generation Chatbot**

*Abstract*—This document outlines the creation of a Retrieval-Augmented Generation (RAG) chatbot using popular technologies. LangGraph, Ollama, Qdrant and were used during implementation of a Python backend application, and VueJS was used to develop the frontend. The results show a working chatbot which successfully responds to queries regarding the subjects it has data on. The shortcomings of using local models and the latency difference between local and cloud-based models are also documented.

*Keywords*—AI, chatbot, education, LangGraph, LLM, Ollama, Qdrant, RAG, VueJS.

**15: Dan CUCIUREANU, Assist. Robert BOTEZ - *Monitoring-based Horizontal Autoscaling of Virtual Machines in Private Cloud Infrastructures***

**Abstract**— Cloud environments require flexible and efficient resource management to handle changing workloads. This paper proposes a horizontal autoscaling solution based on real-time metrics. The system monitors resources usage and dynamically increases/decreases the number of virtual machines. This contributes to ensuring optimal performance and avoiding over or under utilization of resources. The system is fully automated and designed to reduce manual intervention in infrastructure autoscaling.

**Keywords**—autoscaling, cloud computing, IaC, Openstack Pulumi.

## **Section 2 – Student EA**

**1: Alexandro VIDICAN, Assoc.prof. Mihaela CÎRLUGEA - *Sound Sculpting Synthesizer using MatLab***

**Abstract**—This project presents a graphical user interface in MatLab, simulating a sound synthesizer that models or “sculpts” the sound by using an addition of oscillators and by changing the phase, amplitude, pitch and filtering the signals. In the present project, two oscillators are build with modifiable phases, a filter for the sound, 32 keys with 96 pitches, a volume control for each oscillator and a detune of 300 cents.

**Keywords**—audio synthesis, sound synthesizer, sculpting sounds, oscillator, MatLab, graphical user interface component.

**2: Andra SIMEDRONI, Assoc.prof. Lorant SZOLGA - *Mole Analyzer Based on ESP32-CAM***

**Abstract**—This study presents a low-cost, real-time system for melanoma pre-screening using the ESP32-CAM module. By applying the ABCD diagnostic rule—evaluating Asymmetry, Border irregularity, Color variation, and Diameter—the system processes mole images via OpenCV and classifies risk levels through a computed diagnostic score. It supports local and remote assessments and features a Python GUI and Dropbox cloud integration. This lightweight, portable approach offers an accessible, scalable early skin cancer detection alternative.

**Keywords**—Melanoma Detection, ESP32-CAM, ABCD Rule, Image Processing, Cloud.

**3: Alexandru Andrei ALEXA, Assoc.prof. Lorant SZOLGA - *DVD Player Conversion into a Laser Confocal Scanning Microscope***

**Abstract**—Laser Confocal Scanning Microscopes (LSCM) are precise measurement tools used to research modern electronics packages and die structures. The price of a commercial LSCM exceeds the budget of most students or hobbyists; therefore, to give anyone a chance to enter the field of microscopy; this paper proposes a cheap and reliable solution by converting a DVD player into a measuring system. Most commercial DVD players use the same Photo Detector Integrated Circuit (PDIC), which makes the system more universal, but for one axis, they use a DC Motor or a Stepper Motor. The system now accommodates only the DC motor version of DVD Players.

**Keywords**—DVD Player, Laser Scanning, Microscope, Image, resolution.

#### **4: Raul-George HORGOS, Assoc.prof. Liviu VIMAN - *Thermal Sensing Camera***

**Abstract**—This paper proposes the implementation of a portable thermal sensing camera based on the ESP-32 microcontroller, the MLX90640 infrared thermal sensor and an LCD display. The system is designed to detect potential gas leaks, general variations in real-time, the presence of a human in a room and thermal anomalies. It consists of a custom designed PCB with components, powered by a rechargeable battery, all being encased in a 3D-printed enclosure. The compact form factor and low production cost would make this device suitable for applications both in the professional and hobbyist field.

**Keywords**—thermal sensing, PCB, infrared, compact form.

#### **5: Maria MIHAI, Assoc.prof. Mihaela GORDAN - *A CT Scan-Based Multi-Slice Nodule Detection System with Volumetric Features and SVMs***

**Abstract**—Accurately detecting pulmonary nodules in computed tomography (CT) images is critical for early-stage lung cancer diagnosis. This paper presents the design and implementation of a computer-aided detection (CAD) system that automatically detects and classifies lung nodules using classical image processing and machine learning. The multi-stage pipeline includes image enhancement, lung segmentation, three-slice spatial verification, and feature-based classification using a support vector machine (SVM). Benign and malignant nodules are distinguished based on their morphological and intensity based features. The system is implemented in Python and validated on the LIDC-IDRI dataset, demonstrating its effectiveness in detecting nodules of varying morphologies. The classification phase significantly reduces false positives while maintaining high sensitivity, making it a practical tool for assisting radiologists in early lung cancer diagnosis.

**Keywords**— lung cancer detection, computer-aided diagnosis (CAD), medical image processing, LIDC-IDRI, CT scans, support vector machine (SVM).

#### **6: Cristian Valentin CHIRIAC, Prof. Dorin PETREUS - *Digitally Controlled High Performance DC Bench Power Supply***

**Abstract**— Bench power supplies are essential tools for engineers, yet many have drawbacks such as bulkiness due to heat dissipation and a lack of automation capabilities. This paper presents a modified version of the Analog Devices DC2132A [1] supply that addresses the portability limitation, and offers features such as zero-voltage support, and a fast transient response. Enhancements to the original design are digital control, improved output capabilities and a solution to a specific issue introduced by zero-voltage support, all while also lowering the cost of the supply.

**Keywords**—dc power supply, portable, low-cost, digital control.

#### **7: David-Sorin ROȘCA, Paul Gabriel POP (Analog Devices), Prof. Sorin HINTEA, Assist. Claudia CORDOȘ - *Seismic activity measurement system based on FPGAs using SPI Engine***

**Abstract**—As the world is constantly changing, seismic movements, whether of low or high intensity, can cause significant damage to the global population. To measure seismic acceleration, velocity and distance, we integrate a triaxial accelerometer system. This paper aims to develop an SPI Engine based system for seismic signal measurement and detection, implemented on the Cora Z7.

**Keywords**—accelerometer, SPI Engine, seismic, Cora Z7.

**8: Major-Norbert APAI, Esteban FORESI (Tenaris Silcotub), Valeria GÂRLEANU (Tenaris Silcotub), Ovidiu Aurelian CIUPE (Tenaris Silcotub), Assist.prof. Ligia CHIOREAN - Website for optimizing stock monitoring and measurements in Tenaris Silcotub company**

*Abstract*—This paper shows the changes made in various operational activities. Automation, the use of Power BI reports and their publication on a website, contributed to shortening the execution time of processes and activities carried out within the company Tenaris Silcotub, while also providing assistance to employees. Data quality has increased, allowing for more efficient management of resources and better-founded decisions.

*Keywords*—website, QR Code, PowerBI, reports, measurements, stock.

**9: Mihai-Cătălin ILIE, Assist.prof. Ionel BACIU - Parking assistance system based on sensors and wireless remote control using the ESP-NOW network protocol**

*Abstract*— This paper presents the design and implementation of a bidirectional wireless control system using the ESP-NOW communication protocol developed by Espressif Systems. The system comprises a remote control unit and a mobile platform equipped with multiple sensors for obstacle detection. The control module integrates physical buttons for directional commands, a potentiometer for speed adjustment, and a real-time feedback interface via an LED matrix. The mobile unit receives control signals, processes them through PWM to drive motors, and transmits environmental data back to the remote control. The communication was tested in various environmental conditions, including different temperatures and electromagnetic influences. The proposed architecture demonstrates low latency, high reliability, and low power consumption, making it suitable for integration into robotics and industrial automation systems. Future work includes autonomous navigation and advanced obstacle avoidance capabilities.

*Keywords*— ESP-NOW, wireless communication, ESP32, embedded systems, obstacle avoidance, real-time control, PWM.

**10: Radu Bogdan SABĂU, Assist.prof. Radu ETZ - Speed Control of a Permanent Magnet Synchronous Machine**

*Abstract*—Throughout this article one can find the implementation of a speed controller for a Permanent Magnet Synchronous Machine (PMSM) using a different software infrastructure approach for various known techniques. This paper serves to provide a better understanding of Brushless DC Motor (BLDC) control, and how the results can be improved when implemented on low-cost hardware. The design is modeled and simulated in the MATLAB/Simulink software and implemented using commercially available hardware parts.

*Keywords*—Permanent magnet synchronous machine; brushless dc motor; speed control; feedback control; induction motor.

**11: Adina Mariana BODEA, Assoc.prof. Mihaela GORDAN - Traditional Vs. Deep Learning Models for Carotid Segmentation in Ultrasound Images**

*Abstract*—Carotid artery wall identification is crucial for cardiovascular disease diagnosis, as the plaque deposits and the artery stiffness are key indicators of circulatory problems. The most non-expensive and non-invasive medical imaging modality is the ultrasound (US) examination. However the common ultrasound images often suffer from noise and lack of sharpness, which yields the manual and automatic localization and tracing of the blood vessel boundary rather difficult. Several image processing-based automatic approaches have been proposed for the detection of the carotid artery lumen (using image

segmentation algorithms). Some of these are unsupervised, and recently, others are completely supervised (deep learning based). If for large datasets with available ground truth data the supervised approaches prove better accuracy, this is not the case when the size of the annotated dataset is smaller. This paper proposes the implementation and comparison of the performance of two segmentation algorithms for the task of carotid artery localization on a publicly available, small size dataset (Common Carotid Artery Ultrasound Images Dataset): the first method is completely unsupervised and uses SLIC and homomorphic filtering, whereas the second is a low complexity U-Net architecture, trained using the expert annotation. The conclusion based on the experiments is that none of the algorithms can provide a perfect segmentation for all the images, but both the unsupervised and the supervised techniques are in general able to accurately locate the carotid and describe the shape of the vessel wall.

*Keywords*—carotid artery, ultrasound image, image segmentation, SLIC, homomorphic filtering, U-Net.

**12: Andrei VASIU, Assoc.prof. Liviu VIMAN - *Smart Autonomous Robot for Fire Detection and Suppression***

*Abstract*—Due to the risk of fires, this project proposes the development of a smart autonomous robot for fire detection and suppression, capable of quickly detecting and intervening to extinguish fires. The robotic platform is controlled by an Arduino Mega 2560 Rev3, which is responsible for data collection, processing, and coordinating the movement and fire extinguishing mechanisms. It integrates flame sensors as well as the MLX90614 temperature sensor for more accurate ambient temperature detection. The robot is equipped with an ultrasonic sensor and two infrared sensors for obstacle detection and avoidance, in order to optimize its trajectory and reduce response time when moving toward the fire source.

*Keywords*—Arduino Mega 2560 Rev3, flame sensors, MLX90614, obstacle avoidance.

**13: Laurențiu-Vlad BOBOCEA, Assist.prof. Toma PĂTĂRĂU - *Smart Chess Board Using AI***

*Abstract*—In a field of continuously development, the chess engine world neglected bridging the gap between the chess engines and the physical chess board. This project aims to connect an AI-powered chess engine to an interactive physical chess board that will help the player improve his preparation. The chess board uses a matrix of Reed sensor for the “players move” detection and a matrix of LED’s to display the “computer move”. A microcontroller interprets all data from the sensors and communicates it with the AI-based chess engine that runs on a computer.

*Keywords* — chess engine, microcontroller, artificial intelligence, UCI protocol, neural network.

**14: Andrei NEGREA, Assoc.prof. Cristian FĂRCĂȘ - *Automatic parking barrier opening system using a Beacon***

*Abstract*—This paper presents an automatic parking barrier system using Bluetooth Low Energy (BLE). A BLE beacon communicates with an Android app, which triggers a relay and motor driver to open or close the barrier when an authorized device is detected. An emergency stop switch and infrared sensors ensure safety. Powered by a standard 12 V adapter, the compact solution provides an efficient, user-friendly approach to vehicle access automation.

*Keywords*—BLE Beacon Bluetooth, Parking barrier, Android application, Java, Access automation.

## **Section 3 – Master-Doctor**

**1: Elena-Andreea MARIAN, Mădălina-Daniela FARCAŞ (Infineon), Assoc.prof. Marius NEAG, Assist.prof. Raul ONET - Design methodology for a low-power IC relaxation oscillator**

*Abstract*— This paper presents a sizing strategy for low-power, low-frequency relaxation oscillators, achieving a remarkable nominal output frequency error of less than 10%. The proposed design methodology is validated through the successful sizing of an oscillator in a submicron CMOS process, targeting three distinct output frequencies: 200kHz, 1MHz, and 2MHz, while maintaining a maximum current consumption of just 2 $\mu$ A in nominal conditions.

*Keywords*— relaxation oscillator, iterative sizing strategy, low quiescent current.

**2: Maria-Zoia ANDRICA, Prof. Sorin HINTEA - Performance analysis of the multiplier implemented with Booth's algorithm using integration samples with the VHDL language and Basys 3 FPGA board**

*Abstract*—This scientific paper wants to highlight the benefits of using the multiplier implemented with Booth's algorithm in arithmetic circuits. Considering its usefulness, it should be noted that a multiplier exists in all electronic applications. The multiplier implemented with Booth's algorithm has some efficient key points in terms of speed and power dissipation. Thus we study in this paper Booth's 8-bit multiplier with and without the use of integration samples. The language used was VHDL, and the simulations were done in the Vivado program and Basys 3 FPGA board. Simulations in the VHDL language show high operating speed and small number of Look-up-table and Flip-Flop, but also shows how power dissipation is affected when using Booth's algorithm in arithmetic circuits.

*Keywords*—VHDL-VHSIC Hardware Description Language, FPGA - Field Programmable Gate Arrays, DSP – Digital Signal Processing, LUT -Look up table, FF – Flip-Flop.

**3: Raluca-Cosmina-Maria ARDELEAN, Assoc.prof. Laura IVANCIU - Novel method for UCF101 dataset division for HAR and hybrid CNN and LSTM architecture**

*Abstract*—Human activity recognition (HAR) represents a challenging task influenced by body movements, gestures or interactions with various objects. This paper proposes a novel method for dividing the videos of the UCF101 dataset, into 20 categories that group multiple activities. A hybrid CNN and LSTM architecture is trained and evaluated using the new categories. The confusion matrices and classification reports for several categories demonstrate the efficiency of the proposed method, with average accuracies over 80%.

*Keywords*—HAR, CNN, VGG16, LSTM, UCF101.

**4: Iulian-Teodor GOIA, Marius PETREUŞ (Infineon), Assist.prof. Raul ONET –Area-Efficient Active Low-Pass Filter for Noise Reduction in Integrated Voltage References**

*Abstract*—This paper presents an area-efficient active lowpass filter (LPF) designed for noise minimization in integrated voltage references. The proposed architecture combines a T-network resistor configuration with a voltage-mode capacitor multiplier, significantly reducing on-chip area. Compared to a conventional passive RC filter, the proposed solution achieves a fivefold reduction in silicon area. Moreover, this improvement comes with only a modest increase in current consumption – an additional 3.3  $\mu$ A bias current – while preserving the precision of the voltage reference output and providing a

substantial reduction in noise within the frequency band of interest (200 Hz–20 kHz). The circuit was implemented in a standard submicron CMOS technology, offering a compelling trade-off for area-constrained analog and mixed-signal systems requiring low-noise performance.

**Keywords**—low noise, low pass filter (LPF), low power, CMOS technology, capacitor multiplier.

**5: Valentin-Dimitrie POPESCU, Prof. Mircea GIURGIU - Quantized Residual CNN Edge Node for Real-Time Vibration Classification and Secure OTA Updates**

**Abstract**—We present a high-precision, ultra-low-power embedded system for real-time classification of surface-borne vibration events in perimeter-security and infrastructure-monitoring applications. Our solution combines a 20-bit ADXL355 MEMS accelerometer, an STM32L496RET6 Cortex-M4F microcontroller, and an SX1261-based LoRaWAN transceiver in a compact design. A fully quantized 1D Residual Convolutional Neural Network (ResCNN), trained using Adaptive Quantization-Aware Training (AdaQAT), executes on-device in 120 ms and achieves 94.7% classification accuracy across fine-grained motion classes. Event-triggered firmware, ultra-deep sleep (21 µA), and selective peripheral activation yield >6 years autonomy on a 1200 mAh cell. Authenticated AES-GCM OTA model updates ensure maintainability without physical access. Unlike spoofable optical or RF sensors, vibration patterns provide physical, hard-to-fake evidence. Our solution closes key gaps in embedded vibration sensing by delivering a deployable, secure, and high-accuracy TinyML node.

**Keywords**—Edge AI, Residual-CNN, TinyML, Quantization-Aware Training, LoRaWAN, Vibration Monitoring, OTA Updates.

**6: Cătălin-Ionuț OPRITA, Octavian-Constantin AXINTE, Assoc.prof. Mihai DĂRĂBAN - Signal Integrity Analysis on a RGMIIv2.0 Interface**

**Abstract**—This paper presents a signal integrity (SI) analysis of an RGMII interface on a high-speed evaluation board using CST Studio Suite and Keysight ADS. The study focuses on transmission line parameters, layout parasitics, crosstalk, and impedance mismatches in MAC-to-PHY links. Pre-layout simulations guided trace and via sizing as well as routing, while post-layout analysis in ADS evaluated eye diagrams, TDR, and parasitics. Results highlight reflections and crosstalk, emphasizing the value of early SI validation and layout optimization for reliable RGMII performance in embedded systems.

**Keywords**—RGMII, signal, Ethernet, crosstalk, layout, simulation, transmission, CST Studio, Keysight ADS.

**7: Sebastian-Adrian BABICIU, Assist.prof. Iustin IVANCIU - GitOps-Driven Approach for Automating Cloud Infrastructure on GCP with Terraform**

**Abstract**—This project demonstrates a GitOps-based approach to managing cloud infrastructure on Google Cloud Platform using Terraform and GitHub Actions. Git is treated as the single source of truth, with infrastructure changes tracked and executed through automated CI/CD workflows. These pipelines handle validation, planning, and deployment steps. Additionally, a scheduled workflow continuously monitors for infrastructure drift and automatically reconciles discrepancies, enabling a self-healing environment. This method improves reliability, consistency, and auditability in infrastructure operations, aligning with modern DevOps practices.

**Keywords**—Automation, CI/CD, GCP, GitHub Actions, GitOps, Infrastructure Drift, Terraform.

**8: Orlando Sebastian BUHAIU, Assoc.prof. Raul MĂLUTĂN - *AlidoUP Invoice: Fast and secure e-invoicing platform on AWS with Azure DevOps CI/CD***

**Abstract**—The AlidoUP Invoice platform is a web application for electronic invoice that complies with the European standard EN 16931 and the Romanian standard RO-CIUS. It is built on modern Microsoft technologies such as ASP.NET Core, Blazor and C#, and hosted in the cloud with Amazon RDS and Windows Server. It used a hybrid approach (Water-Scrum-Fall) that combines planning and agility. The application update process is fully automated with Azure DevOps. In this paper, we present platform architecture, development and testing (performance and security). We also detail our marketing strategy: 15 enterprises are already using the platform in beta for a monthly subscription fee of €3. The public release of the platform is scheduled for 10 July 2025 and it will include AI technologies for automation and predictive data analysis.

**Keywords**—electronic invoicing, EN 16931, ASP.NET Core, Blazor, CI/CD, data security, GDPR.

**9: Petru-Rareş MOLDOVAN, Cosmin-Sorin PLEŞA (Infineon), George-Gabriel SIMEON (Infineon), Assoc.prof. Marius NEAG - *Stability Analysis of Multi-Loop Voltage Regulators using Signal Flow Graphs and Driving Point Impedance: A Dual-Loop Case Study***

**Abstract**—The increasing complexity of automotive PMICs and the trend towards capacitorless demands advanced regulator architectures such as dual-loop systems, but analyzing the stability of such multi-loop structures is challenging. This paper explores the use of Signal Flow Graphs (SFGs) and the Driving Point Impedance (DPI) concepts as a systematic method for deriving transfer functions and assessing the stability of multiloop regulators, focusing on a dual-loop example. We highlight the mathematical equivalence between SFG parameters and circuit matrix determinants, providing a rigorous foundation for the analysis.

**Keywords**—signal flow graph, driving-point impedance, feedback, multi-loop, stability, voltage regulator.

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