IDSS

3RD INTERDISCIPLINARY DOCTORAL SCHOOL SEMINAR

19–20 MAY 2022

Doctoral School No. III
Exact Sciences and New Techologies

Warsaw University of Technology

The 3rd Interdisciplinary Doctoral School Seminar is a joint space for the exchange of scientific experiences between doctoral students of Doctoral School No. 3 and their supervisors, who are also warmly invited to this event. Within two days of the seminar, all doctoral students who have already completed their first year of studies will present short presentations on their doctoral research, having an opportunity to discuss the results with the audience.

Doctoral School No. III

Exact Sciences and New Technologies

Warsaw University of Technology

ORGANIZING COMMITTEE

Dr hab. inż. Ryszard Piramidowicz, prof. uczelni
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PROGRAMME

	THURSDAY, May 19, 2022	FRIDAY, December 3, 2021
09:00	Opening Ceremont with special guest Vice-Rector for Research Professor Mariusz Malinowski, PhD, DSc	Session #5, Chair: prof. Marcin Iwanowski
09:15	Session #1, Chair: prof. Ryszard Piramidowcz	#O-16: Paulina Tomaszewska, Continual Learning model for streaming data under class-prior shift?
09:30	#O-01: Przemysław Wrona, Modelling transport choices with survey data streams	#O-17: Piotr Marszałek, Digital audio steganography - review of methods
09:45	#O-02: Krzysztof Dygnarowicz, Photosensors and data acquisition systems for water Cherenkov detectors in high energy physics and astrophysics experiments.	#O-18: Karolina Filak, Development of a technology for the production of a multifunctional polymer nanocomposite based on new materials with a 2D structure and its characterization.
10:00	#O-03: Michał Daniluk, Multi-modal recommendation system for e-commerce	#O-19: Emilia Sobieska, Proposition of automate the process of designing a lightning protection systems various types of facilities
10:15	Coffee break	#O-20: Daniel Mostowski, Laser beam diagnostics systems based on artificial intelligence algorithms
10:30	Session #2, Chair: prof. Mieczysław Muraszkiewicz	Coffee break
10:45	#O-05: Tomasz Kabala, Smart wireless sensors and measurement systems dedicated for IoT in aviation component test laboratory.	Session #6, Chair: prof. Piotr Gawrysiak
11:00	#O-06: Mikołaj Małkiński, Universal Learning Systems in Abstract Visual Reasoning	#O-21: Adam Mata, On complements of maximal sublattices of convex geometries
11:15	#O-07: Jakub Łyskawa, Improving Actor-Critic with Experience Replay	#O-22: Ali Soltani Sharif Abadi, Robotic eye surgery
11:30	#O-08: Jakub Tkaczuk, Neural Crossovers? AI techniques for ultimate listening experience	#O-23: Piotr Różański, HIPIMS based thin film technology for resistive random-access memory application
11:45	Coffee break	#O-24: Robert Kołakowski, Data Plane Traffic Engineering algorithms in future mobile networks
12:00	Session #3, Chair: prof. Mieczysław Muraszkiewicz	Special invited presentation:
12:15	#O-09: Wojciech Wójciak, Minimum sample size allocation in stratified sampling under constraints on variance and strata sample sizes	prof. Agata Skowron-Nalborczyk, Muslims in Europe: Perceptions and Reality
12:30	#O-10: Mikołaj Wieczorek, A comprehensive multimodal recommender system for fashion ecommerce	
12:45	#O-11: Tomasz Kowalski, Concept of the LLRF system for stabilization of accelerating EM fields in the resonant cavities of PolFEL linear accelerator utilizing direct sampling of the RF signal	
13:00	#O-12: Filip Łabaj, Adaptive Fourier basis scanning for compressive single-pixel imaging: numerical simulations and evaluation	Lunch break
13:15	Special invited presentation:	Session #7, Chair: prof. Jordi Batalla
13:30	prof. Olaf Żylicz: Thanks God I am Morally so Good	#O-25: Jarosław Miller, Curry-Howard correspondence, linear logic and something about financial markets
13:45	Lunch break	#O-26: Konrad Gobosz, Highly advanced modular integration of insulation, energizing and storage systems for non-residential buildings
14:00		#O-27: Piotr Suchorolski, Development of model of an adaptive ferroresonance oscillations damper cooperating with electric power protection relays in industrial medium voltage networks
14:15	Session #4, Chair: prof. Ryszard Piramidowicz	#O-28: Bartosz Kościug, Security in the Internet of Things
14:30	#O-13: Paweł Kubik, Neural Network Pruning with Gradient-Based Importance Estimation	#O-29: Monika Skowron, Detection of cyber threats in encrypted network traffic with machine learning
14:45	#O-14: Daniela Ruggiano, Two-particle angular correlations of identified particles in pp collisions at the LHC registered by the ALICE experiment.	Wrap-up session and closing remarks
15:00	#O-15 Agata Daniszewska, Technology of graphene flakes production and their properties characterization	
15:15	#O-16: Justyna Stypułkowska, The analysis and selection of digital image processing and analysis algorithms in order to detect and interpret objects of a specific type recorded in photos taken with the Quercus multispectral camera.	
15:30		

POSTERS

#P-01 Aleksandra Osowska-Kurczab, Novel approach to medical image resampling

#P-02 Weronika Hryniewska, LIMEcraft: Handcrafted superpixel selection and inspection for Visual eXplanations

#P-03 Piotr Sowiński, Hybrid Artificial Intelligence Framework

#P-04 Rauzan Sumara, Siamese Network with Gabor Filter for Recognizing Handwritten Digits

#P-05 Piotr Czekała, Electromagnetic characterization of dielectric pills in the microwave frequency range by resonance methods.

#P-06 Maja Kabus, Two-particle correlations of strange and heavy flavor hadrons in the ALICE experiment at CERN

#P-07 Andrzej Wojciechowski, Clock signal phase alignment system for daisy chained integrated circuits

#P-08 Marek Ciesielski, Real-Time High Resolution ISAR Imaging System

#P-09 Agnieszka Zięba, Infinitesimial generators of quadratic harnesses

#P-10 Jacek Piłka, Formation of optical beams in nematic liquid crystals

#P-11 Tomasz Gabler, Microcavity Mach-Zehnder interferometer manufactured in optical fiber for label-free detection of viruses on the example of SARS-CoV-2 nucleocapsid protein

#P-12 Adrianna Wójcik, Electrically active impurities and phenomena limiting carrier concentration in semiconductors investigated using Secondary Ion Mass Spectrometry

#P-13 Joanna Aftyka, Can a stroke be seen in the behavior of the human heart? How much does our heart know about us?

#P-14 Michał Kopania, Development of a hybrid algorithm based on neural networks and classic methods of detection and tracking of fast-moving objects on an example a badminton shuttlecock

#P-15 Adam Małkowski, R-GAE: Graph autoencoder based on recursive neural networks

#P-16 Tomasz Święchowicz, A comprehensive power quality conditioning system with energy storage for low voltage distribution networks

#P-17 Konrad Wilczyński, First principles phonon anharmonicity and thermal expansion in supported
1-5-layered WS_2 nanosheets

#P-18 Mikołaj Pudo, Semi-supervised learning in automatic speech recognition

#P-19 Agnieszka Stelmaszyk-Śmierzchalska, Bracelets are uniquely determined by their complements

#P-20 Piotr Czarnecki, Realtime audio-visual speaker separation

#P-21 Oskar Sadowski, Development of ohmic contacts for GaN-based vertical power devices

#P-22 Sylwester Bułka, High power, high voltage solid state switch supported by a digital system of on-going adjustment of time parameters (for a microwave klystron in a linear electron accelerator installation).

#P-23 Aleksandra Dzieniszewska, Deep learning based melanoma classification

#P-24 Serafin Bachman, Enhanced control strategy for microgrids converters

#P-25 Mateusz Surma, Terahertz hologram for homogenous illumination

#P-26 Tomasz Kublin, Reducing the power consumption of the electrodynamic levitation system (EDS) by changing the fill factor in the Halbach array

#P-27 Alvaro Carreno, Control of a Hybrid Transformer to Improve the Power Quality of a Distribution Network

#P-28 Arkadiusz Czuba, Artificial Intelligence-Based Cognitive Radar

#P-29 Katarzyna Woźnica, Consolidated learning - a domain-specific model-free optimization strategy with examples for XGBoost and MIMIC-IV

#P-30 Paweł Pieńczuk, Readout integrated circuit for MIR detector within ASPIC

#P-31 Małgorzata Andrzejewska, Heart rate dynamics irreversibility in LQTS patients under beta blocker treatment

#P-32 Jarosław Tarenko, Development of methods of gallium nitride surface structuring for fabrication of vertical power devices.

#P-33 Bartłomiej Hryniewicki, A suboptimal strategy for controlling multi-dimensional drying process

#P-34 Konrad Krawczyk, Surrogate-assisted evolutionary algorithms

#P-35 Michal Falkowski, Root Cause Analysis of control errors propagation in complex multi-loop systems

#P-36 Hubert Buczyński, Resource Partitioning in Phoenix-RTOS for Critical and Noncritical Software

#P-37 Michal Gontarz, CNN based phase unwrapping in full-field optical metrology.

#P-38 Małgorzata Żebrowska, Nonlinear analysis of physiological variables in the assessment of adaptation to physical effort

#P-39 Marcin Sowański, Human factor in NLU localization

#P-40 Sevastianos Korsak, Stripes Detection and Simulation of Loop Extrusion

#P-41 Krzysztof Banecki, Image driven 3D modeling – structures of the cellular nucleus based on genomic, epigenomic and microscopic data

#P-42 Jerzy Cuper, An accurate methods for conductive layers characterization in millimeter-wave frequencies

#P-43 Karolina Okrasa, Separator theorem for B_t-free graphs

#P-44 Mateusz Klimaszewski, Knowledge Graphs in Neural Machine Translation

#P-45 Jolanta Sadura, Electromagnetic compatibility of the apparatus controlling the test in the environment of high-current laboratories

#P-46 Grzegorz Panek, Application Relocation in an Edge-enabled 5G System

#P-47 Daniel Giełdowski, Vulnerability detection and attack prevention on a social robot control system that uses deep reinforcement learning

#P-48 Jakub Zieliński, Study of antiprotonic atoms and the limits of the nuclear and electromagnetic forces

#P-49 Marcin Wiśniewski, Design of GaN HEMT amplifiers with Nonuniform Transmission Lines for T/R modules of AESA radars

#P-50 Małgorzata Giza, Van der Waals heterostructures for next generation nano and optoelectronics

#P-51 Stanisław Pawlak, Selective Generative Replay

#P-52 Daniel Wiekieta, The Autonomous Multisensory System for Obstacles Detection at Airports

#P-53 Aleksandra Bieniek, Remote detection of objects using laser techniques

#P-54 Artur Słabuszewski, Compact embeddings of Hajłasz-Sobolev spaces

#P-55 Inajara Rutyna, Machine Learning Techniques used for Wind Power Forecasting

#P-56 Karolina Pondel-Sycz, Speech recognition in conditions of impaired acoustic signal transmission.

#P-57 Szymon Baczyński, Optofluidic systems for sensing applications

#P-58 Arkadiusz Sycz, Supporting rare disease diagnosis with explainable artificial intelligence using domain knowledge models and data mining techniques on the example of early diagnosis of blood cancers.

#P-59 Yevgen Syryanyy, An XANES Investigation of the Electronic Structure of ZnO Films implanted by Yb

#P-60 Jakub Zdziebłowski, Spectral response of $CdIn_2S_4$

#P-61 Bartosz Mirecki, Lensless digital holographic microscopy in a low photon budget regime

#P-62 Tomasz Kaczorek, Evaluation of common distributed simulation protocols as a data source for a simulator of air defense radar.

#P-63 Marcin Lelit, Simulations and design of germanium-based photonic integrated elements working in mid-infrared spectral range

#P-64 Mateusz Pakosz, Development of projectile inertia control system in the electromagnetic gun for use in commercial aviation tests

#P-65 Konrad Kamiński, A method of strong authentication of remote users based on an ID card with an electronic layer

#P-66 Hubert Rachwalski von Rejchwald, Deep profiling of the speech signal with the use of artificial intelligence in order to increase the security of remote user verification based on the voice

#P-67 Emil Pituła, Periodic surface structures for the optical analysis of biological hazards

#P-68 Katarzyna Lechowicz, Thin layers for fiber optic sensors and biosensors: Optical and electrochemical label-free detection of Borrelia using ITO-coated lossy-mode resonance optical fiber sensor

#P-69 Stanisław Hajnrych, Design of High-Speed Synchronous Reluctance Motor for Electric Vehicle Drive

#P-70 Konrad Cop, Intelligent perception in autonomous robotic navigation

#P-71 Justyna Modliborska, Assessment of the development of demand side response services in European Union countries

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ORAL PRESENTATIONS

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#O-01

Modelling transport choices with survey data streams

Przemysław Wrona

One of the factors of the information society is the Internet of Things. These are technologies that allow you to connect any device to the Internet, for example, intelligent sensors. One type of never-ending stream is sent current localization of public transport such as busses, trams or metro lines.

The approach used in the work is the adaptation of traditional machine learning algorithms and artificial neural networks in a non-stationary environment, where the data for training the model flows in an endless stream.

In this paper, we are investigating day-to-day variability in public transport travel time using a GPS data set for a public transport route. It explores the nature and shape of travel time distributions for different departure time windows at different times of the day and factors causing travel time variabilities of public transport, such as distance between stops and destination, quality of vehicle number of seats, delay at the previous stop or using historical data. Additionally, the data from the streams is used to build timetable files (GTFS) based on actual journeys and will serve as one of the parameters in building the model. This data will be used to build a real model of travel behaviour and research the factors that have the greatest impact on these choices. We demonstrate the system with a real-world use case in Warsaw city, Poland.

#O-02

Photosensors and data acquisition systems for water Cherenkov detectors in high energy physics and astrophysics experiments.

Krzysztof Dygnarowicz

The aim of my research problem relates to the Hyper Kamiokande (HK) project, which is currently constructed in Japan. Main component of HK is an enormous water-Cherenkov detector (H-71m, Æ=68m), which will be filled with 258 kt of ultrapure water, placed underground at a depth of 650 m. The research problems which will be examined by HK include measurements of neutrino oscillation, study of CP-violation, study of cosmic neutrino, proton decay research, dark matter search. Project's team involves scientists from 95 institutions from 20 countries.

In Poland, we plan to manufacture around 1120 so-called multi-PMT modules – a combined sensor comprising 19 photomultiplier tubes along with associated electronics. These sensors will augment the main photodetection system of the HK, that is built using 50 cm phototubes. The main purpose of the mPMTs will be calibration and they will allow solving some of the degeneracies of the HK detector that would otherwise be impossible to measure (for ex. better study of water properties, better control of direct vs reflected light). Their main advantage compared to 50 cm PMTs are increased granularity, directionality, much better timing resolution. My research task is related to the development of mPMTs modules, which include PMT characterization, developing of data acquisition system (both hardware and digital signal processing algorithms), developing QA scheme and tools for mass production, and preparing a model for physics simulations.

#O-03

Multi-modal recommendation system for e-commerce

Michal Daniluk

Artificial Intelligence-based recommender systems are present at almost every large e-commerce store and platform, spanning various product sectors from garments, through jewelry to food. It is usually impossible to adjust existing algorithms to include a new modality of data or a new type of attribute. A vast majority of existing recommender systems consider only a single type of interaction, e.g. clicks or purchases.

The goal of my PHD is to study a multi-modal context-aware recommendation system that can be fed with various types of data such as purchases, clicks, page visits, text, image, and other meta-data. The PHD is realized in cooperation with Synerise.

In the two years of my PHD, I proposed a multi-modal recommendation model– EMDE (Efficient Manifold Density Estimator). This work was presented during ICONIP in December 2021.

Furthermore, I also won three very prestigious Machine Learning competitions:

- Booking.com Data Challenge, which aims to make the best recommendation for the next destination of a user trip, based on a dataset with millions of real anonymized accommodation reservations.
- KDD CUP 2021, which goal was to predict the subject area of the given arXiv papers in a heterogeneous academic graph.
- RecSys Twitter Challenge, which focuses on a real-world task of tweet engagement prediction in a dynamic environment.

#O-04

Smart wireless sensors and measurement systems dedicated for IoT in aviation component test laboratory.

Tomasz Kabala

Telemetry systems in form of smart transducers designed according to specific needs of aviation testing could simplify test preparation and improve quality of measurements. Rapid growth of IoT technology in the last decade brings bunch of new communication techniques and electronic design possibilities which were not available before. Combination of high computing power, low power electronic design, low power communication protocols and wireless energy transfer could bring new quality of testing. The main motivation of research works is to propose design concept of smart telemetry system that could be more affordable, handful and could simplify way of component testing. The first part of the research was devoted to rotary telemetry. A prototype of the temperature measurement module was designed and built. Tests of telemetry module will be performed on dedicated test bench which could change and measure the rotational speed and temperature. Before test dynamic balancing of the module have to be performed. When system operation is confirmed, the testing will be continue in Łukasiewicz Research Network – Institute of Aviation on one of bearing test rigs. In the second phase research will be focused on designing the network of stationary and rotary telemetry modules for aviation testing in laboratory. Final tests will be performed in configuration that will be used in future test campaigns.

#O-05

Universal Learning Systems in Abstract Visual Reasoning

Mikołaj Małkiński

One of the fundamental goals of Artificial Intelligence is to reach levels of a so-called Artificial General Intelligence (AGI), characterized by autonomous learning systems with close to human-level reasoning capabilities. Among many AGI milestones, in the planned research we are particularly interested in intelligent systems that can autonomously (i.e. without external supervision) learn to solve disparate tasks of a given type with efficacy similar to specialized methods, dedicated to the particular tasks.

As a first step to develop universal learning systems, the Abstract Visual Reasoning (AVR) domain was reviewed. It contains problems that are commonly used to estimate human intelligence. AVR tasks test the ability of applying previously gained knowledge, experience and skills in a completely new setting, which makes them particularly well-suited for this task. Recently, the AVR problems have become popular as a proxy to study machine intelligence, which has led to emergence of new distinct types of problems and multiple benchmark sets. This presentation introduces two recent papers which review this emerging AVR research. Sample problems are illustrated in Fig. 1.

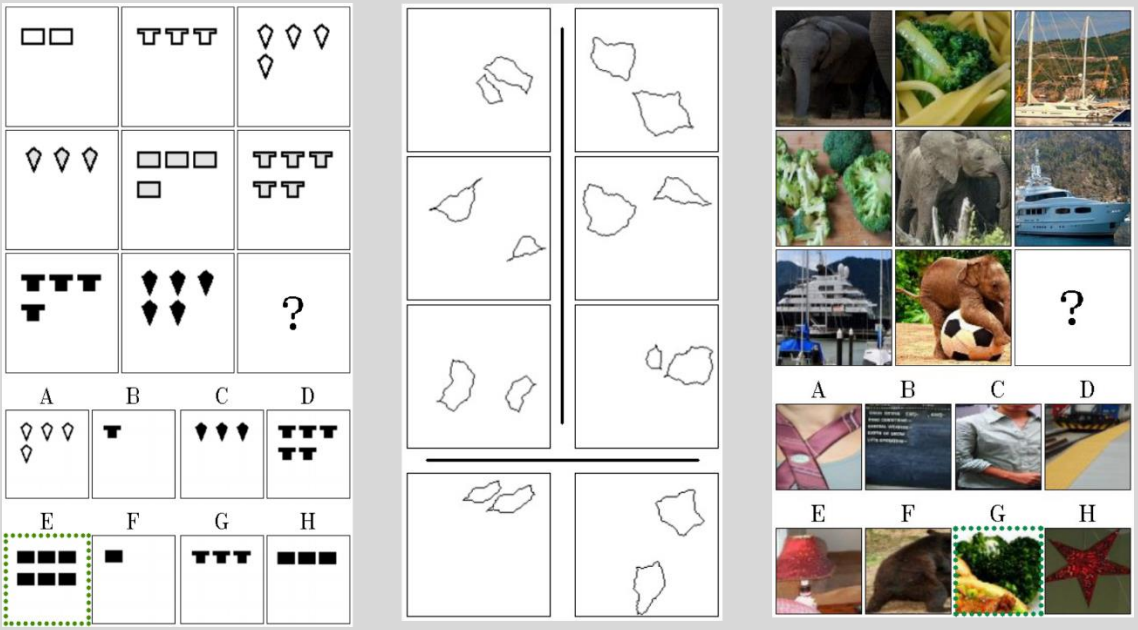


Fig. 1 Examples of AVR problems. (Left): Raven's Progressive Matrix (RPM) from Sandia dataset. (Centre): A matrix from the Synthetic Visual Reasoning Test (SVRT). (Right): RPM with real-world images from the V-PROM dataset.

[1] Małkiński, Mikołaj, and Jacek Mańdziuk. "A Review of Emerging Research Directions in Abstract Visual Reasoning." arXiv preprint arXiv:2202.10284 (2022).
[2] Małkiński, Mikołaj, and Jacek Mańdziuk. "Deep Learning Methods for Abstract Visual Reasoning: A Survey on Raven's Progressive Matrices." arXiv preprint arXiv:2201.12382 (2022).

#O-06

Improving Actor-Critic with Experience Replay

Jakub Łyskawa

In this presentation I describe the work I did, do and am going to do as a PhD student. I focus on the research on improving the Actor-Critic with Experience Replay Reinforcement Learning algorithm.

I start with a short introduction to Reinforcement Learning and overview of the Actor-Critic with Experience Replay algorithm. Then I present 4 primary research directions.

The first is the introduction of autocorrelated actions as a mean to structure exploration and allow reinforcement learning to be used in fine discretization settings.

The second topic focuses on the research on prioritized experience replay. Current methods are designed for action-value function-based algorithms and seem to be unfit for value function-based algorithms. I present the results of ongoing research on a solution that may be able to improve the sample efficiency of value function-based algorithms.

I also present two topics to be investigated in future research. One of them is the utilisation of quantile regression to estimate the distribution of the future rewards. The other one is the adaptation of time discretization that will allow algorithm to start by learning basic task first and to improve the policy later on finer discretization.

#O-07

Neural Crossovers? AI techniques for ultimate listening experience

Jakub Tkaczuk

Traditional sound reproduction systems consist of sound source, amplifier(s) and speaker(s). Idea is to embed artificial intelligence techniques into crossover that splits signal between individual transducers. Basically, our goal is to replace traditional passive filters with set of digital filters that will be controlled with AI engine. AI technology allows multiple applications including not only detection, classification and recognition but also actual signal modifications and AI techniques (e.g. Music Information Retrieval) among others are able to extract multiple parameters about audio signal such as genre, type of instruments and many others.

#O-08

Minimum sample size allocation in stratified sampling under constraints on variance and strata sample sizes

Wojciech Wójciak

The minimum sample size allocation problem in stratified sampling is one of the basic issues of modern survey sampling methodology. It is formulated as the determination of the fixed strata sample sizes that minimize total sample size, under assumed level of the variance of the stratified pi-estimator. In this work, we derive so called optimality conditions for the minimum sample size allocation problem under added one-sided upper bounds constraints imposed on strata sample sizes. This allocation problem will be considered here in the context of some general stratified sampling scheme that includes simple random sampling without replacement design within strata as a special case. Based on the established optimality conditions, we create a new algorithm, termed LrNa, that solves the allocation problem defined above. This new algorithm has its origin in popular recursive Neyman allocation procedure, or rNa, that is used to solve classical optimal sample allocation problem (i.e. minimization of the pi-estimator's variance under fixed total sample size) with only one-sided upper bounds constraints imposed on strata sample sizes. Ready-to-use R-implementation of the LrNa is available on CRAN repository at https://cran.r-project.org/web/packages/stratallo.

#O-09

A comprehensive multimodal recommender system for fashion ecommerce

Mikołaj Wieczorek

This Industrial PhD thesis, conducted in cooperation with Synerise S.A., focuses on creating a comprehensive mutltimodal recommender system for fashion industry.

Such a system consists of three main modules: 1) Visual Recommendations - visual similarity needs to be found between a viewed product and other products in the catalogue; 2) Visual Search - visual similarity between user taken/uploaded photo and products in the catalogue; 3) Outfit Recommendation – an outfit recommendation that consists of complementary and matching garments, based on the user's purchase history and general sense of 'fashionability'.

The system relies heavily on Computer Vision methods to encode and 'understand' images, as clothes are best assesed based on their look. However, the look itself may not suffice, therefore, the system needs additional data about the product and the user such as history of transaction, clicked products etc.. Images, text and behavioural data makes the system multimodal and best suited to serve personalized recommendations to users.

There are two main research challenges: 1) fusion mechanism to combine information from visual appearance, textual data and user behaviour; 2) preparing data and training schema to train a model a notion of 'fashionability' and 'compatibilty'.

During the first year, two papers were publicised with the state-of-the-art results in a fashion retrieval task. Currently, some of the models created in the first phase are being used by Synerise.

#O-10

Concept of the LLRF system for stabilization of accelerating EM fields in the resonant cavities of PolFEL linear accelerator utilizing direct sampling of the RF signal

Tomasz Kowalski

The Low-Level Radio Frequency (LLRF) control system is one of the fundamental parts of a particle accelerator, ensuring the stability of the oscillating electro-magnetic field, which is produced inside resonant cavities in order to accelerate charged particles. It relies on precise measurement of the field by In-Phase/Quadrature (IQ) detection of an RF probe signal from the cavity, which yields the instantaneous phase and amplitude of the field. The result of this measurement is fed to a digital feedback controller, which calculates an error signal and corrects the field amplitude and phase via an RF actuator, as per Figure 1.

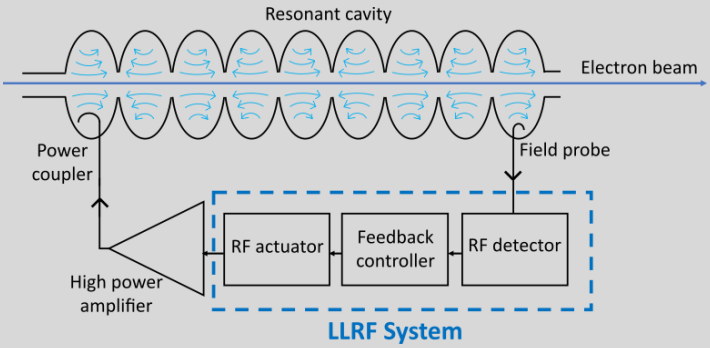


Fig. 1 Block diagram of a LLRF system.

For the purpose of the PolFEL LLRF system, direct sampling is studied for IQ detection of RF signals. This methodology bypasses a downconversion stage, leading to a straightforward implementation without the need for additional calibration. The proposed architecture of the system is presented in Figure 2. It consists of an FPGA Mezzanine Card (FMC) carrier board, implementing the feedback controller and two FMC boards. One of them features a dual digital-to-analogue converter, along with a vector modulator and serves as the RF actuator, while the other houses wide-bandwidth analogue-to-digital converters for direct sampling of RF signals. The system is provided with a single 1.3 GHz reference signal, which is then used to locally synthesise the sampling clock, as well as upconvert the actuator signal to the resonant frequency of the cavities.

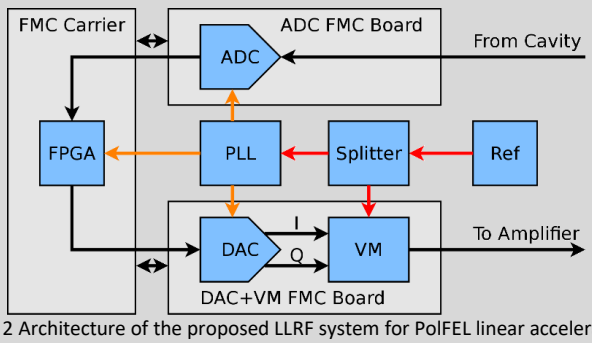


Fig. 2 Architecture of the proposed LLRF system for PolFEL linear accelerator

#O-11

Adaptive Fourier basis scanning for compressive single-pixel imaging: numerical simulations and evaluation

Filip Łabaj

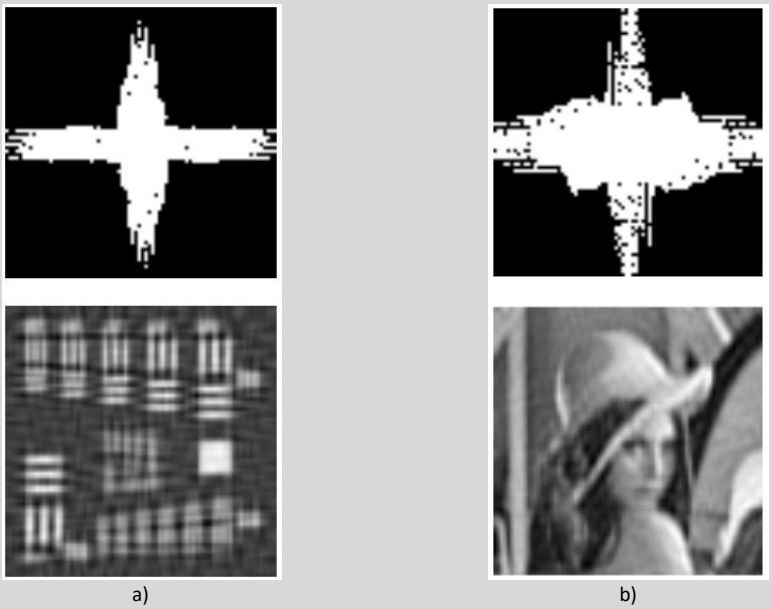
Single-pixel imaging (SPI) is a relatively young field of study that concerns itself with methods of spatial and multimodal sampling employing only a single-point detector or a group of dispersed detectors.

A crucial part of many SPI systems is the use of compressed sensing (CS) methods. CS takes advantage of the fact that most objects and scenes can be nearly completely described using a relatively small, sub-Nyquist set of coefficients in certain sampling bases, reducing the number of samples needed to perform SPI. Commonly used bases include the Fourier, Hadamard and wavelet basis.

A single-pixel, 2-dimensional, *N* x *N* resolved image $f \in \mathbb{R}^{N^2 \times 1}$ is created by performing sequential measurements using a set of *I* modulation patterns $p_i \in \mathbb{R}^{N^2 \times 1}, \{p_i\}_{1 \le i \le I}$, calculating the inner product between the measured scene/object and the patterns. Using the resulting measurement vector $m_i = f^T p_i, \{m_i\}_{1 \le i \le I}$, we can reconstruct the image in several ways, dependent on used patterns and modulation strategy.

In this work we present a novel SPI sampling method that adapts a set of Fourier basis patterns to the measured scene, during the measurement. We show that this method, called the Fourier adaptive basis scan (F-ABS) significantly shortens the sampling time, while maintaining quality of reconstructed images, as compared to standard Fourier and Hadamard basis sampling methods.

To quantitatively evaluate the reconstruction quality, we use local (SSIM) and global (MSE, PSNR) metrics. Additionally, we simulate the influence of white noise and pattern binarization on the reconstructions.



a) b)

Fig. 1 Two Fourier ABS reconstructions in the spectral (top, binarized) and spatial (bottom) domains, for 80x80 px test targets

#O-12

Neural Network Pruning with Gradient-Based Importance Estimation

Paweł Kubik

Pruning is a neural network compression technique that removes weights of a network to reduce its size and computation cost. In a typical compression scheme one: 1) trains the original model; 2) prunes the model to meet performance constraints; 3) fine-tunes the pruned model to recover some of the lost prediction quality. Pruning methods try to limit the loss of prediction quality by removing the least important parts of the network. In order to assess this importance, we associate parts of a network with binary gate variables that control their inclusion in the final network and reuse the original model's training procedure to find optimal values for the gates. We enable flow of the gradients by relaxing the binary gate variables with Gumbel-Softmax distribution. We sample a new set of gate values on each training step, and back-propagate gradient to the distribution parameters with the reparametrization trick. We propose an additional loss function that ensure that the pruned network meet performance constraint, by comparing the expected number of floating-point operations with a value specified as a hyperparameter. The constraint is global for the whole network, which means that apart from selecting the most important weights within each layer, we also search for an efficient model structure, i.e. size of each layer of the network. To further improve the final model, we apply knowledge distillation in the fine-tuning phase with the original network used as the teacher.

#O-13

Two-particle angular correlations of identified particles in pp collisions at the LHC registered by the ALICE experiment.

Daniela Ruggiano

This contribution presents the analysis of two-particle angular correlations of pions, kaons and protons performed in pp collisions with energy $\sqrt{s}$ = 13 TeV, that were registered by the ALICE experiment at the LHC.

Angular correlations are used to describe a wide spectrum of physical phenomena observed in high-energy particle collisions.

The correlations between two-particles in relative azimuth $\Delta\varphi$ and rapidity Δy exhibit different structures that arise from several physical mechanisms that create distinctive structures in the $\Delta y \Delta\varphi$ space.

Each of these effects contribute to the correlation function by showing individual behavior (e.g. different shape of the structures, different dependence on p_T and/or multiplicity).
The main goal is to disentangle mentioned physics effects and study how they depend on the multiplicity of the events.

#O-14

Technology of graphene flakes production and their properties characterization

Agata Daniszewska

The purpose of the research is the development of a technology for the production of new materials with a 2D structure adapted to the industrial scale and testing the physico-chemical properties of the materials. The technology is to be based on a method of bulk material exfoliation in aqueous solution using shear forces without the use of any harmful chemicals. Following problems are being solved: the possibility of the process scalability and its capability, improvement of the structural quality of the material, defect testing, reduction of the production price due to the absence of harmful factors, the possibility of production processes optimization, control of structure of the obtained material.
A series of experiments of graphite exfoliation in liquid phase were carried out using high pressure homogenizer. The quality and the structure of the produced material were tested using Raman spectroscopy, UV-VIS spectroscopy, atomic force microscopy, scanning electron microscopy and thermogravimetric analysis. Preliminary optimization of the process parameters has been performed (e.g. type of input material and solvent, concentration, pressure, number of passes at given pressure).

#O-15

The analysis and selection of digital image processing and analysis algorithms in order to detect and interpret objects of a specific type recorded in photos taken with the Quercus multispectral camera.

Justyna Stypułkowska

The ongoing doctoral thesis focuses on the problem of detection and classification of objects in photos recorded with a multispectral camera. The main objective of the research is, firstly, to select the most effective algorithms for detecting objects on the acquired images, and secondly, to examine the impact of the use of individual spectral channels and appropriate camera settings during image recording on the effectiveness of these algorithms. This will allow for the development and optimization of the entire process not only from the implementation side, which is a common procedure, but also from the hardware side, which will indicate the right direction of the image acquisition method in order to achieve the most effective method of detection and classification of objects recorded on them. The research uses digital image processing and analysis algorithms, artificial intelligence techniques and deep learning algorithms.

The research is innovative, because so far no one has studied the impact of the use of individual spectral channels on the effectiveness of the detection process and classification of objects in the acquired images. The results of the conducted research will allow for the proper selection of both algorithms and hardware solutions, which are key at the stage of the image acquisition itself. The developed solutions will be implemented in the work of the Remote Sensing Department of the Łukasiewicz Research Network - Institute of Aviation.

#O-16

Continual Learning model for streaming data under class-prior shift? (LIMES)

Paulina Tomaszewska

Offline Deep Learning based solutions work well in production as long as the input at the prediction time has similar characteristics to data used for training. Otherwise, if the discrepancy is substantial, the model may need to be modified e.g. by fine-tuning using new data or the change of the model architecture that may require training from the scratch. Later, the previous model can be replaced by the new one. Another approach is training a model in a continuous manner on streaming data. In my work, I focus on a case where class-priors change over time. The results on the Twitter dataset show that the proposed LIMES algorithm improves the metric in a form of the minimum model accuracy within a day.

#O-17

Digital audio steganography – review of methods

Piotr Marszałek

Steganography is the art of hiding communication without being noticed by a third party. This can be used to provide safe and reliable transmission on public networks, but also brings an opportunity for cybercriminals. For instance, an innocent-looking „cute kitten" JPEG may have a computer virus embedded or may contain detailed orders for a botnet to attack a given host in cyberspace. Hence, multimedia files are often used as steganographic carriers. However, most of the research carried out on digital steganography focuses on still images rather than on audio data.

There is a lot of methods of embedding hidden data on audio streams and those methods can be grouped into the following three domains: time, frequency, and wavelet. For instance, the most known „time domain" technique uses the least significant bit (LSB) of each audio sample to store steganographic information. On the other hand, there is a lot of widely available steganographic software that can operate on various well-known file formats e.g., WAV, MP3, FLAC to name a few. However, detailed information about the principle of operation of most of this software remains unknown.

The aim of this work is to present audio data hiding techniques utilized nowadays in cyberspace.

#O-18

Development of a technology for the production of a multifunctional polymer nanocomposite based on new materials with a 2D structure and its characterization.

Karolina Filak

The discovery of new materials drives the economy, which constantly requires more efficient solutions with extreme properties. Along with the continuous development of technology in various sectors of the economy, there are newer threats, and thus the possibilities of their solutions. Materials with a two-dimensional structure appear to be ideal candidates for achieving excellent characteristics. These materials implemented in composites are advanced materials and thanks to their properties, including low weight, thermal and electrical stability or shielding of electromagnetic radiation have a wide range of applications.

Fig. 1. Manufactured nanocomposites that initially meet the assumed requirements as to physical properties.

The research goal was to develop composite materials (Fig. 1) producing method consisting of thermoplastic polymers and fillers. It is crucial that this method is cheap, uncomplicated and scalable. It was assumed to develop nanocomposites that will show an EMI shielding efficiency of minimum 20 dB, a thermal conductivity of at least 1 W/mK and the lowest possible volume resistivity. Research is being carried out on the selection of an appropriate filler and its concentration in order to achieve the assumed goal.

The previous research activity has included the production of composites from various polymers and fillers, as well as various concentrations of these fillers. In addition, new methods of producing composite materials were developed that improved the electrical and thermal properties of nanocomposites.

#O-19

Proposition of automate the process of designing a lightning protection systems various types of facilities

Emilia Sobieska

The procedure for designing lightning protection systems defined by the PN-EN 62305 standard is characterized by some imperfections and limitations. When determining the lightning risk, the values of some coefficients describing the lightning threat, are selected on the basis of the subjective assessment of the designer. As a result, there are cases of overestimating or underestimating the parameters of the lightning protection system. The process of estimating this risk may be improved by the use of artificial neural networks to correctly classify the values of the aforementioned coefficients on the basis of input data, such as photos of the object and its vicinity. Neural networks construct the models needed by the user using the learning process based on examples. Such action is aimed at automatically creating the necessary data structure in the memory. The network, based on a self-created data structure, performs all the functions related to the use of the created model after completing the learning process.

In the scope of the research work, it is planned to perform an analysis to verify the possibility of implementing at a certain level of automation of relevant calculations with the use of a neural network and to conduct the process of inference about the optimal type of external lightning protection. The tests will be carried out for such facilities as, for example, a rectangular building, a free-standing photovoltaic power plant and a high voltage power line.

#O-20

Laser beam diagnostics systems based on artificial intelligence algorithms

Daniel Mostowski

The market problem to be solved by the system developed as part of the PhD concerns is very long downtime of laser systems used in industry or medicine. In the case of a laser system failure, the repair time is close to 4 weeks. Such long breaks cause huge financial loses on the company side.

The solution to the above-mentioned problem will be to build artificial intelligence algorithms that will analyze data from laser beam profilometers. Additionally, based on the data, these algorithms will send the information to the user about the state of the laser beam. Main objectives for PhD are: creation of a dataset for AI algorithms, detection of laser beam misbehavior, time trend analysis of the laser beam.

At the moment, we have managed to generate training data using numerical scripts. We are able to successfully generate 6 classes of data. Figure 2. shows sample data generated using numerical methods. This step was very important for the project as there are no commercial datasets available on the market.

The next step was to assemble the measuring setup. With his help, we will get real data for our data set.

Figure 1. shows the assembled stand. At this point, we are training our models on 300 thousands elements dataset. We are still focused on getting more real data from different sources. This will allow for more and more accurate learning of algorithms and for the generalization of the model itself.

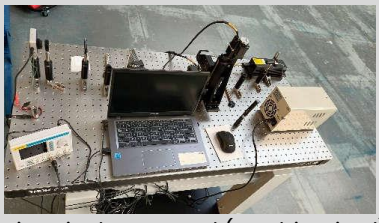


Fig. 1. Two Fourier ABS reconstructions in the spectral (top, binarized) and spatial (bottom) domains, for 80x80 px test targets.

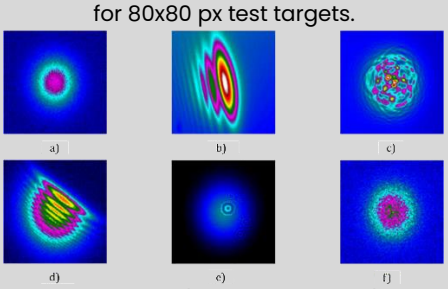


Fig. 2. Examples of laser beam profiles a) perfect beam, b) beam with linear diffraction, c) beam with spherical diffraction, d) beam with rounded aperture, e) beam with dust, f) beam with roughness.

The PhD program is realized with Perspectiva Solutions company which develops the Huaris system utilizing AI component (https://perspectivasolutions.com, http://www.laser-beam-profile.com)

#O-21

On complements of maximal sublattices of convex geometries

Adam Mata

Lattices are algebraic structures, frequently denoted as $(L, \vee, \wedge)$, where:

- L is an arbitrary, nonempty set,
- $\vee$ and $\wedge$ binary operations on L which are associative, commutative and idempotent,
- $\vee$ and $\wedge$ satisfy absorption laws, namely (for all elements $a, b \in L$):
  - $a \vee (a \wedge b) = a$
  - $a \wedge (a \vee b) = a$

If it does not lead to disambiguation we call L itself the lattice without mentioning the binary operations. We say that S is a sublattice of the lattice L if $S \subseteq L$ and S is closed under binary operations inherited from L. A sublattice S is considered maximal if $S \neq L$ and there is no sublattice R of lattice L such that $S \subsetneq R \subsetneq L$.

The algebraic definition of lattices may be equivalently transformed to order-wise definition. We can introduce partial order on the set L by the following rule (for all elements $a, b \in L$):

- $a \leq b$ if and only if $a = a \wedge b$, or equivalently
- $a \leq b$ if and only if $b = a \vee b$.

Convex geometry is a pair (C, α) where C is an arbitrary, nonempty set and α is a closure operator with an extra condition involved called anti-exchange property which generalizes the notion of convexity in affine spaces. The lattice of all closed sets in C, I.e. $B \subseteq C$ such that $B = \alpha(B)$, ordered by inclusion is called shortly a convex geometry, too.

It is known that for many classes of lattices the complements of their maximal sublattices are intervals, e.g. it holds for distributive lattices. It is not the case for the convex geometries but our hypothesis states that the complement has has a minimal element and is a convex set (for any elements a,b in the elements between them are in the complement, too). There are many properties of the complements which confirm the conjecture.

In parallel to search for the formal proof, we are investigating computer-generated examples which are on their own interests due to the one-to-one correspondence of convex geometries and anti-matroids widely studied in combinatorics. There were positive verification of smaller cases carried out, namely the vast implemented on the computer. The implementation of algorithms has been performed in Haskell programming language what enabled us exploiting recursive character of this language to find sublattices of a particular convex geometry. The automated check, in all cases, returned the positive answer to the hypothesis. This gives a solid background and good motive to continue the research on that matter.

This is a joint work with Kira Adaricheva (Hofstra University, (Hofstra University) and Anna Zamojska-Dzienio (Warsaw University of Technology).

#O-22

Robotic eye surgery

Ali Soltani Sharif Abadi

In recent decades, a number of surgical systems have been developed and are applied for a growing variety of surgeries. This presentation will consider the significant challenges of robotic surgery for the eye. These challenges take into account the different eye diseases, available technologies, and costs in different surgical systems for the eye. The conditions of a suitable controller will be discussed with consideration of relevant control engineering concepts. Comparison will be made between the different characteristics of surgical robots for the eye. In this presentation, some comparisons will be made in eye surgical robots, control algorithms, sensors in surgical robots, communication protocols, and actuators.

#O-23

HIPIMS based thin film technology for resistive random-access memory application

Piotr Różański

This work is devoted to the technology and characterization of thin films fabricated employing reactive magnetron sputtering using HIPIMS discharge. These materials include metal oxides such as zyrkonium oxide (ZrO_x), hafnium oxide (HfO_x), titanium oxide (TiO_x) and aluminum oxide (AlO_x) . The investigated materials play several important functions in various types of devices for novel electronic and photonic devices. The ultimate goal of this work is the examination of mutual dependences between the input parameters of the fabrication process (technological parameters) and the output parameters (properties of the obtained materials) to obtain ultrathin layers for the application of the MIM (Metal-Insulator-Metal) structures. Those structures are the basis of resistive random-access memory (RRAM) devices. In the first part of this work, optical properties of the fabricated materials will be examined and compared to the layers deposited through the typical pulsed-DC processes. Several oxide materials will be characterized in terms of thickness, refractive indices, transmittance, and reflectance in the UV-VIS range. In order to monitor the stoichiometry of the oxide layers, MIS structures will be fabricated. The analysis of the obtained electrical characteristics will be performed. The results of the electrical characterization of the fabricated test structures will be described indicating concluding remarks on the feasibility of applying the studied structures in RRAM devices.

#O-24

Data Plane Traffic Engineering algorithms in future mobile networks

Robert Kołakowski

The future mobile networks (5G +, 6G) are expected to support a much wider range of services with diverse and elevated requirements for user data transmission (bandwidth, delay, reliability) in comparison to the previous network generations. The broad spectrum of applications incorporates i.a., Industry 4.0, Smart Cities, road safety services, drone-based services, and entertainment (augmented and virtual reality). As a result, effective handling of user traffic, while ensuring required Quality of Service, becomes problematic. One potential solution to satisfy the mentioned requirements is utilizing the Software Defined Networks (SDN) architectural approach, in which, network devices have separate control and data plane functionalities. Such separation enables dynamic reconfiguration of network components and facilitates control of user data flows within the network.

This research is focused on developing traffic engineering algorithms that will leverage the concept of the distributed SDN network and enable scalable and effective traffic handling in future mobile networks. To this end, in addition to the traffic engineering applications, the in-network mechanisms that enhance the support for user mobility are planned to be delivered.

#O-25

Curry-Howard correspondence, linear logic and something about financial markets

Jarosław Miller

Formal methods is a branch of theoretical computer science that deals with the mathematical proving of the properties of programming languages ??and the programs themselves. One of the most powerful (and probably the most beautiful) tools of formal methods is Curry-Howard correspondence. This is a surprising property that links logic systems with typed programming languages. In short, it identifies propositions of logic with types and, going further, programs of a given type with proofs of the corresponding proposition. It is worth emphasizing: these programs do not generate proofs, they are proofs! By using tools based on Curry-Howard correspondence, such as the Agda proof assistant, we can, inter alia, construct new languages and prove their properties.

In my research, I try to use Agda and linear logic (also known as logic of resources) to construct a language used to describe the operation of the financial market. Such a language could define not only basic market operations, such as exchanging currencies or buying shares, but also sophisticated financial instruments such as shorts. Combined with modern technologies such as blockchain, this language can be used to create a decentralized and automated stock market whose security would be formally proven.

#O-26

Highly advanced modular integration of insulation, energizing and storage systems for non-residential buildings

Konrad Gobosz

The building and building construction sectors are responsible for more than a third of global energy consumption and nearly 40% of CO_2 emissions. Improving the energy efficiency of buildings can thus have tremendous impact. Insulation plays an important role in energy efficiency by reducing the need for artificial heating and cooling. The use of renewable energy systems to power the buildings is yet another important way to reduce the environmental impact of buildings. The goal is to combining enhanced insulation and renewable energy technology based on photovoltaics in modular solutions for retrofit in existing curtain walls. Innovative smart technologies will improve thermal insulation and on-site energy generation and storage to deliver significant advantages in all types of environments.

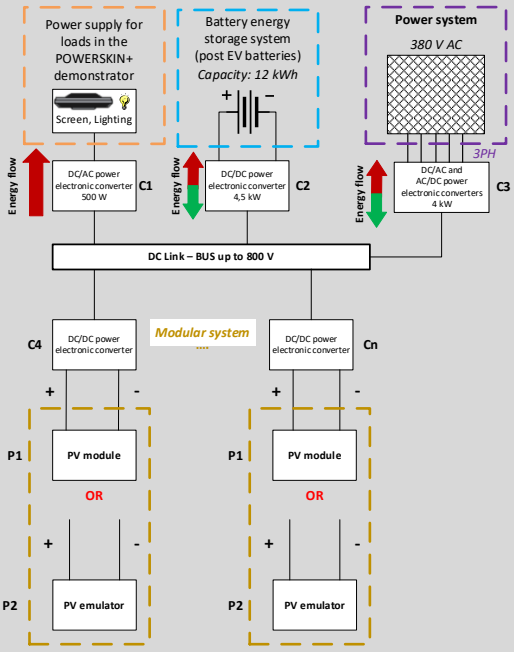


Fig 1. Concept of autonomous power supply system for non-residential buildings

To allow buildings to operate autonomously without the need for connection to the external electricity grid, an internal micro-grid is required to integrate all the installed generation units and to acquire energy storage capacity. The main obstacle to achieving this, is the construction of a coherent and stable control system, integrating all the actuators at their respective operating points.

#O-27

Development of model of an adaptive ferroresonance oscillations damper cooperating with electric power protection relays in industrial medium voltage networks

Piotr Suchorolski

Parallel ferroresonance is a disturbance that often occurs in industrial medium voltage networks. Both the explanation and analysis of this phenomenon requires knowledge of many areas, such as the theory of nonlinear dynamical systems, electrical transients in power systems and electrical power protection relays theory. Ferroresonance is a challenge both during attempts to analyze it, but also during the implementation of algorithms for its detection or methods of effective elimination.

The undertaken doctoral thesis focuses on the mathematical description and simulation modeling of harmonic and subharmonic ferroresonance oscillations in medium voltage networks, researching the impact of these oscillations on the operation of protection relays used in industrial distribution networks and finally the development of a model (concept) of an adaptive ferroresonance oscillations damper that would cooperate with protection relays systems.

In addition, as part of the research work, recordings of ferroresonance oscillations excited in physical model of the medium voltage network will be performed. The obtained recordings will then be used to develop a computer simulation model, its tuning and validation of the simulation results.

Both the recorded waveforms and those created by simulation models will be used to study the effect of ferroresonance on the operation of protection relays and the damping efficiency of the developed adaptive ferroresonance oscillations damper.

#O-28

Security in the Internet of Things

Bartosz Kościug

The aim of the thesis is to design and implement robust and secure communication protocol for the Internet of Things programmable microcontrollers. In the thesis the author considers aspects of security for wide area wireless networks. The one of the aspects that was especially taken into account during design of the solution components was the energy consumption. The three aspects of secure communication such as encryption, data integrity and authentication were achieved in the developed protocol. This was done by the selection and adaptation security providing methods such as symmetric encryption based on the chaotic sequence generation, lightweight cryptographic hash functions and Schnorr signatures. The proposed system is resistant for the attacks such encryption attack, man-in-the-middle attack, brute-force attack. Although, the proposed solution is not resistant in the case of physical attack or firmware hijacking attack. The prototyping of the protocol library was done with the usage of ATmega32 microcontrollers and the Lora Hat 433MHz I/O radio transceivers. Moreover, the proposed protocol was optimized in the manner of utilizing less dynamic random-access memory and flash memory.

#O-29

Detection of cyber threats in encrypted network traffic with machine learning

Monika Skowron

Network traffic has been one of the key sources of data leveraged by cybersecurity practitioners to detect and research multiple types of cyber threats. However, the ubiquitous use of encryption leaves the security monitoring teams blind to potentially malicious activities or forces them to implement computationally expensive full packet inspection, which is also questionable from user privacy perspective.

The aim of the project is to examine the effectiveness of cyber threat detection (such as malicious network tunnels) enhanced by machine learning techniques. The current work focuses on the analysis of encrypted traffic (encrypted DNS in particular) based only on TLS protocol fields and statistical traffic features without the need to perform decryption and full packet inspection. It includes the application and performance comparison of several machine learning algorithms (anomaly detection, clustering, density estimation, DNN, tree-based algorithms etc.) on publicly available network traffic datasets enriched by samples of new protocol versions. Moreover, supervised and unsupervised learning approaches are to be compared in terms of efficiency and practicality of use in real life scenarios.

Another important concept to be discussed is machine learning security represented in this case by the models' resistance to adversarial attacks. Lastly, the work will include an attempt of practical implementation of online anomaly detection on real life traffic and will conclude by preparing response guidelines to alerts triggered by the designed model.

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#P-01

Novel approach to medical image resampling

Aleksandra Osowska-Kurczab

Image resampling is frequently used as a preprocessing step in many computer vision tasks, such as classification or segmentation. Though image resizing is an inevitable step in many processing pipelines (e.g. utilizing pretrained architectures), tuning of the resizing method is usually omitted in the studies. Admittedly, there are many applications in which the exact influence of resampling on image textures and gradients is significant, e.g. medical image analysis.

The presented study analyses the impact of the image reconstruction in the downstream task of the renal tumour classification. A novel image reconstruction method is introduced, namely Sampling Kantorovich Algorithm (SKA). It is compared to six other popular techniques widely used in image processing. Based on the qualitative and quantitative analyses, it has been proved that the choice of image reconstruction method impacts the system's overall performance. SKA turns out to be the best performing method in the classification setup. It boosts the performance of the texture-based classifier to 75% of the weighted F1-score by approximately three percentage points (pp) compared to the best baseline solution. The results of this work may apply to a wide range of computer vision tasks, especially those established in medical image processing problems.

#P-02

LIMEcraft: Handcrafted superpixel selection and inspection for Visual eXplanations

Weronika Hryniewska

The increased interest in deep learning applications, and their hard-to-detect biases result in the need to validate and explain complex models. However, current explanation methods are limited as far as both the explanation of the reasoning process and prediction results are concerned. They usually only show the location in the image that was important for model prediction. The lack of possibility to interact with explanations makes it difficult to verify and understand exactly how the model works. This creates a significant risk when using the model. It is compounded by the fact that explanations do not take into account the semantic meaning of the explained objects. To escape from the trap of static explanations, we propose an approach called LIMEcraft that allows a user to interactively select semantically consistent areas and thoroughly examine the prediction for the image instance in case of many image features. Experiments on several models showed that our method improves model safety by inspecting model fairness for image pieces that may indicate model bias. The code is available at: https://github.com/MI2DataLab/LIMEcraft

#P-03

Hybrid Artificial Intelligence Framework

Piotr Sowiński

Recent years have seen rapid advancements in machine learning, which transformed many industries. Modern AI is becoming an indispensable tool in engineering, finance, marketing, management, and more. There are also many companies trying to broadly implement AI in completely new areas, such as self-driving cars and medicine.

However, these new applications raise some crucial questions. Would I trust a car driver that cannot explain their actions? Do I want to be treated by an AI doctor that does not understand causality? Or do I feel comfortable deploying an AI consultant whose basic language skills were trained on highly biased and toxic online content? All of these questions describe real issues with state-of-the-art AI systems, that were praised for their incredible performance. However, such issues remain largely unsolved and thus may be argued to be the largest obstacles in modern AI research.

We are starting to see the limitations of the modern, neural network-based AI paradigm and its grim implications. In my research I explore ways for combining neural networks and other statistical approaches with explicit knowledge representations, such as knowledge graphs and ontologies. Can an AI look up the necessary knowledge from a database? Can it reason with strict, deductive logic? Yes, it can, however, this is currently extremely hard to implement in practice. Thus, currently, I am working on giving AI researchers new, powerful tools for building such hybrid systems.

#P-04

Siamese Network with Gabor Filter for Recognizing Handwritten Digits

Rauzan Sumara

Recently, Handwritten Digit recognition was one of the most challenging issues. That has been studied by many researchers seriously during the last few years. The current demand is how researchers are able to find new techniques for handwritten digit recognition problems.

The methods are to improve system performance better in terms of accuracy, time, and computational complexity. Therefore, in this study, we formulated Siamese Network with Gabor Filter for handwritten digit recognition. This research focuses on a recognition process that involves inputting a handwritten digit image of the MNIST dataset (Fig. 1) using Siamese Network, which Gabor Filter will be the kernel on the input layer of the network. After the embedding process is complete, then it is forwarded to classifiers using k-NN and SVM.

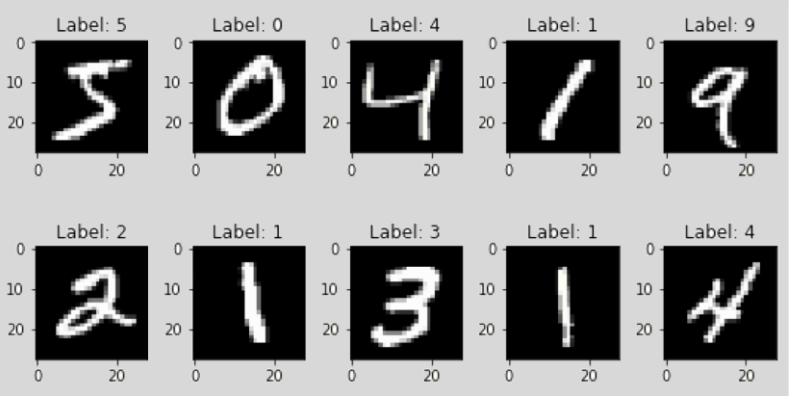


Fig. 1. MNIST Dataset

Inspired by several studies on both Siamese Network and Gabor Filter which have already achieved superb performances, our research purpose is on bringing out the best qualities on their fusion.

#P-05

Electromagnetic characterization of dielectric pills in the microwave frequency range by resonance methods.

Piotr Czekała

In the proposed research we aim at constructing new measurement equipment dedicated to characterization of dielectric samples, which in microwave band have shape of small cylindrical discs (pills). Knowledge of the electromagnetic properties of these materials is of importance for industry and academia working on 5G/IoT technologies. The measurement set-up for characterization of these materials will be based on Fabry-Perot open resonator (FPOR), which offers high quality factor, easy access to the cavity and due to high spectral density of resonant states allows measurements at many frequencies in range 20-100 GHz. Measured resonance frequency shift caused be placing sample with unknown permittivity (ε) inside the FPOR is susequently compared with data based calculated using a mathematical model of FPOR and as a result of that comparation ε can be determined.

Proposed model divides resonator into three non-resonant sections (as shown in Figure 1) and describe each section by it's scattering matrix. Scattering matrix of mirrors are calculated based on near-field scattering equations, while in order to calculated scattering matrix of sample's section axial mode matching method has been used. Resonance frequencies of the structure may be found be searching for zeros of the characteristic equation:

$$\det\left(\left|\bar{\bar{I}} - \overline{\overline{S_M(f)S_R(f)}}\right|\right) = 0$$

where I - unit matrix, SM - scattering matrix of left mirror and SR - scattering matrix of right mirror and sample. SM and SR are calculated at left sample's boundary.

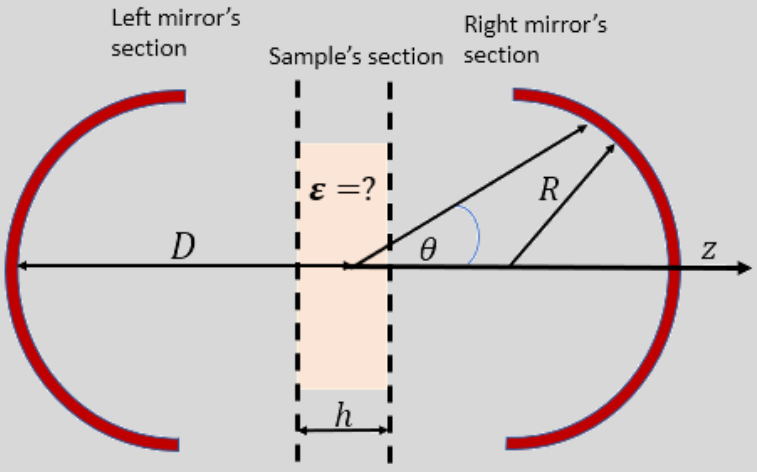


Fig. 2. Dividing FPOR into 3 nonresonant sections.

#P-06

Two-particle correlations of strange and heavy flavor hadrons in the ALICE experiment at CERN

Maja Kabus

ALICE is one of the 4 experiments at the Large Hadron Collider at CERN. It focuses on analyzing quark-gluon plasma (QGP) created in lead-lead and proton-proton collisions. Because of their large mass, charm quarks are produced at the early stage of the reaction, before the QGP is formed. Thus, one can use them as a probe to study the properties of the partonic matter as they interact with the QGP at all stages of its evolution.

Femtoscopy is a technique to calculate particle source space-time characteristics from their correlations at low relative momenta. The correlations are also sensitive to the final-state interactions: Coulomb and strong interaction. The thesis will focus on femtoscopic correlations between charmed mesons and hadrons to quantify the parameters of their strong interactions in the final state.

The azimuthal correlations of charm meson and its antiparticle are sensitive to the energy loss at high transverse momenta. When low-momentum particles are considered, then the correlations provide insights into the thermalization of charm quarks.

These studies require large data samples and a significant improvement in the efficiency of the charm meson reconstitution. Thus, the thesis will focus on analyzing data from ALICE Run 3 (starting in summer 2022) and necessary technical development. This novel kind of analysis, combining femtoscopy and heavy-flavor studies, will be possible only from now on with the Run 3 data-taking rate and data volume.

#P-07

Clock signal phase alignment system for daisy chained integrated circuits

Andrzej Wojciechowski

Multiple individual systems clock signal phase alignment is a major issue. Its importance increases with the demand for higher precision, reliability, and speed. Over the years, multiple synchronization methods were invented, but most of them operate in larger time scale (from seconds to individual clock cycles) or are very complicated and aimed for big systems synchronization (such as White Rabbit protocol). This creates a need for simpler phase alignment system that will enable high precision synchronization on sub-clock cycle level. In order to ensure sufficient performance, this kind of system needs to be implemented in an integrated circuit or using specialized hardware.

Clock signal phase synchronization implemented in integrated circuits can enable numerous advantages in digital integrated circuits. The areas which can benefit are multiple devices synchronization or cooperation of individual integrated circuits and more. Furthermore, it may have additional impact on the design and time of development of final products.

Current works include synchronization system's architecture concept, mathematical model, the calibration algorithm, computer simulations, as well as first prototypes. Next steps include implementation using FPGA chip resources and verification of the idea using FPGA-based prototypes.

#P-08

Real-Time High Resolution ISAR Imaging System

Marek Ciesielski

This paper describes the results of the X-band ground-based FMCW radar demonstrator which was designed as a multichannel system for synchronous signal reception and simultaneous recording of the data from multiple array antenna channels. The demonstrator was designed as a wideband system allowing up to 1.28 GHz of bandwidth transmission. The purpose of the design was to develop a high-resolution system for imaging purposes using inverse synthetic aperture radar techniques (ISAR). Additionally, the demonstrator has been equipped with a real-time processor based on parallel and independent DSP modules implemented using OpenCL which was designed to track and visualize the echoes of the non-cooperative air targets by displaying to the radar operator their current position and Range-Doppler map fragments as in Figure 1. The Paper describes the whole process of the hardware development and effective real-time ISAR processor implementation and also shows the first outdoor measurements with real planes (non-cooperative air targets). An example glider aircraft echo obtained using this system is in Figure 2.

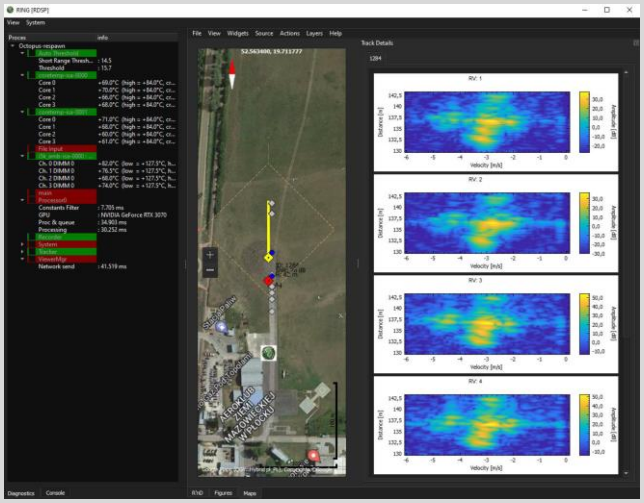


Fig. 1. Real-time processing result.

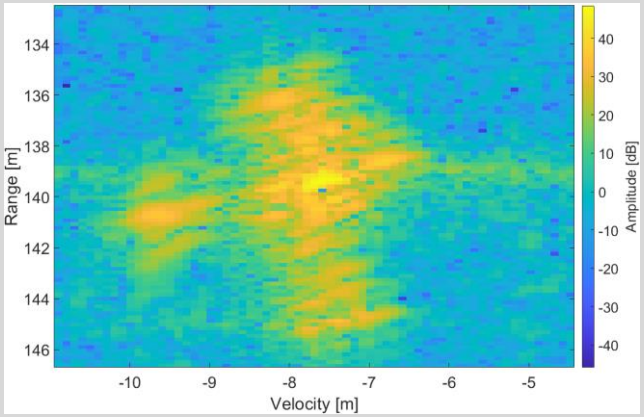


Fig. 2. Echo of the glider.

#P-09

Infinitesimial generators of quadratic harnesses

Agnieszka Zięba

Quadratic harnesses are time-inhomogeneous Markov polynomial processes with linear conditional expectations and quadratic and linear conditional variances with respect to the past-future filtrations. Typically they are determined by five numerical constants hidden in the form of conditional variances. Well-known examples of quadratic harnesses are Wiener, Poisson or Gamma processes. This class includes also classical versions of the free Brownian motion, q-Gaussian process and q-Lévy-Meixner process.

In our work we derive infinitesimal generators of such processes, extending earlier known results, which are identified through a solution of a q-commutation equation in the algebra of infinite sequences of polynomials in one variable. The solution is a special element, whose coordinates satisfy a three terms recurrence and thus define a system of orthogonal polynomials. It turns out that the respective orthogonality measure μ uniquely determines the infinitesimal generator (acting on polynomials or bounded functions with bounded second derivative) as an integro-differential operator with explicit kernel, where the integration is with respect to the measure μ. Such formulas for infinitesimal generators of quadratic harnesses are of special interest due to their relation to the ASEP (asymmetric simple exclusion process), one of the most extensively studied stochastic particle models nowadays.

#P-10

Formation of optical beams in nematic liquid crystals

Jacek Piłka

Nematic liquid crystals, due to their unique properties, are reliable materials in optics, allowing easy manipulation of light beams, which has gained them nonfading attention of researchers. Especially, due to their birefringence and the ability to reorientate molecules via electric field, liquid crystals make an exceptional medium for observing formation of optical beams via nonlinear effects.

This work will cover the case of co-propagation of linearly polarized high-power optical vortex and a low-power gaussian beam in nematic liquid crystal. The first beam is characterized by its phase's rotation around propagation axis resulting with achieving unique donut-shaped profile with point of zero intensity in the centre and carrying orbital angular momentum. Due to high nonlinearity of the medium, such beam creates a waveguide in which the second one can propagate. However, the results show not only a profile change of the low power gaussian beam, but also a phase rotation, indicating the transfer of the orbital angular momentum between the two beams. Such effect is not dependent on the wavelengths of each participated beam, making the results the first step towards the new type of broad spectral range light manipulator designed for optical vortices generation in various experimental and industrial applications.

#P-11

Microcavity Mach-Zehnder interferometer manufactured in optical fiber for label-free detection of viruses on the example of SARS-CoV-2 nucleocapsid protein

Tomasz Gabler

Poster presents miniaturized sensing solution based on a microcavity in a side surface of a single mode optical fiber (125 μm in diameter) for label-free virus detection. The microcavity is fabricated using a femtosecond laser micromachining, and when forming an in-line Mach-Zehnder interferometer (μIMZI), it shows exceptional high refractive index sensitivity (>14,000 nm/RIU). Moreover, when antibodies were covalently immobilized at the μIMZI's surface, the structure may work as an immunoassay to detect conserved regions of the SARS-CoV-2 viral particles, while the volumes of the investigated sample may be as small as hundreds of picoliters. In this work, custom-made biological components were used. Synthesized SARS-CoV-2 virus-like particles (VLPs) and nucleocapsid protein alone were detected at 3 ng/mL and 1 ng/mL concentration, respectively. The optical response was measured in a real-time and the result were obtainable in less than 30 minutes. The sensor shows no cross-reactivity with other respiratory tract viruses, thanks to the manufactured antibodies that show strong and highly specific affinity to RNA binding domain of nucleocapsid protein of SARS-CoV-2. The sensor offers a time-effective and highly sensitive alternative to other affinity-based SARS-CoV-2 detection approaches. Except for detection itself, the μIMZI could also analyze and validate the interaction between the low-concentration/low-volume receptors and chosen targets.

#P-12

Electrically active impurities and phenomena limiting carrier concentration in semiconductors investigated using Secondary Ion Mass Spectrometry

Adrianna Wójcik

Precise and reliable determination of the spatial distribution of dopants in the structure as well as prediction of its temperature behavior is crucial for the practical applications of semiconductors. Standard dynamic Secondary Ion Mass Spectrometry (SIMS) provides depth profiles of impurity atoms without distinguishing electrically active and inactive parts. Whereas Electrochemical Capacitance-Voltage (ECV) technique yields depth profiles of all carriers present in the structure.

Recently, it has been demonstrated that using ultra-low impact energy SIMS (ULIE-SIMS) it is possible to access the qualitative distribution of impurity which is electrically active by measuring complex dopant-host signals. Furthermore, the ECV profiling shows a great promise to be a suitable tool for the calibration of ULIE-SIMS profiles.

This work presents the experiment designed to investigate the diffusion of electrically active and inactive impurities by complementary use of ECV and SIMS techniques. The initial ECV and SIMS experiments suggest that the total impurity distribution extends substantially deeper than its electrically active part. Si-doped GaAs layer of 500 nm thickness embedded between undoped GaAs layers will be subjected to thermal treatment at various temperatures. SIMS, ULIE-SIMS, and ECV measurements will be used to quantitatively determine the diffusion parameters of the active and total impurity giving a starting point for a discussion on the varying diffusion mechanism.

#P-13

Can a stroke be seen in the behavior of the human heart? How much does our heart know about us?

Joanna Aftyka

A stroke is a neurological disorder. There are two types of stroke: ischemic (more common) and hemorrhagic. The results show that by observing the heart rate variability (HRV) it is possible to determine in which hemisphere of the brain (right or left) the stroke occurred.
An ischemic stroke is caused by severe narrowing or blockage of the vessels that supply blood to the brain. As a result of an ischemic stroke, blood does not flow to the brain, so the brain is cut off from oxygen and nutrients. As a result, the hypoxic fragments die.

For several years, the concept of a physiological network has been postulated in the field of biomedical science. The human body is not a collection of several independent organs, but a system of interconnected and interacting systems. Changes in one system in the human body can affect the functioning of another system.

In my research, I analyze the records of heart rate variability in patients after ischemic stroke. The records of 64 people in the acute phase of ischemic stroke (within the first 7 days of admission to the hospital) were analyzed. 24h Holter EKG recordings were analyzed.
The use one of the non-linear method of HRV - Sample Entropy analysis significantly differentiates patients with ischemic stroke of the right hemisphere vs. stroke of the left hemisphere of the brain.

#P-14

Development of a hybrid algorithm based on neural networks and classic methods of detection and tracking of fast-moving objects on an example a badminton shuttlecock

Michał Kopania

For the past few years, together with another Ph.D. student Jarosław Mówisz we have been building an instant review system for badminton. The system uses 14 to 20 fast cameras to track the shuttlecock and detect when and where it landed on the floor of a court. In order to track the object, it must be first found on an image among other objects. In a poster, I present a very fast, novel method I have developed for finding a fast-moving shuttlecock within the image from a camera.

#P-15

R-GAE: Graph autoencoder based on recursive neural networks

Adam Małkowski

In the last years, many solutions and models were designed to realize standard AI tasks, e.g., classification, regression, or generation. To allow using those tools for specific data types which haven't fixed numerical representation (e.g., text, video, or audio) were created the idea of embeddings (transforms a particular object, e.g., a sentence, into a fix-sized numerical vector). That transformation allows for the processing of that object in the same way as standard tabular data.

One of the most complex data types is graphs. Despite the wide usage of graph data (molecules, topologies, social media, relationships), graph datasets are still less popular than text or image datasets. Moreover, they have several very uncomfortable features like lack of natural order, ambiguity representing, and difficulties with working on different graph sizes or comparing graphs. Existing neural models for graph processing are currently of lower maturity than analogical for other data types.

In my research, I propose a new neural architecture for processing graph data – recursive autoencoder (R-GAE). The model encodes examples into fixed-size embeddings and tries to reconstruct original samples based on those embeddings. A single instance of R-GAE could process graphs with various nonrestricted sizes. The model, besides calculating embeddings, could be used as a base model for graph generation (VAE, GAN), transformation, or classification.

#P-16

A comprehensive power quality conditioning system with energy storage for low voltage distribution networks

Tomasz Święchowicz

Technological advances in electric industry bring greater requirements regarding the quality of power in the grid and stability of the grid. These requirements are being enforced on industry and plans to extend them to private consumers may be ahead of us. Passive filters are common choice in the industry because of their low complexity, but they are limited to reactive power compensation and require individual selection of compensation blocks for each consumer. Active filters based on power electronics on the other hand offer flexible solution able to:

- compensate reactive power
- balance active power between phases,
- compensate grid current harmonics,
- control active power flow if combined with energy storage or source.

The main objective of this thesis is elaboration of control method allowing simultaneous and selective operation of above functionalities. It should operate correctly with high grid impedance and capacitive loads. In case reference current could exceed converter ratings, these functionalities have to be linearly limited/disabled in prioritized order. Control algorithm allowing three first functionalities has been developed and is already sold in commercial product. Fig. 1 and Fig. 2 are waveforms taken by this device. Another objective is to enable operation of aforementioned control method on parallel connected power electronic converters with proprietary communication protocol that transmits data through high speed plastic optical fibers.

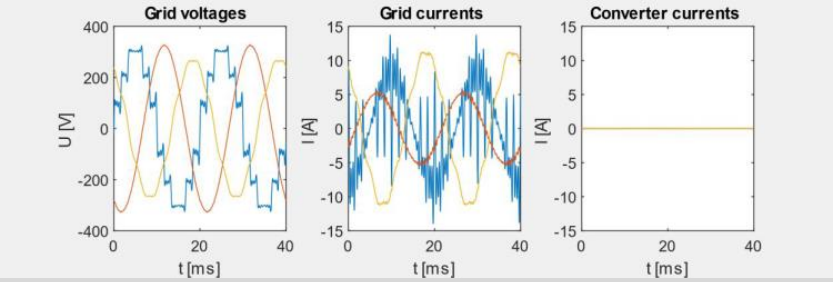


Fig. 1. Converter turned off.

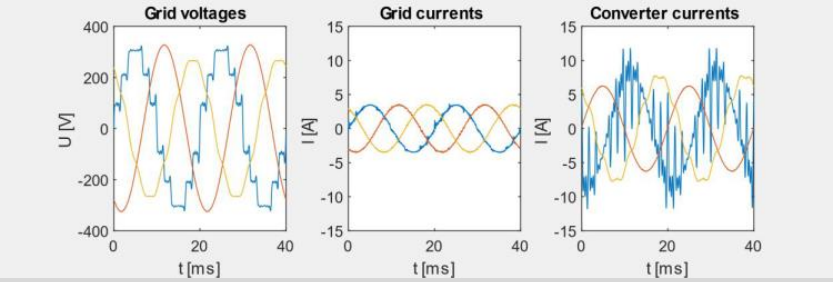


Fig. 2. Converter turned on.

#P-17

First principles phonon anharmonicity and thermal expansion in supported 1-5-layered WS2 nanosheets

Konrad Wilczyński

Although temperature-dependent Raman studies for 2D materials as a function of number of layers are available for the most popular compounds (e.g. MoS_2), as well as individual studies of substrate impact on Raman bands (including strain and charge doping), a comprehensive ab-initio study of temperature-induced phonon evolution in supported multi-layered nanosheets is missing in the literature. However, studies of phonon propagation are important due it its significant impact on thermal and electrical conductivity, crucial for applications.

In this work, I study phonons in 1-5 layered WS_2 thin films, including phonon-phonon anharmonic interactions, thermal expansion, and interaction with substrate. For representative Raman active phonon modes, I calculated temperature-dependent phonon shifts and lifetimes, using ab-initio DFT simulations. Moreover, I investigate phonon shifts caused by substrate-induced strain and charge doping. The simulation results are compared to temperature-dependent Raman spectra of exfoliated WS_2 nanosheets.
The results indicate that the number of layers significantly affects the harmonic (temperature-independent) part of the phonon energy, and slightly affects the temperature-dependent shifts. The impact of temperature on phonon energies and lifetimes can be well described with models including phonon interactions and thermal expansion. Additionally, a significant impact of the substrate on the harmonic phonon frequencies was observed.

#P-18

Semi-supervised learning in automatic speech recognition

Mikołaj Pudo

Training production-ready machine learning models usually requires large amounts of good quality data. Gathering the data in many cases is easy, however, preparing annotations is costly and time consuming. This is caused by the fact that this task still needs to be done by human experts. Furthermore, the model should be trained with the same type of data which will be most commonly processed during inference. End users of the models are the best source of such data. However, manual preparation of the annotations is time-consuming and might cause privacy breach.

The above mentioned problem appears in the field of Automatic Speech Recognition (ASR). There are large amounts of good quality data available in the public domain, but they do not contain transcriptions. Since these databases contain thousands of hours of speech data, their manual transcription is very difficult. Semi-supervised learning methods (SSL) attempt to solve this issue. In this work we present selected SSL methods which can be applied to train ASR models. Our experiments prove that even a limited amount of unlabeled data can improve performance of the models. Performing adaptations with small datasets does not require large amounts of computation power. Hence, performing such adaptations on the user's device becomes feasible. In consequence, such an approach can solve the issue of possible privacy breach, since the user data do not need to be sent outside of the device at any moment.

#P-19

Bracelets are uniquely determined by their complements

Agnieszka Stelmaszyk-Śmierzchalska

Knots are uniquely determined by their complements, but this result does not hold for all links. Therefore, it is natural to try to find families of links in which, any two links with homeomorphic complements are equivalent. The conclusion is true for the family of bracelet shaped links.

#P-20

Realtime audio-visual speaker separation

Piotr Czarnecki

Real-time speaker separation and localization is crucial to enable applications for video call enhancement, automatic subtitle localization, as well as spatial voice generation/panning. The common approach to perform speaker localization and separation is to detect candidate faces and then perform visual guided voice separation for each. There are two methods used for face detection: with using face detector on static video frames or with audio visual sequence processing for active speaker detection. In this work, crucial improvements is proposed for the visual guided speaker separation model to make it real-time. The described model follows the approach with a face detector. The model extends real-time models known for speech enhancement by adding face processing to ultimately perform speaker separation. The system is lightweight with 0.6M trainable parameters. It performs speaker separation near instantaneously with the delay of a single input audio frame. To my knowledge, it is the first real-time system for visual guided speaker separation. From the application point of view it is important that the model performs both tasks at the time: speech separation and active speaker localization.

#P-21

Development of ohmic contacts for GaN-based vertical power devices

Oskar Sadowski

Due to the limited availability of good-quality, large-diameter monocrystalline GaN substrates, the development of vertical devices has been limited for many years. The first working devices have been demonstrated only in recent years. The improvement of device parameters and demonstration of the possibilities resulting from the excellent electrophysical properties of GaN still requires intensive construction and technological works.

In first semester of my doctoral studies, I was working on ohmic contacts to p-type epitaxial GaN layer. The fabrication of low-resistive ohmic contacts for p-GaN is still a challenge, and the achieved resistivities rarely fall below $1x10^{-4}$ Ωcm^2.

In order to optimize the contact to p-type GaN the samples with metal contacts containing Ni, Au and Pd were prepared and characterized. The investigation include different metal deposition methods, different thickness of metallic layers, different semiconductor surface preparation methods and different annealing temperatures and atmosphere. The resistivity of ohmic contacts was estimated by circular transmission line method (cTLM). The best result obtained in this series of experiments was $5x10^{-5}$ Ωcm^2.

This work was partially supported by The National Centre for Research and Development under Agreement nr TECHMATSTRATEG-III/0003/2019 for project „Complete vertically integrated technological chain for vertical GaN-on-GaN power electronics: from GaN substrate to Intelligent Energy Bank".

#P-22

High power, high voltage solid state switch supported by a digital system of on-going adjustment of time parameters (for a microwave klystron in a linear electron accelerator installation).

Sylwester Bułka

The key issue in such systems is to obtain an even voltage distribution between individual switching elements; static, and above all dynamic, which is to ensure that they work in the area of safe values recommended by the manufacturer. The postulated method of achieving and maintaining the proper dynamic voltage distribution is the software control of the switching moment based on the data collected from the entire switch system.

Research task: for the adopted architecture of the connector, creating its numerical model, determining the data profile for acquisition from specific nodes of the system, developing a control algorithm that ultimately ensures the conservative nature of the model in a specific range of changes in operating conditions (including load parameters, temperature).

The current and adaptive correction of the commutation moments for each individual element can be performed in real time by the computing unit based on data collected from a signal acquisition system working in parallel and simultaneously on all elements of the switch. The design and implementation will show new possibilities in the field of designing high-power pulse switches for special, high reliability devices.

#P-23

Deep learning based melanoma classification

Aleksandra Dzieniszewska

Melanoma is one of the deadliest kinds of skin cancer, but it might be completely cured if detected early. Therefore, monitoring and early diagnosis of skin lesions have a crucial meaning in preventing cancer diseases. The major problem and the major challenge, however, is patients' resistance to being diagnosed towards cancer and also limited access to specialists.

The automation of the diagnosis process might to some extent help in solving these problems by providing easy access to mass and sufficiently reliable testing methods, which patients might have access to in a family doctor's office, or at home.

This work is focused on developing a new solution for a comprehensive automated skin analysis system allowing the classification of changes based on multimodal image data and deep learning models.

In particular, the application of neural networks to enhance the recognition of human skin lesions based on dermatoscopy images with additional polarization channel was investigated. The main research problem identified is to find a method of using available (open) RGB image data sets for the initial training of neural network models to compensate for a small amount of polarization data. To solve it, two main approaches were tested – early and late fusion of information. The architectures were tested on RGB data to find the most promising candidates for transfer learning with polarization images. A multi-path neural network was created to combine results from different images pro

#P-24

Enhanced control strategy for microgrids converters

Serafin Bachman

The world's energy future rests on the shoulders of the microgrid concept. This concept involves combining AC and DC installations into a whole coherent system to adapt to the needs of various solutions in the field of electrical engineering developed around the world. Examples of technology applications are AC/DC/DC/AC converters used in renewable energy solutions; charging systems for intelligent energy storage; electric vehicle charging substations using hydrogen technology, network systems using DC Bipolar installations. The stability and operational reliability of such a system are necessary to achieve the assumptions of the concept of electromobility, V2G (ang. Vehicle to Grid). The inability to control and disconnect parts of the system safely precludes these concepts. The current problems faced by all power systems include: the development of the power grid, increasing the demand for electricity, improving the quality of electricity, increasing the share of renewable energy sources in the energy market, and managing the expanding electricity network.

#P-25

Terahertz hologram for homogenous illumination

Mateusz Surma

The development of terahertz sources and detectors allows for designing more complicated optical systems, including dedicated passive optical elements. Diffractive structures tend to be much thinner than refractive elements, introducing less attenuation. Shapes of diffractive structures are limited by the manufacturing method. For this reason, diffractive structures allow for a generation of a wide variety of intensity distributions. One of the specific tasks that passive optical elements may realize is a generation of uniform sample illumination. The following paper presents diffractive elements - holograms - forming uniform illumination at a particular plane. The radiation transformed by them forms a square area at the desired plane. The optimization method for phase modulation generation uses an iterative algorithm. Multiple different designs for phase modulation with a division of modulation area have been simulated, implemented and tested. The design frequency was 260 GHz selected due to available sources and detectors. Solutions giving the best results in numerical simulations have been manufactured. Then, diffractive optical structures were modeled and 3D printed. Styrene-butadiene copolymer (SBC) was selected as a printing material due to its good terahertz optical properties (refractive index: 1.557 and absorption coefficient: 0.18 cm^{-1} @ 260 GHz). Produced structures have been experimentally verified and the results compared with numerical calculations.

#P-26

Reducing the power consumption of the electrodynamic levitation system (EDS) by changing the fill factor in the Halbach array

Tomasz Kublin

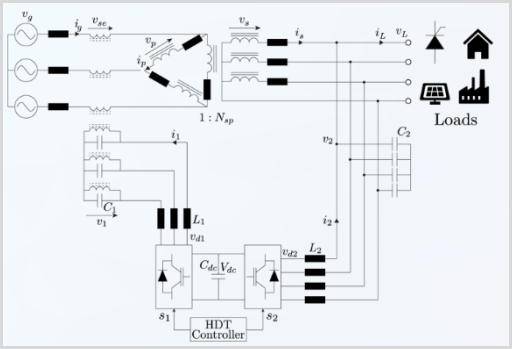
Electrodynamic levitation systems (EDS), which may find application in magnetic railways, despite their many advantages generate magnetic braking forces. Although the value of these forces decreases with increasing velocity, they account for a significant portion of high-speed magnetic rail energy demand . This work is concerned with the analysis of the power consumption of EDS as a function of the fill factor in the Halbach arrays made of permanent magnet package.

#P-27

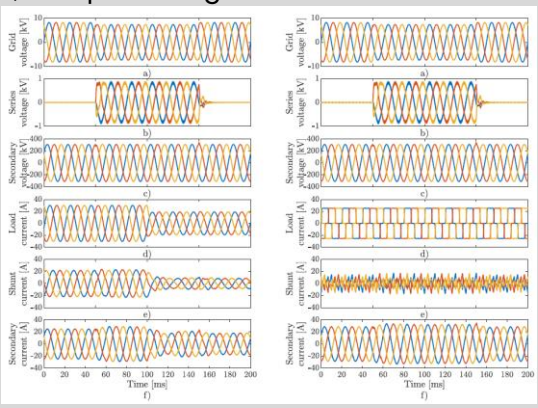
Control of a Hybrid Transformer to Improve the Power Quality of a Distribution Network

Alvaro Carreno

Hybrid Distribution Transformer (HDT) combines in a single-solution a power converter and a conventional Low-Frequency Transformer (LFT). The most recurrent configuration consists of shunt converter supplied by the Auxiliary Winding (AW) of the LFT, and a series converter connected in series to the low-voltage grid. An alternative to this configuration consists in connecting the series converter into the medium-voltage grid utilizing a Coupling-Transformer (CT). Despite being able to mitigate grid current harmonics and provide load voltage regulation, in both configurations the load harmonics circulate through the LFT, which attempts against its lifetime. Therefore, in this work a HDT composed of a series converter connected to the primary-side through CTs, and a shunt converter directly connected to the secondary-side is presented, focused in extending the LFT lifetime.



Both converters are controlled utilizing discrete-time linear quadratic regulators, which include resonant terms to be able to compensate the main load current and grid voltage harmonics. The resonance of both output filters can make their operation unstable, therefore a state-feedback controller is utilized to provide proper dampening. The states are obtained through a state observer. The HDT is able to improve the grid power quality, specially improving the currents that flows through the LFT windings. The HDT is able to operate under different conditions, such as a supplying linear and nonlinear loads, unbalanced grid and load, and polluted grid.



#P-28

Artificial Intelligence-Based Cognitive Radar

Arkadiusz Czuba

Cognitive architectures are part of artificial intelligence. They have found an application in among other places, robotics, and autonomous driving. However, research related to the topic of integrating artificial intelligence architectures with cognitive radar is limited. In this work, cognitive abilities such as learning, perception, attention, and decision-making mechanisms were conformed to radar capabilities. As a result of that customization, a novel cognitive radar architecture has been proposed. This concept is introducing promising multimodal perception, visual attention mechanisms for resource allocation and target prioritization, memory-based cognitive models, and reinforcement learning for learning receiver-transmitter relation. Currently, the work is on the stage of implementation of the proposed system. The most similar cognitive capabilities to the proposed cognitive radar have Soar cognitive architecture. The validation implementation of AICR is based on the integration of Soar architecture with a radar system. Particular emphasis is placed on the development of human-like procedural and declarative memories adapted to the processing of radar knowledge. All of the aforementioned components combined with a memory-based cognitive control subsystem are looking promising to improve overall radar performance.

#P-29

Consolidated learning - a domain-specific model-free optimization strategy with examples for XGBoost and MIMIC-IV

Katarzyna Woźnica

For many machine learning models, a choice of hyperparameters is a crucial step towards achieving high performance. Prevalent meta-learning approaches focus on obtaining good hyperparameters configurations with a limited computational budget for a completely new task based on the results obtained from the prior tasks. This paper proposes a new formulation of the tuning problem, called consolidated learning, more suited to practical challenges faced by model developers, in which a large number of predictive models are created on similar data sets. In such settings, we are interested in the total optimization time rather than tuning for a single task. We show that a carefully selected static portfolio of hyperparameters yields good results for anytime optimization, maintaining ease of use and implementation. Moreover, we point out how to construct such a portfolio for specific domains. The improvement in the optimization is possible due to more efficient transfer of hyperparameter configurations between similar tasks. We demonstrate the effectiveness of this approach through an empirical study for XGBoost algorithm and the collection of predictive tasks extracted from the MIMIC-IV medical database; however, consolidated learning is applicable in many others fields.

#P-30

Readout integrated circuit for MIR detector within ASPIC

Paweł Pieńczuk

Under the MIRPIC project, the established consortium (VIGO Photonics, Warsaw University of Technology, Łukasiewicz-IMiF) designs the know-how for Application-Specific Photonic Integrated Circuits (ASPIC) for mid-infrared (MIR, 3-8 µm) range. MIR photonics is promising in the field of gas and complex chemical compound sensing. One of the last blocks is the Readout Integrated Circuit (ROIC), which converts the current signal from the MIR detector to the output signal. This ROIC will be integrated within the ASPIC package by the need for miniaturization.

The ROIC (depicted in Fig. 1) unit is based on a transimpedance amplifier (TIA) structure, which converts the input current signal to the output voltage. The TIA is based on a fully differential amplifier (FDA), which can result in high speed and high external noise rejection. The TIA unit is followed by 50 Ohm output buffer (OUT_BUF). Both blocks are polarized by configurable biasing block (BIAS).

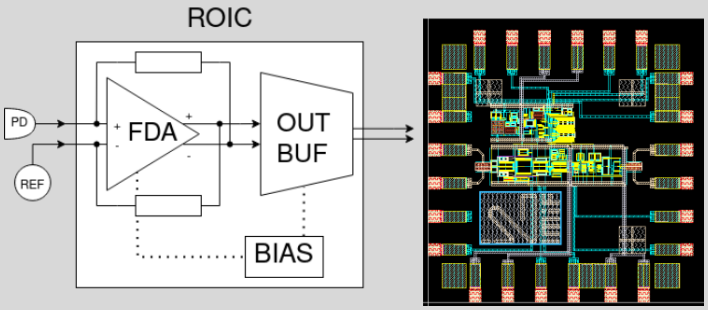


Fig. 1. ROIC scheme block (left) and layout (right).

The layout (Fig. 1) is created and sent to production in UMC CMOS 180 nm process. The simulations (Fig. 2) after parasitic extraction show promising results of bandwidth (300 MHz), noise (10 pA/sqrt(Hz) @ 100 MHz), and gain. However, this has to be silicon-proved by experimental tests in the lab.

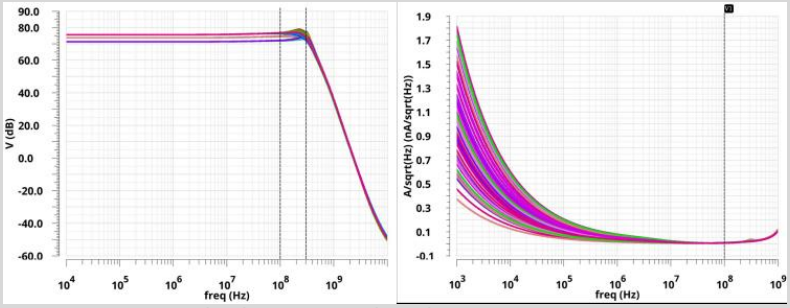


Fig. 2. ROIC AC (left) and noise (right) characteristics - simulations.

This work has been supported by the National Centre for Research and Development, project "Photonic Integrated Circuits Technologies for mid-IR", MIRPIC, (TECHMATSTRATEG-III/0026/2019)

#P-31

Heart rate dynamics irreversibility in LQTS patients under beta blocker treatment

Małgorzata Andrzejewska

Physiological systems, such as the human body, for example, are considered complex. They consume energy to build into more complex and ordered structures. This ability to self-organize is linked to the directionality of energy flow and the irreversibility of the processes involved. The irreversibility over time is greater in healthy and young organisms. The decrease of irreversibility in time can relate to aging of the organism or with diseases. Many studies indicate that such a decrease can be linked to reduced heart rate variability (HRV). In many important pathologies, such as sudden cardiac death, efficient clinical indices which could be used for risk stratification and better patient management are still missing. Visibility graphs (VG) allow mapping time series to the form of graphs. VGs can be used to study the information contained in nonlinear signals like RR or QT intervals. This approach can be extended to analyze multivariate time series using multiplex VG. I will focus on comparison whether beta blockers (BB), which are used as pharmacological treatment in LQTS treatment, have an impact on non-linear parameters of HRV. VG methods will be compared with the results for time asymmetry indices. I observe that patients taking BB are characterized by higher irreversibility when characteristic of univariate time series is considered. However, for multivariate time series, VG similarity is unchanged, which concludes that BB do not change physiological network.

#P-32

Development of methods of gallium nitride surface structuring for fabrication of vertical power devices.

Jarosław Tarenko

The main goal of the proposed doctoral dissertation is to develop methods of gallium nitride surface structuring for fabrication of vertical power devices . The scientific aim of the dissertation is to answer the question to what extent and how it is possible to control the structure of gallium nitride surface regarding to two main technological issues - the fabrication of the trench area in vertical MOSFETs and the fabrication of beveled mesa structures in p-i-n diodes and examining and explaining the influence of the structuring processes parameters on the electrical parameters of the final devices.

In first two-semesters of my doctoral studies, I was working on developement of photoresists mask with desired shape and profile (bevel angle) and later on the pattern transfer to the gallium nitride surface by dry etching using inductively coupled plasma reactive ion etching. The influence of the various photoresists as well as reflow process parameters was studied. Finaly, preliminary GaN etching proceses were performed to reproduce the desired shape and slope angle of the photoresist mask. An example of vertical GaN p-i-n diodes fabricated through developed process was also presented.

This work was partially supported by The National Centre for Research and Development under Agreement nr TECHMATSTRATEG-III/0003/2019 for project „Complete vertically integrated technological chain for vertical GaN-on-GaN power electronics: from GaN substrate to Intelligent Energy Bank".

#P-33

A suboptimal strategy for controlling multi-dimensional drying process

Bartłomiej Hryniewicki

The drying process of wood has been studied for many years and is quite well described, unfortunately, the very complicated nature of the physico-chemical phenomena taking place during the process made it impossible to accurately model it. However, the drying of wood must be carried out on an industrial scale. Solution to the problem of automation on the batch version of this process has been reduced to limiting the speed of wood drying in accordance with the operator's experience. Such action significantly extends the duration of the process and increases energy consumption, but ensures that the material does not crack and does not bend making it useless. The first stage of research was to create a physical model that would simulate the drying process of wood in three-dimensional space. Now it was extended with the module for approximating the stresses inside the drying material. Its application will allow for the development of a process control strategy that significantly increases the final quality of the material while reducing energy consumption and the time needed. Additionally, the designed strategy will take into account the dynamics of the elements responsible for heating and air exchange inside the drying chamber, allowing for the optimization of the entire process. This new solution will provide total control over drying process, preventing both mold and material losses caused by fractures.

#P-34

Surrogate-assisted evolutionary algorithms

Konrad Krawczyk

Evolutionary computation is a nature inspired approach to optimisation which is the process of getting the most out of something and making it better. During this process we are looking for the best or optimal solution to the defined problem. For evolutionary algorithms, standing problems are usually complex functions where with iterative evaluations we have to find the best solution. The general idea behind this whole process is that if a biological evolution can produce something as amazing as humans over many generations, we should be able to use similar process artificially to evolve optimal solutions for various defined problems.

Evolutionary algorithms often use functions which evaluations are computationally expensive. In that case there are methods such as surrogate models, which can improve efficiency of this process. Surrogate models are used to substitute „black-box models" which are computationally expensive. In the evolutionary computation we can try to approximate complex functions with surrogate models which results should also provide an optimal solution for the defined problem with computational savings. With that background, the problem could be defined as looking for how to optimize the optimisation.

#P-35

Root Cause Analysis of control errors propagation in complex multi-loop systems

Michal Falkowski

Work addresses the subject of causality analysis using simulation data and data collected from a real control system. Simulated data includes Gaussian and Cauchy noise signals. Real-time series include various, mostly unknown distortions, like trends, oscillations, and noises. Presented research focuses on the components in data and its propagation in multi-loop control systems. The analysis is based on a deep decomposition process for control error time series. Identified periodic signals are used for further causality processing. The analysis uses the Transfer Entropy approach. This method belongs to the group of model-free methods. The determination of information pathways is conducted without any model or a priori process knowledge.

#P-36

Resource Partitioning in Phoenix-RTOS for Critical and Noncritical Software

Hubert Buczyński

Modern embedded systems' increasing complexity and varied safety levels make it hard to coordinate all functionalities within a single run-time environment. Access to more advanced and capacious hardware changes the trend from utilising many separated platforms into one managing the whole compounded system. Providing an appropriate isolation and synchronisation level is achievable only by adapting an operating system with separation mechanisms.

This paper introduces Phoenix-RTOS, the microkernel structured real-time operating system designed to be consistent with aerospace standards DO-178C and ARINC 653. The current market offers many counterparts like VxWorks, Integrity 178, PikeOS and many others. These products are well known and used in leading-edge avionics and space projects. However, it is not possible to use them in many low-budget projects due to the high price. The Phoenix-RTOS differs from others and is an open-source project becoming a standard solution for energy and gas meters.

In this paper, we focus on the currently designed mechanisms of microkernel architecture for providing a mixed-criticality system, particularly for compliance with ARINC 653. Engineers have been identifying time and space partitioning issues to cope with tight worst-case execution bounds of critical tasks.

#P-37

CNN based phase unwrapping in full-field optical metrology.

Michal Gontarz

Whenever we perform a measurement with the use of interferometric or grid methods, we aim in obtaining phase information in which the object's shape, displacement or other measurand is coded. However, due to the nature of phase retrieval algorithms, the results are wrapped into phase mod(2π). In order to obtain a continuous phase distribution, the phase discontinuities have to be eliminated in a process known as unwrapping. Due to significant noise and a complexity of discontinuities in real phase images, solving this problem with traditional image processing is time consuming and unreliable.

Therefore I propose a CNN based pipeline, which consists of two steps: denoising of wrapped phase images and eliminating discontinuities. The denoising is done with a small encoder-decoder architecture CNN (U-Net). Unwrapping is solved by semantic segmentation of wrapped phase images, where one label corresponds to one phase wrap level. It is done by a similar architecture, however, bigger and more complex.

The performance of this pipeline was tested on computer generated phase images with complex distributions and on realistic phase images, which originate from holographic tomography measurements. In both cases denoising has been successful, whilst not sacrificing information at phase discontinuities, whilst unwrapping is done efficiently and reliably. With both models of CNN working together, both noisy synthetic and experimental phase fringes have been unwrapped with high accuracy.

#P-38

Nonlinear analysis of physiological variables in the assessment of adaptation to physical effort

Małgorzata Żebrowska

The analysis of adaptation processes in the living organisms can be considered on different functioning and organization levels. The scope of the study includes the identification of physiological markers that can be used as non-invasive diagnostic tools to describe the adaptation processes occurring during physical effort. The methodology assumes the development, testing and verification of the suitability of non-linear signal analysis methods used to characterize the couplings and the complexity of time series. The previous project have shown the usefulness of the symbolic entropy transfer (STE) in the assessment of the strength and direction of couplings between ergospirometric signals. The hypothesis whether the accumulation of exercise had an effect on the reduction of the ventilation feedback level, the fraction of exhaled oxygen and carbon dioxide was verified. Results indicate that coupling between selected variables is reduced in the second exercise test, which began after insufficient regeneration of the body. Another project investigated the hypothesis of the usefulness of the exponential function and the Hill model for the quantification of the short-term recovery phase following intense exercise on a bicycle ergometers. Parameters were introduced to characterize the dynamics of changes in oxygen uptake and the concentration of oxyhemoglobin in the blood of the working muscle. The developed tools make it possible to distinguish the efficiency of healthy people.

#P-39

Human factor in NLU localization

Marcin Sowański

Machine translation models in some use cases present translation abilities close to human translation. If translated text is short, as short as one sentence, and the context of previous sentences is not particularly needed, we can expect that the translation done by machine will be as good as translation done by humans. Such assumption (short sentences without context) is met in the domain of virtual assistants. Commands used for communication with virtual assistants (such as Bixby) typically are between 1 and 10 words and context is rarely needed. Machine translation models are therefore used to automatically translate testing and training corpora of virtual assistants. In a typical pipeline the corpus is translated by machine and then evaluated and fixed by a human language expert. Such pipelines, apart from bringing cost reduction, is at the same time wasting a lot of human creative potential because tasks are repetitive and boring. In this work we present ways of measuring whether the process in which a human evaluator works is using their creativity enough. This knowledge can be used to design better processes that can increase human satisfaction from work and at the same time help improve translation at the same time.

#P-40

Stripes Detection and Simulation of Loop Extrusion

Sevastianos Korsak

In this poster we discuss how we can create simulations from stripes in ChIA-PET datasets. Stripes usually are connected with one-sided loop extrusion (LE), which is a biological process mediated by two factors: an Smc complex like cohesin or condensin which has a ring-like structure and acts as motor so as as to extrude the loop, and boundary elements like CTCF proteins which act as barriers for Smc complexes and they indicate the ending points of LE mechanism. So our process can be spitted up in two main steps: (1) the detection of stripes in ChIA-PET data, and (2) having gathered the positions of stripes and the intensities that correspond to them, to create realistic 3D models. For stripes detection we used a computer vision technique named StripeNN, which uses canny edge detection. For the 3d modelling we used OpenMM, which is a library for molecular simulation based on C, which can be called from python.

#P-41

Image driven 3D modeling – structures of the cellular nucleus based on genomic, epigenomic and microscopic data

Krzysztof Banecki

The main goal of our project was to create a complete pipeline for the conversion of the microscopic images of the nuclei of a particular cells into their 3-dimensional chromatin models. In our project we used the images of the nuclei of the flowering plant Arabidopsis Thaliana. The local packing of chromatin is consistent with the behavior of a fractal globule with a distinct chromosomal territories which we sought to recreate in our modelling.
Stages of chromatin modelling.

(A) Input microscopic image.
(B) Critical points estimated as local maxima.
(C) Delaunay triangulation graph created on those maxima. Red color signifies larger edge weights.
(D) Critical points divided into chromosomal territories by the graph partitioning algorithm.
(E) Final chromosomal paths smoothed by the splines.

#P-42

An accurate methods for conductive layers characterization in millimeter-wave frequencies

Jerzy Cuper

In the proposed research we aim at constructing new measurement equipment dedicated to characterization of conductive layers and as well as low-loss dielectric samples, which is of importance for industry and academia working on 5G/IoT technologies. The measurement set-up for characterization of these two types of materials will be based on Fabry-Perot open resonator (FPOR), which offers high Q-factor (>10^5), while allows easy access to the cavity.

The set-up dedicated for characterization of conductive materials will be based on a modified configuration of the forementioned FPOR. The classical configuration of FPOR requires that two concave mirrors are employed. In our set-up one of the mirrors is replaced by a flat reflector (see Fig. 1.), which is used during a reference measurement and, then, by a material sample during the material measurement phase. Such resonant experiments are supposed to lead to obtaining conductivity of measured materials e.g. the metallization layer PCB substrate or bulk conductive materials (see Fig. 2.).

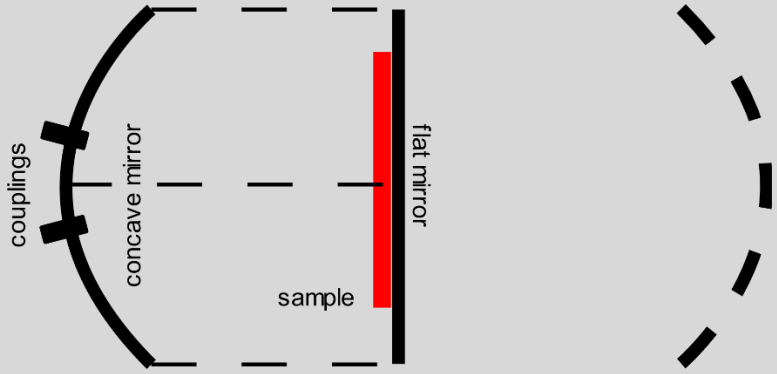


Fig. 1 Plano-concave Fabry-Perot resonator

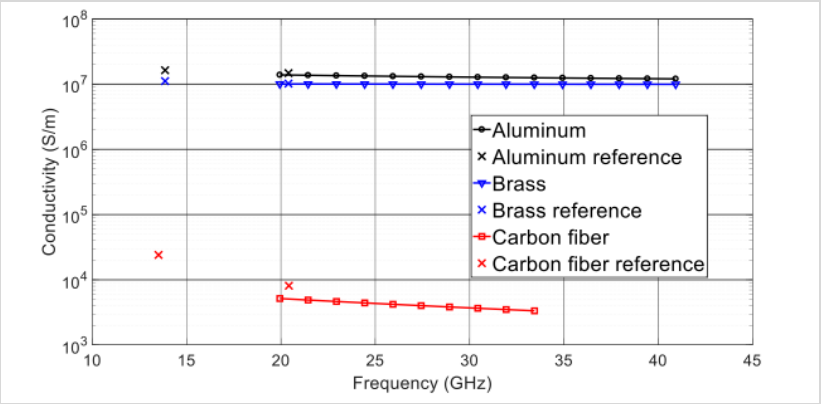


Fig. 2 Conductivity of bulk metals.

#P-43

Separator theorem for B_t-free graphs

Karolina Okrasa

Let G be a graph on n vertices, and let S be a subset of vertices of G. Let $p \in (0,1)$. We say that S is an p-balanced separator if each connected component of G-S (i.e., each „part" of the graph obtained by removing vertices that belong to S) has at most pn vertices.

We consider a class B_t of graphs that excludes some certain structures that consist of a path and a cycle. We prove that every graph from the class B_t contains a „small"-size set X, such that the set consisting of X and the vertices adjacent to X, is a 3/4-balanced separator. In particular, if the maximum degree of a vertex in G is bounded, we can obtain a 3/4-balanced separator of bounded size.

This result leads to several algorithmic corollaries -- we illustrate how this result can be applied when solving a classic graph problem called Independent Set. In the Independent Set problem, we are given a graph G and the task is to find the size of the largest subset of vertices of G that are pairwise non-adjacent. We show that if we assume that G belongs to the class B_t, then we can compute the size of the largest independent set in G in time subexponential in n.

This is a joint work with Paweł Rzążewski.

#P-44

Knowledge Graphs in Neural Machine Translation

Mateusz Klimaszewski

In recent years, Knowledge Graphs have played an essential role in natural language generation. Primarily the work focused on the question answering and dialogue systems. Neural Machine Translation (NMT), the task of automatic translation between languages, can be viewed as another text generation task due to the same technical schema - sequence-to-sequence architectures and similar evaluation metrics. However, there are significant differences. First, translation models must understand two languages' syntactic and semantic nature instead of one. Also, the degree of freedom and the error margin is much lower - the translation must preserve the meaning and fluency.

Our work evaluates whether it is possible to use Knowledge Graphs to improve NMT. In the experiments, we studied the impact of the shallow representation of a KG, Knowledge Graph Embeddings, on a task which requires in-depth natural language understanding - Word Sense Disambiguation. Our preliminary study demonstrates improvements in out-of-domain datasets in English to German translation.

#P-45

Electromagnetic compatibility of the apparatus controlling the test in the environment of high-current laboratories

Jolanta Sadura

Does in situations where the high precision and reliability is required, uncontrolled operation of the control equipment can happen? The High Current Laboratory conducts research and development works covering in particular studies of switchgear, transformer stations, earthing, connectors, etc. One of the tests is the short circuit test which is always preceded with powering MV side of the test transformer by unloaded LV side. Thereafter the controller must wait for release of the operator to start the test. Sometimes electromagnetically disturbed controller starts the test without release. Such situation is undesired and can be destructive for the device under test. Identification of the transient fields during powering the test transformer is indispensable by assessing hazard of EM interference of the controller.

The beginning investigation gave the hint that repetitive damped oscillatory waves DOW are component of electromagnetic environment. For identification of the problem instrumentation such as D-dot and B-dot field probes were used. The poster shows results of field measurements along with recording the voltage signals at the gates of controller. It was suspected that repetitive ignition and extinction of the short arc by closing the circuit breaker in the MV circuit is origin of the DOW. Additional investigation of the circuit breaker in stand-alone operation exclude this hypothesis. The only possibility of the DOW is pulse travelling forth and back in the MV circuit which can happen in lines with distributed parameters.

Presented investigations expands the scope of electromagnetic phenomena present in the High Current Laboratory. All information about existing disturbances and their sources are used as main and basic information for prototyping new control equipment working in such an unfriendly environment.

#P-46

Application Relocation in an Edge-enabled 5G System

Grzegorz Panek

With the growing development of 5G and its new services, edge computing is becoming the cornerstone of the ongoing network transformation. We are dealing with the problematic of Edge Relocation, which aims to relocate edge application instances between edge clusters in order to ensure an uninterrupted service. To achieve our objective, we propose a cloud-native Edge-enabled 5G solution that complies with ETSI and 3GPP standards. The latter performs relocation of edge applications in order to support the service continuity.

#P-47

Vulnerability detection and attack prevention on a social robot control system that uses deep reinforcement learning

Daniel Giełdowski

Robots already operate outside the closed IT networks of factories and laboratories. They require appropriate security measures against attacks and their consequences for these reasons. Utilizing deep reinforcement learning make it possible to teach a robot complex tasks, but even small disturbances applied to the signals can lead to unpredictable behaviour of the robot and in consequence, to physical damage of the system or it environment. Social robots are capable of performing multiple tasks, for example helping the elderly or taking care of the disabled. One of the crucial elements of that work is providing them with the sense of security and privacy. Vulnerabilities of the robotic system may lead to situations potentially dangerous to people who interact with the machine.

The first phase of the research included exploring and analyzing the current state-of-the-art of deep reinforcement learning and its vulnerability to cyber-attacks. The next step was defining the most probable types of attacks on the robotic system and the magnitude of their consequences for the functioning of the social robot along with possible security measures employable against them. Currently, the scheme of the possible procedure for vulnerability analysis of the system is presented. The next step of the research assumes the practical evaluation of the procedure in the form of implementation: firstly in the simulated environment and secondly on real hardware.

#P-48

Study of antiprotonic atoms and the limits of the nuclear and electromagnetic forces

Jakub Zieliński

Access to a variety of highly charged ions is crucial for fundamental research and for technological applications. However, not all isotopes can be accessed with the existing production paths. Therefore, in order to provide an alternative production mechanism of either difficult to obtain radioisotopes or short-lived Highly Charged Isotopes (HCI), new approaches are needed.

We suggest that many species of HCI can be accessed using antiprotonic atoms. They are atoms in which one electron is replaced by an antiproton ($\bar{p}$). The lifetime of these atoms depends on the relaxation of the antiproton and ultimately annihilation with the nucleus matter of the atom. The annihilation happens on the surface and with little recoil momentum of the nucleus. Pions (or more rarely, kaons) that are produced in the annihilation can then interact with nucleus matter creating new isotopes, already in HCI state.

We have studied in detailed simulations done using GEANT4 code the annihilation of very low energy $\bar{p}$ on atoms at rest. According to this simulation it is possible to create isotopes^{Z+} with energies which enable their capture for further studies and manipulations, which could not be achieved with previous methods.

#P-49

Design of GaN HEMT amplifiers with Nonuniform Transmission Lines for T/R modules of AESA radars.

Marcin Wiśniewski

The main goal of research is to develop a design method of power amplifiers with GaN HEMT (High Electron Mobility Transistors) T/R (Transmit/Receive) modules of AESA (Active Electronically Scanned Array) radars. The method will include usage of the technology of NML (Nonuniform Microstrip Lines) in amplifier matching networks. The research concerns a nonuniform microstrip line with shape changing continuously toward the direction of wave propagation.

Power amplifier is a crucial element of T/R module of radar which defines many of its parameters. It is assumed that the developed design method will allow fabrication of amplifiers characterized by high output power, high efficiency, linearity and robustness even in extremely demanding environment. Two of the greatest challenges concern development of electro-thermal GaN HEMT model and modeling of nonuniform microstrip lines for which ECAD tools as ADS (Advanced Design System) and CST Studio Suite will be used.

Given that this doctorate is of industrial-type, an equal emphasis will be placed on performing computation, simulation and device prototyping. The device must be adapted for serial production and military use, therefore properties like invariance of electrical parameters, operating temperature, shock resistance, EMC compatibility and MTBF (Mean Time Between Failures) will be taken care off.

#P-50

Van der Waals heterostructures for next generation nano and optoelectronics

Małgorzata Giza

Due to electrical, optical, and thermal properties, two-dimensional materials are widely studied in the field of modern electronics and optoelectronics. However, despite the promising results, atomically thin layers have some limitations (sensitivity to the environment, formation of the Schottky barrier in the metal-semiconductor junction) that can affect the performance of the devices. Such negative features can be overcome by stacking layers of different 2D materials into a van der Waals heterostructure (Fig. 1 top left, bottom). Therefore, we can obtain a completely new material that will have the properties of the component layers.

This research is focused on the fabrication of van der Waals heterostructures and the study of their structural and electrical properties. For this purpose, the method of gold-assisted mechanical exfoliation was used, which allows the production of large-area continuous layers of TMDs (Fig. 1 top right). The layers are stacked on top of each other using a 2D material transfer system. Next, it is possible to produce devices such as transistors or photodetectors on the obtained heterostructures using e-beam lithography. The large area of the material is a great advantage, because it enables the production of multiple devices on a heterostructure made of the same layers, allowing a reliable comparison of their performance.

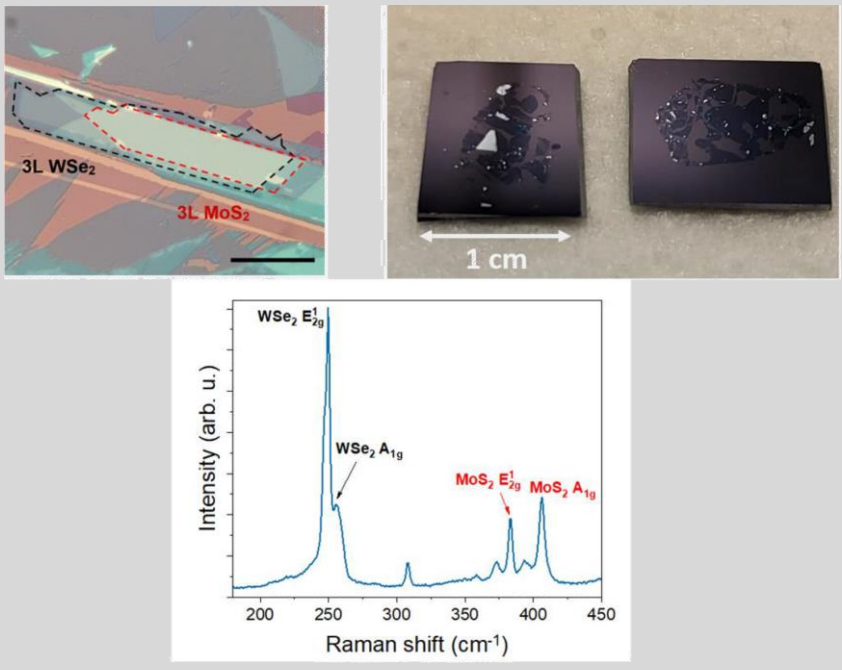


Fig. 1 (Top left) Example of fabricated MoS_2/WSe_2 heterostructure (L – layer, scale bar 50 μm). (Top right) Mechanically exfoliated large-area flakes of MoS_2 monolayer. (Bottom) Raman spectrum of MoS_2/WSe_2 heterostructure.

#P-51

Selective Generative Replay

Stanisław Pawlak

In Continual Learning scenarios, the model gets training data in subsequent batches. Accumulating gathered knowledge between iterations is problematic because the model forgets previous information when learning new things (this phenomenon is called catastrophic forgetting). Most Continual Learning methods use a subset of regularization, architectural, or replay strategies to prevent forgetting.

We explore the Generative Rehearsal framework used to produce past examples for rehearsing process in Continual Learning. While replay-based strategies are known to overcome catastrophic forgetting, the use of generative rehearsal methods is still limited by the low quality of generated replay samples. We address this limitation and propose a novel method called Selective Generative Replay, which assigns weights to samples during training to increase the precision of generations. SGR can be easily applied in conjunction with other generative rehearsal methods to bring further improvement. Experiments validate that our method is effective, showing that it boosts the performance of other generative rehearsal methods no matter if they replay full-size generations or internal representations of previous samples.

#P-52

The Autonomous Multisensory System for Obstacles Detection at Airports

Daniel Wiekieta

Presented, the off-road environment perception system is implemented in the autonomous vehicle to examine the load capacity of runway safety areas (RSA). It is an innovational use of cutting-edge camera, lidar and radar (CLR) sensor fusion technology to detect ICAO standard obstacles at airports. This type of multi-modal sensor fusion is caused by the risk of the system running in adverse weather conditions and the high cost of eventual collision with the airport infrastructure. The high-reliability requirements are affected also using a two-stage detection system currently considered the best. This system uses a Bayesian Neural Network (BNN) in the first stage and Support Vector Machines (SVMs) in the second one. The BNN does a sensor data fusion and extracts regions of interest (RoI) for the classification's second stage.

#P-53

Remote detection of objects using laser techniques

Aleksandra Bieniek

Modern defense technologies continuously call for new photonic covering, among others, aspects of security and safety. A good example of these is passive laser detection system, widely used to alarm about unfamiliar illumination, potentially indicating danger to human resources and/or advanced equipment. The typical sources illumination are laser rangefinders, illuminators, and beam riders. There is also an obvious tendency observable to use more and more low-power laser systems, which are getting harder to detect. As a result, passive enemy detection techniques are no longer sufficient. That is the reason to add to warning systems also active laser detection of dangerous objects nearby.

This work shows an approach to develop laser system for detection and tracking, which would enable acquisition of characteristic optical signatures and categorizing them as dangerous or not. The main parameters of optical signatures are shape and wavelength, power, pulse length and polarization of the reflected laser beam. The laser system should scan an environment and detect objects, which are considered as potentially dangerous - like camera, telescope, rangefinder lenses. Objects like windows, bottles and car headlights should be categorized as not interesting. Proposed system and practical solution could find place in military as good as in civil sector.

#P-54

Compact embeddings of Hajłasz-Sobolev spaces

Artur Słabuszewski

In the 90s of the last century Hajłasz has introduced the so called Hajłasz-Sobolev spaces as a generalisation of the Sobolev spaces to the setting of arbitrary metric-measure space. Since then, the theory is still being developed. One of the fundamental results in the theory of Sobolev spaces is the Rellich-Kondrachov theorem, which states that for bounded domains with sufficiently regular boundary, any family of the functions with bounded Sobolev norm is pre-compact in L_p The question which naturally arises is if there is a counterpart of this result in the theory of Hajłasz-Sobolev spaces and what do we need to assume on the underlying measure and metric. There are few papers in which L_p compactness of bounded Hajłasz-Sobolev functions was obtained with various assumption involving metric and measure (e.g. geometrically doubling condition).

However, in my recent article with Przemysław Górka we proved very general version of Rellich-Kondrachov theorem. It turns out that it is sufficient to assume only total boundedness of the metric space. On the other hand, I have found the example of a metric-measure space which is not totally bounded but the compact embedding still holds. In other words, a total boundedness is not a necessary condition.

#P-55

Machine Learning Techniques used for Wind Power Forecasting

Inajara Rutyna

Forecast models used to predict wind energy are considered chaotic by nature due to their dependence on weather conditions, which can imply in complex formulations.

The formulation of wind forecasting models is based on historical data obtained from Numerical Weather Predictions (NWP) and time series, represented by features directly connected to the wind in different steps of time.

The classical approaches used for wind forecasting are categorized by naive methods, physical models, statistical methods and artificial intelligence techniques.

Machine learning as a subset of artificial intelligence is considered the most effective technique for wind forecasting. It is able to obtain higher accuracy in predictions, by mimicking human behavior without a predefined mathematical model, and is used to generate a model for future generation. However, machine learning techniques also have its disadvantages, such as, low convergency speed, overfitting, computational complexity and problem generalization.

To avoid these problems, ensemble and hybrid methodologies combined with machine learning techniques are able obtain best prediction performance, by aggregating different methodologies in weak spots of the model.

#P-56

Speech recognition in conditions of impaired acoustic signal transmission.

Karolina Pondel-Sycz

The research concerns the issue of speech recognition with distorted acoustic signal transmission. It concerns mainly telephone conversations, where signal distortions and interferences occur. The first step in research is to investigate the type of interference and distortion present and then to select appropriate repair methods. A wavelet transform can be used for cleaning, analysis of the processed signal and preliminary assessment of its quality. The next step in speech signal preprocessing is amplitude normalisation, use of a preemphasis filter, time alignment, etc. Once the signal has been properly prepared, feature extraction can proceed. Currently, in the field of ASR systems, it is particularly interesting to apply deep neural networks using cepstral features of the signal and MFCC analysis. Of particular note is the PNCC analysis, which, according to literature sources, gives promising results for speech recognition carried out in the presence of various types of additive noise, reverberant or noise environment. Convolutional neural networks, time-delay neural networks and recurrent neuron networks including Bidirectional Long Short-Term Memory layers, (which are able to exploit temporal context), can be particularly useful as feature extractors and classifiers. The research is conducted for speech in English and concerns keyword recognition.

#P-57

Optofluidic systems for sensing applications

Szymon Baczyński

The main research area of my Ph.D. is to create optofluidic systems using polydimethylsiloxane (PDMS) and liquid crystals (LC). PDMS structures with appropriately designed microchannels are filled with nematic liquid crystals which molecules can be periodically reoriented by an electric field. This research is directed toward the fabrication of an optofluidic system. Before the geometry of the system can be finalized, many research areas should be explored, many simulations will be performed, and the technological process will have to be fine-tuned. At this point, the smallest LC-filled microchannels tested are 12 µm high and 11 µm wide.

The most important aspects that have been explored are:

1) different technological processes to manufacture the
2) investigation of the orientation of LC nematic molecules in PDMS microchannels
3) preliminary simulations and experiments on the reorientation of LC molecules using an electric field
4) transition to a technological process using photolithography and SU-8 examination of the structures using high-resolution scanning electron microscopy (SEM)

Future research areas to be explored:

1) simulations considering the capabilities of the mold manufacturing process
2) research on a compatible electrode
3) accurate measurements of the orientation of LC molecules in the microchannel volume
4) light transmission in a PDMS microchannel filled with LC

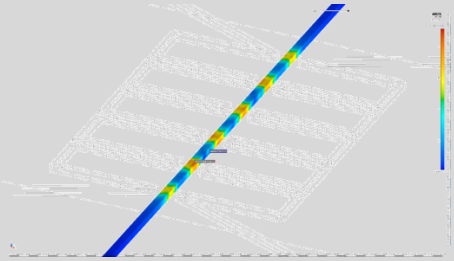


Fig. 1 Electric field simulation for electrode with advanced geometry.

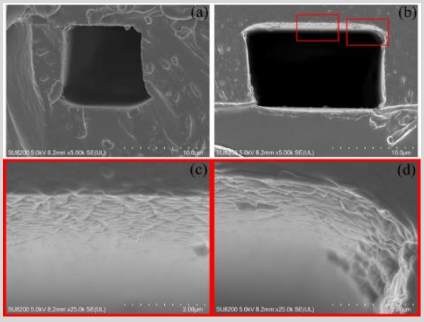


Fig. 2 Images of PDMS:PDMS structures with the microchannels with the height of 12 µm taken with a Hitachi SU-8230 SEM in a case of 11-µm- (a) and 17-µm- (b) wide microchannel and highlighted the regions in which the images with the higher magnification were taken, representing a top surface (c) and a top corner (d) of the microchannel.

#P-58

Supporting rare disease diagnosis with explainable artificial intelligence using domain knowledge models and data mining techniques on the example of early diagnosis of blood cancers.

Arkadiusz Sycz

The problem I address in my research concerns the identification of patients with blood cancers based on information collected in hospital systems. The basic assumption of the experiment is the ability to improve the diagnosis of blood cancers with the help of expert knowledge supported by artificial intelligence. The raw data of the experiment are laboratory results, textual descriptions of patients, their diagnoses as well knowledge about state-of-art in diagnostics. The data are electronic health records sampled from databases of Polish hospitals. The challenge is to overcome data flaws, data mining and interpretation of results, performed under the supervision of a domain expert - a hematologist. We aim to conduct research using statistical modeling tools combined with domain knowledge engineering with the intention of confirming hypotheses, feature engineering, detecting new patterns hidden in the data and using them to build a reliable explainable predictive model in circumstances of uncertainty and incompleteness of real-world data, assessing model efficiency and utility. To achieve these goals, we will use structure learning (networks, trees), probabilistic estimation of cause-and-effect relationships.

#P-59

An XANES Investigation of the Electronic Structure of ZnO Films implanted by Yb

Yevgen Syryanyy

The electronic structure of ZnO:Yb epitaxial layers grown on GaN/sapphire substrates was studied using X-ray absorption spectroscopy at the Zn L_3, O K and Yb M_5 edges at Solaris light source. Knowing that the ZnO crystallizes in an anisotropic wurtzite structure, the linear polarization of synchrotron radiation was exploited to estimate the influence of the crystal structure anisotropy on the distribution of the local density of states at the site of Zn and O. The calculated partial density of states describes the observed anisotropy in the measured spectra. Influence of the core–hole effect on the analyzed absorption spectra was verified.

Acknowledgements: We acknowledge National Synchrotron Radiation Centre SOLARIS for provision of synchrotron radiation facilities, and we thank the beamline „PEEM/XAS" team for assistance; and dr R. Ratajczak from National Centre for Nuclear Research (Otwock, Poland) for assist in samples preparation. The work was partially supported by the Interdisciplinary Centre for Mathematical and Computational Modelling (ICM) at University of Warsaw, Poland (G 3557) and National Science Centre, Poland (UMO-2020/39/B/ST5/03580). The samples growth was co-financed by international project supported by the Polish Ministry of Science and Higher Education (3846/HZDR/2018/0) and Helmholtz-Zentrum Dresden-Rossendorf (17000941-ST).

#P-60

Spectral response of $CdIn_2S_4$

Jakub Zdziebłowski

Cadmium indium sulfide ($CdIn_2S_4$) aroused interest among researchers when its contribution to performance improvement in CIGS solar cells was discovered. Various studies have shown inherence of persistent photoconductivity due to the presence of the metastable defect states in this material. The possibility of controlling metastability by defect engineering and resulting switching phenomena makes $CdIn_2S_4$ a very promising candidate for base material for neuromorphic devices.

Study focuses on spectral response photoconductance measurement of $CdIn_2S_4$ thin-films at various temperatures and pre-illumination. Hence, basic information about band structure was obtained.

Conducted experiments show significant growth of conductivity, dependent on pre-illumination, using incident photons with both sub-bandgap and above bandgap energy. Obtained data will throw light on the matter of $CdIn_2S_4$ metastability. Presented work is one of the first results of broad research covering many aspects and applications of the studied material.

#P-61

Lensless digital holographic microscopy in a low photon budget regime

Bartosz Mirecki

Lensless digital holographic microscopy (LDHM) is a widely used technique that allows reconstructing an optical field in a unique large field of view and around micrometer resolution. Due to the simple setup, these features are primarily limited by the size of the used CCD matrix and the single-pixel dimensions. An unfocused captured hologram is reconstructed by the numerical propagation to the focused plane, usually realized by auto-focusing algorithms. Reconstructed data carry information about an examined sample's amplitude (absorptive features) and phase (refractive features). We study the LDHM ability to operate in the low photon budget (LBP) regime to enable imaging of unimpaired live cells without phototoxicity and any photo-stimulation. We show that recording data in the LBP regime (down to 7 μW) does not limit the contrast and resolution of the hologram reconstruction in comparison to the regular illumination. LPB generates hardware camera thermal noise. However, we eliminate this by the BM3D numerical algorithm. The ability to obtain high-quality, high-resolution optical field reconstruction was confirmed using: USAF 1951 as amplitude sample, phase resolution test sample, and finally, biological sample. We selected live glial restricted progenitor cells as a challenging biomedical sample to investigate the LDHM system in the LPB regime.

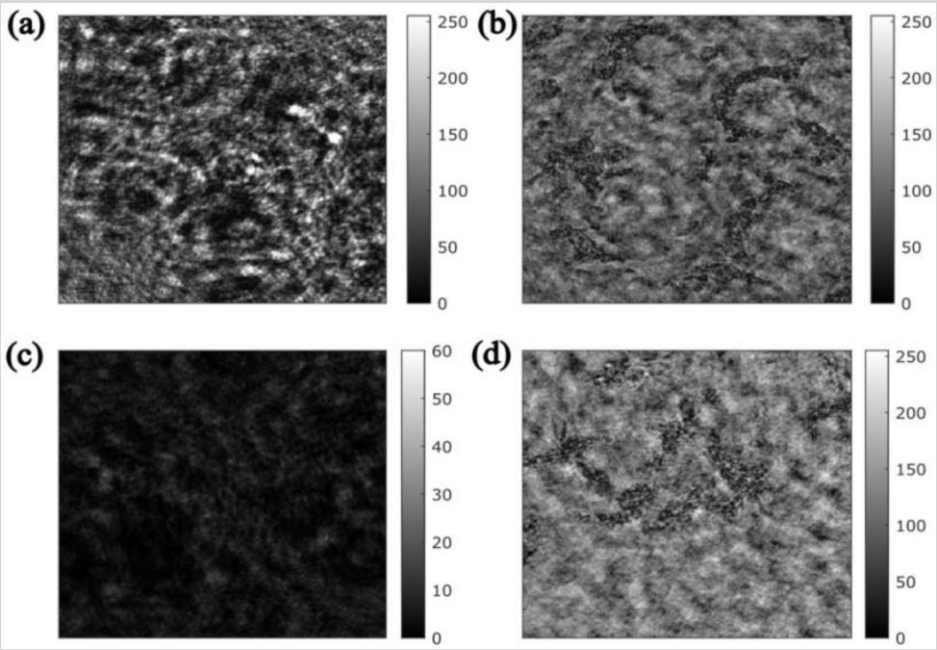


Fig. 1 (a) Standard illumination hologram, (b) reconstructed amplitude from hologram a, (c) low photon budget regime hologram, (d) reconstructed amplitude from hologram c.

#P-62

Evaluation of common distributed simulation protocols as a data source for a simulator of air defense radar.

Tomasz Kaczorek

DIS is a long standing, widely adopted IEEE standard for conducting military simulations. Due to ever growing popularity of international wargames and quickly evolving arms trade the question arises: Has this 20 year old protocol stood a test of time? To verify this statement a high fidelity simulator of a modern air defense radar has been proposed. It's primary objective is to determine if the scope of exchanged information is sufficient to reliably model radar echo signals. As a consequence, necessary extensions both to protocols and to datasets required to be supplied by other means will be proposed. Further considered factors include the effects of network unreliability (dropping or reordering messages), dead reckoning usage (which may lead to differences in calculated position depending on the internal refresh and smoothing rates), intentional obfuscation of technical parameters by other participants or desynchronization. A substantial part of the research will be related to creating a simulation tools which enable testing constructed hypotheses, including the whole RES. The planned software architecture is highly modular to allow to swap different components in the processing chain and examine their influence on the fidelity of simulation.

#P-63

Simulations and design of germanium-based photonic integrated elements working in mid-infrared spectral range

Marcin Lelit

The interest in mid-infrared photonics is focused on sensing applications due to presence of strong absorption lines of gasses and liquids [1] i.e. CO_2, NO_x, SO_x. One of material platform used for such applications is germanium-on-silicon (Ge-on-Si) which provide refractive index contrast of 0.7 at at 3.8 μm [2]. This work reports early stages of development of Ge-on-Si photonic integrated photonic platform operating in range from 3.0 to 5.2 μm. Two sets of test elements and topographies were designed, one series of test structures was manufactured and is under characterization process.

First stage in development of photonic integrated platform, after the material is chosen, are numerical simulations of straight waveguides and bends to determine basic geometrical constraints of the elements. Two different heights of germanium were considered: 1 and 2 μm. Examples of mode profiles with fully etched waveguides cross-sections are presented in Figure 1.

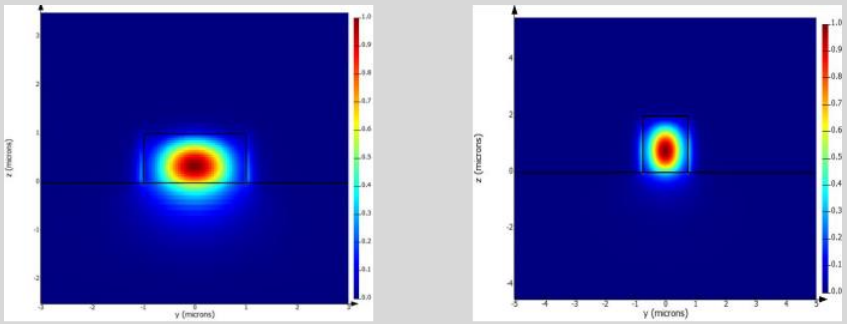


Fig. 1 (a) mode profile for waveguide H = 1 μm, W = 2 μm at λ = 5.2 μm ; (b) mode profile for waveguide H = 2 μm, W = 1.5 μm at λ = 5.2 μm.

In the second stage of design process, grating couplers geometries were optimized for full etch process and for shallow etch in 2 μm germanium layer. Theoretical efficiencies up to 20% were achieved with potential for further improvement with more complex material stack that emulates substrate refractive index equal 2.

[1] A. Malik, M. Muneeb, Y. Shimura, V. J. Campenhout, V. D. R. Loo, i G. C. Roelkens, „Germanium-on-silicon planar concave grating wavelength (de) multiplexers in the mid-infrared", Applied Physics Letters, t. 103, nr 16, s. 161119–1/4, 2013, doi: 10.1063/1.4826114.

[2] W. Li i in., „Germanium-on-silicon nitride waveguides for mid-infrared integrated photonics", Appl. Phys. Lett., t. 109, nr 24, s. 241101, grudz. 2016, doi: 10.1063/1.4972183.

#P-64

Development of projectile inertia control system in the electromagnetic gun for use in commercial aviation tests

Mateusz Pakosz

The task is to develop automatic control system for electromagnetic gun, which can be used in aviation industry certification and engineering tests, such as bird strikes and bird ingestions. Developed solution can be replacement for used up to day pneumatic gas guns and the aim is to achieve better reliability and time consistency. The main innovative feature should be possibility to shot with non-ferromagnetic projectiles made from ice or ballistic gel. The project includes developing of the concept control system with selection of electrical components, building the electrical and mechanical prototype, building the sabot catcher and drive system, physical parameters of projectiles measurements and time consistency tests and reporting. Literature research was made. Currently tests of electrical components and control solutions are conducted partially basing on existing prototype of the gauss gun. Some of electrical and physical parameters was measured and waiting for further description. The next step is to change the control system for FPGA based one. The controller has been pre-selected. The next step is to prepare one stage of the gun, which should be scalable, based on target controller and independent. Main task of that future part of work is increasing the reliability by further testing of electrical components and developing new control algorithms.

#P-65

A method of strong authentication of remote users based on an ID card with an electronic layer

Konrad Kamiński

In my searching I want to find method to effective use Polish ID Card to authenticate Orange Polska employees and partners (or other person, maybe clients in future) with or (better) without PWPW intermediation. Goal is to create strong authentication method during remote contact in cases of issuing and enrolment and emergency unlock of the organizational smart card. After the covid-19 pandemic, Orange Polska works in a hybrid model, and many employees have decided to use teleworking. A main tool to strong authentication in Orange is smart card with X.509 certificates. But corporate smarty card can be accidentally broken or locked. Additionally Orange Polska has offices in many cities in Poland. Therefore, it is important to find an alternative method of remote strong authentication.

This goal can be reached in few ways:

- using NFC reader connected to PC (costly) and provide mutual TLS authentication,
- using dedicated smartphone application as NFC reader (aka German solution) and provide mutual TLS authentication
- using dedicated smartphone with NFC application as authenticator
- using intermediation of PWPW service (last choice)

Now I read about ICAO standards about machine readable documents and make review for solutions in other countries. A lot of countries use contacts card (electric interface ISO 7816-2). Contactless card require additional and costly hardware (NFC reader), but a lot a new smartphones have NFC module and can communicate with Polish ID Card.

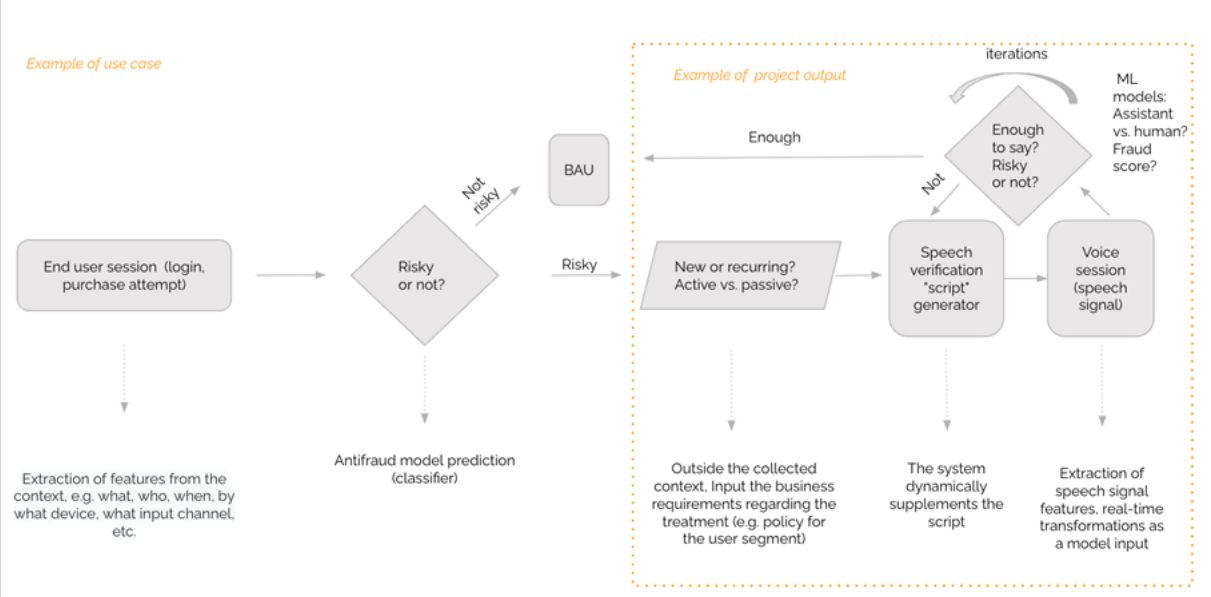
#P-66

Deep profiling of the speech signal with the use of artificial intelligence in order to increase the security of remote user verification based on the voice

Hubert Rachwalski von Rejchwald

The research concerns a topic of deep profiling of the speech signal. Main research objectives are the following: i) extraction of a set of features from the audio signal (relevant from the perspective of combating abuse) enabling the desired levels of classification prediction to be obtained; ii) developing a method of transforming source data into features based on experience from the anti-fraud market; iii) creating machine learning models to protect against the widest possible range of adversarial ML attacks in the situation of heavily unbalanced classes; iv) verification of hypotheses of the legitimacy of making the predictive engine independent of linguistic / cultural features as well as the ability to dynamically parametrize the conversation in the context of the diverse needs / specificity of many clients; v) designing a solution that automatically generates scenarios (script) of interaction with the user, supporting the detection of fraud; and vi) verification of hypotheses regarding the parameterization potential of the conversation scenario and the sequence of interactions with a parallel analysis of interactions and immediate issuance of recommendations.

The desired project's outcome has been visualized below:



#P-67

Periodic surface structures for the optical analysis of biological hazards

Emil Pituła

In this work I present a new material solution for optical sensing application. The material had been achieved by well-controlled anodization process of Titanium (Ti) thin film deposited on indium tin oxide (ITO) covered glass substrate. Anodization technique allows for repeatable formation of ordered structure that is crucial for application at a large technological scale. The process involves connecting coated substrates to a power supply as an anode, while platinum mesh was utilized as cathode. Through the anodization in thermostatic reactor filled with specific solution the TiO2 structures grow out of the Ti layer. In this work parameters were optimized to receive a thin-walled nanotubes array. Glass substrate of the structure acts as an waveguide. For the nanostructured TiO₂ and ITO layer it is possible to observe Lossy Mode Resonance (LMR) effect. LMR coupling occurs between lossy-modes guided in a thin film and modes in a waveguide. Optical measurement of the sensor was performed in the wavelength range of 400-1700 nm (Fig. 1). In the setup the coated glass slide was put between two multimode fibers with free-space coupling.

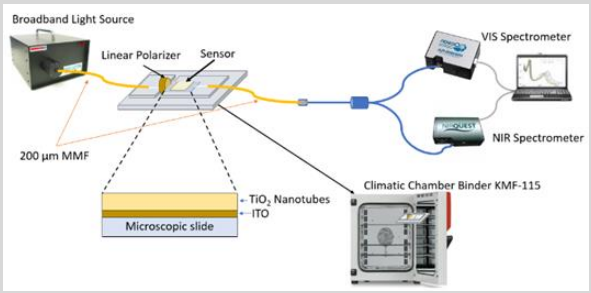


Fig. 1 Schematic representation of an optical setup used in this experiment.

A series of measurements in climate chamber was performed in cycles of changing humidity ranging from 30% up to 90% (Fig. 2).

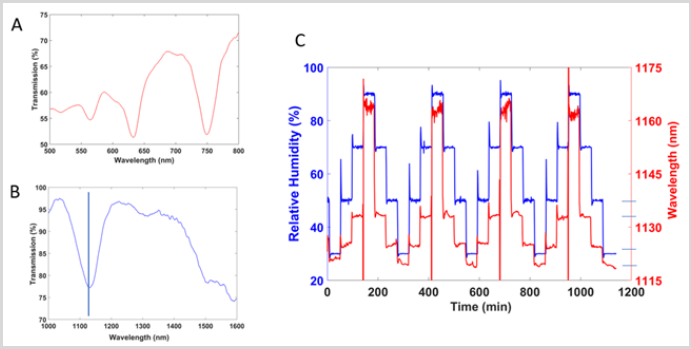


Fig. 2 . (A) TE mode transmission spectrum of the sensor in visible range and (B) in NIR range with LMR minimum considered for humidity sensing. (C) Sensogram showing shift of the LMR wavelength with humidity change (red) and control readout of built-in chamber sensor (blue).

#P-68

Thin layers for fiber optic sensors and biosensors: Optical and electrochemical label-free detection of Borrelia using ITO-coated lossy-mode resonance optical fiber sensor

Katarzyna Lechowicz

Despite intensive development of various biosensing solution, fast and reliable detection of Borrelia bacteria is challenging. In this work we report for the label-free optical fiber sensor where the measurement can be simultaneously performed in optical and electrochemical domains. The sensor is based on multimode optical fiber, where a short section of the core was coated with indium tin oxide (ITO) thin film using RF magnetron sputtering method. Application of transparent conductive oxide, such as ITO, provides a possibility of double-domain detection where due to the film conductivity, the sensor may be investigated by electrochemical (EC) methods where ITO-coated fiber is used as working electrode (WE), as well as optical methods where lossy-mode resonance (LMR) is investigated. LMR-based sensors are relatively easy to fabricate and are considered as a cheaper alternative for surface plasmon resonance sensors. Detection of Borrelia burgdorferi CB43 has been performed by using bacteria’s surface protein directed antibodies as bioreceptor. As a redox probe for EC measurements 1mM 1,1’-Ferrocendimethanol (0.1M PBS) has been used.In order to provide binding agent between ITO’s surface and the receptor layer,sensors have been chemically functionalized using APTES silanization. Investigated concentrations were in range from 340 ng/mL up to 34 μg/mL. Due to application of double-domain sensing concept, we enhance the sensitivity of the structure and decrease of false results.

#P-69

Design of High-Speed Synchronous Reluctance Motor for Electric Vehicle Drive

Stanisław Hajnrych

As Electric Vehicle (EV) market is growing in fast pace in response to zero emissions targets there is constant need for better drive components to decrease production costs, reliance on rare earth materials and carbon footprints of manufacturing process itself. Synchronous Reluctance (SyR) motors without neodymium magnets are one of the possible best technologies to meet these demands. However mechanical and power density constrains of the SyR motors pose challenge in design of such motor suited for EVs. The aim of this doctoral research is to find the best design of SyR motor for such applications. After comparing various electric machine types and EV drive topologies, SyR motor is designed, simulated in various FEM software and a prototype is build. The results are verified by laboratory measurements on the test-stand and compared with these state of the art mass produced EV motor – the current stage of the research.

#P-70

Intelligent perception in autonomous robotic navigation

Konrad Cop

Autonomous robots can significantly facilitate human work, however, full automation of work is still a huge challenge. The main difficulty is to successfully navigate in highly variable environments. Robot's behaviour is planned in a previously generated representation of an environment called basemap. Normally, the basemap is fixed and does not provide updates opportunity. In situations when the environment changes, the information contained in the basemap used to plan activities deviates from the currently perceived state of the environment, resulting in general suboptimal robot behavior. This challenge can be solved through the perception that takes into account the previous experience of the robot operating in a given environment.
In the classic approach to robotic navigation, the data obtained from sensors is used only at the planning stage. Thanks to the use of machine learning, using previous observations, a lot of additional information can be inferred already in the perception phase. Such information can e.g. include the class of the object, the estimation or missing part or the predicted trajectory of observed objects. The aim of the research is to improve the navigation system by using historical observations of the robot to improve the current perception.

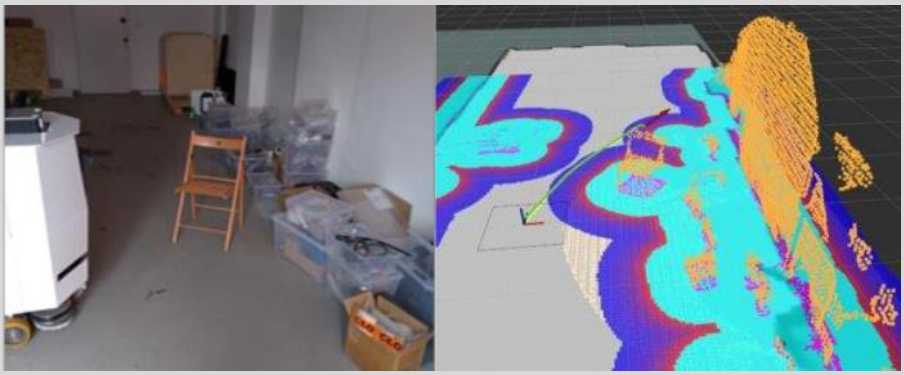


Fig. 1 The way robots perceive environment.

#P-71

Assessment of the development of demand side response services in European Union countries

Justyna Modliborska

The aim of this poster is to present the classification of stages of development of DSR services in European Union countries, Great Britain, Norway and Switzerland. The discussion is based on information about legal conditions and accessible market mechanisms influencing the current state of DSR resources in the power sector. The provisions of the EU Efficiency Directive defining the existence of reduction resources were used as a basis for comparative analysis. The assessment was made in three criteria, such as availability of DSR services on the energy market, possibility to aggregate reduction resources and requirements related to the technical feasibility of DSR products. Based on the obtained results, Finland, France, Ireland and the United Kingdom were identified as the countries with the highest level of implementation and operation of DSR services, pointing to positive actions that favour the development of reduction resources in contrast to the other analyzed entities. Moreover, this presentation identifies areas which pose real threats and difficulties in each of the considered aspects for new entrants, i.e. aggregators and their aggregated resources.