IDSS

4th INTERDISCIPLINARY DOCTORAL SCHOOL SEMINAR

28–30 SEPTEMBER 2022

Doctoral School No. III
Exact Sciences and New Techologies

Warsaw University of Technolody

The 4th 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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Bartłomiej Hryniewicki

PROGRAMME

	WEDNESDAY September 28, 2022
09:00	Opening ceremony with special guest Vice-Rector for Research, Professor Mariusz Malinowski, PhD, DSc
09:15	Session #01 Chair: prof. Ryszard Piramidowicz #O-01: Alvaro Carreno, Control of a Hybrid Transformer to Improve the Power Quality of a Distribution Network
09:30	#O-02: Grzegorz Panek, Application Relocation in an Edge-Enabled 5G System
09:45	#O-03: Jacek Piłka, Formation of optical beams in nematic liquid crystals
10:00	Coffee break
10:15	Session #02 Chair: prof. Ryszard Piramidowicz #O-04: Agnieszka Zięba, Infinitesimial generators of quadratic harnesses
10:30	#O-05: Filip Łabaj, Design of a static Fourier transform spectrometer for the 8-12 um infrared region
10:45	#O-06: Karolina Gabor-Siatkowska, Is An Eyetracker Calibration In Human-Computer Interface Always Necessary?
11:00	#O-07: Katarzyna Woźnica, Consolidated learning – new approach to domain-specific strategy of hyperparameter optimization
11:15	Special invited presentation: prof. Michał Bilewicz, Effective strategies to confront online hatred. Psychological perspective
11:30	
11:45	
12:00	
12:15	Lunch break
12:30	
12:45	
13:00	Session #03 Chair: prof. Jordi Mongay Batalla #O-08: Emil Pituła, Ordered Titanium Dioxide Nanotubes for Lossy-mode Resonance-based Humidity Sensing
13:15	#O-09: Maja Kabus, Two-particle correlations of charm hadrons in the ALICE experiment at CERN
13:30	#O-10: Adrian Wielgos, Nonlinear, quasistatic models of viscoplasticity with gradient-type nonlinearity
13:45	#O-11: German Peinado, Security policies definition and enforcement utilizing policy control function framework in 5G
14:00	#O-12: Bartłomiej Hryniewicki, A suboptimal strategy for control multi-dimensional drying process
14:15	Coffee break
14:30	Session #04 Chair: prof. Jordi Mongay Batalla #O-13: Tomasz Gabler, Label-free detection of SARS-CoV-2 nucleocapsid protein using optical fiber microcavity Mach-Zehnder interferometer
14:45	#O-14: Andrzej Wojciechowski, Clock Signal Phase Alignment System for Daisy Chained Integrated Circuits
15:00	#O-15: Karolina Wielgos, On a thermo-visco-elastic model with non-linear damping forces and L1 temperature data
15:15	#O-16: Marek Ciesielski, Time-Based Angle of Arrival Estimation Method for FMCW Radar
15:30	#O-17: Joanna Aftyka, Symbolic dynamics as an indicator of clinical progression in people with ischemic stroke
15:45	Coffee break
16:00	Session #05 Chair: prof. Ryszard Piramidowicz #O-18: Mikołaj Pudo, Semi-Supervised Learning with Limited Data for Automatic Speech Recognition
16:15	#O-19: Małgorzata Andrzejewska, Assessment of time irreversibility of heart rate variability in LQTS patients
16:30	#O-20: 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
16:45	#O-21: Michał Gontarz, CNN based phase unwrapping in full-field optical metrology
17:00	#O-22: Aleksandra Dzieniszewska, Skin lesion diagnosis using autoencoder neural networks
17:15	#O-23: Michał Kocon, Predictive maintenance of the production line based on an intelligent vision quality control system
17:30	

	THURSDAY September 29, 2022
09:00	Session #06 Chair: prof. Teresa Zielińska
09:15	#O-24: Aleksandra Osowska-Kurczab, How state-of-the-art image processing methods can contribute to renal tumour diagnosis
09:30	#O-25: Marcin Lelit, Advances in development of germanium-based mid-infrared passive photonic platform
09:45	#O-26: Adam Mata, On (un)decidability of the variety of Boolean semilattices
	#O-27: Rauzan Sumara, Siamese Network with Gabor Filter for Recognizing Handwritten Digits
10:00	Coffee break
10:15	Session #07 Chair: prof. Teresa Zielińska
10:30	#O-28: Filip Włodarczyk, Arrays of diffractive optical elements for applications in optical systems of photonic integrated circuits
10:45	#O-29: Artur Słabuszewski, Embeddings of Slobodeckij spaces on metric-measure spaces
11:00	#O-30: Yevgen Syryanyy, Electronic Structure of ZnO:Yb examined by XANES
	#O-31: Szymon Baczyński, Optofluidic systems for sensing applications
11:15	Special invited presentation:
11:30	Kamil Kopania, Ph.D., The Middle Ages: Debunking Stereotypes
11:45	
12:00	
12:15	
12:30	Lunch break
12:45	
13:00	Session #08 Chair: prof. Piotr Gawrysiak
13:15	#O-32: Konrad Krawczyk, Surrogate-assisted evolutionary algorithms
13:30	#O-33: Adrianna Wójcik, Diffusion of electrically active and total Si in GaAs investigated separately using depth-profiling techniques
13:45	#O-34: Piotr Czekała, Electromagnetic characterization of dielectric pills in the microwave frequency range by resonance methods
14:00	#O-35: Michalina Milewicz-Zalewska, Management of the Scientific Projects in the post-soviet countries using modern tools
	#O-36: Marika Grochowska, Missing VIA check algorithm
14:15	Coffee break
14:30	Session #09 Chair: prof. Piotr Gawrysiak
14:45	#O-37: Mateusz Klimaszewski, Knowledge Graphs in Neural Machine Translation
15:00	#O-38: Jakub Zdziebłowski, Investigation of photoconductivity in cadmium indium sulfide – a promising material for neuromorphic devices
15:15	#O-39: Jakub Zieliński, Synthesis of cold and trappable fully stripped HCI's via antiproton-induced nuclear fragmentation in traps
15:30	#O-40: Oskar Sadowski, Development of ohmic contacts for GaN-based vertical power devices
	#O-41: Konrad Cop, One-shot Obstacle Footprint Estimation from Incomplete 3D Data for Efficient Robotic Navigation
15:45	Coffee break
16:00	Session #10 Chair: prof. Marcin Iwanowski
16:15	#O-42: Karolina Pondel-Sycz, Speech recognition in conditions of impaired acoustic signal transmission
16:30	#O-43: Adam Małkowski, ReGAE: Graph autoencoder based on recursive neural networks
16:45	#O-44: Sevastianos Korsak, A Stochastic Monte-Carlo model for Loop Extrusion of Chromatin
	#O-45: Krzysztof Banecki, Physical models of chromatin based on Hi-C contact maps
17:00	#O-46: Stanisław Pawlak, Selective Generative Replay
17:15	
17:30	

FRIDAY
September 30, 2022

09:00 Session #11 Chair: prof. Cezary Zieliński
09:15 #O-47: Małgorzata Żebrowska, Nonlinear analysis of physiological variables in the assessment of adaptation to physical effort
09:30 #O-48: Małgorzata Giza, Influence of 2-dimensional interlayer on contact resistance in TMD-based field-effect transistors
09:45 #O-49: Konrad Wilczyński, First principles studies of temperature-dependent lattice vibrations in van der Waals materials
10:00 #O-50: Mateusz Surma, Optimization of holograms for homogenous illumination in the terahertz range

10:15 Coffee break

10:15 Session #12 Chair: prof. Cezary Zieliński
10:30 #O-51: Michał Bortkiewicz, Rapid reinforcement learning with the hierarchy of policies that chase fleeing targets
10:45 #O-52: Paweł Pieńczuk, Readout integrated circuit for MIR detector within ASPIC
11:00 #O-53: 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
11:15 #O-54: Piotr Czarnecki, As We Speak: Real-Time Visually Guided Speaker Separation and Matching

11:30 Special invited presentation:
11:45 prof. Joanna Siwińska-Gorzelak., Robots and labour markets: will a robot take your job?
12:00

12:15 Lunch break
12:30
12:45

13:00 Session #13 Chair: prof. Tomasz Kozacki
13:15 #O-55: Michał Falkowski, Root Cause Analysis of control errors propagation in complex multi-loop systems
13:30 #O-56: Jolanta Sadura, Electromagnetic compatibility of the apparatus controlling the test in the environment of high-current laboratories
13:45 #O-57: Tomasz Kublin, Novel Halbach array for electrodynamic levitation system for high speed magnetic railways
14:00 #O-58: Tomasz Święchowicz, A comprehensive power quality conditioning system with energy storage for low voltage distribution networks

14:15 Coffee break

14:15 Session #14 Chair: prof. Wojciech Matysiak
14:30 #O-59: Jarosław Tarenko, Development of gallium nitride surface structuring for fabrication of vertical power devices
14:45 #O-60: Karolina Okrasa, Computing homomorphisms in hereditary graph classes
15:00 #O-61: Arkadiusz Wójcik, Study of a decentralized electricity market
15:15 #O-62: Marek Kościelski, Embedding of the components into the PCBA

15:15 Coffee break

15:30 Wrap-up session and closing remarks
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30

POSTERS

#P-01 Paulina Komorzycka, Analysis of cubic modeling index in general interior lighting

#P-02 Paulina Radecka, Abstract evolution systems

#P-03 Jan Sawicki, ARC Welding

#P-04 Sebastian Wildowicz, Decomposing bipolar ECG signal using CNN autoencoder

#P-05 Tomasz Wichary, Management of network slices in shared resources with isolation scoring

#P-06 Tomasz Lehmann, Algorithms for monocular depth estimation using deep neural networks

#P-07 Laboni Manna, Lepton-Hadron collisions in MadGraph5_aMC@NLO

#P-08 Mateusz Chiliński, ChIA-BERT: prediction of CTCF-mediated chromatin loops identified by Chromatin Interaction Analysis with Paired-End Tag (ChIA-PET) from DNA sequence

#P-09 Anton Safronov, Computation of nuclear effects in MadGraph5_aMC@NLO at Next-to-Leading order accuracy

#P-10 Marta Piecyk, Graph homomorphism problem for bounded-cutwidth graphs

#P-11 Piotr Zych, Impact of low-voltage electromechanical switches on the electromagnetic environment

#P-12 Bartosz Kozłowski, $K^*(892)^0$ meson production in nucleus-nucleus interactions at SPS energies measured by NA61/SHINE at CERN

#P-13 Karolina Pawlak, Fractional Stefan Problem

#P-14 Łukasz Lepak, Day-ahead energy market trading strategies using reinforcement learning and evolutionary algorithms

#P-15 Katarzyna Nałęcz-Charkiewicz, The use of quantum computing in the analysis of biological sequences on the example of de novo assembly and multiple sequence alignment

#P-16 Piotr Łukaszewski, Detection and classification of faults in the distribution grid.

#P-17 Wioleta Rzęsa, Analysis of femtoscopic correlations of pairs containing deuteron in Pb-Pb collisions in the ALICE experiment at the LHC

#P-18 Wiktor Łodyga, GPU Implementation of Particle-in-Cell With Monte Carlo Collisions in Julia

#P-19 Paweł Kowaleczko, Super-resolution reconstruction for satellite imagery

#P-20 Mikołaj Koszel, Operation of the DC / DC converter in the microgrid

#P-21 Mateusz Kałuża, 3D printed THz MIMO diffractive structures

#P-22 Muhammad Farhan Safdar, A denoising and Fourier Transformation-based spectrograms in ECG classification using Convolutional Neural Network

#P-23 Milena Ojrzyńska, Intercalation and exfoliation of graphite by SO3 molecules

#P-24 Mustafa Mohsin, O-RAN Beamforming

#P-25 Konrad Kamiński, A method of strong authentication of remote users based on an ID card with an electronic layer

#P-26 Julianna Krasowska, Modeling physical processes in a group of eukaryotic cells exposed to ionizing radiation

#P-27 Dominik Kolasa, Platform for malicious clients detection in federated learning

#P-28 Adam Borkowski, Measurements of the parameters of the integrated circuit at cryogenic temperature

#P-29 Priyanka Roy Chowdhury, Femtoscopic correlation between D^0-hadron (π, k, p) pairs within STAR experiment

#P-30 Michał Ostapowicz, Variant-based business processes simulation

#P-31 Mikołaj Płachta, A simple neural network for detection of various image steganography methods

#P-32 Kinga Pilch, Assamese Character Recognition

#P-33 Moncy Sajeev Idicula, Multi-incident holography profilometry for low and high gradient object

#P-34 Zbigniew Kostka, Dynamic control for autonomous underwater vehicle (AUV) with variable-buoyancy propulsion.

#P-35 Monika Wysoczańska, Towards Unsupervised Visual Reasoning: Do off-the-shelf features know how to reason?

#P-36 Paweł Matraś, Subalgebras of matrices satisfying some identities

#P-37 Anna Cichocka, Steinberg Algebras

#P-38 Radosław Maksymiuk, Drone Detection with 5G - based passive radar

#P-39 Mikołaj Rogalski, Object 4D tracking in lensless digital in-line holographic microscopy

#P-40 Mateusz Bartosiewicz, A unified framework for testing image captioning models.

#P-41 Przemysław Nowak, Rank distribution in Github networks

#P-42 Marcin Macias, Efficient anomaly class detection and comprehension using segmentation techniques in RGB images

#P-43 Andrzej Polatynski, Modelling of Generic Process Design Kit (PDK) Components
 for Photonic Integrated Circuits (PICs)

#P-44 Ali Soltani Sharif Abadi, Robotic eye surgery

#P-45 Krzysztof Stasiak, Measurement Error Correlation in FMCW Radar with Processing of Overlapping Blocks

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INVITED TALKS

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#INV-01

Effective strategies to confront online hatred. Psychological perspective

Prof. Michał Bilewicz

Michał Bilewicz specializes in social and political psychology, and his main research focus is human intergroup relations.

Polish social psychologist, sociologist, publicist. Head of the Center for Research on Prejudice at the University of Warsaw.

#INV-02

The Middle Ages: Debunking Stereotypes

Kamil Kopania, Ph.D.

The Middle Ages is commonly treated as a whipping boy amongst other historical epochs. Backwardness, violence, lack of hygiene, oppressive attitude to sexuality and religious fanatism are the most frequent associations coming to mind when one thinks of this period. The majority of people perceive those who lived in the Middle Ages as unlearned and gloomy barbarians. All these, however, are deeply-rooted stereotypes. The aim of this lecture is to show the bright side of the Middle Ages. Drawing on visual material, mostly works of art, I will argue that this epoch was in fact completely different. The picture of the Middle Ages I would like to demonstrate is that of open-minded people, curious about the world and often critical of church authorities. The great desire to have fun and enjoy sexuality was not absent from medieval reality. Neither were bathing and – generally – hygiene. The Middle Ages lurking from behind the stereotypes turns out fascinating epoch to discover.

Kamil Kopania, assistant professor, Ph.D., since 2009 works at the A. Zelwerowicz National Academy of Dramatic Art in Warsaw. From 2009 till 2019, he was an assistant professor at the Institute of Art History of the University of Warsaw. He is interested in the relationship between art and theatre in the Middle Ages, the function and reception of works of art in the Middle Ages, the history of European puppet theatre, and selected aspects of contemporary art. Founder and chairman of Podlaskie Towarzystwo Zachety Sztuk Pieknych (Podlaskie Association of Fine Arts, 2004-2016) – a society whose purpose was to develop and promote "Collection II" of the Arsenal Gallery in Białystok (www.galeria-arsenal.pl), one of the most important public collections of contemporary art in Poland.

See also: https://atb.edu.pl/o-wydziale/pedagodzy/dr-kamil-kopania/

#INV-03

Robots and labour markets: will a robot take your job?

Prof. Joanna Siwińska-Gorzelak

The fear of technological unemployment has always been accompanying the great waves of innovations, and today's technological transformation is not an exception. "Will a robot take your job?" – is a question that often emerges in various discussions. During the talk, I will try to summarize the on-going research the impact of digital transformation on employment and highlight the main changes that are observed on the EU labor markets.

Joanna Siwińska-Gorzelak is a professor at University of Warsaw, Faculty of Economic Sciences. She specializes in macroeconomics; and her main are of research are growth & development, fiscal policy, local public finance.

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ORAL PRESENTATIONS

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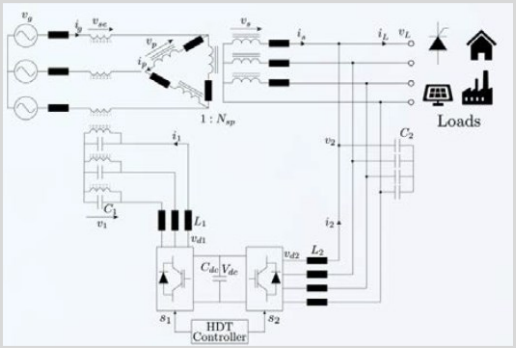
#O-01

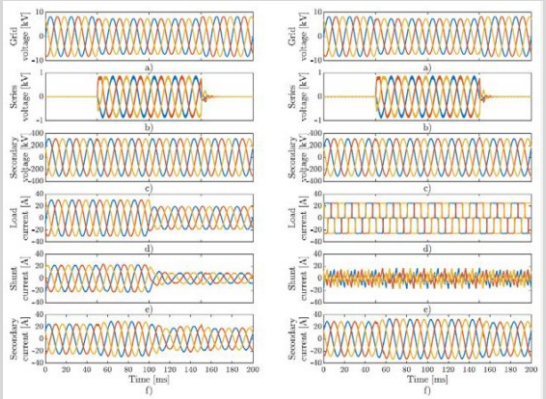
Control of a Hybrid Transformer to Improve the Power Quality of a Distribution Network

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 an 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. The series stage of the HT can be controlled in order to control the LFT flux, which can mitigate the generation of inrush currents.



#O-02

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. Its integration into 5G network infrastructure brings new research opportunities related to the design and implementation of high-performance systems, enabling the accomplishment of the three main promises of 5G: very high speed, low latency, and massive connectivity. This trend has generated strong interest in realizing effective life cycle management of latency-sensitive edge applications in order to achieve a high level of QoS while ensuring the service continuity in the case of user mobility. This presentation deals with the relocation of edge services, commonly called edge relocation, which aims to relocate edge application instances between edge clusters in order to ensure uninterrupted service. To achieve our objective, we propose a cloud-native edge-enabled 5G solution that complies with ETSI and 3GPP standards. We would like to share also algorithm of selection best target MEC cluster and procedure of relocation of contenerized application across Kubernetes clusters. All implemented in open-source way in order to make it profitable to others.

#O-03

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.

#O-04

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.

#O-05

Design of a static Fourier transform spectrometer for the 8-12 µm infrared region

Filip Łabaj

We present results of ongoing development on a mid-infrared, static Fourier transform spectrometer (sFTS) based on the triangular Sagnac interferometer configuration and designed to work in the 8-12 µm spectral range. This enables access to spectral data from the so-called „fingerprint region" and in effect – to a plethora of potential analytes.

Preliminary numerical simulations were performed using ray-tracing software in order to select a suitable interferometer architecture. Theoretical parameters and detection limits of the setup were calculated in order to confirm its suitability for spectrometric applications. The designed setup was then constructed and experimentally tested, first by analyzing well-defined, quasi-monochromatic light sources and afterwards – by measuring spectral transmission characteristics of thin samples and spectral filters illuminated by a broadband thermal source.

Two approaches to interferogram sampling were compared during the experimental phase – a high resolution, two-dimensional microbolometer array and a single-element detector scanning setup.

Interferograms measured in the system are processed in several steps, which include denoising and demodulation. Spectral data is then retrieved using the fast Fourier transform (FFT) algorithm.

An outline for future work on the system is presented, as well as potential applications of the setup.

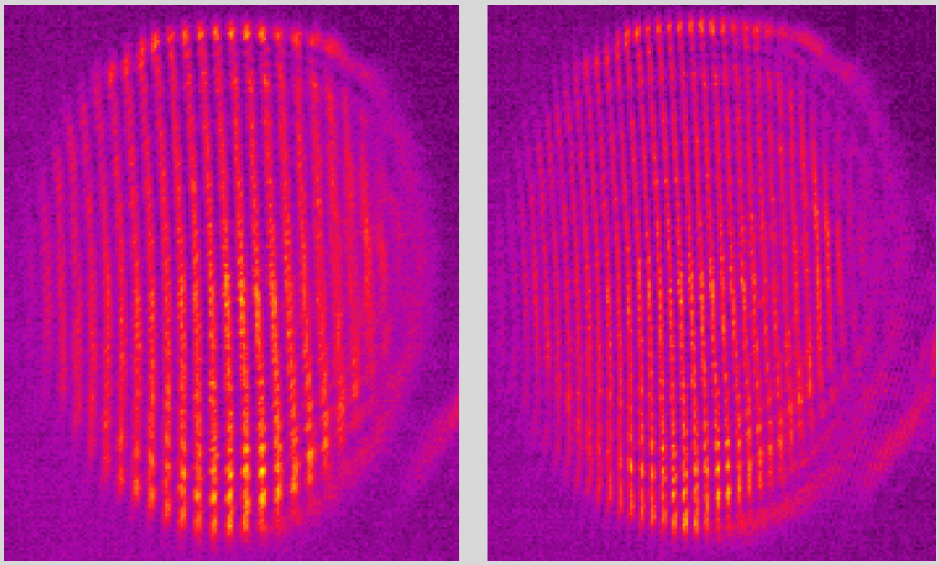


Fig. 1 Example of interferograms measured in the sFTS system

#O-06

Is An Eyetracker Calibration In Human-Computer Interface Always Necessary?

Karolina Gabor-Siatkowska

Chatbots and dialogue systems, are conversational agents interact socially with people by analysing spoken or written data, so that they can provide an appropriate response. Their popularity is rising in many fields e.g. in healthcare, and psychiatry. Because of the growing interest in psychological therapies, there is a special need for those dialogue systems.
The ability to deliver some forms of behavioral therapy via computers could be a very helpful step in mental health care. The combined use in computer-based therapies may offer many possibilities for the treatment of physical and mental disabilities. Therefore, computer-assisted therapies have to be studied in depth.

Eyetrackers are used to measure, e.g., eye movements, recently are also used in the human-computer interface. They serve as a source of data e.g. of the psychological state of a person.

Manufacturers of eyetrackers recommend their calibration, which may be in everyday use very troublesome (especially in certain domains). The purpose of my recent studies was to determine if this calibration is necessary, in order to be able to use this eyetracker in further studies and experiments.

The studies compared data obtained from an eyetracker with and without calibration, e.g., pupil diameter was measured. Preliminary analysis showed that there was no significant difference between the results of these measurements.

#O-07

Consolidated learning – new approach to domain-specific strategy of hyperparameter optimization

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. In this presentation, I will present a new formulation of the tuning problem, called consolidated learning, more suited to these practical challenges faced by ML developers creating models on similar datasets. In domain-specific ML applications, ones do not solve a single prediction problem, but a whole collection of them, and their data sets are composed of similar variables. In such settings, we are interested in the total optimization time rather than tuning for a single task. Consolidated learning assumes leveraging these relations and supporting meta-learning approaches. Providing the benchmark metaMIMIC, we show that consolidated learning enables an effective hyperparameter transfer even in a model-free optimization strategy. In the talk, we will show that the potential of consolidated learning is considerably greater due to its compatibility with many machine learning application scenarios. We investigate the extension of the application of consolidated learning through integrating diverse data sets using the ontology-based similarity of data sets.

#O-08

Ordered Titanium Dioxide Nanotubes for Lossy-mode Resonance-based Humidity Sensing

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 TiO_2 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 TiO_2 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.

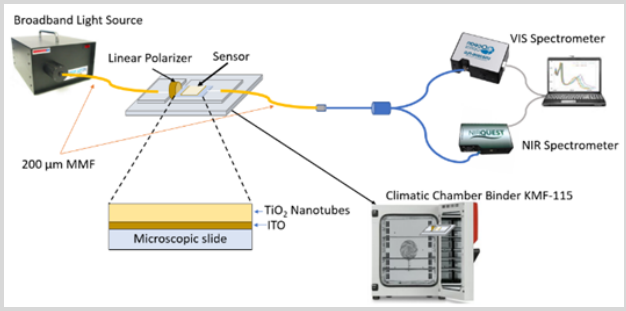


Fig. 1 Schematic representation of an optical setup used in this experiment.

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

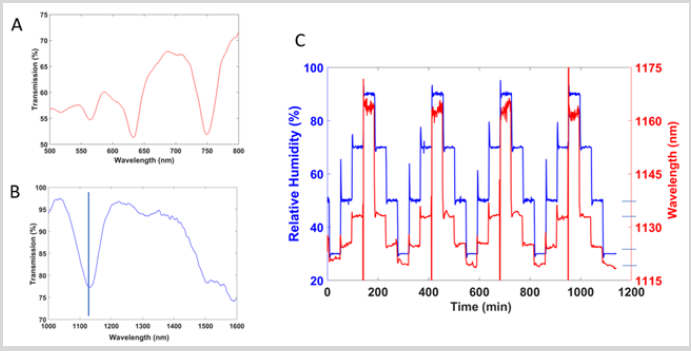


Fig. 2 . (A) TE mode transmission spectrum of the sensor in visible range and (B) in NIR range with LMR minimum considered for humidity sensing. (C) Sensogram showing shift of the LMR wavelength with humidity change (red) and control readout of built-in chamber sensor (blue).

#O-09

Two-particle correlations of charm 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 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.

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, the correlations provide insights into the thermalization of charm quarks.

The analysis begins with the most abundant charm mesons, D^0. D^0 often decays into a pion and a kaon, so the selection of the particles is checked with the invariant mass distribution of π-K+ pairs. The first results on the invariant mass fit and particle yield with the converted Run 2 data are shown. The analysis code will be further prepared for the new Run 3 data by the end of the year.

Next, the implementation of other analysis tools is discussed: event mixing and particle identification. Event mixing means combining pairs of particles from different collisions to subtract the combinatorial background from the correlation calculations. Particle identification is being upgraded with machine learning techniques, such as Domain Adversarial Neural Networks (DANNs). They will improve the precision of initial D0 meson selection.

#O-10

Nonlinear, quasistatic models of viscoplasticity with gradient-type nonlinearity

Adrian Wielgos

The aim of the presentation is to briefly introduce the audience to my research topic which is an existence theory for plasticity theory models. In the first part I will show a general model of theory of plasticity. Then, I will note, why this model is not sufficient for some particular engineering applications and how it should be modified for such purposes. This will lead us to the class of models that I study in my research.

This class consists of models with equation of motion with nonlinear force term and inelastic constitutive law in form of differential inclusion of gradient-type. Moreover, I assume that studied body is made of viscoplastic material. Such models can be used to describe plastic deformation of charged, dielectric bodies in external electric field.

In the second part of the presentation I will put more emphasis on methods used in my research. First, I will show how I introduce simplified problems, which allow to find approximate solutions. Next, I will explain, why energy estimates are needed to show that approximate solutions converge to the solution to the base problem. Lastly, I will mention, in what sense the limit of approximate solutions satisfies the equations of studied model.

In the last part I will note, what parts of the theorems' proofs are most problematic to deal with. I will show some of the sub-classes of models for which it is possible to avoid these problems.

#O-11

Security policies definition and enforcement utilizing policy control function framework in 5G

German Peinado

This research analyses new approaches to security enforcement in fifth generation (5G) architecture from end to end perspective. With the aim of finding a suitable and effective unified schema across the different network domains, it shows that policy control framework may become the cornerstone for the definition and enforcement of security policies in new 5G networks. The 5G core network architecture reference model is defined as a Service Based Architecture (SBA). The Policy Control Function (PCF) is a Network Function (NF) that constitutes, within the SBA architecture, a unique framework for defining any type of policies in the network and delivering those to other control plane NFs. In previous generations the policy control approach has been restricted to Quality of Service (QoS) and charging aspects. In contrast, the 5G system is now based on a unified policy control scheme that allows to build consistent policies covering the entire network. By utilizing the unified 5G policy framework we have found an effective security enforcement schema flexible to create new security policies, and agile to react to the constantly changing environment, across the end to end architecture. Within this schema we have defined mechanisms to apply the QoS principles to security use cases. We have also set up the user plane security enforcement within the session management and established security policies. Our overall vision is to consider security as a quality element of the network.

#O-12

A suboptimal strategy for control multi-dimensional drying process

Bartłomiej Hryniewicki

The wood drying process has been studied for many years and actually is quite well described. Unfortunately, exact phenomenological model of this process is not available due to the very complicated physics and chemical phenomena taking place by drying. The solution to the problem of the batch version of this process is to reduce the drying speed in order to avoid wood cracking. This is performed in accordance with the operator's experience. The beneficial is that such approach typically avoids wood cracking and bending. The output of performed research is a physical model that is ready to be used for simulating wood drying process in the three-dimensional space. Later on, it was extended with autotuning capabilities which allow automated adaptation of its parameters depending on actual wood condition. Finally, the model was extended by the functionality providing approximated distribution of the internal wood mechanical stresses. This allows to develop a process control strategy that considers both moisture content and internal stress of the wood. Together with the dynamic models of heating and air exchange inside the drying chamber, the new control strategy will be helpful by optimizing entire drying process. It is expected that developed control strategy will prevent wood losses caused by bending and splitting. This will not only give an opportunity to save energy but also guarantee the final quality of the dried wood but also reduce time of the process.

#O-13

Label-free detection of SARS-CoV-2 nucleocapsid protein using optical fiber microcavity Mach-Zehnder interferometer

Tomasz Gabler

The presentation shows miniaturized sensing solution based on a microcavity in a side surface of a single mode optical fiber (125 µm in cladding 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.

#O-14

Clock Signal Phase Alignment System for Daisy Chained Integrated Circuits

Andrzej Wojciechowski

Phase difference of the clock signals is a critical factor in high precision synchronization of interconnected integrated circuits. In order to synchronize a daisy-chained set of individual systems, a novel concept of clock signal phase alignment circuit as well as calibration algorithm was developed. The work includes a high-level analog circuit description and calibration procedure implemented in digital control module. The high-level implementation was tested using Verilog HDL language and conclusions are presented.

The motivation of this work is to develop a clock signal phase alignment for a system composed of individual ASIC devices. One of the use cases for the ASIC and the described system is a vacuum chamber actively cooled down to cryogenic temperature. Due to other requirements, multiple units of the designed ASIC system will be connected using as few signals as possible, hence a daisy chain connection topology.

The proposed circuit for clock signal phase alignment together with the calibration algorithm is presented. The calibration algorithm was confirmed to work correctly. The general idea was implemented with Verilog HDL language and functionally verified. The presented concept is an on-going work and will be researched and developer further using a FPGA-based prototype as well as a dedicated ASIC system.

#O-15

On a thermo-visco-elastic model with non-linear damping forces and L^1 temperature data

Karolina Wielgos

The aim of my presentation is to roughly show my work on a thermo-visco-elastic model with non-linear damping forces and L^1 temperature data. I plan to start with showing from which field of mathematics my problem comes and refer to its physical aspects. I will present the equations which describe thermo-visco-elastic effects in the materials with proper initial and boundary conditions and their physical derivation. I will also note that model is thermodynamically consistent.

My system depends on the temperature that enters the mechanical part both in the elastic constitutive equations and in describing the evolution of visco-elastic strain. This fact determines the steps of the proof of the existence of the solutions. I will show the proposed two-level Galerkin approximation and explain why two levels are needed. Thanks to this I can obtain a non-negativity of temperature in the entire deformation process, what is a crucial aspect. I plan to present the shortened proof of this feature. I also assume that initial temperature data is only of L^1-regularity, so I have to use Boccardo-Gallouet's approach to obtain proper estimations. I will show the idea of this method based on my system.

Eventually, I will finish with the summary of the obtained solutions. The regularities of the displacement, elastic stress tensor and temperature will be noted. Additionally, I will mention further steps of the work on the topic which I will analyze later during my PhD studies.

#O-16

Time-Based Angle of Arrival Estimation Method for FMCW Radar

Marek Ciesielski

The paper presents a novel technique of angle of arrival (AoA) estimation, applicable to scenarios requiring large spatial separation of the antennas, such as interferometric ISAR (InISAR) imaging for non-cooperative target recognition (NCTR) applications. Large distances between the antennas pose a significant problem for methods based on phase difference, limiting the range of unambiguous angle measurement. The authors propose a solution for AoA estimation using elements of radar signal processing for determining the differences between the range to the target for particular receiving antennas. The proposed solution is not restricted by the ambiguities emerging from large separation between the antennas. The paper focuses on two variants of the proposed solution: the first based on traditional range estimation with center of mass and the second based on correlation between fragments of the range-Doppler map in different channels. Both solutions are described in detail in the paper. Simulations, as well as real measurements, are included and analyzed for evaluation of the performance of the proposed method. The paper is concluded with discussion of the obtained results.

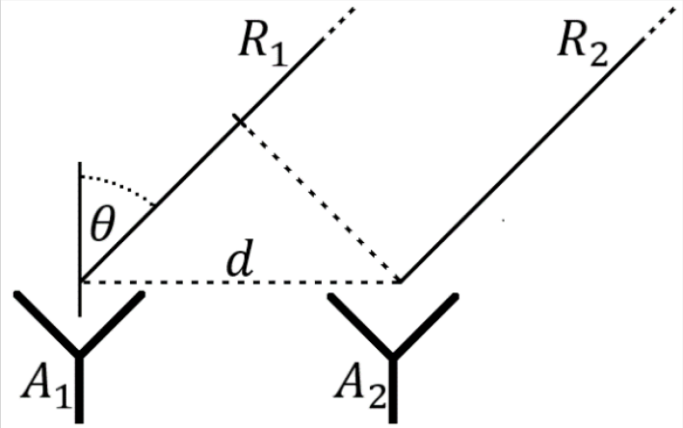


Fig. 1 Simple antenna array for DoA estimation.

#O-17

Symbolic dynamics as an indicator of clinical progression in people with ischemic stroke

Joanna Aftyka

An ischemic stroke is a neurological condition that results in severe narrowing or blockage of the blood supply to the brain. The brain fragment affected by an ischemic stroke is not supplied with oxygen and nutrients. As a consequence, certain parts of the brain die. In the initial stage of a stroke, it is difficult to determine the patient's further prognosis for the future. Currently, there is no indicator that would indicate the prognosis of a particular patient in the future.

The purpose of this work is to find an indicator that predicts the clinical progression of patients in the acute phase of stroke.

Symbolic dynamics methods have been used since the end of the 1990s. They have evolved over the years. In this paper, I proposed my own modification of the symbolic dynamics method for the assessment of nocturnal heart rate variability records. In my research, I change each RR interval into one of the 4 available symbols {0, 1, 2, 3} and then analyze the lengths of the longest words that are sequences of identical symbols. I notice statistically significant differences in the length of the longest words in the group of people who had clinical progression during hospitalization after ischemic stroke vs. people without deteriorating health. The presented results are a proposal for the creation of a new indicator that would fill the information gap in the health status of a patient in a post-stroke treatment unit.

#O-18

Semi-Supervised Learning with Limited Data for Automatic Speech Recognition

Mikołaj Pudo

We analyze the performance of semisupervised learning (SSL) methods for the automatic speech recognition (ASR) task. We focus on the case of model adaptation using small unlabeled datasets. The basic SSL method that we apply uses pseudo-labels generated by the adapted model itself, however, we also propose and analyze a number of improvements to SSL. Furthermore, we investigate the possibility of using these methods on the datasets with the token distributions significantly different from the one represented by the training data. We show that in certain conditions, even very small amounts of data can improve the ASR model performance. Using the proposed SSL variant, we were able to reduce WER by 12-22%, depending on the dataset.

#O-19

Assessment of time irreversibility of heart rate variability in LQTS patients

Małgorzata Andrzejewska

The human body is a complex system that consists of many subsystems working together. This results in non-linear interactions between the individual components. Aging and disease can be associated with a loss of complexity, which can be estimated using heart rate variability signals. In this presentation, two approaches will be presented to determine irreversibility in time series. The first is an asymmetry analysis of time series using, for example, the Porta (P%) and Guzik (G%) indices. More advanced methods for estimating irreversibility are based on directed horizontal visibility graphs (dHVG). They consider the direction of the arrow of time by comparing the degree distributions of the vertices entering and leaving each vertex of the graph. Measures that can be used to compare these distributions are the Kullback-Leibler divergence (KLD) and the Jensen-Shannon divergence (JSD). It appears that measures based on the concept of irreversibility over time can be used to create better methods for stratifying the risk of sudden cardiac death (SCD). Results from the analysis of the THEW database, which includes healthy subjects and patients with long QT syndrome (LQTS), will be presented. Analysis of univariate and multivariate series shows, in general, a higher complexity in case of healthy people.

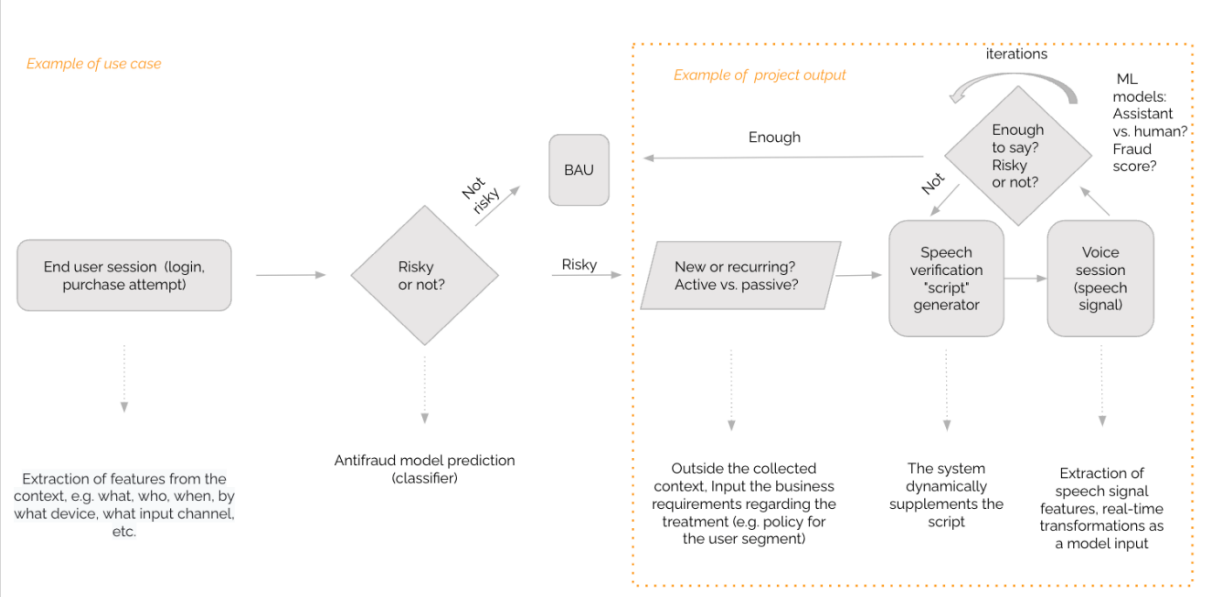
#O-20

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:



#O-21

CNN based phase unwrapping in full-field optical metrology

Michał Gontarz

Whenever we perform a measurement with the use of interferometric or grid methods, we want to obtain phase information about a measured object. 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 the complexity of discontinuities, solving this problem with traditional image processing for real phase images is time consuming and unreliable.

Therefore I propose a CNN based pipeline, which consists of a denosing step, done by a small U-Net architecture CNN, and an unwrapping step proposed in two ways: semantic segmentation based technique with an Attention U-Net architecture and image translation with a U-Net architecture with residual blocks and a leaky-ReLU activation function.

The noise removal has been able to remove noise and retain crucial information about the phase distribution on computer generated phase images, as well as real phase images obtained from holographic tomography. Each phase unwrapping pipeline direction has shown good performance and little unwrapping error, whilst, in some cases, outperforming conventional unwrapping methods. The pipeline shows great promise and high accuracy even with a difficult wrapped phase distributions obtained from optical diffraction tomography and optical coherence tomography measurements of highly diffusive objects.

#O-22

Skin lesion diagnosis using autoencoder neural networks

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 are crucial in preventing cancer diseases. The major problem and challenge, however, is patients' resistance to being diagnosed with cancer and 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 in RGB colorspace and with additional polarisation information was explored. The main goal of the research was to employ deep learning techniques to support the diagnosis process and provide full automatization. Multiple approaches to skin lesion diagnosis were tested to find the best accuracy using a limited data set and provided insight into diagnosis. The work is focused on different approaches to autoencoder neural networks that can be modified to perform reconstruction or segmentation and classification simultaneously.

#O-23

Predictive maintenance of the production line based on an intelligent vision quality control system

Michał Kocon

The research will focus on investigating the problem of monitoring the condition of production line components using signals from intelligent vision systems for product quality control. The planned research consists of two parts.

The first part concerns the issue of ensuring the consistent accuracy of machine learning algorithms in a changing environment. During this part of research, a review of methods for continuous control of machine learning algorithms accuracy will be performed. The issue of continuous training of machine learning models known as „continual learning" will also be investigated.

The second part of the research is to analyze the possibility of using signals from quality control systems in predictive maintenance of the production line. The possibilities of improving the currently used solutions will be checked by introducing additional information about the condition of currently manufactured products. The possibility of developing a predictive maintenance system based only on information from quality control systems will also be explored.

Currently, research is focused on finding methods for detecting changes in inputs provided to machine learning algorithms. It can be achieved by expanding the functionality of classification and anomaly detection models based on convolutional neural networks.

#O-24

How state-of-the-art image processing methods can contribute to renal tumour diagnosis

Aleksandra Osowska-Kurczab

Medical imaging is significant in tumour diagnosis and treatment planning, especially in abnormality localisation and early-stage examinations. Due to the unsatisfactory performance of pure radiology, additional histopathological tests are conducted to confirm the final diagnosis. Though this approach yields satisfactory results from the patient perspective, the whole process lacks cost and time optimisation, causing hampering and extensive expenditures on diagnostic procedures.

The universality of medical imaging and its wide popularity constitute considerable potential in providing adequate and direct treatment, especially in expanding the means of early diagnostics. The doctoral research project intends to find efficient automated methods of supporting medical doctors in diagnosing renal tumours, which still suffer from insufficient diagnostic methodology. Exploration of tumour representation methods from contrast-enhanced Computed Tomography is the main focus of the research project. The quality of representations is tested in the downstream tasks of abnormality classification into the 8 most prominent subtypes, which are not all visually differentiable. Both deep learning and texture analysis offer comparable efficacy of tumour representation, tested throughout various classification setups. The presented study summarises the project's outcomes, concurrently emphasising more general recommendations for computer vision applications in medical image analysis.

#O-25

Advances in development of germanium-based mid-infrared passive photonic platform

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 3.8 μm [2]. This work reports advances in development of Ge-on-Si photonic integrated photonic platform operating in range from 3.0 to 5.2 μm. Waveguides, tapers, grating couplers (GCs) and Arrayed Waveguide Gratings (AWGs) de-/multiplexes were designed. First series of photonic integrated circuits (PICs) comprising test structures was manufactured and is under characterization process.

GCs allow for vertical coupling and decoupling of light without need for PICs dicing. AWGs which are the most complex type of passive photonic elements. Colourless AWGs with 8 output channels and wide channel spacing of 40 to 50 nm are designed in the first set.

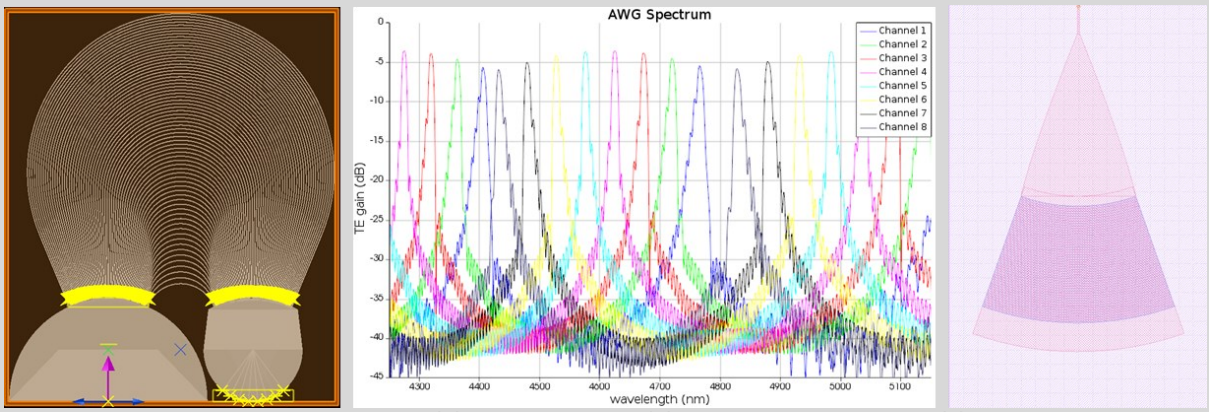


Fig. 1 AWG layout (a); AWG spectrum (b); Grating Coupler layout (c).

In the second stage of design process, GCs and AWGs geometries are optimized for shallow etch in 2 μm germanium layer. Theoretical efficiencies of GCs up to 20% were achieved with potential for further improvement with more complex material stack.

This work received support from the National Centre for Research and Development through MIRPIC project (TECHMATSTRATEG-III/0026/2019-00).

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#O-26

On (un)decidability of the variety of Boolean semilattices

Adam Mata

A semilattice is a partially ordered set $(S, \leq)$ in which for any non-empty finite subset its meet (greatest lower bound) exists. Algebraically it can be described as the structure $(S, \cdot)$ where:

- $x \cdot (y \cdot z) = (x \cdot y) \cdot z$,
- $x \cdot y = y \cdot x$,
- $x \cdot x = x$,

for all x, y, z in S. Both approaches are related by the rule: $x \leq y \Leftrightarrow x \cdot y = x$.

A Boolean semilattice is a Boolean algebra with additional semilattice operation $\cdot$. This is an example of a Boolean algebra with operators which are widely applied in modal logic.

An algebraic variety is a collection of structures defined by equalities (identities). A class of all Boolean semilattices is a variety.

We consider a theory of a particular variety as all statements about structures in the variety (formulas) which are true.

Let us denote the theory of some variety V as Th(V). The variety V is called decidable if there exists an algorithm which for any given statement Φ computes within finite steps, the answer for the question whether Φ belongs to Th(V) or not.

The main hypothesis of my work is that the variety of all Boolean semilattices is undecidable although there may exist some significant subclasses of this variety which may turn out to be decidable.

#O-27

Siamese Network with Gabor Filter for Recognizing Handwritten Digits

Rauzan Sumara

Even though several advances have been made in recent years, handwritten script recognition is still a challenging task in the pattern recognition domain. This field has gained much interest lately due to its diverse application potential. Nowadays, different methods are available for handwritten digit recognition. The current demand is how researchers are able to find new techniques with better performance for handwritten digit recognition problems. To alleviate this shortcoming, this paper proposes a new approach: Siamese Network with Gabor Filter, for handwritten digit recognition. Inspired by several studies on Siamese Network and Gabor Filter, which have already achieved superb performances, our research purpose is to bring out the best qualities of their fusion. The computational experiments have been conducted on a handwritten digit image of the MNIST dataset. Empirically, the results implied that the proposed Siamese Network with Gabor Filter algorithm outperforms the classical Siamese Network and other existing methods with higher accuracy.

#O-28

Arrays of diffractive optical elements for applications in optical systems of photonic integrated circuits

Filip Włodarczyk

Nowadays the light from single mode fibers (SMFs) is launched directly to the waveguides of photonic integrated circuits (PIC). This method forces to put the SMF close to the PIC's facet (<1 μm). This project assumes the use of properly designed DOEs (in the form of micro-optical diffraction elements arrays) constituting the interface between the SMFs array and PIC waveguides. The proposed solution ensures the proper distance between the optical interface and the PIC facet (> 200 μm), while maintaining the acceptable optical coupling efficiency. Diffraction elements are used to accurately depict the SMF cross-section of 5-9 μm diameter on the integrated waveguide face (having rectangular 2.0 μm×0.32 μm cross-section). Consequently, individual diffraction elements diameters are comparable with their distances from PIC and fiber array. Therefore, diffraction deflections are large, implicating the need of accurate off-axis design approach.

Designed diffraction elements will be produced using electron beam lithography allowing components shape 3D mapping with nanometer precision. Fabricated structures operation will be verified by implementing them in the PIC optical interface and checking the signal coupling efficiency and distance between PIC facet and the diffractive elements matrix.

#O-29

Embeddings of Slobodeckij spaces on metric-measure spaces

Artur Słabuszewski

We consider a fractional Slobodeckij space defined on a metric-measure space (X, d, μ). During the talk I will present that under some additional assumption, there is an equivalence between boundedness of the Sobolev embedding operator and the lower regularity of μ. Moreover, I will discuss compactness of L^p embedding operator and relation with Hajłasz-Sobolev spaces. The talk is based on a joint work with Przemysław Górka.

P. Górka, A. Słabuszewski, Embedding of fractional Sobolev spaces is equivalent to regularity of the measure, Studia Mathematica, in press.
P. Górka, A. Słabuszewski, Embeddings of the fractional Sobolev spaces on metric-measure spaces, Nonlinear Analysis, 2022.

#O-30

Electronic Structure of ZnO:Yb examined by XANES

Yevgen Syryanyy

In recent years, the materials science has made increasing use of ion implantation as a method of doping semiconductors in order to obtain either novel material properties or improve the existing ones. However, the important limitation of ion implantation technology is the build-up of lattice disorder, which leads to deterioration of the physical characteristics of the studied materials. Consequently, the resulting defective structures caused by the ion implantation process and methods of their elimination (e.g., sample annealing) require systematic and profound study. This work is devoted to testing the possibility of donor-acceptor clustering in Yb-implanted ZnO using XANES as the main experimental method.

Polarization-dependent XANES spectra of w-ZnO thin films (primary and implanted Yb) were analyzed. Calculations of XANES spectra with orbital resolution provided by the FEFF code for the O K edge successfully reproduced the observed anisotropic effects, shedding light on the responsible mechanisms. A linear combination of theoretical models corresponding to selected point defects and their complexes confirmed the presence of donor-acceptor complexes in the examined samples. In addition, it was possible to estimate the numerical values of the concentrations of the selected point defects and their complexes formed in the examined samples.

#O-31

Optofluidic systems for sensing applications

Szymon Baczyński

The combination of rapidly developing technologies from the field of chemistry and the gaining popularity of photonics has led to the development of optofluidics. Microfluidic systems that exploit the possibilities offered by changing the parameters of light are increasingly used in biology and chemistry, but also in the area of photonics. The phenomena used in such systems include, e.g., changing the refractive index of the medium in which light propagates or of the cladding. In the course of research work in the area of my Ph.D., I am trying to fabricate microfluidic structures where a periodic change of refractive index is possible. To obtain such structures, polydimethylsiloxane (PDMS), well-known in chemistry, and liquid crystals (LCs), widely studied in photonics, are applied. By using appropriately designed electrodes, it is possible to control the orientation of liquid crystal molecules and thus modify the spatial distribution of the refractive index. For the structures to be tested in the systems with optical fibers, they must have a central channel with a diameter close to the fiber core. At this point, the minor channels that have been tested in experimental conditions are 12×10 micrometers. Technologies used for fabrications that have been explored so far range from 3D printing, and micromilling to photolithography, with a two-photon polymerization process planned to be used in the next step.

#O-32

Surrogate-assisted evolutionary algorithms

Konrad Krawczyk

Evolutionary computation is a nature inspired approach to optimization 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, that 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 optimization.

#O-33

Diffusion of electrically active and total Si in GaAs investigated separately using depth-profiling techniques

Adrianna Wójcik

Progressing miniaturization of electrical devices dimensions requires constant development of characterization techniques. 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. The observation of significant discrepancies between the profiles measured by these two techniques, which exceeds their measurement uncertainty, sparks the discussion on the varying diffusion of electrically active and inactive impurities.

In this work GaAs:Si sample was investigated using a combination of depth-profiling techniques. The shape of a carrier profile obtained by ECV was found to be in good agreement with the As-Si_x profile measured by Ultra Low Impact Energy SIMS (ULIE-SIMS) depth profiling confirming that these two techniques can be used interchangeably. However, the superior depth resolution of ULIE-SIMS allows to access nanometers-thick structures.

SIMS and ULIE-SIMS results obtained for the sample annealed at 800°C for 30 minutes revealed that the electrically active and total impurity distributions in the sample significantly vary. The analysis based on Fick's laws allowed for quantitative comparison of the diffusion rates of electrically active and total Si, and for preparing further work plans for an in-depth study of Si diffusion.

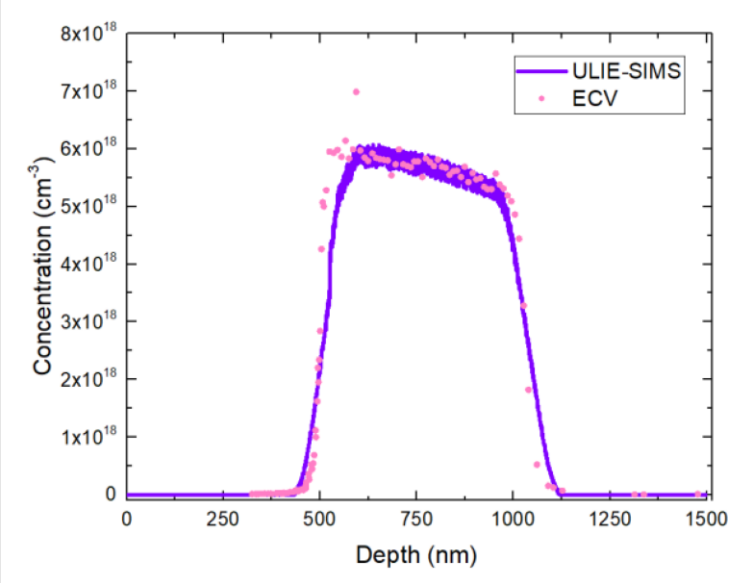

Fig. 1 VECV carrier profile and ULIE-SIMS active Si profile obtained for GaAs:Si sample.

#O-34

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

Piotr Czekała

In the proposed research we aim at constructing measurement equipment dedicated to characterization of dielectric samples, which in microwave frequency 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 technologies. The measurement set-up for characterization of these materials will be based on Fabry-Perot open resonator (FPOR), which offers high quality factor ($Q>10^5$), easy access to the cavity and allows measurements at many frequencies in range 20-50 GHz. Measured resonance frequency shift caused be placing sample with unknown permittivity (ε) inside the FPOR is subsequently 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 parameters. In case of mirrors scattering parameters may be computed using near-field scattering equations, while in case of sample mode matching technique has been used. Resonance frequencies of the structure may be found be searching for zeros of the characteristic equation:

$$\det\left(\bar{\bar{I}} - \overline{\overline{\Gamma_M}}(f)\bar{\bar{\Gamma}}_R(f)\right) = 0$$

Where f is frequency, $\bar{\bar{I}}$ unit matrix, $\bar{\bar{\Gamma}}$ multimodal reflection coefficient matrix. $\overline{\overline{\Gamma_M}}$ describes left mirror section while $\bar{\bar{\Gamma}}_R$ sample and right mirror. Both $\overline{\overline{\Gamma_M}}$ and $\bar{\bar{\Gamma}}_R$ are computed at left sample's boundary.

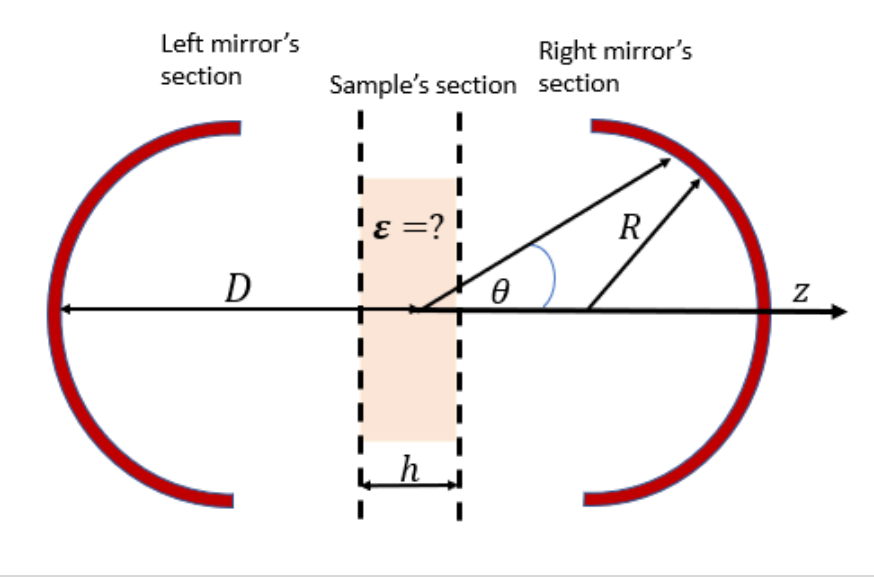

Fig 1. FPOR divided into 3 non-resonant sections.

#O-35

Management of the Scientific Projects in the post-soviet countries using modern tools

Michalina Milewicz-Zalewska

The work presents a design of an IT system for managing a scientific project in the country of the former Soviet Union. The work considers the cultural aspects of Eastern European countries and the multicultural and international character of the research projects. The designed system is based on the JIRA (Atlassian) system and enables the supervision of scientific projects using elements of agile methodologies. The Multi-Purpose Detector Collaboration in NICA Project at the Joint Institute for Nuclear Research in Dubna (Russia) was used as a reference.

#O-36

Missing VIA check algorithm

Marika Grochowska

Today, there are many tools for verifying technological masks of integrated circuits. However, there are still areas, especially in large analog circuits, where the designer is unable to catch all the issue. One of this which we struggle in the company that I work is verifying connections between metals, so-called VIAs. It often happens that due to porting projects, VIA contacts are meaningfully reduced which is difficult to catch especially in large design with high numbers of metals. This is why one of the goals of my PhD is to create program which finds places where additional VIA contact can be added between the conductive paths. The algorithm is written in the Physical Verifcation Language that is compatible with Cadence tools such as PVS or Pegasus. First, the algorithm analyzes the topography of the chip and take into account the physical connections between the metals that make the conductive paths. Then, according to the design rules for a given technology, it searches for places where additional contacts (VIA) can be placed without breaking the design rules and not causing short between different conductive paths. Thanks to the placement of additional VIA contacts, the path resistance is reduced, which significantly improves the efficiency of the system. Program with some additional functions was written and successfully implemented in company. Right now, is one of the basic checks that is run on designed topography before delivery.

#O-37

Knowledge Graphs in Neural Machine Translation

Mateusz Klimaszewski

The recent rise of deep learning changed the Machine Translation field, introducing the next-gen approach - Neural Machine Translation (NMT). The NMT methods require large-scale datasets with parallel sentences in source and target languages. However, the NMT quality suffers when the amount of data is limited or the translation is out-of-domain.

Following the successful work in question answering and text generation fields, we aim to include Knowledge Graphs (KG) to improve the mentioned shortcomings of NMT. Knowledge Graphs are specific knowledge bases intended to extract and structure human knowledge. Formed as a graph, Knowledge Graphs allow AI systems to perform complex reasoning leveraging organised data.

In our experiments, we studied the impact of the shallow representation of a KG, Knowledge Graph Embeddings. To verify whether the data in KG is robust enough for complex reasoning, we extended the previous research with out-of-domain evaluation and expansion beyond named entities. Our preliminary study demonstrates improvements in English to German translation on out-of-domain datasets.

#O-38

Investigation of photoconductivity in cadmium indium sulfide – a promising material for neuromorphic devices

Jakub Zdziebłowski

Cadmium indium sulfide ($CdIn_2S_4$) is a chalcogenide semiconductor material, in which past re-search found effects characteristic for devices exhibiting memristive properties i.e. resistive switching and memory effect.

This work focus on optoelectronic research of $CdIn_2S_4$ thin-films for application in memristive devices. Photosensitivity creates a possibility to apply $CdIn_2S_4$ in phototunable resistive switch-ing devices – a novel growing field on the verge of photonic and neuromorphic computing.

Thin-film layers of annealed polycrystalline $CdIn_2S_4$ were prepared. We measured photocurrent kinetics at various wavelengths in visible and IR band in temperature ranges of 100-300K. Hence, we acquired wavelength-dependent resistivity relationship and basic information about band structure. Bandgap energy and conductivity dependence of the annealing process and significant change in spectral response after pre-irradiation of the sample were obtained.

We propose a consistent model describing photoconductivity change controlled by Fermi level pinning among samples of various stoichiometry. Finally, we found, that photoconductivity in-creases significantly after sample pre-illumination. The effect is persistent and vanishes gradually along with temperature increase. Thus, it implies a high impact of metastable defects on sample behaviour. This phenomenon can be turned off by lowering Fermi energy, which gives approxi-mate location of the responsible defect or defect complex.

#O-39

Synthesis of cold and trappable fully stripped HCI's via antiproton-induced nuclear fragmentation in traps

Jakub Zielinski

Access to a variety of highly charged ions is crucial for fundamental research and technological applications. However, not all isotopes can be accessed with the existing production paths. Therefore, in order to provide an alternative production mechanism for either challenging 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 ($\overline{p}$). 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) produced in the annihilation can then interact with nucleus matter creating new isotopes already in the HCI state.

We have studied in detailed simulations done using GEANT4 code the annihilation of very low energy $\overline{p}$ 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.
Studying cold antimatter is only possible at CERN. The AEgIS (Antihydrogen Experiment: Gravity, Interferometry, Spectroscopy) experiment is finalising its recent upgrade. It aims to obtain antihydrogen later this year. Its unique scheme of pulsed antihydrogen production makes it the best candidate for experimental testing of our hypothesis.

#O-40

Development of ohmic contacts for GaN-based vertical power devices

Oskar Sadowski

The main goal of my PhD thesis is to develop manufacturing technology of low-resistive ohmic contacts for GaN-based vertical power devices. The scope of research includes analysis of influence of technological aspects (thicknesses of metallic layers, substrate surface preparation methods, annealing temperatures and atmosphere) on ohmic contact properties and an attempt to explain the mechanism of formation of ohmic contacts to n-type GaN (including n-type GaN substrate with nitrogen-face surface (N-face) and p-type GaN.

In first year of my doctoral studies, I was working on ohmic contacts to p-type epitaxial GaN layer and to N-face n-type GaN substrate. In order to optimize the ohmic contact to p-type GaN the samples with metal contacts containing Ni, Au and Pd were prepared and characterized. The Ti /Al-based ohmic contacts were prepared and characterized for N-face n-type GaN substrates as well as on Ga-face n-type epitaxial GaN layers for comparison. The resistivity (ρ_c) of ohmic contacts was estimated by circular transfer lenght method (cTLM). As a result Ni/Au ohmic contacts with ρ_c=2x10^{-4} Ωcm^2 for p-type GaN and ~1x10^{-6} Ωcm^2 for N-face n-type GaN substrate were obtained.

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".

#O-41

One-shot Obstacle Footprint Estimation from Incomplete 3D Data for Efficient Robotic Navigation

Konrad Cop

In order to navigate through an environment a robot must be able to estimate a path which avoids all obstacles on its way. If a new object appears in the environment, the information about the shape, which a robot perceives, can be incomplete as the observation is done from a single viewpoint only. To avoid driving around the obstacle for full observation we propose a system that predicts the obstacle footprint based on the partial view form the onboard sensors. Our system is based on autoencoder to predict a 2D footprint and a PointNet -based network to estimate potential shift of a partial cloud origin. To provide close to reality data we propose a data generation pipeline that emulates sensor views using simulation environment and meshes of real object models. The output of the system is estimated 2D footprint which can be directly used in navigation occupancy grid.

Our solution is validated on a synthetically generated dataset and can heavily reduce additional motion which a robot would need to perform to obtain the full view of the obstacle.

#O-42

Speech recognition in conditions of impaired acoustic signal transmission

Karolina Pondel-Sycz

The research concerns speech recognition with distorted acoustic signal transmission. This mainly concerns telephone conversations, where signal distortion and interference occur. The first step is to assess what kind of distortion and interference is present in the tested signal. The next step is to select and prepare a suitable database and to examine the signal and propose methods for its repair. Then, the appropriate ASR system architecture must be selected. Currently, the most promising architecture for ASR systems is End-To-End (E2E). In these systems, the input audio signal is directly converted into an output result (transcription) using deep neural networks. Recognition in an E2E system can be divided into three stages: encoding by mapping the input speech sequence to a feature sequence, aligning the feature sequence to the language, decoding the final classification results. The E2E system is a complete structure, and it is often difficult to determine which part of it performs the above subtasks. The networks directly map acoustic signals to label sequences without the need for intermediate states. The E2E model uses soft alignment. Each audio frame corresponds to all possible states with a specific probability distribution, which does not require forced explicit alignment. In the field of E2E systems, there are three main models: Connectionist Temporal Classification (CTC), Attention-based Encoder-Decoder (AED) and Recurrent Neural Network Transducer (RNN-T).

#O-43

ReGAE: 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 (ReGAE). The model encodes examples into fixed-size embeddings and tries to reconstruct original samples based on those embeddings. A single instance of ReGAE 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.

#O-44

A Stochastic Monte-Carlo model for Loop Extrusion of Chromatin

Sevastianos Korsak

The structure of chromatin can be seen as the superposition of two main factors: compartmentalization, which organizes the genome in A and B compartments and loop extrusion, which is responsible for the formation of topologically associated domains (TADs). The loop extrusion process is carried by Smc complexes with ring-like structure such as cohesin or condensin, which are responsible for the formation of loops, whereas CTCF proteins or nucleosomes work as barriers for the motion of cohesin and they are capable of constructing stripes in the boundaries of TADs. Here we present a way to simulate chromosomal regions with more than one TAD as a stochastic Monte Carlo simulation process. In this method, we locate CTCF proteins according to the peaks of CTCF ChIP-seq data and we define a relocation probability with which each cohesin can randomly relocate to another place of the chromatin fibre. The folding of chromatin plays the role of the ergodic mean of the simulation, which help us to understand when it has converged to the equilibrium state. Having reached the equilibrium we can produce 3d structures by a molecular simulation model called „Spring model" and we end up with a thermodynamical ensemble whose average distance heatmap is similar to the CTCF ChIA-PET data. Finally, we succeeded to predict the burning period of the simulation and the final state of the Markovian process from the input parameters by using a simple system of nonlinear differential equations.

#O-45

Physical models of chromatin based on Hi-C contact maps

Krzysztof Banecki

Chromatin models have proven to be powerful tools in studying spatial genome organization in cell nucleus. Since both microscopy and 3C-based methods do not allow to directly infer the underlying structure of the genome physical models are necessary. Moreover, such models provide a quantitative framework for testing the hypotheses regarding molecular mechanisms that take place in the nucleus. Over the last 20 years a variety of algorithms have been presented to solve the problem of 3-dimentional genome organisation. However, the task that those algorithms are seeking to achieve is plagued with problems. Starting from the biases that naturally occur in Hi-C contact matrices together with inability of this kind of data to grasp the nature of the complex processes of chromatin folding leave the goal of thorough understanding those processes elusive.

Here we present some of the recent advancements in the field of 3-dimentional chromatin modelling based on Hi-C data together with some of our own results. Example 3D genome reconstruction algorithms are going to be discussed. Our consensus method for chromatin folding reconstruction is presented and our image-driven model of the cell nuclei of Arabidopsis Thaliana is going to be shown.

#O-46

Selective Generative Replay

Stanisław Pawlak

In this work, we focus on a generative rehearsal of past examples in a continual learning scenario. While these strategies tend to partially mitigate the effects of catastrophic forgetting, they often suffer from low-quality reconstructions of past samples, degrading with the increasing number of tasks. Inspired by boosting and curriculum learning, we address this limitation by introducing a weighting mechanism that assigns and dynamically adjusts the weights of data samples during training of a generative rehearsal model. This modification increases the flexibility of a generative model by prioritizing the reconstruction quality of specific samples according to the proposed weighting function. Effectively, it reduces the interference introduced by samples that can be entirely dropped in the next stages of continual training. More specifically, we implement our approach, dubbed Selective Generative Replay, by enforcing mini-batch composition based on the distribution of sample weights, selecting only a subset of training samples instead of their uniform representations. The proposed mechanism can be coupled with different weight assignment functions and used together with any generative rehearsal method. We show that even a basic weighting scheme improves the performance of the resulting continually learned model.

#O-47

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

Małgorzata Żebrowska

Disorders of body homeostasis caused by exercise are one of the factors causing adaptive changes in individual organs, physiological systems and comprehensively throughout the body. One of the currently used methods that allows to analyze the body's reaction to the given effort are the cardiopulmonary exercise tests (CPET). The scope of the study includes the identification of physiological nonlinear markers that can be used as non-invasive diagnostic tools to describe the adaptation processes occurring during physical effort. The projects conducted so have confirmed the usefulness of symbolic transfer entropy and the Hill's model of oxyhemoglobin concentration in a protocol with increasing load to maximum fatigue in young and healthy people. The aim of the last project is to verify the hypothesis about the applicability of multivariate non-linear methods in CPET research. We will assess whether it is possible to present the body's adaptation to the effort without introducing the subject to the maximum load phase resulting in the refusal to continue the test. The test is based on the non-invasive measurement of the respiratory, cardiovascular (ECG) and muscular (non-invasive near infrared spectroscopy) responses to medium exercise during exercise on a bicycle ergometer. Currently, data recording in the Laboratory of Effort at the Faculty of Physics on a group of 20 people has been completed. The obtained time series are in the analysis phase.

#O-48

Influence of 2-dimensional interlayer on contact resistance in TMD-based field-effect transistors

Małgorzata Giza

The electrical contacts to two-dimensional semiconductors such as Transition Metal Dichalcogenides are still a main limiting factor in the device's performance. This significant bottleneck in an efficient current injection into the 2D active layers is due to the formation of the Schottky barrier. In order to reduce the Schottky barrier height, one can put an additional layer (interlayer) between the metal and 2D semiconductor.

This research is focused on studying the influence of interlayers on contact resistance in TMD-based field-effect transistors. For this purpose, using the gold-assisted mechanical exfoliation method, large-area TMDs monolayers are produced and shaped with e-beam lithography. The large area of the material enables the fabrication of multiple devices on the same layers, allowing for a reliable comparison of their performance. Using 2D materials transfer system, the additional layer is placed only on the contact area of the device. Then the metal layer is thermally evaporated on top of the contact structure. In this way, one can obtain monolayer back-gate transistors with a 2D interlayer under metal contact (Fig.1). Devices are designed in TLM architecture with channel lengths under 4,5 µm, which allows for accurately determining contact resistance. The results of this work contribute to improvement in contact engineering strategy which leads to enhanced performance of 2D TMDs-based devices.

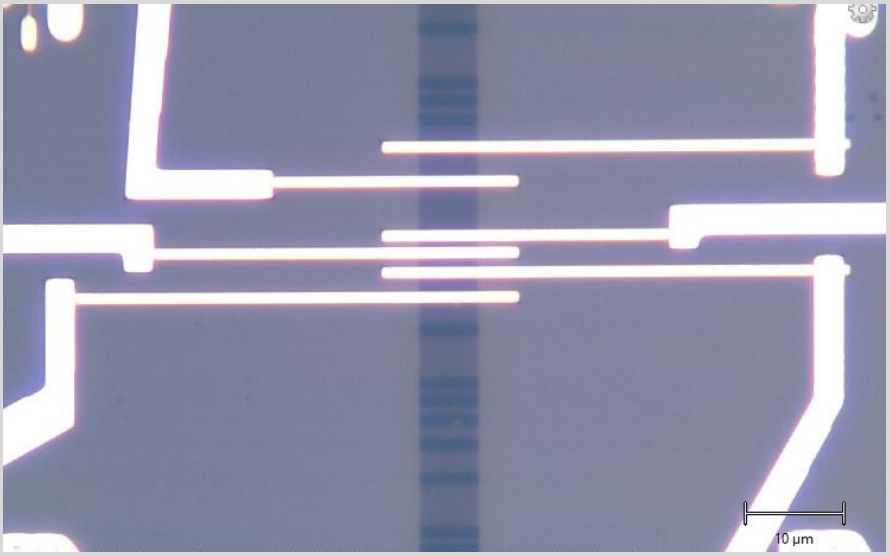

Fig. 1 1L-WS2 field-effect transistors with 1L-MoS2 interlayer under contact.

#O-49

First principles studies of temperature-dependent lattice vibrations in van der Waals materials

Konrad Wilczyński

Anharmonicity is an important feature of van der Waals layered materials due to its significant impact on the thermally induced movement of atoms in the lattice – including interactions between phonons (elementary lattice vibrations) and thermal expansion. Understanding lattice dynamics is important not only from the basic research perspective but also to better interpret experimental data obtained within spectroscopic characterization and from the point of view of potential applications - including the impact of the phonon propagation on thermal conductivity.

In this work, I use first-principles modeling to study layered materials' vibrational properties, including their temperature-dependent evolution. The calculated results are used to interpret or explain available experimental results. The studies are performed as a function of different structural modifications - interesting from the point of view of potential applications. Here, I consider the following modifications:
- The number of layers in thin multi-layered films,
- Effects of substrate-induced strain and charge doping,
- Formation of structural defects.

As representative examples, multi-layered tungsten disulfide (WS_2) and defected titanium disulfide (TiS_2) are chosen.

#O-50

Optimization of holograms for homogenous illumination in the terahertz range

Mateusz Surma

The homogenous illumination finds its application mainly in imaging. One can obtain more uniform illumination in many ways. In the case of wideband illumination, one would usually use optimized refractive setups or micro-lens structures. For monochromatic sources, there is the possibility of using diffractive structures instead. Diffractive structures, compared with refractive, are thinner, resulting in smaller losses due to absorption – an essential feature for weaker THz sources. This paper describes an algorithm for optimizing holograms for homogeneous illumination based on the Ping-Pong algorithm and sub-division of phase modulation. The phase modulation was divided into four segments, each responsible for reconstructing the target at slightly different distances and put together in various combinations. Holograms were designed and simulated for 260 GHz (wavelength of ca 1.2 mm). Later structures were manufactured with fused deposition modeling 3D printing method with styrene-butadiene copolymer (BendLay by OrbiTech). The material was chosen based on good optical properties at the selected frequency. Prepared structures were tested in THz setup with a Schottky-diode-based multiplier chain used as the source and detector.

#O-51

Rapid reinforcement learning with the hierarchy of policies that chase fleeing targets

Michał Bortkiewicz

Hierarchical division of control and sequential decision-making is unavoidable in large systems. In reinforcement learning, it is usually introduced with handcrafted subtasks to learn or with learned inflexible subgoals indicated within the original state space. In this paper, we reconsider assumptions that underlie those approaches and propose a new set of assumptions: 1) Goals of lower-level control are defined by projections returned by high-level controller, 2) higher-level control constantly verifies if lower-level goals are still valid, 2) if there is a better lower-level goal to pursue, our agent switches the target for lower policy even if the previous was not achieved. Consequently, we propose a novel hierarchical reinforcement learning algorithm that solves navigation tasks in dynamic environments based on these assumptions that lead to fast learning typical for hierarchical architectures. They also lead to smooth and dexterous control but above all, enable a fast reaction to unanticipated changes in the environment that exhibit dynamic situations for which the agent is not prepared. Also, lower-level policies considered within our approach are versatile enough to be useful in different tasks. This creates a natural framework for the transfer of knowledge in reinforcement learning.

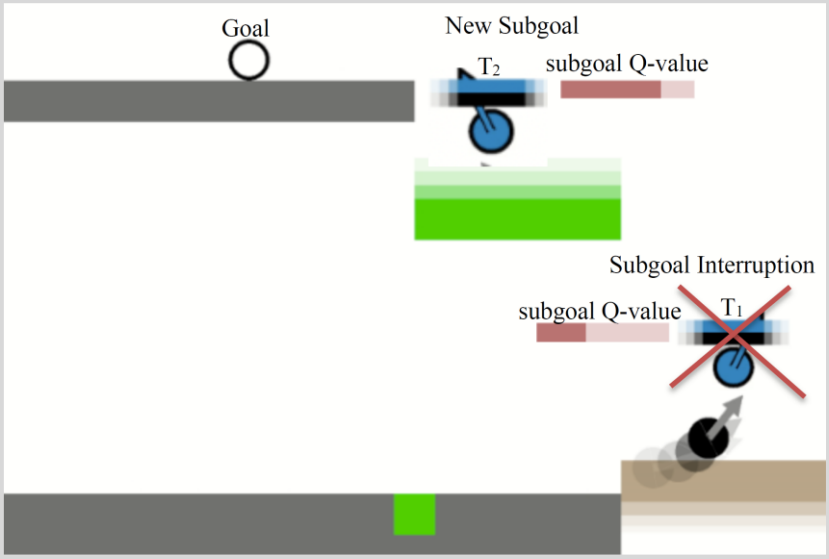

Fig. 1 Visualization of subgoal switching based on the subgoal Q-value. If the currently realized high-level action is suboptimal to the subgoal predicted in this moment, according to the Q-value, the agent switches the target it pursues.

#O-52

Readout integrated circuit for MIR detector within ASPIC

Paweł Pieńczuk

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

The ROIC unit (depicted in Fig. 1) is based on a transimpedance amplifier (TIA), 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 external noise rejection. The TIA unit is followed by 50 Ohm output buffer (OUT_BUF). Both blocks are polarized by configurable biasing block (BIAS).

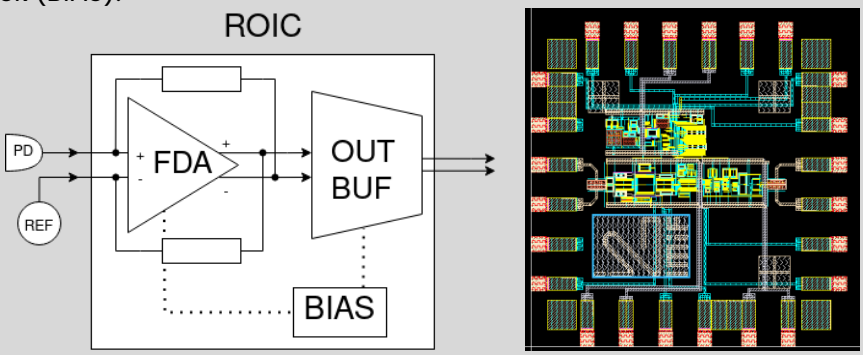

Fig. 1 ROIC scheme block (left) and layout (right).

The layout (Fig. 1) is created and sent to production in CMOS 180 nm process. The simulations after parasitic extraction show promising results of parameters. This has to be proved by experimental tests in the lab, with text fixture under development (Fig.2).

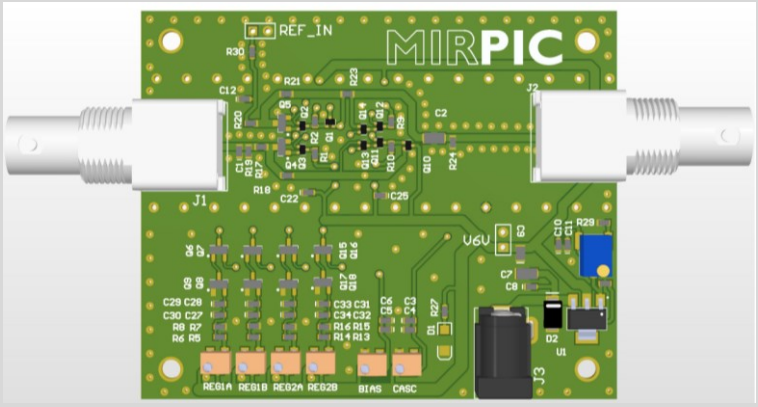

Fig. 2 Transconductance amplifier PCB for ROIC text fixture.

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)).

#O-53

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 information 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, structure learning (networks, trees), probabilistic estimation of cause-and-effect relationships will be used.

#O-54

As We Speak: Real-Time Visually Guided Speaker Separation and Matching

Piotr Czarnecki

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

#O-55

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

Michał Falkowski

Modern industrial processes are characterized by a high degree of interconnection between individual control loops. One of the most difficult issue regarding analysis of large-scale industrial processes is to find root cause of faults. Faults that are commonly caused by inappropriate control loops operation may lead to low productivity of whole system, can increase operational costs and in the most dangerous cases, an unwanted system shutdown or its destruction. Effective and quick answer to this type of problems is Root Cause Analysis. This approach allows for non-invasive finding such errors in large-scale industrial control systems.

However, to begin this type of analysis, causality between variables of a given process should be determined first. One may find several various approaches, which have been developed in different domains. None of them are applied in industry. They are mainly used in medicine or chemistry and they are based on the model. It has been shown that building a model is a tedious process and its accuracy depends on many factors. This is a complex and time-consuming issue; thus the universality of these methods is negligible. Problem also appears because these approaches work well only for linear systems.

Work focuses on broadly understood signal analysis and use of the Transfer Entropy method - an information theoretic interpretation of Wiener's causality definition.

#O-56

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

Jolanta Sadura

Very often when the project of the laboratory is under developing, engineers don't know what kind of problems they meet during their work.

The topic of this research is concentrated on the high current laboratory where type tests like the short circuit tests of MV apparatus for example: switchgear, transformer stations, earthing, connectors, etc. are performed. It is a place where the test instruments responsible for controlling the test process faces electromagnetic fields which are influencing their electronic. It is demanded that the apparatus controlling the tests will work correctly without malfunctioning. Uncontrolled test when the apparatus is working without supervision of the operator is undesired and can be destructive for the device under test. The commercial solution can't be applied in case of the high current laboratory because the laboratory environment differs from the ordinary one and therefore some aspects of it are out of normative documents.

The steps of performed research were devoted to an analysis of electric and magnetic fields and identifying the existing electromagnetic disturbances. With measuring of electric and magnetic fields the problem was recognized as repetitive damped oscillatory waves DOW which are component of electromagnetic environment. They appear due to switching process of circuit breaker (closing of CB and powering the MV side of test transformers). The identification of existing disturbances and their sources was necessary to cre

#O-57

Novel Halbach array for electrodynamic levitation system for high speed magnetic railways

Tomasz Kublin

The author in his research focuses however on electrodynamic levitation systems. The system does not need any power supply to sustain levitation neither on the vehicle side nor on the track side. Electrodynamic levitation is based on arrays of permanent magnet in Halbach arrays mounted underneath the vehicle and conducting slabs mounted along the tracks. Levitation occurs as a result of vehicle movement. Then currents, that are induced in the track, are repel permanent magnets.

The author during his research work conducted numerous series of analytical calculations and simulations with the usage of FEM programs. The goal is to design the most energetically effective arrangement of permanent magnets and conducting track that would stably lift the traveling vehicle while generating very low dragging force especially when travelling with low speeds. The author found an novel Halbach array arrangement allowing to decrease the power consumption of the EDS systems up to 15%.

#O-58

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.

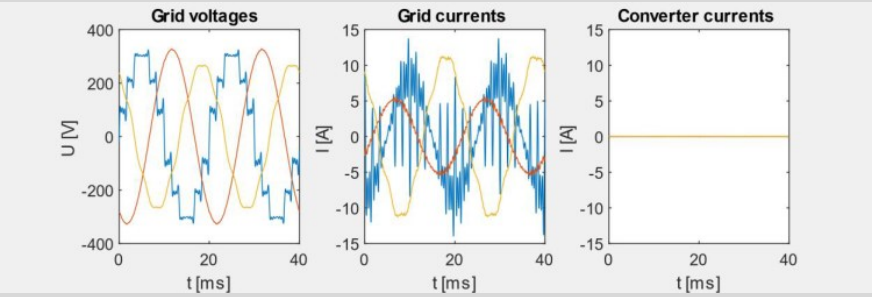

Fig. 1 Converter turned off.

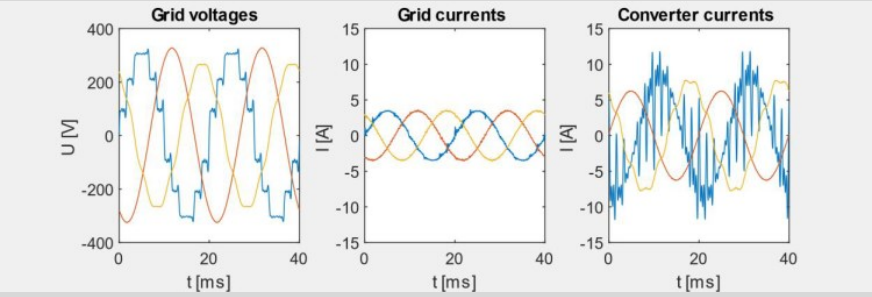

Fig. 2 Converter turned on.

#O-59

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

Jarosław Tarenko

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

Till now I was working on development of photoresists mask with desired shape and profile (bevel angle) and later on the pattern transfer to the GaN surface by dry etching using inductively coupled plasma reactive ion etching. With optimization of reflow process parameters the different angles of bevelled mask were obtained. Subsequently I examine the effect of various BCl3 ICP/RIE plasma parameters (RIE and ICP power) on the etching of bevelled mesa structures . The selectivity of etching of GaN over photoresists mask was close to 1:1 allows to exact transfer of the pattern from the mask to the semiconductor structure with low bevel angle.

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".

#O-60

Computing homomorphisms in hereditary graph classes

Karolina Okrasa

The k-coloring problem is, arguably, one of the best studied and well-known graph problems: given a graph G, we ask whether we can assign k colors to the vertices of a graph in a way that no two adjacent vertices receive the same color.

If we have $k \geq 3$ colors, the k-coloring problem is NP-complete. This means, in particular, that we do not know any algorithm which decides whether the graph G on n vertices can be colored using k colors, and does that in time polynomial in n. However, it may happen that we want to solve our problem only for graphs G with some additional properties (e.g., planar graphs, or such that each vertex has only four neighbors). The intuition suggests that these additional information may help to solve our problem faster. Thus, we are interested in theorems characterising the structure of graphs which belong to some given graph class, as usually they show how to use our additional knowledge about G to reduce the problem to a simpler one. This, in turn, obviously helps to design effective algorithms. Moreover, we can use these theorems to solve more general problems than graph coloring: graph homomorphism problems.

In this talk I will focus on the complexity of the graph homomorphism problem when the class of input instances excludes a fixed graph as an induced subgraph.

#O-61

Study of a decentralized electricity market

Arkadiusz Wójcik

Over the last decades, new technologies have significantly changed the way information is transmitted and stored. Renewable energy sources have become prevalent and affordable. Cooperation of the Information and Communication Technology industry and Renewable Energy industry makes it possible to create a next generation, decentralized power grid.

In this context, the study seeks to identify benefits to the local economy as a result of the development of a decentralized electricity market. The general approach aims to integrate an economic analysis with externalities that are not quantifiable in monetary terms.

The simulation is the scientific basis for economic impact analysis. Various types of sources of energy have been taken into account: private wind farm, residential wind turbine, residential solar panels and private solar farms. Analysis of local geographic and economic conditions allowed creating a customized business model. Finally, the devised simulation outlines the expected rate of return on investment.

#O-62

Embedding of the components into the PCBA

Marek Kościelski

The now a days trend in electronics is miniaturization. The shift can be seen in the amount of transistor per area or the amount of space used for components. The packages become multi-functional as System in a Package (SiP) is gaining more attention. Also the build up of components in the Z-axis can be seen in packages such as Package on Package (PoP) or the amount of stacked dies especially in the memory chips. All these trends are especially manifested in the mobile devices where minimizing the of the Printed Circuit Board Assembly (PCBA) enables to fit batteries with higher capacity.

All those trends may lead not only to use the Z axis and populate components on top but also embedding them into the Printed Circuit Board (PCB). Such embedding models with a stack-up will be presented. The focus will be the embedding of the passive components such as capacitors and resistors. Exemplary stack-up and lay-out of the PCB are presented below on figure 1.

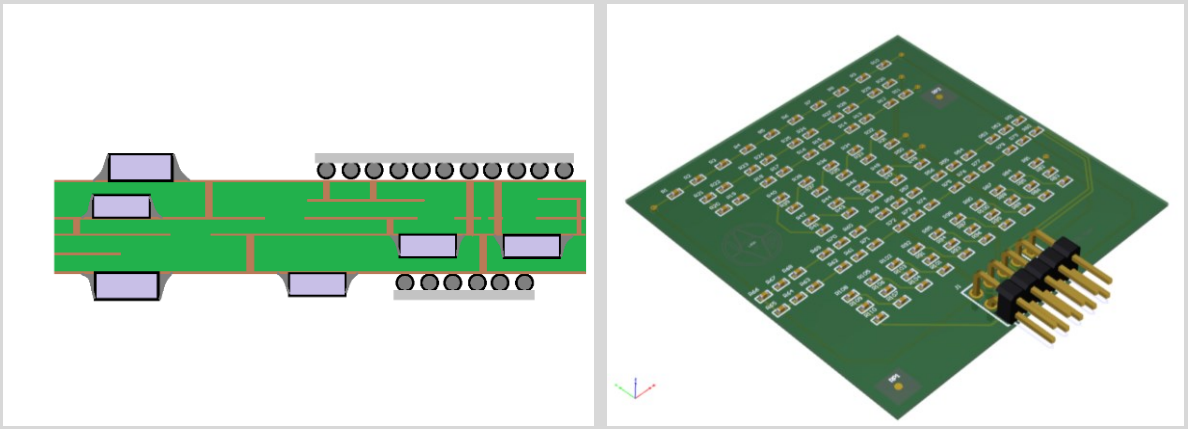

Fig. 1 Stack-up of the tested PCB (left),
the projection of proposed test coupon internal-layer after assembly (right).

The design of the DUT (Device Under Test) and the components that would be embedded would be presented. Together with the technical line-out of the embedding process and process that would influence the reliability. The planned layout and test routine would enable testing the samples in different environmental conditions and to monitor the electrical parameters in-situ. The set conditions will be based on highly reliable market and reaching from the ESA's (European Space Agency) ECSS standard the temperature conditions can vary from -55°C up to 150°C, or even higher. Also vibration tests are crucial and are planned in the wide range of states.

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#P-01

Analysis of cubic modeling index in general interior lighting

Paulina Komorzycka

General interior lighting should be neither overly directional nor overly diffused. Providing the right balance between directional and diffused lighting allows you to eliminate undesirable effects, such as too strong shadows (modeling is then too strong) or to create too monotonous lighting environment (modeling is then too weak). One measure used to assess the effect of the directionality of lighting in the interior is the Cubic Modeling Index (MCU), which is the ratio of the illuminance vector to the illuminance scalar at a point on the reference plane. Research shows that obtaining the required interior modeling index is significantly limited. The study considered the influence of the room size (RI), the reflection coefficients of the main surfaces in the interior (RO), the lighting class of the luminaire (CL), the semi-spatial lower light distribution of the luminaire (LID) and the arrangement of luminaires (SH) on the value of the modeling index. A total of 432 lighting situations were simulated in the DIALux program. The analysis of the results showed that the parameter having the greatest impact on the value of the modeling index is the arrangement of the luminaires. Due to the use of the multiple linear regression model, equations describing the relationships between the dependent variable (the value of the modeling index) and the explanatory variables (RI, RO, CL, LID, SH) were obtained. Knowledge of these equations allows you to verify the suitability of lighting fixtures in terms of producing the desired modeling effect in interior lighting already at the stage of developing the lighting concept.

#P-02

Abstract evolution systems

Paulina Radecka

An evolution system is a category with a distinguished class of arrows - called transitions - and a fixed object called the origin. This simple yet powerful concept turns out to be a convenient framework for studying both infinite and finite Fraïssé limits – the unique (up to an isomorphism), most complicated, generic objects in a suitable category.

First we state the definition of an evolution system and show some relevant examples of such systems to develop a bit of intuition. Next, we define the most important, in our setting, version of the amalgamation property, which is a notion well-known in model theory. Then, we will state necessary conditions for existance of the unique (up to an isomorphism) evolution with the absorption property. The colimit of such an evolution is precisely the Fraïssé limit of our category. Turns out that the crucial notion for the existence of such an evolution is our amalgamation property and some kind of 'smallness' of the system.

We shall explain these ideas, showing a few interesting properties of evolution systems - regularity, termination and determination. Moreover we present the notion of confluence and local confluence in evolution systems and how is it connected to the amalgamation property. Lastly, we show that a variant of famous Newman's lemma (also known as the diamond lemma) holds in our setting.

References:
Kubiś, W., Radecka, P., Abstract evolution systems, link to preprint:
https://arxiv.org/abs/2109.12600

#P-03

ARC Welding

Jan Sawicki

The research „ARC Welding" (Analysis of Reddit Communities Welding) focuses on enucleating topical inter-subfora similarities on Reddit.

The proposed method is designed based on an extensive Reddit and natural language processing (NLP) literature review. It is based on analysing real graph networks built with named entities from Reddit posts detected with neural network models based on text embedding and „transformers" architecture.

The main recent highlights of the research are:

1) The most significant discovery is that „crossposts" (posts from one subreddit posted to another one), because they contain partial response variables and are key to evaluation.
2) The dataset was extended with additional 200 subreddits with most crossposts and it was also migrated to 2021 to reduce COVID-19-related posts (total of over 1200 subreddits in timespan of 12 months)
3) Reviewed named entity linking and disambiguation methods are inapplicable due to being inaccurate, extremely long-running, softwarely deprecated or simply nonfunctional.
4) Modelling based on user profiling is currently impossible due to extremely large granularity of post authors and relatively small percent of users posting vs users watching/evaluating the content
5) Experiments with time granularity emphasised the rarity of crossposts and did not improve the results.
6) The best results are obtained using entity post score and entity node degree centrality. Joining merging methods are the current focus of the resea

#P-04

Decomposing bipolar ECG signal using CNN autoencoder

Sebastian Wildowicz

This research is aimed at developing new methods of ECG signal analysis, the aim of which is to develop medical diagnostics in the area of cardiology and neuroinformatic. The work concerns the issues of modelling the electrical activity of the heart and the development of techniques for the analyse of the signal source state. The thesis presents an innovative and modern approach for AI solution - CNN autoencoder, which allows decompose and reconstruct bipolar ECG signal from a chosen model of the single base function. Created algorithm is based on the convolution of gaussian curve with single base function. Model consist of: input shape [N x L x K], output shape [N x ADn x 3], 1.360.339 total parameters(trainable parameters: 1.357.299, non-trainable parameters: 3.040)
where: N – number of train datasets, L – number of single ECG lead samples, K – number of bipolar ECG leads, ADn – number of single gaussian curve samples.

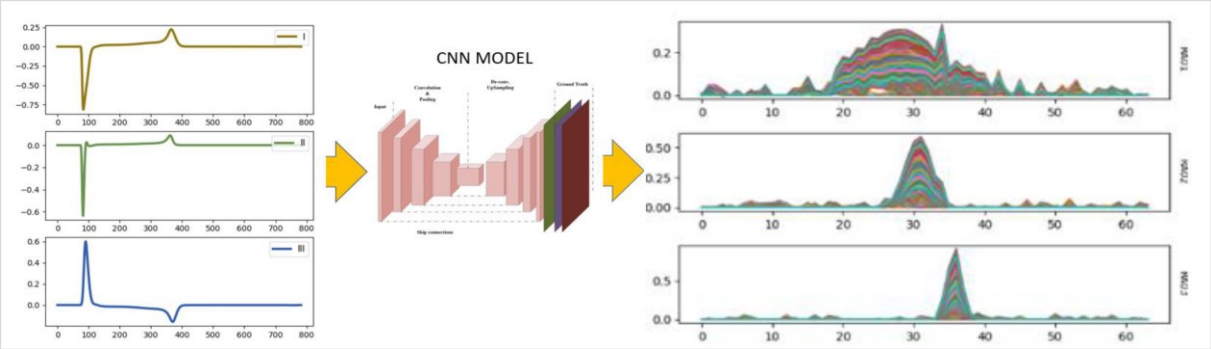

Fig. 1 ECG decompose model.

The results of created model presents on Fig. 1 allows to decompose and reconstruct the bipolar ECG signal for the selected base function. Results shows that the ECG signal can be represented by a convolution of gaussian curve with a base function, QRS amplitudes were correctly reconstructed by CNN autoencoder.

#P-05

Management of network slices in shared resources with isolation scoring

Tomasz Wichary

The network slicing concept provides mobile network capability to reuse existing resources for different vertical customer requirements. The resources shared across network slices require attaching security mechanisms to isolate each data slice. The network conditions are dynamic, and data protection of data slices needs to be evaluated throughput.

The author of this research work aims to deliver a security model in the context of optimising resources for network slicing. The multi-layer network describes the architecture of mobile networks well. The service or customer demand isolates resources at one layer that shares the lower layers. Evaluating resource security protection is critical, especially security mechanisms at shared layers of resources. The author, during research, introduced an isolation scoring model for mitigating vulnerabilities or resources under attack, show dependencies between layers and requirements for protection mechanisms for lower layers. Each layer's isolation score/metric calculation is based on different criteria. Evaluate the isolation level and isolation risk at each management layer (accept, modify for self-healing purposes) and report the isolation score/metric to management in the higher layer.

The presented isolation is scored in conjunction with hierarchical management for classification resource protection based on security metrics and human behaviour. It allows for evaluating resources regarding security for the demands placed on them.

#P-06

Algorithms for monocular depth estimation using deep neural networks

Tomasz Lehmann

Monocular depth estimation from images is applied in many applications and computer vision tasks. Nowadays there are many convolutional neural network based architectures for computing a high-resolution depth map given a single RGB image. The state of the art for one of the most popular databases dedicated to the depth estimation problem – NYUv2 - is set up by dense vision transformers and encoder-decoder structures. Inspired by solutions used in the image super resolution tasks I made a decision to implement Deep Recursive Residual Network and Enhanced Super Resolution Generative Adversarial Network to generate predictions with realistic textures during single image depth estimation. The first of mentioned architectures contain almost 150 times less parameters than auto-encoders usually used for depth estimation while the gargantuan potential of GANs seems to be an interesting alternative for the most popular solutions. Both architectures made a significant contribution in the image restoration problem. The achieved results are very preliminary and at this time it is hard to predict if the proposed methods will outperform others in any of NYUv2 metrics but there is still a long way ahead to optimize calculations by choosing suitable loss function and network modification experiments.

#P-07

Lepton-Hadron collisions in MadGraph5_aMC@NLO

Laboni Manna

The overall objective of my research is to deepen our understanding of the internal structure of nuclei and nucleons.In the coming years, the Electron-Ion-Collider (EIC) in the United States will enable researchers to study lepton-hadron collisions with unprecedented precision. In particular, it will be the very first collider of leptons and nuclei. Its first objective is to advance our knowledge of the partonic content of the hadrons. In order to plan and optimize various measurements, it is essential to include radiative corrections in our simulations for the lepton-hadron reactions. For the time being, there does not exist any automated simulation tools including even only next-to-leading order (NLO) radiative corrections. A NLO code such as this is however vital in light of the development of the EIC in the coming decade.

MadGraph5_aMC@NLO (MG5) is a framework that aims at providing all the elements necessary for the standard model and beyond standard model phenomenologies, such as the computations of cross sections, the generation of hard events and their matching with event generators, and the use of a variety of tools relevant to event manipulation and analysis. The code allows one to simulate processes in virtually all configurations of interest, in particular for hadronic and e+e- colliders. The aim of my PhD work is to include electron-proton collisions and then extend the work for the electron-nucleus collisions inside MG5. In case of electron-proton collisions there are two regimes: photoproduction & deep-inelastic collisions (DIS). In this study, we are going to present the development of photoproduction at NLO (without parton shower) where the photon is coming from an electron by comparing our results with experimental data from HERA (a particle accelerator) and with theoretical predictions. Moreover, we will also present the development of DIS at leading order (LO) with parton shower mode which describes the particles and the radiation resulting from high-energy particle collisions.

#P-08

ChIA-BERT: prediction of CTCF-mediated chromatin loops identified by Chromatin Interaction Analysis with Paired-End Tag (ChIA-PET) from DNA sequence

Mateusz Chiliński

The spatial architecture of the human genome is considered to play a major role in controlling biological processes in a cell. The spatially close DNA regions, while linearly distal, can interact with each other, thus regulating the expression of genes. One of the experimental methods for the identification of statistically important 3D interactions of chromatin fiber is ChIA-PET, which observes chromatin loops mediated by CCCTC-binding factor proteins. However, not always an experimentally identified chromatin loops are possible to obtain.

That is why multiple statistical learning algorithms have been proposed to simulate in-sillico 3D genomics experiments. We have developed ChIA-BERT, a deep learning algorithm based on transformers. We can predict from DNA sequence chromatin loops mediated by CTCF with an accuracy of up to 78%. The machine learning algorithm uses as input two DNA sequence segments that are interacting, and as the negative set, we use random segments of the remaining genome that are not interacting in 3D space.

Our results show clearly that the modern-day deep learning methods can predict chromatin looping from the DNA sequence. The proposed approach can have a major impact on creating in-sillico statistical models extrapolating the knowledge gathered from molecular biology experiments. The improvements in the in silico predictions from DNA sequence have a major impact on functional studies allowing to predict the effect of mutations on gene expression.

#P-09

Computation of nuclear effects in MadGraph5_aMC@NLO at Next-to-Leading order accuracy

Anton Safronov

Automated perturbative computations of cross sections for hard processes (like production of charm and bottom quarks) in asymmetric hadronic/nuclear A+B collisions at the next-to-leading (NLO) order in α_S will offer a wide range of applications, such as more robust predictions for new experimental programs, the phenomenology of heavy-ion collisions, and the interpretation of the LHC and RHIC data. Such a goal can be achieved using MadGraph5_aMC@NLO, a well-established tool for automatic generation of matrix elements and event generation for high energy physics processes in elementary collisions, such as decays and 2→n scatterings.

I have extended the capabilities of MadGraph5_aMC@NLO capabilities by implementing computations for asymmetric collisions, for example $p + Pb$, $\pi + Al$ or $Pb + W$ reactions. These new capabilities will soon be made available via the EU Virtual Access NLOAccess (https://nloaccess.in2p3.fr).

I'm going to present the objectives of the NLOAccess initiative, the implementation of asymmetric computation computations in MadGraph5_aMC@NLO along with the computation of the nuclear PDF and scale uncertainties, our cross checks with previous results and codes (FEWZ, MCFM), and predictions for $p + Pb$ collisions at the LHC for charm, bottom and top quark production, as well as fancier observables now made predictable with these new capabilities.

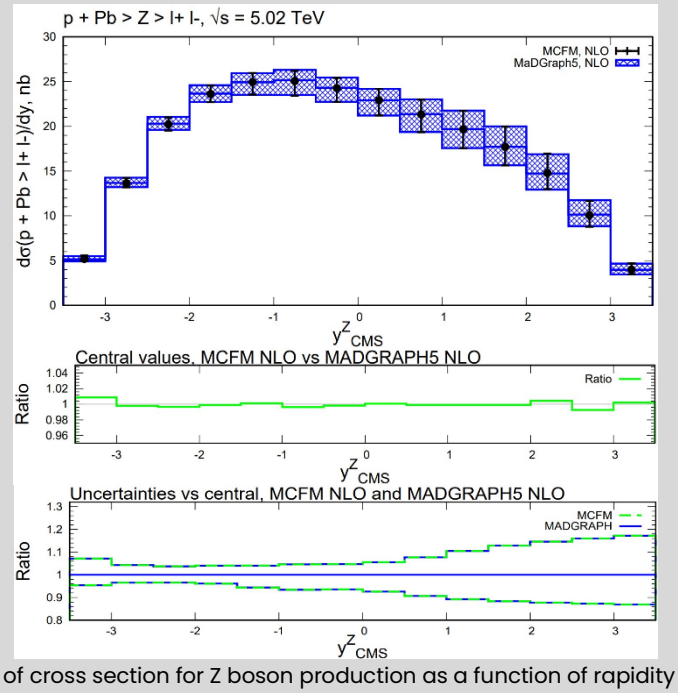

Fig. 1 Comparison of cross section for Z boson production as a function of rapidity in center of mass frame in p-Pb collisions for MG5 and MCFM.

#P-10

Graph homomorphism problem for bounded-cutwidth graphs

Marta Piecyk

For a fixed graph H, in the graph homomorphism problem, denoted by Hom(H), we are given a graph G and we have to determine, if there exists a homomorphism from G to H, i.e., an edge-preserving mapping f: V(G) -> V(H). In the list version of the problem, denoted by LHom(H), the graph G is given along with lists L: V(G) -> 2^V(H), and we ask if there exists a homomorphism f from G to H that additionally respects lists, i.e., for every v in V(G) we have that f(v) in L(v). Let us note that the graph homomorphism problem is a generalization of the well-known k-coloring problem.

For many graph parameters t(G), the typical behavior is as follows. There is an algorithm solving k-coloring in time k^t(G)* |G|^O(1) and this running time cannot be even slightly improved under standard complexity assumptions. This is not the case for a parameter called cutwidth, denoted by ctw(G). Jansen and Nederlof [TCS 2019] provided a randomized algorithm that solves k-coloring in time 2^ctw(G) * |G|^O(1), and a deterministic one with running time 2^(omega* ctw(G))*|G|^O(1), where omega is the matrix multiplication constant.

A natural question is if this behavior can be extended to a more general problem, i.e., (list) homomorphisms. It appears that there is no constant c such that for every H, the Hom(H) problem can be solved in time c^ctw(G)*|G|^O(1). In my poster I will show more details of this result.

Joint work with P. Dvořak, C. Groenland, I. Mannes, J. Nederlof, and P. Rzążewski.

#P-11

Impact of low-voltage electromechanical switches on the electromagnetic environment

Piotr Zych

The research deals with the issue of electromagnetic disturbances caused by electromechanical relays. Electromagnetic compatibility (EMC) is important for the reliable work of electrical and electronic devices. My research focused on the low-voltage relay, which is the source of electrical fast transients (EFT)/burst disturbances. The voltage and current waveforms were tested on the constructed stand while opening the relays' contacts. We investigated one-circuit topology with varied element parameters in order to observe their influence on the burst phenomenon. The new technologies in the measurement equipment allow us to observe many detailed aspects of the burst phenomenon, which were not reported up to now. To analyze the disturbances, they have been fragmented into restoration, ignition and arc times. The number of disturbance cycles differs depending on the value of the circuit capacitance on the load side. The effect of capacity on times of restoration, ignition and burning arc was also observed. The division into cycles allowed us to observe changes in the studied phenomenon along with the increased distance between the relay contacts during its opening. There were also discrepancies between the presentation of the phenomenon in the standard defining the method of measuring the resistance to interference EFT/burst and the measurement results.

#P-12

K*(892)^0 meson production in nucleus-nucleus interactions at SPS energies measured by NA61/SHINE at CERN

Bartosz Kozłowski

The NA61/SHINE is an experiment studying hadron production in proton-proton, proton-nucleus and nucleus-nucleus collision at the Super Proton Synchrotron (SPS) at the European Organization for Nuclear Research (CERN). The physic program is focused on study of the properties of the onset of deconfinement and searching for the critical point of the strongly interacting matter.

Resonance production is one of the key observables to study the dynamics of high-energy collisions. In particular, it was predicted that in dense nuclear matter their properties (e.g., widths, masses) can be modified as a result of the partial chiral symmetry restoration. The analysis of K*(892)^0 meson allows to better understand the time evolution of high-energy nucleus-nucleus collision, particularly the ratio of K*(892)^0 to charge kaons is used to determine the time between chemical (end of inelastic interactions in the system) and thermal/kinetic (end of elastic interactions) freeze-outs.

Using data collected by the NA61/SHINE experiment and template method used in analysis of K*(892)^0 production in proton-proton interactions at 158 GeV/c beam momentum, analysis of the production of K*(892)^0 meson in Ar+Sc inelastic collisions at SPS energies is being performed. The aim of the analysis is to determine width and mass, calculate mean multiplicities of K*(892)^0 resonances and estimate time interval between chemical and kinetic freeze-outs in nucleus-nucleus collisions.

#P-13

Fractional Stefan Problem

Karolina Pawlak

Stefan problem is one of the most famous free boundary problem of evolution type. It describes the process of melting of solid. In general, at the beginning the domain $[0,R] \times [0,T]$, where R,T are positive, is divided into the solid and liquid part. By the left boundary we provide the heat, which makes the ice melt. As the result of melting of solid, the interphase between solid and liquid part is moving. In the classical formulation, there are two unknowns: the temperature and the function describing the free boundary.

In my work, instead of considering the equation separately in the solid and liquid part and looking for the free boundary, we consider the problem in the whole domain. We have only one unknown: the enthalpy function, which encode the information in which state the material is. Enthalpy function is not continuous, because it has the jump at the critical temperature. As the result, we need consider weak solutions, which are more general than classical one.

We prove the existence and uniqueness of weak solutions of the fractional Stefan problem with the distributed order Caputo derivative. We consider the one phase problem, so we assume that temperature = $\max\{0, \text{enthalpy} - 1\}$ and our problem is nonlinear. Our result holds only on a sufficiently small interval of time. In order to get the global existence, we will need to show that the solutions of evolution equations with distributed order fractional derivative are Hölder continuous.

#P-14

Day-ahead energy market trading strategies using reinforcement learning and evolutionary algorithms

Łukasz Lepak

Energy is a popular topic today. Rising prices, move towards renewable sources, atomic energy – these are just some areas that are wildly discussed. In this work, we focus on day-ahead energy markets and trading strategies. A hypothetical prosumer is considered who is able to generate energy and store it in batteries or use it for his own needs. He is also a market participant, which allows him to sell excess energy or buy deficit energy. The goal of the prosumer is to increase his profit, which may be accomplished by an appropriate trading strategy. In this work, two approaches are proposed. The first one is a fully automatic trading strategy, which is learned with reinforcement. It uses a set of observations, like previous prices, weather forecasts or battery state forecasts, to optimize its policy so that it creates the best buy and sell orders possible. The second approach uses hand-crafted strategies, in which parameters are optimized by a 1+1 evolutionary algorithm, to optimize the results obtained by these created strategies. Both approaches operate on a day-ahead energy market, where orders for each hour need to be submitted on a day preceding actual energy deliveries. We assess the results of proposed approaches by comparing various metrics, including profit/loss during the operation, the characteristics of submitted orders or the changes in battery states of the hypothetical prosumer.

#P-15

The use of quantum computing in the analysis of biological sequences on the example of de novo assembly and multiple sequence alignment

Katarzyna Nałęcz-Charkiewicz

On the example of two problems belonging to the essential tasks in bioinformatics, namely de novo assembly of DNA sequences, as well as the problem of multiple sequence alignment (MSA), the idea of using the quantum computational paradigm in the analysis of biological sequences will be presented. Both of these problems can be expressed as an optimization task, namely the travelling salesman problem, which makes them good candidates for solving with the help of a special purpose quantum computer - quantum annealer. Although the era of quantum computing is still in the introductory phase - especially in terms of the current hardware capabilities - it is important to conduct appropriate research on exploring the capabilities of quantum computers and developing dedicated algorithms.

#P-16

Detection and classification of faults in the distribution grid.

Piotr Łukaszewski

Rapid removal of faults reduces damage to devices and reduces their negative impact on the quality of electrical power. Hence, the development of fast and accurate protection algorithms and fault locators is crucial both from an economic and a technical point of view. The conventional approach to fault detection is based on the analysis of currents and voltages at the fundamental frequency of the grid. For this reason, algorithms based on these values ??require a signal analysis over a long period of time to be sure that the short has actually occurred. A more modern approach is based on the analysis of traveling waves. This type of protection is called „ultrafast" because of its greater speed. The developed method belongs to the „ultrafast" branch of protection algorithms.

The method uses travelling waves in the phase voltage signal. Measurement takes place in a substation with the use of voltage sensors - increasingly popular measuring devices used as a substitute for voltage transformers. The sensors are characterized by a more precise transformation of the signal. The method utilizes short-time matrix pencil method to detect the waves and measure their amplitudes. Due to the fact that the voltage values are taken into account, it is possible to easily estimate the shape of the expected fault wave and to classify the type of it.

#P-17

Analysis of femtoscopic correlations of pairs containing deuteron in Pb-Pb collisions in the ALICE experiment at the LHC

Wioleta Rzęsa

This contribution presents the analyses of two-particle femtoscopic correlations of pairs containg deuteron produced in Pb-Pb collisions with energy $\sqrt{S_{NN}}$ = 5.02 TeV, that were registered by the ALICE experiment at the LHC. The analyses are based on the femtoscopy technique which allows studying the properties of matter under extreme conditions produced in high-energy heavy-ion collisions. The femtoscopic correlation function depends on both, the properties of the particles emitting source created after the collision and the two-particle final state interactions. In this work there are considered pion-deuteron pairs and preliminary kaon-deuteron pairs. Particles considered in this work are electrically charged hadrons which interact thus via the strong and Coulomb forces. However, neither the parameters describing the strong interaction of both considered particle pairs nor the creation mechanism of (anti)deuterons in heavy-ion collisions are known. The study presented in this contribution contains the methodology of selection of particle samples and the first calculations of the correlation function for these pairs of particles.

#P-18

GPU Implementation of Particle-in-Cell With Monte Carlo Collisions in Julia

Wiktor Łodyga

Particle based simulations are essential tools for performing numerical simulations of charged particles and low-temperature plasma sources. Over the years the Particle-in-Cell algorithm, combined with the Monte Carlo Collisions, has become an important tool, especially for the simulation of various low-pressure plasma sources. Good GPU parallelization potential of these simulations has been already proven by many with CUDA C based solutions, although the advent and rapid development of Julia programming language makes it possible to solve the two-language problem. This paper describes an original parallel implementation of a one-dimensional electrostatic plasma simulations based on the Particle-in-Cell method with Monte-Carlo collisions designed for NVIDIA GPUs. Whole implementation, including GPU kernels, has been implemented in pure Julia. The performance of this implementation has been compared to other solutions based on C/CUDA C combination. The correctness of the simulation has been verified by four benchmark cases related to capacitively coupled discharges.

#P-19

Super-resolution reconstruction for satellite imagery

Paweł Kowaleczko

Super-resolution reconstruction (SRR) of natural colour images is one of the most popular research topics in the area of computer vision. In recent years most developed solutions are based on deep neural networks. The generalization of natural colour images SRR is hyperspectral images (HSI) SRR. In this case, each image contains many narrow spectral bands, which usually results (due to the limitations of sensors) in lower spatial resolution when compared to natural images. Most of the natural images SRR methods can also be applied to the HSI SRR, however, better results are usually obtained when the method is designed specifically for the HSI. HSI SRR methods can be grouped into four categories - single image super-resolution (SISR), multi-image super-resolution (MISR), multispectral and hyperspectral image fusion (MSI/HSI fusion) and pansharpening. In SISR a single HSI is used for reconstruction, in contrast to MISR, in which multiple HSIs representing the same object are used for this task. MSI/HSI fusion fuses low resolution hyperspectral image with high resolution multispectral (e. g. natural colour) image. A special case of MSI/HSI fusion, in which the MSI is replaced by high resolution single channel image, is called pansharpening. In this work, the results of multiple SRR methods applied for satellite imagery are presented.

#P-20

Operation of the DC / DC converter in the microgrid

Mikołaj Koszel

Connecting numerous, dispersed, unstable sources of electricity to the grid is often the cause of disturbances in the operation of the grid and deterioration of the quality of electrical energy. One way to minimize the growing problems is to use DC microgrids. However, despite the many advantages of the proposed solutions, they are not widespread, mainly due to the difficulties occurring in the case of installations with a power of tens or hundreds of kW. The key components of these systems are power electronic converters, ensuring highly efficient and stable electricity flow and its appropriate quality. One of the widely developed DC/DC topologies is the dual active bridge (DAB). Currently, optimization algorithms and artificial intelligence are increasingly used in the design and control of converters.

An important issue is the optimization of power distribution between converters connected in parallel, aimed at minimizing power losses. Among others, the poster presents the optimization results based on the SLSQP algorithm. Another key aspect of the DC microgrid operation is the stabilization of the main DC bus voltage. In the case of island operation, it must be ensured by the DC / DC converter control system. It is important here to maintain an appropriate and stabilized voltage level, regardless of the disturbances introduced by the AC grid and the step changes in the energy flow in the microgrid. he main challenges and methods of solving them are highlighted.

#P-21

3D printed THz MIMO diffractive structures

Mateusz Kałuża

The development of telecommunication systems requires fast, wireless signal transmission. One of the possible solutions is a multiple-input multiple-output (MIMO) system for the terahertz (THz) radiation range, which significantly increases the optical channel data transfer ratio. The MIMO system can be realized using two diffractive optical elements (DOEs): multiple-input single-output (MISO) used for coupling (multiplexing) of the THz radiation and single-input multiple-output (SIMO) for demultiplexing of THz radiation.
SIMO and MISO structures were designed using the iterative ping-pong algorithm, known from computer-generated holography. SIMO and MISO holograms in the form of the grey-scale bitmap are presented in Fig. 1a and Fig. 2a.

Fused deposition modeling (FDM) technology was used in the manufacturing process of structures. Our research and material measurements show that in the THz radiation range, some polymer materials like Cyclic Olefin Copolymer (COC) or Styrene Butadiene Copolymer (SBC) have desired optical properties and can be used in the manufacturing of phase structures. The fabricated SIMO and MISO structures are shown in Fig. 1b and Fig. 2b. The obtained simulation and experimental results indicate on correct performance of both structures. MISO structure combines and focuses incoming off-axis radiation on the optical axis. SIMO structure splits radiation asymmetrically to the optical axis, which can be applied in time-division multiplexing.

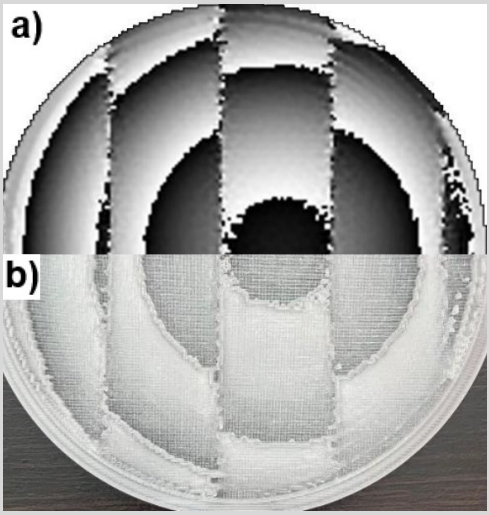

Fig. 1 FSIMO structure, a) phase distribution generated with iterative algorithm, b) lens fabricated with FDM 3D printing technique from COC material.

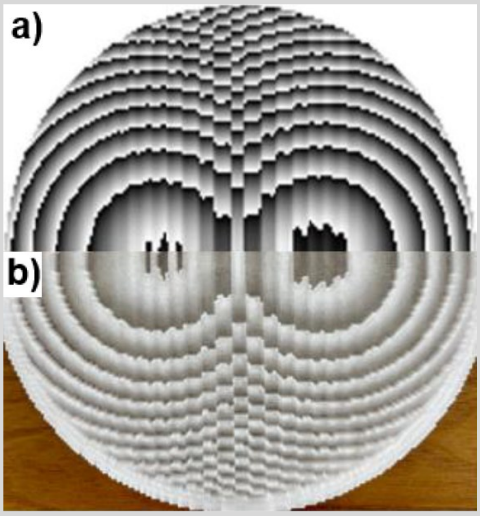

Fig. 2 MISO structure, a) phase distribution generated with iterative algorithm, b) lens fabricated with FDM 3D printing technique from SBC material.

#P-22

A denoising and Fourier Transformation-based spectrograms in ECG classification using Convolutional Neural Network

Muhammad Farhan Safdar

The non-invasive Electrocardiogram (ECG) signals are useful in heart condition assessment and are found helpful in diagnosing cardiac diseases. However, traditional ways require effort, knowledge, and time to interpret the ECG signals due to large data size. Neural networks have shown to be efficient recently and can play an essential role in interpretation. The purpose of this work was to increase the classification accuracy and to reduce the data size by retaining the essential information through Fourier Transformation.

In this study, we adopted the diverse approach by acquiring spectrograms as an input to convolutional neural network model. A large publicly available PTB-XL dataset was utilized, from which two datasets were prepared i.e., spectrograms and raw signals to classify the signals as myocardial infarction. The signal denoising, unnecessary frequency filtration and Short Time Fourier Transformation were applied to generate the spectrograms. Further, we performed up and down sampling of the signals at various points and accuracies attained. The classification model was assessed on spectrograms and raw signal datasets separately. Study results revealed that the spectrograms achieved high accuracy of 99.06% with 100% precision and 0.04 minimum loss. On the other hand, 75.93% accuracy was obtained on raw signal dataset. The conversion of raw signals into spectrograms can achieve better classification results with early convergence and holds less physical memory.

#P-23

Intercalation and exfoliation of graphite by SO3 molecules

Milena Ojrzyńska

High quality and high yield production of graphene flakes is the goal of today's graphene technology that would allow commercialization and industrialization. Recently developed innovative methods still suffering from low quantities, controllable qualities, processability, and costs [1]. Here, we developed a simple, yet compelling chemical route for industry-scale production of few-layer graphene that relay on simultaneous nonoxidative intercalation and exfoliation of raw graphite in oleum with nearly 100% efficiency, one of the highest ever reported. High yield is enabled because un-bounded SO3 molecules dissolved in sulfuric acid can effectively intercalate the graphite boosting spontaneous exfoliation and providing undefected, thin graphene flakes. The X-ray and vibrational spectroscopy confirm the absence of defects and oxides in the graphene layers and the electron microscopy and diffraction method show the structure.

Acknowledgments: This research was supported by the PRELUDIUM BIS project (UMO2019/35/O/ST5/01440).

#P-24

O-RAN Beamforming

Mustafa Mohsin

The open radio access network (O-RAN) concept is changing the landscape of mobile networks (5G deployment and 6G research). O-RAN Alliance's suggestions that O-RAN can offer openness and intelligence to traditional RAN vendors will enable the multi-vendors capability to reshape the RAN structure and optimize the network. One of the main challenges of the O-RAN approach is beamforming implementation. From this point, this seminar will discuss the beamforming methods in O-RAN, address challenges and potential solutions, and suggest the introduction of zero-forcing as a precoding vector in the channel-information-based beamforming method. This may be one of the solutions for achieving flexibility in a high-traffic communication environment while reducing the radio unit interferences caused by implanting the precoding in the open radio unit.

#P-25

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

Konrad Kamiński

In my research I want to find method to effective use Polish ID Card with an electronic layer to authenticate Orange Polska employees and partners (maybe clients in future). Goal is to create strong authentication method during a remote contact. Orange Polska works now in a hybrid model, and many employees have decided to use teleworking. Additionally Orange migrate its cybersecurity paradigms to strict control access, also from internal network. A main tool to strong authentication in Orange is smart card with X.509 certificates. But corporate smarty card must be secure delivered and activated by user, and it can be accidentally broken or locked. Therefore, it is important to find an alternative method of remote strong authentication.

Polish ID Card use NFC (Near-field communication) interface to exchange an information with other devices. The main problem is the communication between the user's computer and his ID Card. Second problem is secure integration ID Card authentication with organization systems.

Now my focus is on using ID Cards in Organizational Identity Provider. I was able to verify the concept to authenticate person with an ID card using a USB NFC reader. At first stage I plan to allow users to authenticate with USB NFC reader. This stage will be very limited due to low availability of readers. In parallel I search method to develop remote NFC reader solution, based on smartphone with NFC interface.

#P-26

Modeling physical processes in a group of eukaryotic cells exposed to ionizing radiation

Julianna Krasowska

The purpose of my work is to analyze intracellular processes, with particular focus on the processes that occur in cells exposed to ionizing radiation, and to develop a model implementing these effects while preserving their stochastic nature.

The knowledge and understanding of the effects of ionizing radiation on cells is particularly important in radiation protection (radiation accidents), epidemiology (effects of an increased radiation background) and oncology (radiation therapy).

The effects of ionizing radiation on cells have been studied for many years, and while the effects of high doses of radiation are relatively well understood and described, the phenomena associated with low doses, such as the adaptive response or the bystander effect, are still quite mysterious for us. One of the important effects of ionizing radiation, which the model being developed will implement, is the induction of mutations and carcinogenesis in cells, which can occur even after a long time after exposure to radiation. Therefore, to simulate the long-term effects of ionizing radiation, it is important to take into account natural cellular processes such as spontaneous damage and repair, cell death and proliferation.

The present model implements all the mentioned effects in a simplified way, but it is important to choose the right functions to best describe these processes. Which will be the next part of my work.

#P-27

Platform for malicious clients detection in federated learning

Dominik Kolasa

Federated learning is a process where many clients contribute to the global model. In this scenario I found that some of the clients may intentionally or by a mistake provide wrong updates to the global model. I address this issue to filter such contributions. I've developed a new method where no testing data is required. The research shows that the method works for different setups, filters out malicious clients accurately when compared with other methods and does not require any data to run. I developed a model using multiple protection strategies - testing, weights comparison method and rating. Currently I am working on an implementation of a federated learning platform with malicious clients protection enabled. The platform gives the ability to test malicious protection against different datasets.

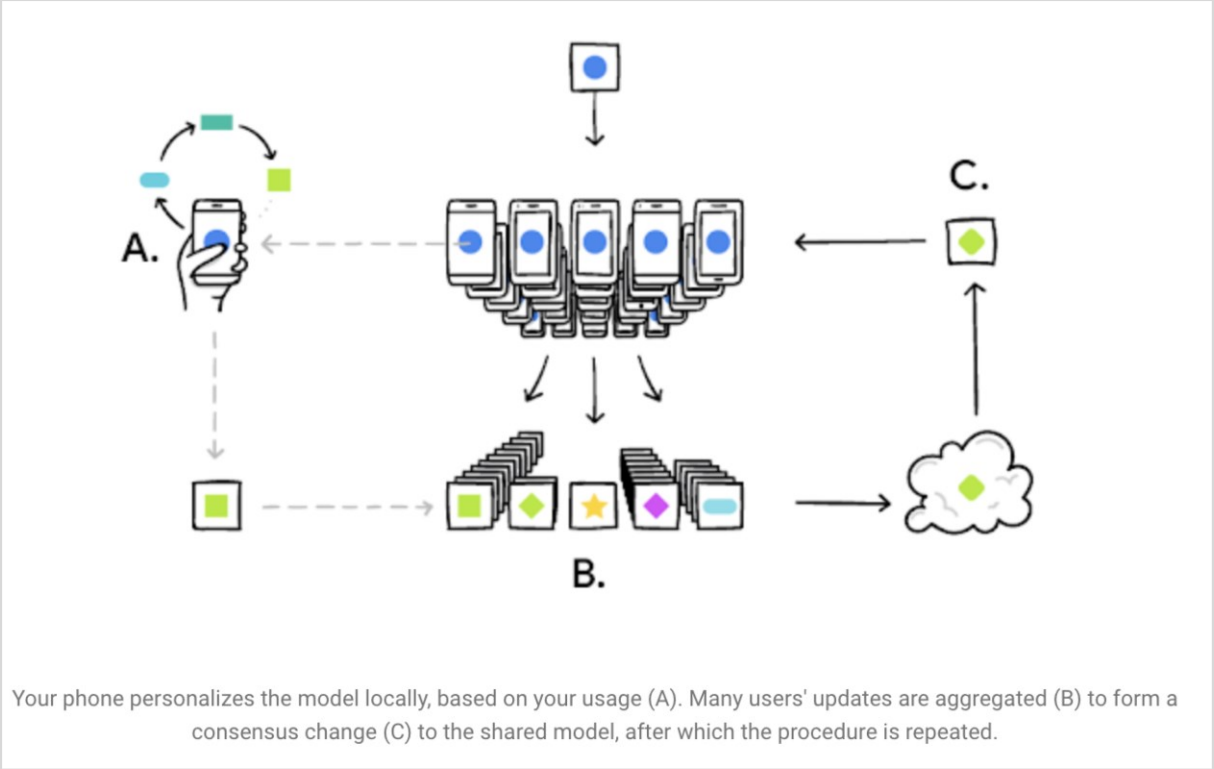

Fig. 1 Federated learning with mobile phones.

Federated learning is a new way of distributed machine learning for multiple clients. It can be used to train models using mo-bile phones, IOT devices and any device which has the power to compute a training round. All of them collaborate to build a global model. In my research I am trying to resolve problems with malicious updates which may affect federated learning process and cause the global model to predict even randomly.

#P-28

Measurements of the parameters of the integrated circuit at cryogenic temperature

Adam Borkowski

One of the major obstacles to the design of integrated circuits operating at cryogenic temperatures is the lack of simulation models provided by the manufacturer. Typically models provided in Process Design Kit (PDK) are valid down to -55°C. Therefore, the aim of this experiment is to investigate the effect of very low temperature (4K) on the performance of an integrated circuit. For this purpose, a dedicated printed circuit board has been designed to be placed in the cryogenic chamber. Using the USB interface and the python library it will be possible to integrate the whole into the measurement system.

The integrated circuit (IC) that will be measured is a fully integrated Global Navigation Satellite System receiver containing: multi-core microcontroller, radio frequency and baseband signal processing chain, analog to digital converter, power management circuits and clock generators including phase locked loop. Although the IC is a complex system measurements that are planned, include basic parameters, such as: reference current, reference voltage, clock frequency, phase locked loop frequency, and LNA scattering matrix. The characterization assumes that the microcontroller that is in the system is working (additionally the PLL, which is supplied by the clock). At such low temperatures, this assumption may be wrong. In case the system will fail other solutions will have to be considered. One possible approach is preconfiguring the system at room temperature and placing

#P-29

Femtoscopic correlation between D^0-hadron (π, k, p) pairs within STAR experiment

Priyanka Roy Chowdhury

The main goal of the project is to measure the femtoscopic correlations of D^0 mesons with charged hadrons (pion, kaon, proton) in Au-Au collisions at center of mass energy per nucleon pair $\sqrt{S_{NN}}$ = 200 GeV in the STAR experiment at RHIC (Relativistic Heavy Ion Collider). The project is related to the studies of Quark Gluon Plasma (QGP) properties with a measurement of the J/ψ ($c\bar{c}$) production. In heavy ion collision, suppression in J/ψ production is a proof of presence of QGP state. On the other hand, there's a possibility of production of secondary J/ψ from the produced charm quarks in QGP state. To study the secondary J/ψ production, we need to calculate the correlation function between charm and anti-charm quarks but that is difficult.

We propose to measure the effective size of the source r_0 from which correlated pairs of D-mesons and hadrons are emitted. From r_0 we can calculate the effective volume V_{eff} of the source. For a strong correlation between $c/\bar{c}$ (from D^0 candidates) and hadrons (charm or any other quarks), source size (where $c/\bar{c}$ quarks interact with other partons in the QGP) will be small compared to the size of the fireball in the QGP and vice-versa. By fitting the analytical result into a suitable model, a conclusion can be drawn for the $c-\bar{c}$ correlation which is the determinant factor for the secondary production of J/ψ meson in the QGP. Using Au-Au run 2014 and 2016 data, we calculated the correlation function for D^0-(π/k/p) pairs and applied corrections.

#P-30

Variant-based business processes simulation

Michał Ostapowicz

The typical way of simulating business processes is to use Petri nets as a data structure that contains information about the state of each business process case in the environment. This way, we can precisely reflect the structure of business processes i.e., concurrency of executed tasks.

The abovementioned approach has a significant drawback that makes simulating processes discovered from real-life event logs difficult.

Petri nets mined from complex event logs include artificially created places and transitions that were not present in the original event log. That makes simulating transitions between tasks based on the frequency probability almost impossible while keeping the complexity of the actual event log.

A novel approach to simulating business process cases uses business process variants extracted from the event log. Doing so makes it possible to avoid using Petri nets since we a priori know what all the process cases can look like. To do so, I use the PM4PY Python library and also get the frequency for each variant appearing in the event log. Also, the other important part of the simulation is calculating the duration of each task in the business process while executed by the particular resources present in the environment. The duration of a task executed by the given resource is calculated as the median of all such occurrences. To make this calculation statistically significant, I exclude all resources that completed a task fewer than a specified number of times.

#P-31

A simple neural network for detection of various image steganography methods

Mikołaj Płachta

Information security is becoming an increasingly important issue in our world. As a result, more and more sophisticated attack methods are emerging, and among them are methods using image steganography. Therefore, in the first part of my research for my dissertation, I focused on methods for automatic detection of this type of steganography. The main part of my research is the use of deep machine learning methods. For feature extraction methods, several methods were tested. The first idea was to analyze the discrete cosine transform and teaching a neural network to classify JPEG images. This method did not give satisfactory results, so the next step was to use other coefficients that can extract relevant information from images and help perform detection. For this purpose, DCT Residuals (DCTR), Gabor Filter Residuals (GFR) and PHase AwaRe pRojection Model (PHARM) were used. The BossBase kit, well known in the world of steganography, was used for testing. It consists of carefully selected black and white images in amount of 10,000. Based on it, files with encrypted data were generated using jUniward, nsF5 and UERD algorithms for two data densities of 0.4 and 0.1. Pairs of images (without steganography and with hidden data) were used to train and verify the network. Research was then performed to find a single model that can perform well in multi-threat detection. It was possible to achieve a detection efficiency of 72 percent with a single model.

#P-32

Assamese Character Recognition

Kinga Pilch

Optical character recognition (OCR) is the oldest branch of pattern recognition. It refers to the conversion of handwritten letters or symbols in general to machine-coded text.

Much work has been done on OCR in Western scripts and popular languages like Chinese, Indian or Japanese. However the main Indian language in the northeast is still not examined. Assamese is spoken by over 14 millions of people. There were some attempts but the researchers achieved an accuracy of up to 90%. In their work, the major limitation of neural networks is their inability to capture spatial features in images. This problem can be omitted by using convolutional neural networks. CNNs eliminate the need for manual feature extraction as they learn features directly during training. Since no standard image data set for Assamese characters was available the cooperating institute has collected and generated handwritten drawing samples with over 12000 images.

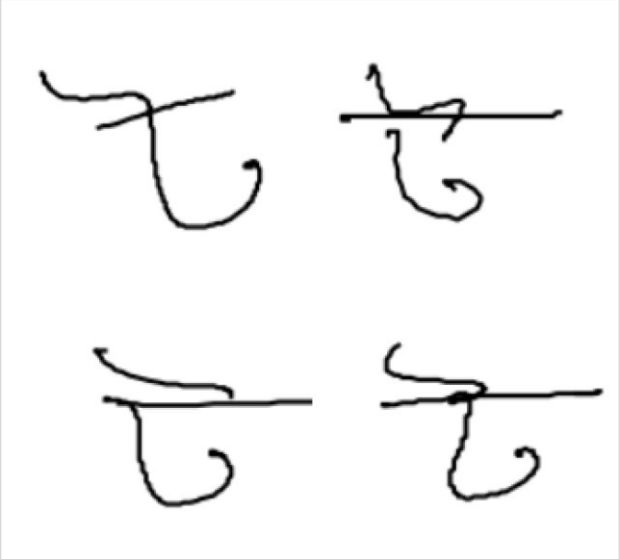

Fig. 1 Examples of Assamese letters.

The aim is to create the best possible solution for Assamese characters recognition. So far the dataset was created, images were preprocessed using different methods such as otsu binarization, normalization or image smoothing. Moreover, many models were tested, both created by myself or available online (like DenseNet 201, U-Net). Meta deep learning models were developed. The best obtained result is 95,4% so far but there is still ongoing work on improving this result.

#P-33

Multi-incident holography profilometry for low and high gradient object

Moncy Sajeev Idicula

Digital holographic microscopy (DHM) is a non-contact, profilometric tool that allows obtaining microscopic object topography from the captured holograms. However, the use of DHM is limited when the object under observation has a high gradient or is discontinuous. Multi-angle digital holographic profilometry (MIDHP) is an alternative solution for overcoming this limitation for measuring the topography with discontinuities. This method combines digital holography and multi-angle interferometry. The method requires a certain number of holograms that are processed into a longitudinal scanning function (LSF). The topography of the object is recovered by finding the maxima of the LSF. MIDHP enables to enlarge the measurement range and provides a high axial resolution. This paper investigates MIDHP to measure surfaces with various (low and high) surface gradients. The calculations of LSF requires many Fourier Transforms (FT) and the computations are slow. In this paper, we improve LSF calculations by introducing two algorithms. The first algorithm reduces the number of FT needed by applying summation in the frequency domain. The second approach applies the method of 3D filtering, which improves the quality of the reconstructed shape. The introduced approaches are verified both numerically and experimentally.

#P-34

Dynamic control for autonomous underwater vehicle (AUV) with variable-buoyancy propulsion.

Zbigniew Kostka

A glider is an underwater robot that utilizes variable-buoyancy propulsion instead of standard propulsion systems employed in the most of the conventional autonomous underwater vehicles (AUV). At the water surface, the robot becomes negatively buoyant and sinks down to a certain depth, where its buoyancy becomes positive, thus it returns back to the surface. The motion is controlled by moveable internal weights that travel back and forth, changing the vehicle's center of gravity and in the result altering its trajectory. Such a cycle is called saw tooth glide pattern. The vehicle usually moves at very low speed, but it can operate for months and traverse thousands of kilometers, what makes it very energy efficient method of collecting information on ocean conditions. This class of UAV is underactuated, what leads to their limited maneuverability.

The research focuses on finding a new control algorithms that can address the issue. In the first stage of the process, a mathematical model that would simulate the glider in two-dimensional space was created and some simple movement strategies (LQR and Dubin's path) were prepared. In such a setup, the vehicle is limited to vertical movement only. In the next steps, the model will be moved to full 3D space and it will be tested on real hardware with an appropriate electronics and communication system.

#P-35

Towards Unsupervised Visual Reasoning: Do off-the-shelf features know how to reason?

Monika Wysoczańska

Recent advances in visual representation learning allowed to build a plethora of powerful features that are ready-to-use for numerous downstream tasks. Contrary to existing representation evaluations, the goal of this work is to assess how well these features preserve information about the objects, such as their spatial location, their visual properties and their relative relationships. We propose to do so by evaluating them in the context of visual reasoning, where multiple objects with complex relationships and different attributes are at play. Our underlying assumption is that reasoning performances are strongly correlated with the quality of visual representations. More specifically, we introduce a protocol to evaluate visual representations for the task of Visual Question Answering. We build an attention-based reasoning module with limited capacity trained on top of the frozen visual features to be evaluated. In order to decouple visual feature extraction from reasoning, we design a specific attention-based reasoning module of limited capacity and trained on the frozen visual representations to be evaluated in a spirit similar to standard feature evaluations relying on shallow networks. This involves constraining the complexity of the reasoning module as well as the size of the visual features. Using the proposed evaluation framework, we compare two types of off-the-shelf visual representations, densely extracted local features and object-centric ones.

#P-36

Subalgebras of matrices satisfying some identities

Paweł Matraś

In ring theory algebras, which are rings with a structure of linear space, satisfying identities form an important class. For them, there are known different structure theorems, not true for rings in general. On the other hand, the problem of determining subalgebras satisfying a given identity in a fixed class of algebras is also interesting. One of the simplest examples of algebras with identity are commutative algebras.

The classical problem solved by Schur was to determine the maximal dimension of a commutative subalgebra of matrices over a field. Later, with some restrictions on a field, a characterization of commutative subalgebras of matrices with maximum dimensions up to conjugation was proven. In last years maximal dimensions of subalgebras of matrices with identities generalizing commutativity were found.

We develop study of these algebras, characterizing one of them up to conjugation. We also study the isomorphism problem and other structural problems.

#P-37

Steinberg Algebras

Anna Cichocka

Steinberg algebras are an example of associative algebras defined based on ample topological Hausdorff groupoid. For any considered commutative ring $\boldsymbol{R}$ with a unit and an ample groupoid $\boldsymbol{G}$, the elements of Steinberg algebra $\mathcal{A}_R(\boldsymbol{G})$ are functions acting on $\boldsymbol{G}$ in $\boldsymbol{R}$ satisfying certain specified properties. The class of Steinberg algebras $\mathcal{A}_R(\boldsymbol{G})$ is a generalization of such classes of algebras as, for example, the graph algebras of Leavitt paths.

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#P-38

Drone Detection with 5G - based passive radar

Radosław Maksymiuk

This poster presents the first successful drone detection results using a fully operational and cooperative 5G network as a source of illumination in a passive radar system. Also, a novel adaptive strategy for signal integration is shown. The proposed approach is based on the Rényi entropy. It allows one to select time frames with a densely allocated downlink channel both in the time and frequency domains. The resource allocation is strongly related to a network load and has a crucial influence on passive radar range resolution and detection capabilities. The proposed technique was validated using simulated and real-life signals confirming the possibility of detecting unmanned aerial vehicles (UAVs) in a 5G-network based passive radars. Moreover, the proposed methodology can be directly used in passive radar systems where the illuminating signal duration and bandwidth are content-dependent, and the radar resolution may vary significantly.

#P-39

Object 4D tracking in lensless digital in-line holographic microscopy

Mikołaj Rogalski

Lensless digital in-line holographic microscopy (DIHM) is a well-known technique that enables observing specimens in a large field of view (even above 100 mm2) and without optical aberrations. DIHM hardware setups are usually composed of only illumination source, camera and the sample placed between those, Fig1(a). On the camera there is recorded a sample's Gabor hologram, which then needs to be backpropagated to the object plane to recover the measured object's complex optical field (both amplitude and phase information). DIHM is also faced with a several challenges, that need to be solved to provide satisfactory specimen's imaging. One of them is the problem of finding the propagation distance at which the retrieved optical field of the object would be in-focus, what is usually done by applying one of the several proposed autofocusing algorithms. Those algorithms are robust as long as the sample is placed only in a single focus plane, to which the hologram will be backpropagated. However, when the DIHM is used for observing a group of objects placed at different distances form the camera, in the single reconstruction only a single plane may be reconstructed in-focus.

Here is presented an algorithm called DarkTrack, that can reconstruct 3D object positions from a single 2D hologram or to perform 4D tracking (x,y,z,time) from the hologram series. It is based on classical binarization-based methods for segmenting the objects in 2D (x,y) and then it is applying the DarkFocus autofocusing algorithm individually to each found object, to find its defocus distance (z). Processing path finishes with objects temporal linking across different frames (time). Proposed algorithm is evaluated both on simulated microbeads, Fig. 1(b), and experimental data consisting human spermatozoids, Fig. 1(c),(d).

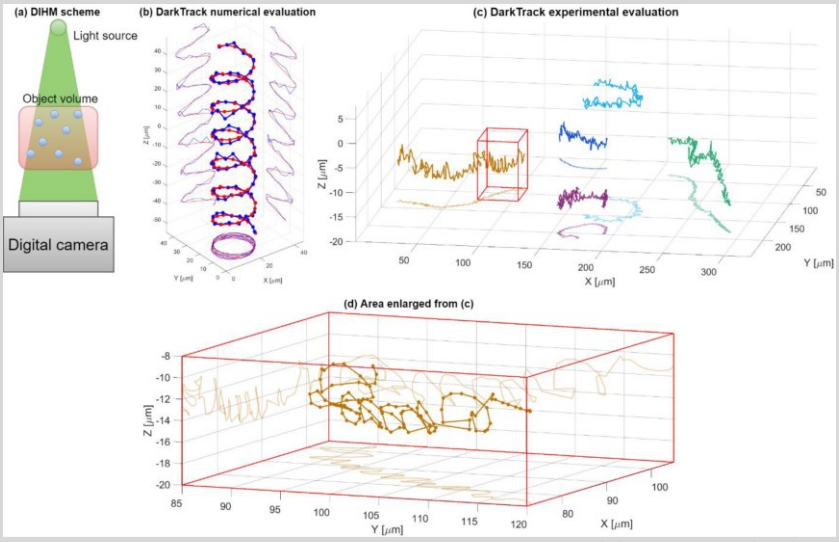

Fig. 1 (a) scheme of a DIHM system for imaging a high depths volumes, (b) simulated (red) and reconstructed (blue) 4D locations of the 5 µm microbead, (c) reconstructed 4D locations of the human spermatozoids, (d) enlarged fragment from (c), where the spermatozoid spiral movement may be observed.

#P-40

A unified framework for testing image captioning models.

Mateusz Bartosiewicz

My doctoral dissertation focused on investigating methods and algorithms for image captioning. The work aims to automate the process of generating image descriptions in the form of sentences fully describing the scene.

Unified Testing Framework allows to automate the process of designing image captioning models and provides a repeatable, heterogenous data environment to test models at each stage of development. Furthermore, it provides a unified input data structure that the model can easily use.

The framework is applicable in each stage of development of the target model. It allows focusing on designing model architecture rather than other steps like data loading, data preprocessing, or building an evaluation engine. Framework support COCO, Flickr8k, Flickr30k datasets, and available languages are Polish and English. Users can also shuffle splits of mentioned datasets.

Unified Testing Framework is built along six general-purpose modules. It operates on the basis of a configuration file, where the user defines the source dataset for the training and testing stages. In the Data Loader module, data is loaded to the unified structure accordingly to the configuration defined in the configuration file. Data Processor prepares captions and images to be consumed by the model. Users can entirely change components of this module to check how it affects the training results. In the Model module user defines the general Image Captioning model. The sample is already provided in the Framework source code. Model Evaluator is a part of the testing stage and evaluates the model with the BLEU_1-4, METEOR, CIDEr, WMD, ROGUE, and SPICE metrics. Implementations are placed in the separated module to maintain consistency in the versions of implementations of those metrics. Finally, Framework generates a report, with all previously mentioned metrics, separately for each caption from the test set and, overall, for the whole test set. Furthermore, the general overview of all testing results is generated for all previously run metrics.

Unified Testing Framework provides easy to run and customize research environment. It may be applied to check how datasets affect the results of the particular model run.

#P-41

Rank distribution in Github networks

Przemysław Nowak

In the studies of scale-free networks, where degree distribution follows a power law, there are dosen of methods to analyse them. Most of them focus on heavy-tailed distribution, where the main goal is to compute power law exponent.

In our case, we switch perspective into rank-size distribution, which is a distribution of size by rank, in decreasing order. From mathematical point of view, it's nothing but inverse survival function of given random variable. However, this allow us to recreate new methods to fit parameters and compute goodnes of fit.

This way we perform mentioned methods for the networks of commits from GitHub. Recently we discover that DGBD (Discrete Generalized Beta Distribution) is a good model to predict numer of commits in various repositories from GitHub – from small to big, from open source to closed source, and many more.

#P-42

Efficient anomaly class detection and comprehension using segmentation techniques in RGB images

Marcin Macias

In this poster I have collected all the motivation and the information related to my current research. The main goal of my PhD thesis is to improve existing algorithms or propose new ones that can be used in the problem of automatic detection and comprehension of small objects in the RGB images. The real life examples of such classes that I currently focus on involves labels used in the retail stores that contain price information about the presented product. Those labels can be treated as anomalies on the initial image, if we compare their size with rest of the image. This data is usually easily noticeable by a human eye and is highly important for the later analysis. Nowadays this price tag detection is quite important due to high inflation worldwide. My task requires usage of different image analysis, segmentation and processing techniques and each of those methods has some known drawbacks and minor imperfections that I hope to improve. After the complex research of state-of-the-art literature, I have focused my efforts on the implementation of such processing flow and collection of benchmark dataset from the real life examples. I am currently finishing the implementation phase and moving to experiments and validation of my work.

#P-43

Modelling of Generic Process Design Kit (PDK) Components for Photonic Integrated Circuits (PICs)

Andrzej Polatynski

Recent developments in versatile Photonic Integrated Circuit (PIC) technologies and hybrid integration processes offer a flexible and cost-efficient way for creating very complex photonic components and integrated circuits for many applications. The fast and efficient test, optimization and verification of new ideas requires an automated and reproducible simulation and design process supporting flexible layout-aware schematic-driven methodologies. When considering very complex designs, even small fabrication tolerances of one building block could make a significant difference in the performance and manufacturability of the whole structure. To reduce the risk of failure and to make performance predictions by virtual prototyping reliable, the simulation model of each single building block needs to be working correctly based not only on the appropriate mathematical and physical equations but also on adequate information provided by the foundry where the final structure will be manufactured.

Within the MIRPIC project, we address these design challenges and establish a new versatile integration platform working at the Mid-Infrared wavelength range covering numerous photonics applications in the sensing market. In this poster, I will present our recent platform developments working at the MIR wavelength range (from 3.0 μm to 5.2 μm), including methodologies for modelling and prototyping optical elements and simulation techniques for optimization of crucial parameters. I will demonstrate how the seamless integration between the photonic circuits design tool and foundry knowledge enables the rapid virtual prototyping of complex photonic components and integrated circuits.

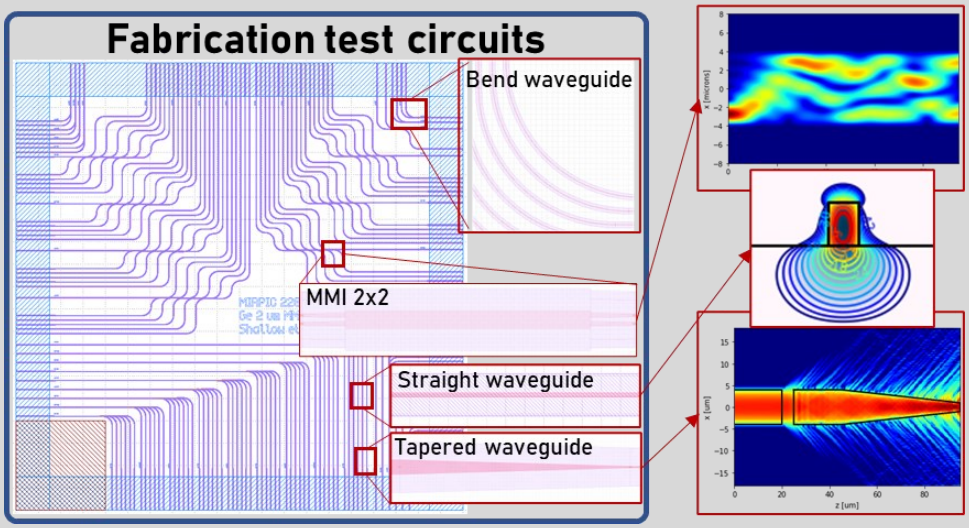

Fig. 1 Exemplary test circuit including developed PDK building blocks.

This work received support from the National Centre for Research and Development through MIRPIC project (TECHMATSTRATEG-III/0026/2019-00).

#P-44

Robotic eye surgery

Ali Soltani Sharif Abadi

In recent decades, several surgical systems have been developed and applied for a growing variety of surgeries. The robotic eye surgery topic will consider the significant challenges of robotic surgery for the eye. These challenges consider the different eye diseases, available technologies, and costs in different surgical systems for the eye. Considering relevant control engineering concepts, the conditions of a suitable controller will be discussed. Comparisons will be made between the different characteristics of surgical robots for the eye. In this topic, some comparisons will be made in eye surgical robots, control algorithms, sensors in surgical robots, communication protocols, and actuators. This poster shows the main objectives of the robotic eye surgery topic, the next steps of its studies, and current progress and published papers.

#P-45

Measurement Error Correlation in FMCW Radar with Processing of Overlapping Blocks

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The paper investigates measurement error correlation caused by the processing of overlapping blocks in FMCW (Frequency-Modulated Continuous-Wave) radar. The problem is analyzed theoretically by discussing the impact of measurement error correlation on tracking and mathematical evaluation of the effect. Statistical properties of measurement for both range and radial velocity in the radar influence operation of the tracking subsystem, therefore must be quantitatively evaluated. Processing of overlapping blocks in the FMCW radar leads to sharing part of the signal data between multiple blocks used for estimation of target parameters. Hence, processing of overlapping blocks introduces correlation between measurements. The paper describes predicting measurement error correlation to allow for proper addressing the issue in the tracking subsystem. The results are confronted with simulation and data from an real experiment. Simulations consist of emulating radar signal and evaluating statistical properties of the measurements. The real experiment involves using a radar demonstrator with an analog front-end with a fiber-optic delay line emulating stationary target. Simulations and real experiments confirm correctness of analytical derivations presented in the paper.