IDSS

1ST INTERDISCIPLINARY DOCTORAL SCHOOL SEMINAR

5-6 NOVEMBER 2020

Doctoral School No. III
Exact Sciences and New Techologies

Warsaw University of Technolody

The 1st 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

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PROGRAMME

	THURSDAY, November 5, 2020	FRIDAY, November 6, 2020
09:00	Opening Vice-Rector for Research Professor Mariusz Malinowski, PhD, DSc	Session #7, Chairman: prof. Mieczysław Muraszkiewicz
09:15		#7.1: Jolanta Sadura, Electromagnetic compatibility of the apparatus controlling the test in the environment of high-voltage and high-current laboratories
09:30	Session #1, Chairman: prof. Ryszard Piramidowicz #1.1: Jarosław Nowisz, Instant review system	#7.2: Artur Zygadło, Intelligent therapeutic dialogue agent for Polish
09:45	#1.2: Michał Kopania, Flicker remover #1.3: Agnieszka Zięba, Infinitesimal generators of quadratic harnesses	#7.3: Karolina Gabor-Siatkowska, Eyetracker in the context of mental illness diagnosis #7.4: Justyna Modliborska, Selected aspects of local flexibility markets
10:00	Coffee break	Coffee break
10:15		
10:30	Invited talk: Astrocent - or how to explore the hidden Universe Prof. Leszek Roszkowski, AstroCeNT	Session #8, Chairman: prof. Mieczysław Muraszkiewicz #8.1: Grzegorz Panek, Methods of offloading in cloud native edge computing
10:45		#8.2: Patryk Bojarski, Mutation of information in messages spreading processes in social networks #8.3: Katarzyna Woźnica, Towards better understanding of meta-features contributions
11:00	Session #2, Chairman: prof. Ryszard Piramidowicz #2.1: Arkadiusz Czuba, Cognitive Radar	#8.4: Małgorzata Andrzejewska, Time irreversibility in the assessment of the state of the human cardiovascular system
11:15	#2.2: Jerzy Cuper, An accurate methods for conductive layers and dielectric samples characterization in millimeter-wave and THz frequencies	
11:30	#2.3: Karolina Okrasa, Complexity of H-coloring in restricted graph classes #2.4: Aleksandra Osowska-Kurczab, How deep learning can contribute to renal tumour diagnosis	Lunch break
11:45		
12:00	Lunch break	
12:15		Invited talk: Infrared detectors – technology and applications Dr Adam Piotrowski, VIGO System S.A.
12:30	Session #3, Chairman: prof. Michał Bartyś	Session #9, Chairman: prof. Andrzej Dzieliński
12:45	#3.1: Jacek Piłka, Formation of optical beams in nematic liquid crystals	#9.1: Marcin Sowański, Multilingual Machine Translation System for Dialogue Agents
13:00	#3.2 Małgorzata Żebrowska, Nonlinear analysis of physiological variables in the assessment of adaptation to physical effort	#9.2: Artur Słabuszewski, Continuous embeddings of fractional Sobolev spaces #9.3: Mikołaj Pudo, Signal Processing and Automatic Speech Recognition for Embedded Systems
13:15	#3.3: Andrzej Wojciechowski, Clock signal phase synchronization system for integrated circuits #3.4: Marcin Grząbka, Detecting human-object interactions	#9.4: Michalina Milewicz-Zalewska, Heavy ion collisions simulations for NICA-MPD. NICA-MPD assembly and calibration.
13:30	Coffee break	Coffee break
13:45		
14:00	Session #4, Chairman: prof. Michał Bartyś #4.1: Bartłomiej Hryniewicki, A suboptimal strategy for automatic control of multi-dimensional wood drying process	Session #10, Chairman: prof. Andrzej Dzieliński #10.1: Michał Falkowski, Root Cause Analysis of control errors propagation in complex multi-loop systems
14:15	#4.2: German Peinado Gomez, Security in the Interconnection of Mobile Networks in the context of 5G	#10.2:Tomasz Kublin, Electrodynamic levitation system for high speed magnetic railways
14:30	#4.3: Mateusz Surma, Optimization of terahertz diffractive optical elements functioning in off-axis regime #4.4: Piotr Czarnecki, Looking to listen: Audio separation and localization with visual clues	#10.3:Tomasz Święchowicz, A comprehensive power quality conditioning system with energy storage for low voltage distribution networks #10.4:Priyanka Roy Chowdhury, Study of the Quark-Gluon Plasma using heavy quarks in the STAR experiment
14:45	Coffee break	Coffee break
15:00		
15:15	Session #5, Chairman: prof. Marcin Iwanowski #5.1: Konrad Krawczyk, Surrogate-assisted evolutionary algorithms	Session #11, Chairman: prof. Ryszard Piramidowicz #11.1 Paweł Szelągowski, Review and examples of applications of vehicle recognition methods
15:30	#5.2: Marek Ciesieliski, Introduction to radar tracking	#11.2 Grzegorz Mąkosa, Integrated information and IT services management system
15:45	#5.3: Joanna Rymko, Analysis of cardiovascular regulation in patients with brain stroke #5.4: Paweł Pardela, Training NLU Models on End User Devices with Privacy Protection	#11.3 Salomea Grodzicka, Content-based music recommendation system #11.4 Mateusz Klimaszewski, COMBO - System for Morphosyntactic Analysis of Multiple Languages
16:00	Coffee break	#11.5 Jerzy Stefanowicz, Spaceborne ship detection in synthetic aperture radar imagery using FPGA-accelerated deep learning
16:15		
16:30	Session #6, Chairman: prof. Marcin Iwanowski #6.1: Weronika Hryniewska, Applications of explainable artificial intelligence for COVID-19 on medical imaging	Wrap up session
16:45	#6.2 Szymon Baczyński, Optofluidic systems for sensing applications #6.3: Łukasz Bala, Deep learning in video quality mapping and action recognition	Backup session (optional)
17:00	#6.4: Konrad Wilczyński, Temperature-Dependent Studies of Phonon Properties of Layered Materials with the use of Ab-Initio and Molecular Dynamics Simulation Methods	
17:15	#6.5: Stanisław J. Hajnrych, Analysis, Design and Control of Novel Electric Vehicle Propulsion Drive Base on Synchronous Reluctance Hybrid Electric Machine with Integrated Epicyclic/Vernier Magnetic Gear Drives and Integrated Mechanical Brake	
17:30		

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Instant review system

Jarosław Nowisz

For the past few years, together with another Ph.D. student Michał Kopania we have built an instant review system for badminton. The system uses 14 to 20 fast cameras to track flying shuttlecock and detect when and where it landed on the floor of a court. Players may challenge the decisions of line judges when they do not agree with IN/OUT decisions.

We used our system in many tournaments. The biggest one was Badminton World Senior Championships in 2019.

To build such a system, we did quite a lot of research in the computer vision area and also invented our algorithms.

Last year we prepared a paper: "Real-time flicker removal for fast video streaming and detection of moving objects" it is now in the second round of a review process. We offer the system commercially, but we are still working on improving it. Now we concentrate on a better algorithm to detect the exact frame at which a shuttlecock hits the ground. We plan to write a paper this year describing our experiments and our method combining neural network working on sequences of raw frame patches and an ML model analyzing parameters from our trajectory approximation algorithm.

Flicker remover

Michał Kopania

For the past few years, together with another Ph.D. student Jaroslaw Nowisz we have built an instant review system for badminton. The system uses 14 to 20 fast cameras to track flying shuttlecock and detect when and where it landed on the floor of a court. Players may challenge the decisions of line judges when they do not agree with IN/OUT decisions.

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Infinitesimal generators of quadratic harnesses

Agnieszka Zięba

Infinitesimal generator of the Markov process is one of the tools which are used to describe this process. The general theory and properties of this mathematical object are well-known, because as the name of infinitesimal generator suggests, it determines transition probabilities of the process uniquely.

In my presentation I will be interested in infinitesimal generators of quadratic harnesses - a special family of square-integrable processes with linear conditional expectations and conditional variances being the polynomials of degree two where the conditioning is with respect to the past-future filtration of the process.

This class contains such well-known processes as Wiener and Poisson as well as some stochastic processes important for quantum mechanics. Typically, quadratic harnesses can parametrized by five numerical constants.

In order to find infinitesimal generators of quadratic harnesses, it is sufficient to find a solution of some equation in a special non-commutative algebraic structure. This solution depends significantly on five parameters of quadratic harness and it is closely related to the celebrated Askey-Wilson scheme orthogonal polynomials in the known cases.

Cognitive Radar

Arkadiusz Czuba

The basic concept of cognitive radar enables radar systems to achieve intelligent adaption to a changeable environment using feedback facility from receiver to transmitter. Cognitive abilities can for example adjust waveform parameters, provide very short reaction time for environment changes and help to manage tasks in multi-function radars. Implementation of cognition can drastically improve performance of new and existing radar systems. Cognitive radar architectures are based on traditional perception-action cycle, but there is still lack of research in this field. I am going to investigate a new approach which maps integrates radar system functionalities onto human-level cognitive architectures, which are part of research in general artificial intelligence. This mapping will hopefully lead to expanding cognitive radar capabilities by meta-learning, situational awareness, short-term and long-term memories or reasoning. Second part of research will consider implementation of radar functionalities such as target detection, tracking, recognition, radar resource management or waveform generation with use of modern signal processing techniques, machine learning algorithms and optimization methods. The goal is to develop more reliable, robust and effective radar system.

An accurate methods for conductive layers and dielectric samples characterization in millimeter-wave and THz frequencies

Jerzy Cuper

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

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

The second part of this research will be focused on developing reliable tool for material characterization of dielectric materials in THz regime. As a signal source we will use a commercial THz time-domain spectrometer. We are going to couple a FPOR composed of two concave mirrors with a THz beam emitted by the TDS, which seems to be the main challenge. Upon successful implementation of the concept, experiments leading to permittivity and loss tangent estimation of various materials are planned.

Complexity of H-coloring in restricted graph classes

Karolina Okrasa

A graph is a pair G=(V(G),E(G)), where V(G) is called a set of vertices of G and E(G) is some set of two-element sets of vertices of G, called edges of G. For a fixed positive integer k, a k-coloring of a graph G is a function c: V(G) -> {1,..., k}, such that c(u) ≠ c(v) for each {u, v} ∈ E(G).

For a fixed graph H=(V(H),E(H)), a homomorphism from G to H (or, in other words, an H-coloring of G) is a function h: V(G) o V(H), such that {h(u),h(v)} ∈ E(H) for each {u, v} ∈ E(G). Graph homomorphisms form a natural generalization of graph colorings: if H is a graph with k vertices and all possible edges (called a k-clique), then G admits an H-coloring if and only if it admits a k-coloring.

In my research, graph colorings and graph homomorphisms are considered mainly from the point of view of computational complexity. For example, for a fixed graph H, we study how fast we can decide if there exists a H-coloring of a given graph G.

My work is focused on the complexity of variants of graph homomorphism problems in restricted graph classes. In general, there are no known algorithms to solve most of these problems significantly faster than by a "brute force" (i.e., by enumerating all possibilities), if G is an arbitrary graph. However, the situation may change if we restrict the class of graphs G only to graphs satisfying certain properties. During the talk I will show well-known examples of such results, together with a sketch of my recent contributions to the field.

How deep learning can contribute to renal tumour diagnosis

Aleksandra Osowska-Kurczab

Though the development of modern medicine has helped lead to a surge in average life expectancy, there are still numerous obstacles waiting to be solved. One of them is the diagnosis of renal cancers. This neoplastic disease seems perplexing in detection and treatment, mainly because of unspecific symptoms. Due to this fact, almost 50% of cases are diagnosed accidentally, during imaging tests conducted towards other diseases. Early diagnosis is a crucial factor determining survival prospects and chances for minimally invasive procedures. Therefore there is a need for new methods supporting the diagnosis and treatment of renal cancers.

In my doctoral research project, I'm devoted to the development of an automated system aiming at supporting the medical doctors in detecting renal tumours basing on Computed Tomography scans. My latest works were mainly focused on methods of differentiation of 8 subtypes of renal tumours. Identification of lesion type is critical from the point of view of surgery planning and one of the most important research problems to be solved in my doctoral thesis. Deep learning, texture analysis, as well as ensemble learning, were investigated as potential building components of the detection system. The final performance of the system reached 94% of the weighted F1-score. During the talk, I present a full classification component of the system and discuss research outcomes introduced in my publications in IJCNN, CPEE and BPAST.

Formation of optical beams in nematic liquid crystals

Jacek Piłka

Nematic liquid crystals are in the researchers' spotlight for many years due to their unique properties including nonlocal response associated with the large reorientational nonlinearity making them a very useful optical material. Among others they allow for easy manipulation of light beams, both phase and polarization as well as modification of angular momentum. Recently, it has been shown both experimentally and theoretically that employing nematic liquid crystals as nonlinear, nonlocal media with reorientational nonlinearity leads to stabilization of nonlinear vortex beam.

This work mainly focuses on the novel polarization converter. Such setup containing three different nematic liquid crystal cells can convert linearly polarized gaussian beam into one of eight polarization states including space-variant ones. The device is electrically steered allowing for an easy integration with an automated setup and works in a wide spectrum. Addition of glass spherical phase plate initiating a phase rotation then can results with a single setup for linear polarized gaussian – vector vortex beam conversion.

The second presented topic will be the interaction of a linearly polarized high-power vortex and a low-power gaussian beams co-propagating in nematic liquid crystal. Due to the reorientation of molecules in medium, the first one will generate a waveguide for the second, however it will also result with appearing of a new, low-power vortex with the same charge as high-power beam.

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

Małgorzata Żebrowska

The analysis of adaptation processes in the living organisms can be considered on different function and organization levels. Recurring disturbances in body homeostasis, caused by physical effort, inducing adaptive changes in individual organs, physiological systems and comprehensively throughout the whole organism. The scope of the study includes the identification of physiological markers that can be used as non-invasive diagnostic tools to describe the adaptation processes occurring during physical effort. The assessment of couplings detection and quantitative characterization of theirs direction and strength is considered. The methodology assumes the development, testing and verification of the application of non-linear signal analysis methods used to characterize the couplings and the complexity of time series. As part of the potential tools, the entropy and correlation measures, both in classical and symbolic terms, will be considered, e.g. symbolic transfer entropy, mutual information, Granger causality. It is also planned to verify the methods of signal processing in the frequency domain, including empirical mode decomposition and Hilbert transform for the classification of fatigue development. The analyzes will be conducted on the basis of medical data, for groups of healthy people registered during cardiopulmonary exercise tests.

Clock signal phase synchronization system for integrated circuits

Andrzej Wojciechowski

Multiple individual systems synchronization is a major issue. It's importance increases with the demand for higher precision, reliability and speed. Over the years, multiple synchronization methods were invented, but most of them operate in larger scale (from seconds to individual clock cycles). For higher precision, phase of the clock signal needs to be adjusted. This creates a need for phase synchronization system that will enable high precision synchronization on sub-clock cycle level. This kind of system needs to be implemented in integrated circuit to ensure sufficient performance.

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

Current works include synchronization system's architecture concept, coarse mathematical model and early version of the operation algorithm. Computer simulations are in progress. Next steps include the actual design of the system and actual parameters extraction for further simulation.

Detecting human-object interactions

Marcin Grząbka

Understanding interactions between objects is a crucial element towards detailed scene understanding.

Recent achievements in object detection using Deep Neural Networks allow a step forward from image level interaction classification to instance based interaction detection. An important sub task involving human as the activity performer is called Human Object Interaction (HOI) and recently gained much attention in computer vision society.

HOI struggles to detect human, objects and infer an interaction creating a triplet <human, verb, object> with corresponding bounding boxes. Because a human can sit on a chair and work on a laptop at the same time HOI is a multi label classification problem. In contrast to typical action recognition task HOI is being processed on static images (frames). Potential benefits are image captioning, image retrieval and human behavior analysis.

Typical HOI processing pipeline consists of three stages: object detector, human/object/spatial stream and interaction classification layer. Object detector (typically Faster-RCNN with ResNet50 backbone) is responsible for detecting objects in a scene, human/object streams process detected instance features and spatial stream infers their relations. Most commonly used data sets are HICO-DET and V-COCO.

The goal of the research is to infer about detailed human behavior in a continuous sequence using detected human-object interactions.

A suboptimal strategy for automatic control of multi-dimensional wood drying process

Bartłomiej Hryniewicki

The drying process of wood has been studied and described for many years. Very complex physical and chemical phenomena are taking place during the wood drying process. This was the main reason why the accurate model of this process was not available. Therefore, in practice, the wood drying process is commonly performed by experienced operators. They typically take care of keeping the approximately constant speed of the drying process. However, this strategy significantly extends the duration of the drying process and increases the consumption of energy. On the other hand, this strategy ensures the demanded quality of the wood.

The early stage of performed research was devoted to developing the physical model of the water and temperature flows in the wood during the drying process.

Next, the water and temperature flow simulation has been implemented by means of the finite element approach. This model is useful for predicting and tracking the drying process. However, it does not allows for having direct insight into the internal wood stress distribution and specific energy consumption. Regarding the aim and topic of the dissertation, these issues are crucial for further works. Therefore, soon the functionality of the developed model will be extended.

These actions will allow for developing a process control strategy that hopefully significantly increases the wood's final quality while reducing time and energy consumption.

Security in the Interconnection of Mobile Networks in the context of 5G

German Peinado Gomez

The Research work aims to deliver a framework supporting the practical Security implementation within the new 5G networks interconnection schemes, with focus on Roaming scenarios and associated Security Service Level Agreements. This framework shall include the definition of key security risk indicators in 5G interconnection, as a basis to establish technical measures and related parametrization used in the Security Service Level Agreements. The obtained results shall serve to build a trust maturity model with the use of AI/ML technics to automate the adoption of Security policies and controls based on the interchanged data.

Optimization of terahertz diffractive optical elements functioning in off-axis regime

Mateusz Surma

Diffractive optical elements (DOEs) can be part of any optical setup designed for narrowband system. DOE's reduced volume leads to the reduction of the total weight of the setup. Although, in on-axis regime parameters of DOEs may be similar to refractive optics, the design procedure is entirely different. In off-axis case refractive elements becomes very bulky and some configurations are even not possible to be realized.

DOE design methods are independent of selected wavelength, which opens the use of terahertz (THz) radiation as a potential choice for testing of designing procedures. Additionally, THz radiation is attractive due to the availability of relatively easy and cost-effective production methods such as 3D printing.

The issue related to finding DOE's shape can be interpreted as optimization problem, especially in off-axis case. In this way the optimization methods search for solution (DOE's phase distribution - single- or multi-plane structures) that binds known input and output intensity distributions. However, one of potential improvements is to optimize DOE phase distribution to assure forming complex output intensity pattern working in broader spectral range.

This presentation introduces basic concepts connected with design and production of DOEs with special focus on THz radiation band and off-axis focusing. Then, the overview of optimization methods is provided with perspective of use in the design of broadband and focusing off-axis DOEs.

Looking to listen: Audio separation and localization with visual clues

Piotr Czarnecki

Presentation on IDSS covers current progress of research related to build model able to localize and separate sounds on unconstrained videos. Unconstrained videos are the ones available on services like YouTube, mostly created by amateurs, not professional produced video content. Such content usually contains raw audio (usually mono, with unwanted noise e.g. wind, sounds of street, etc.), or replaced raw audio with voice recorded by lapel mics, mixed in a single channel in case of more speakers. Ultimate goal is to separate sounds of all visible objects on screen which make sounds, additionally separate all sounds from out of visual scene. Separated sounds of objects should be localized properly on screen.

One of the goal of research is to localize and separate voices (human sounds) in order to enhance audio by adding spatial information correlated to video, i.e. if there are two speakers, each on other side of screen, voice of the one on the right side should be audible on the right speaker, voice of speaking person on the left side should be audible on the left speaker. This feature is important to enhance audio experience, especially when listening on headset, or watching content on big screens.

Current research focuses on improvements in quality and processing complexity of model for voice processing. Presentation covers review of existing approaches for Audio-Video processing for voice sources separation and localization. There are two main approaches for model training, one based on synchronization or simpler correspondence, second based on voice separation. Both approaches usually utilise similar model architecture which also is planned shortly to be presented. As a presentation summary, It is planned to show sample result of own model.

Surrogate-assisted evolutionary algorithms

Konrad Krawczyk

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

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

Introduction to radar tracking

Marek Ciesielski

The presentation shows some of the most important issues related to radar tracking. It focuses on estimating the parameters of the observed object such as distance and radial speed. It also describes ways to improve the results with the Kalman filter. There are some simulations and measurements that confirm the effectiveness of the presented solutions and indicate the direction of actions for further improvements.

The primary task of a typical radar tracker is to handle plots. Plots are produced in the previous processing steps during the detection process. Tracking module In the radar system may have to handle millions of plots every millisecond. They can be real or fake, but always contain some informations about the probable echoes from the targets such as:

- distance,
- radial velocity,
- acceleration,
- SNR,
- amplitude,
- azimuth angle,
- elevation angle.

A simplified example is shown in Figure 1. Plots (yellow stars) were detected within 7 seconds of observation with 200 ms of integration time. Some of them come from the drone

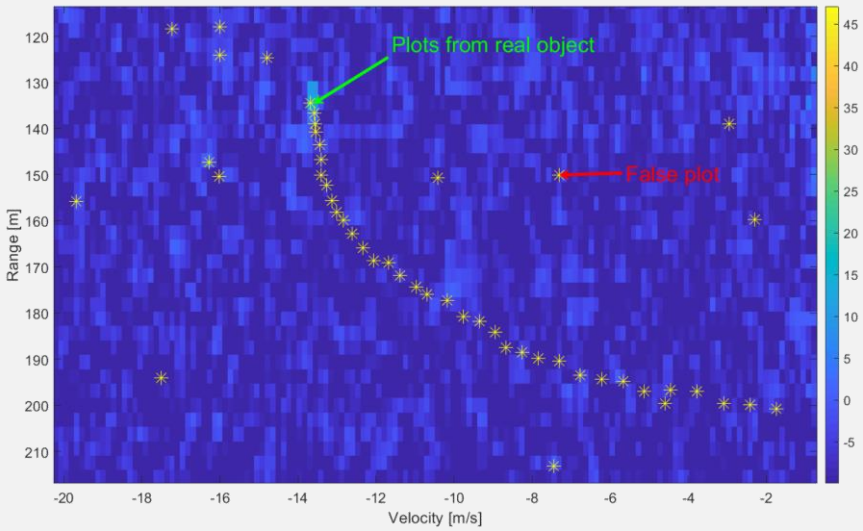

Fig. 1 Small fragment of crossambiguity function from FMCW radar system detecting drones.

As it shown on Figure 1 plots are not ideal, and the estimation of range and velocity is quite far from reality. There is a noise (assumed to be white) that affects the estimate of the plot parameters. Fortunately, in the long-term observations required to determine if a plot is fake or not, its parameters can be improved by applying the appropriate Kalman filter.

Analysis of cardiovascular regulation in patients with brain stroke

Joanna Rymko

According to the World Health Organization stroke is the third cause of death in the world. This disease is a neurological disorder resulting from a sudden cutoff of the blood supply to the brain. There are two types of this illness: ischemic stroke and hemorrhagic stroke. The main, published in scientific articles, studies of stroke refer to imaging methods such as computed tomography or magnetic resonance. Few researchers attempt to analyze the impact of stroke on other systems of the human body, e.g. cardiovascular regulation. This is an area that requires more research, because the knowledge of the association of stroke with heart rhythm variability is still small. I analyze heart rate variability, indicating changes in the cardiovascular system, in patients after ischemic stroke. I execute an analysis of measures of heart rhythm variability in the time and in the frequency domains and also apply nonlinear methods, such as: Poincaré plot, heart rate asymmetry measures - Guzik and Porta indexes, sample entropy, multiscale entropy and multiscale multifractal analysis. In my work, I study 24-hour electrocardiogram (ECG) recordings. ECG examination is definitely more common than computed tomography or magnetic resonance imaging, non-invasive and generating lower cost.

Training NLU Models on End User Devices with Privacy Protection

Paweł Pardela

The presentation will show the motivation for choosing improving the client side processing of voice assistant's natural language understanding (NLU) as the topic of my industrial PhD project. Recent world events made it clear that privacy is an important factor for any user facing artificial intelligence system. Users are more aware of their personal data being shared and stored - feeding one centralized model. Current approach is to use federated learning to meet the criteria of device side processing and data privacy protection. Federated learning solves the problem by design. Early research results suggest that federated models can achieve the same accuracy as their deep neural network (DNN) counterparts. Having a federated model implemented means that user data are not being shared anywhere. The initial common model is sent to all devices and then retrained on device with user data. Only the result of that training is being shared with the cloud model. Averaged device models serve as a seed for the next iteration. Weights of a neural network are obscure and make privacy attacks very difficult. However, federated learning increases system complexity and requires additional data transfers. The presentation will show the potential research areas, such as increasing performance of federated learning when applied to training NLU models or mitigating upload speeds bottlenecks.

Applications of explainable artificial intelligence for COVID-19 on medical imaging

Weronika Hryniewska

When social distancing is necessary, artificial intelligence makes people's work easier. With the lack of human resources, every kind of help is important. The question is, how to ensure that a model is trustworthy and not biased? The answer is provided by explainable artificial intelligence techniques and careful verification of the process of preparing data and neural network for training.

The presentation shows how to determine if the model is biased and how to avoid it while training. The database used during the research consists of up-to-date images of the lungs of COVID-19 patients. Their limited availability makes them even more liable to bias.

Optofluidic systems for sensing applications

Szymon Baczyński

The presentation discusses the principle objectives and results obtained within studies carried out on the subject of optofluidic systems for sensing applications. The main goal of the research performed so far is creation of the photonic structure in polydimethylsiloxane (PDMS) combined with liquid crystals (LCs) as a reconfigurable element that interacts with transmitted light. In order to employ electro-optical response of LCs, and thus to obtain dynamically reconfigurable systems, the electrodes in the form of microchannels (with specific geometry) filled with a metal/metal alloy in a liquid state are used to force specific LC molecular orientation.
The most important areas of research are:

- experimental work on various technologies to obtain good-quality molds for PDMS structures fabrication
- investigations on chemical interactions between liquid crystalline materials and PDMS
- numerical simulations for electric field applied to the system with use of specific electrodes including those of advanced (periodic) geometry
- experimental work for determination of the molecular orientation on the PDMS-LC interfaces
- experimental tests on LC:PDMS structures made with different molds, fabricated with use of different methods with particular attention devoted to the mold made of SU-8 photoresist (for further research on increasingly advanced structures)

The results obtained in each of the above-mentioned areas are presented in detailed and the next steps to be achieved.

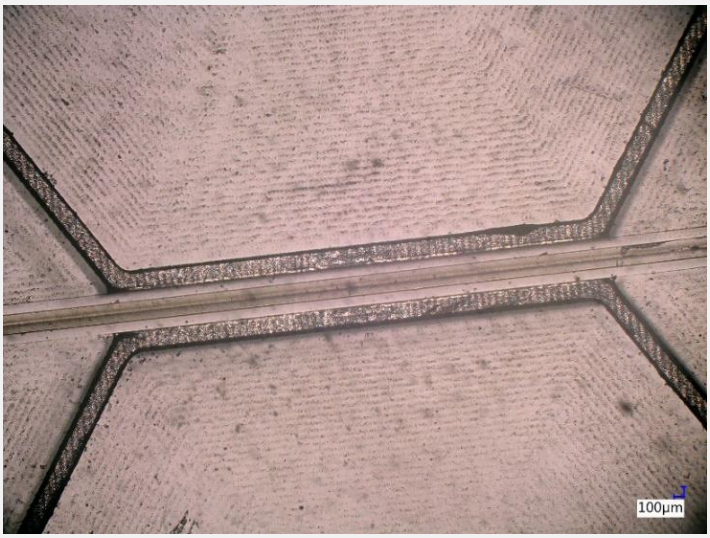

Fig. 1 Optofluidic structure in PDMS – Liquid Crystal E7 (in main channel) and Ga-Ind electrodes (in trapezoidal channels).

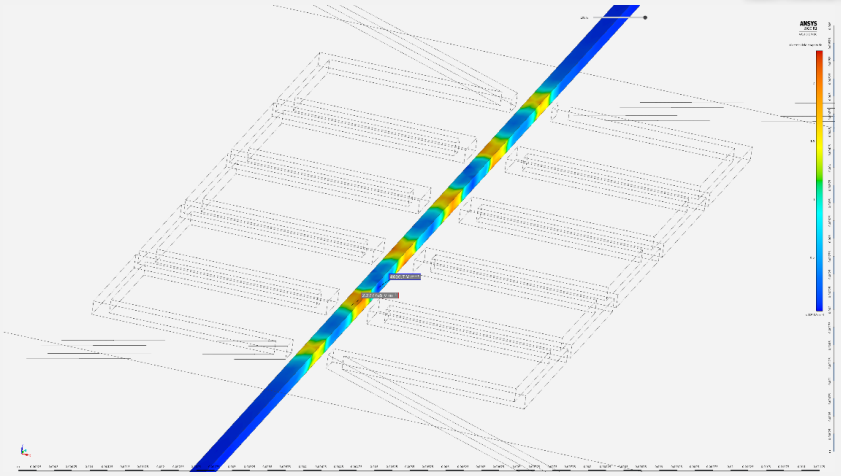

Fig. 2 Electric field simulation for electrode with advanced geometry.

Deep learning in video quality mapping and action recognition

Łukasz Bala

Deep learning gained significant interest after beating record in ImageNet competition in image classification accuracy with AlexNet architecture. Since then it has been applied to all different areas in computer vision such as image segmentation, object detection and image inpainting. However when it comes to video, the quality of predictions is much worse as compared to single images. It is associated usually with the fact that for tasks like classification require additional context that has to be taken into account (for example, interactions between humans and objects), whereas challenges like improving the quality of video requires smooth transition between frames. I'm going to present results from NTIRE 2020 competition where we used architecture based on U-Net and EDVR, along with explanation of basic concepts used in our work. Training procedure, our results as well as those of other teams that participated in the competition are also going to be shown. Moreover I'm going to talk about few-shot learning in action recognition, which is going to be my next step in the research during PhD studies. I'm going to focus on existing architectures and my ideas to improve them - particularly neural architecture search.

Temperature-Dependent Studies of Phonon Properties of Layered Materials with the use of Ab-Initio and Molecular Dynamics Simulation Methods

Konrad Wilczyński

The purpose of this work is the study of temperature dependence of lattice vibration energies in layered materials, including two-dimensional films and heterestructures. The analysis is being performed with the use of ab-initio and molecular dynamics computational methods. The understanding of the phonon properties is necessary to properly interpret experimental results of Raman spectroscopy, which is one of the preferrable methods for material characterization.

Ab-initio simulations enable to study quantum-mechanical properties of lattice vibrations (i.e. their energy levels) and identify physical phenomenons responsible for the observed experimental results (such as phonon-phonon interactions, thermal expansion, lattice defects). Molecular dynamics computation, on the other hand, as performed at different lattice temperatures, helps to identify creation of lattice defects and enables to validate the results obtained with quantum-mechanical methods.

The material being studied in the thesis at the moment is titanium disulphide (TiS_2). Its potential, promising applications include: thermoelectric devices, biosensors, energy storage and solar cells. However, phonon properties of titanium disulphide are still poorly understood: the origin of one of the experimentally observed Raman peaks is unknown and its temperature dependence is intriguing. The understanding of this phenomenon can be useful for further characterization of TiS_2 films for advanced applications.

Analysis, Design and Control of Novel Electric Vehicle Propulsion Drive Base on Synchronous Reluctance Hybrid Electric Machine with Integrated Epicyclic/Vernier Magnetic Gear Drives and Integrated Mechanical Brake

Stanisław J. Hajnrych

The aim of the PhD research program is to develop and design novel high power density integrated electric vehicle drive based on reluctance/hybrid motor with high speed fixed gearbox, integrated power electronics and dedicated control. The reluctance electric drive will be of wheel-hub or near-wheel type. Up to this stage work including background research of existing and researched technologies, electromagnetic finite-element method (FEM) simulations of different types of reluctance and hybrid machines, mechanical 3D modelling of introduced electric drive and preliminary mechanical FEM simulations have been done. Optimal construction has been chosen and is currently analyzed in depth. As a direct effect of the conducted research up to this point a publication comparing reluctance Vernier machines performance to other reluctance electrical machines and explaining torque production mechanism in Vernier machines had been written and other related article published. One research project related to the work has been started. Moreover concept of a new synchronous reluctance electric machine topology and winding method has been developed and is currently researched.

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

Jolanta Sadura

The time-phased controller is the most important instrument of the control apparaturs in high voltage and high current laboratories. We set the time parameters of our test in it (time start, time stop, and electrical angle of signal). At normal work, the time-phased controller must wait for release by the operator to start the test. Sometimes the controller receives interference and starts the test without release. Such a situation is undesired and can be destructive for the device under test. Identification of the transient fields during the short circuit test is indispensable by assessing the hazard of EM interference in the control apparatus. The first step of our identification was to focus on powering the primary side of the test transformer by the unloaded secondary side. The measurement of fields suggested that repetitive damped oscillatory waves can cause malfunctioning of the controller. The origin of them is repetitive ignition and extinction of the arc by closing the circuit breaker in the medium voltage circuit.

Intelligent therapeutic dialogue agent for Polish

Artur Zygadło

The goal of this research is to create an intelligent therapeutic dialogue agent, based on artificial intelligence methods, capable of understanding the user's inputs and responding in Polish.

In the initial phase, the research focus is on semi-automatic creation of a relevant training dataset, a so-called corpus of dialogues in Polish. It is planned to prepare sentences containing so-called slots, which can then be filled with dictionary values, e.g. names, numbers, temporal expressions, items from a given category etc.

The dialogue system will be implemented within the Chatterbot framework. Such an agent responds by selecting the sentence that best matches the user input in terms of a particular sentence similarity metric. Experiments with different sentence similarity metrics are planned, including those using so-called word embeddings, neural network-based methods like word2vec or BERT, for which models for Polish are available.

Within this research, it is planned to evaluate the developed system in terms of its correctness and user acceptance. One of the research goals is to create a system, with which the user will be willing to interact and develop a relationship. The conclusions from the evaluation will lead to the further improvement of the dialogue system, making it an innovative solution.

Eyetracker in the context of mental illness diagnosis

Karolina Gabor-Siatkowska

The aim of my presentation is to provide information about the progress of my PhD thesis. The presentation will cover various aspects, e.g. a literature review about experiments conducted on patients with Alzheimer's disease, Parkinson's disease, Huntington's disease and others. Furthermore the most important parameters of eyetrackers will be presented,which are allowed to be used for medical purpose. Additionally, an explanation of the crucial aspects of eye movement and pupil behaviour in context of early stage mental illness diagnosis will be discussed.

Selected aspects of local flexibility markets

Justyna Modliborska

The area of research work is the analysis of selected aspects of the functioning of local flexibility markets. Due to the growing share of distributed energy resources (DER) and the move away from the centralized dispersed power system, it is necessary to introduce actions aimed at ensuring security and supply of electricity at the local level. The solution is to introduce dedicated services and products (so-called flexibility services and products) of the local area (used in a given node) to ensure the proper functioning of the energy area, ensure the reliability of its operation and maintain quality parameters of electricity. To provide continuity of balancing demand and generation at this level of supply, the full cooperation of production resources (microgeneration and small generation) and end-users such as industrial, commercial (tertiary), and households, as well as the use of battery energy storage is necessary. Therefore, the most important issue at the beginning of the work is to define what flexibility and the flexibility market is. Then the legal, technical, and economic requirements for the functioning of the local flexibility market should be defined and the variant simulations carried on.

Methods of offloading in cloud native edge computing

Grzegorz Panek

The 5G network promise is to provide connectivity to end users with high throughput and low latency services. We can expect in the near future many applications that will require very low latency and high throughput. With such an exceptional evolution of demands, the network infrastructure struggles to accommodate the exponentially increasing load. In this context the concepts of cloud-native infrastructure and Multi-access Edge Computing are gaining momentum and providing new innovative techniques and approaches to tackle those challenges. In particular, Multi-access Edge Computing aims to bring computation workloads and network intelligence as close as possible to the end user, i.e. to the Edge, while ensuring resource efficiency and maintaining service high performance and low latencies. The Application Function (AF), one of the main MEC concepts, can be viewed as the backend that will process the heavy workloads of the end user at the edge. Since the UE (user equipment/end user) mobility supported by the underlying network can result in UE moving to a network entity associated with a different MEC host from the current serving MEC host. Computation of user workload in a new MEC Host carries needs of offloading application deployed in MEC to a new MEC instance in order to maintain handling users' requests. The meaning of the application/service offloading is to migrate applications across multiple edges hosts to guarantee target QoS parameters.

Mutation of information in messages spreading processes in social networks

Patryk Bojarski

Lots of people get information from social media, where users can exchange messages. In most cases, content is being transmitted without any changes. However, the specifics of these portals allows to modify form, content and even combine information from many sources. Understanding mechanism of message mutation could allow to become more resistant to misinformation and better efficiency in identifying fake newses.

I proposed a simple social network model in which agents (users) can communicate with each other. Whether they take action depends on their views and the content of messages shared by their friends (nearest neighbors on the network). They can transmit information, create new ones, and modify them. This model is very similar to social networks like Facebook or Twitter. I believe that it can effectively show the mechanisms governing the change of information and better understand the spread of disinformation.

Towards better understanding of meta-features contributions

Katarzyna Woźnica

The classical approach to train a machine learning model is to start with some default parameters and tune them for a selected dataset to maximize some measure of performance. And such process is repeated from scratch for each problem independently.

Meta-learning offers an alternative paradigm. This is a wide area of methods of systematically observing how different machine learning models perform on a wide range of learning tasks. Knowledge, which is extracted from some tasks, can be transferred to design optimal, predictive pipeline for new data.

This is an important problem as it may decrease training time, improve model generalisation and increase our knowledge about the training process.

It assumes that the expected performance of a model can be predicted based on various task's aspects called meta-features. The most frequently considered qualities are algorithm hyperparameters, statistical and information-theoretic dataset properties and model-based landmarkers trying to describe the relations between studied tasks in high dimensional space.

Existing approaches in meta-modeling are focused on searching for the best model but do not explain how these different aspects contribute to the performance of a model. To build a new generation of meta-models we need a deeper understanding of the relative importance of meta-features and construction of better meta-features.

In this talk, I will present novel technique to evaluate the relative importance of different groups of met.

Time irreversibility in the assessment of the state of the human cardiovascular system

Małgorzata Andrzejewska

Energy dispersal in real systems leads to irreversibility of processes in the time-domain. Entropy can be understood as a measure of the process of energy dissipation, and, therefore, a greater entropy is synonymous with a greater energy dispersal, a greater disorder. Production of entropy in an organism can be used to assess homeostasis. Gradients of various quantities related to metabolism arise in the body, which affects the rate of entropy production in the system. Entropy production is associated with irreversibility of processes. The aim of the planned research includes the study of the characteristics of irreversibility in time series of physiological signals, in particular those from the cardiovascular system. The main goal is to create new diagnostic methods for the human blood circulation system. To achieve that, measures of complexity, non-stationarity and multi-scale methods are used. During presentation the results of applying the concept of irreversibility to the study of repolarization in the ventricles will be presented using Horizontal Visibility Graph methods. We focused on the comparison of the nighttime recordings between healthy and patients with the LQTS1 syndrome. We obtained a statistically significant difference between those groups in time irreversibility of QT intervals. I will also present my current research objective which includes the analysis of asymptomatic COVID-19 patients about a fortnight after their being declared convalescent.

Multilingual Machine Translation System for Dialogue Agents

Marcin Sowański

Natural language understanding systems, such as multilingual virtual assistants, are created from large amounts of text data in a given language. In the process of adding another language to such systems language resources needs to be either translated or localized. This process usually involves hiring many language experts for this purpose which is expensive both in terms of time and money. Additionally, when adding new functionalities to the system we also have to take into account maintenance and consistency between languages, which generates additional costs related to communication and project management.

As part of my PhD thesis, research is being conducted to determine the methods and tools needed to create machine translation models that will be used to automatically translate language resources of multilingual virtual agents. The translation of language resources must meet the language characteristics of the assistant, such as the domain language and semantic annotations. The challenge is to translate sentences that will take into account the knowledge and domain vocabulary of the virtual assistant. Furthermore, in order to minimize costs, effective ways of automatically determining the correctness of translated sentences must also be developed.

During the seminar I will present the results of my work, including resources created and presented in the article "Leyzer: A Dataset for Multilingual Virtual Assistants" and also current research results and plans that focus on creating resources and methods for automatic evaluation of machine translation.

Continuous embeddings of fractional Sobolev spaces

Artur Słabuszewski

Let (X,d) be a metric space equipped with a Borel regular measure μ. It has been shown by R. Alvarado, P. Górka and P. Hajlasz that Sobolev embeddings for Hajlasz-Sobolev space M^{1,p} (X,d,μ) are equivalent with lower Ahlfors regularity of the measure. Similar results (obtained by Y. Zhou) are also known for Sobolev spaces of fractional order (also known as Slobodeckij space) defined on open subsets of Euclidean space. During the talk I will present generalisation of Zhou results obtained with Przemyslaw Górka. It turns out that if we consider fractional Sobolev space defined on the metric measure space, then with some additional assumptions on (X,d,μ) Sobolev embeddings holds if and only if μ is lower Ahlfors regular.

Signal Processing and Automatic Speech Recognition for Embedded Systems

Mikołaj Pudo

This talk will present main research areas of the author, which include audio signal processing and automatic speech recognition (ASR). Both tasks rely strongly on machine learning techniques and especially on deep neural networks. The main goal is to optimize models used in the abovementioned tasks for embedded systems such as mobile phones. This assumption brings multiple constraints, such as: limited amount of memory and compute power, necessity to process data in an on-line manner.

Additionally end-of-speech (EOS) detection will be presented as an exemplary task. In this case an improved method of model training is proposed. This method can be used for all model types, which rely on binary cross-entropy during the training. The novel method was confronted with the loss function previously used. Experiments performed on clean data as well as on data containing background noise showed that the proposed method is significantly more robust to noisy and far-field environments compared to the baseline solution.

Heavy ion collisions simulations for NICA-MPD. NICA-MPD assembly and calibration.

Michalina Milewicz-Zalewska

At the Joint Institute for Nuclear Research (JINR) in Dubna, a complex of accelerators called NICA (Nuclotron-based Ion Collider fAcility) is being built. One of its parts is the Multi-Purpose Detector (MPD), which is currently being assembled. The MPD experiment will study the phase diagram of QCD matter, including the properties of the phase transition and the location of the critical point, analyzing heavy-ion collisions in the energy range 4-11 AGeV. During the course of Ph.D. studies, the simulations of those collisions will be prepared and analyzed using the MPDRoot environment. Observables such as monoparticle and biparticle inclusive momentum spectra of identified particles, correlation functions, electromagnetic signatures, and production of charm particles will be studied. Data obtained during the simulations will be analyzed. The second part includes the calibration of the MPD's subdetectors, namely Time of Flight, Time Projection Chamber, and other, using cosmic rays and storing the calibration data in the Equipment Database (EqDb). The EqDb is still under development. The first year of the Ph.D. was conducted at JINR, unfortunately, due to COVID-19 restrictions, work was mostly done in a remote mode.

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.

Electrodynamic levitation system for high speed magnetic railways

Tomasz Kublin

Suspension systems of currently operating high speed magnetic railways is most often based on active electromagnetic levitation. Such type of levitation needs an on-board power supply which can be provided in two ways: with an on-board energy source or through some energy transmission system which work while traveling (i.e. pantograph or wireless energy transmission). The author in his research focuses however on electrodynamic levitation systems. The main difference is that this 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 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.

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. Static VAR Compensators are common choice in the industry because of their low material cost, but they are limited to reactive power compensation and require individual selection of compensation blocks to match given consumer needs. Power electronic counterparts on the other hand offer flexible solution able to:

- compensate reactive power,
- symmetrize 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. In case of reference current exceeding converter ratings, these functionalities have to be linearly limited/disabled in prioritized order. Control algorithm allowing three first functionalities has been developed in the recent year and is already implemented in commercial product. Another objective is to enable operation of aforementioned control method on parallel connected power electronics converters. The lack of a standard high-speed communication system enabling synchronization requires the development of a tailor-made system.

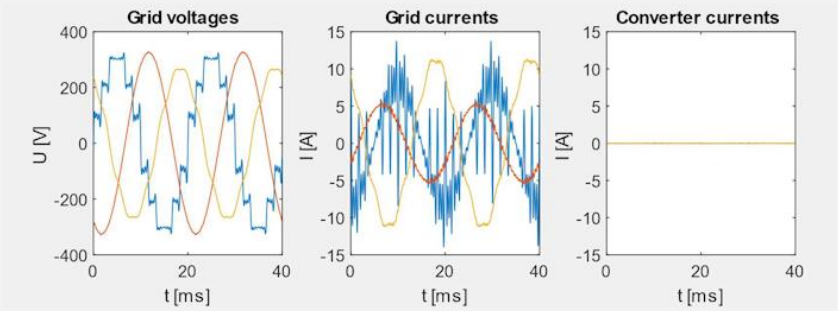

Fig. 1 Converter turned off.

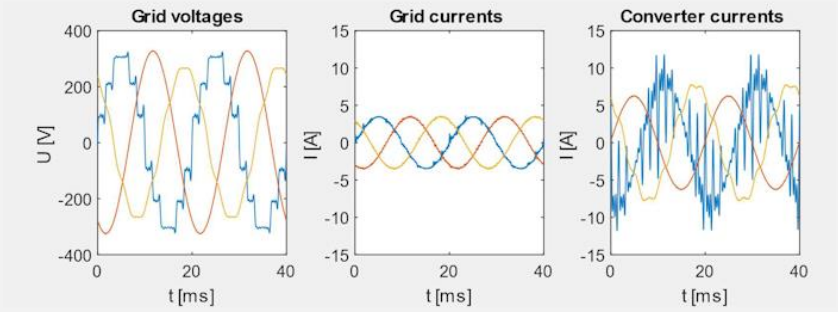

Fig. 2 Converter turned on.

Study of the Quark-Gluon Plasma using heavy quarks in the STAR experiment

Priyanka Roy Chowdhury

My field of research is experimental high energy particle physics and I am working in a project within the STAR experiment under supervision of Prof. Daniel Kikola. This experiment is located at RHIC (Relativistic Heavy Ion Collider), BNL, USA. STAR consists of different type of detectors and each of them are designated to study different particles and their motion. We are particularly interested on the study of the Quark-Gluon-Plasma (QGP) state of matter which is an extremely dense and hot state of matter created in the universe just after the Big Bang. To study that, we will analyze the particles comprise of charm quarks (heavy quarks) and light qurks and by studying the behavior of the charm quarks in a soup of light quarks (u and d) we can measure diffusion coefficient of the quark-gluon plasma. We will study the details of the charm quark-light quark interactions via correlations at low relative momentum between charm and light quark.

So far, I have gone through literature review about the experiment and done some tasks on how to deal with the data for analysis. I have used CERN ROOT toolkit and picoDST toolkit for calculating mass, momentum, transverse momentum, rapidity, pseudo rapidity of different particles and making histograms for those.

Review and examples of applications of vehicle recognition methods

Pawel Szelągowski

The presentation will present basic information about the toll collection systems and control systems for paying the appropriate toll on toll roads. Typical requirements and assumptions that must be met by the toll control system will be presented. A model of a control system based on a vision system will be presented, as well as an overview of image processing methods used in such systems.

An overview of vehicle recognition methods used in vision systems will be presented.

Integrated information and IT services management system

Grzegorz Mąkosa

Companies and public institutions face the challenges of the most effective use of IT systems and infrastructure for which they have incurred expenses, to achieve both business benefits and effective action towards their customers and stakeholders, delivering the expected value. These challenges are now, in the era of dynamic digital transformation, more and more, due to the rapid technological changes in IT, IT initiatives undertaken by competitors and market and social environment entities, and the growing expectations of customers and stakeholders.

The purpose of the project is development of a model of an integrated process and system system for managing information and IT services (quality, availability, security) and implementing it in a public sector entity. This system will be compliant with ISO standards (e.g. ISO 20000, ISO 27001, ISO 9001 and other identified in the course of research), meeting the legal requirements for.

The scope of planned research works:

- literature research;
- examination of legal provisions concerning the obligations to implement the quality, continuity, information security and IT systems management system;
- research of industry norms and standard concerning management, quality, continuity, information security and IT systems, etc. (e.g. ISO 20000, ISO 27001, ISO 9001 and others);
- developing a model of an integrated information and IT service management system.

Content-based music recommendation system

Salomea Grodzicka

The majority of currently utilized music streaming applications provide different kinds of song recommendation systems, vast majority of which are based on other user's preferences (collaborative systems). The problem arises when it comes to signal analysis, due to signal-based features variations within a song as well as individuality of user's music taste.

The system should employ the most efficient decision algorithm. During the research, the effectiveness of neural network classifiers will be verified (e.g. Bayesian Classifier, Nearest Neighbours Classifier, Support Vector Machines, Decision Trees or their combinations with gradient boosting).

The idea is to find continuous segments of each song (such as verse, chorus and bridge) and to perform signal analysis and decision algorithms on those consistent fragments. Another viable solution would be to take into consideration rhythmic patterns, oppose to most common recommendation content-based systems which use only danceability, tempo or power of the beat features. The next step could be to compute analogical features in tonal scale by using chromagrams.

The thesis will be introduced on an openly accessible dataset called Free Music Archive. It provides full-length and high-quality audio as well as pre-computed features, along with track- and user-level metadata and tags. Some of those audio features are introduced by Echonest (now well-known Spotify).

COMBO - System for Morphosyntactic Analysis of Multiple Languages

Mateusz Klimaszewski

We present COMBO - a flexible and language-independent NLP system for accurate part-of-speech tagging, morphological analysis, lemmatisation, dependency parsing, and thematic role labelling. COMBO is an easy to install Python package built on top of the AllenNLP platform and the PyTorch library. An inherent feature of the system is its flexibility. It allows to estimate model variants that differ in terms of the range of input features, the prediction scope, and the type of vector representation of input data, i.e. optional use of pre-trained (contextualised) word embeddings. COMBO is a language agnostic system that can be used to train a morphosyntactic prediction model for a dependency treebank in any language. Results of the evaluation on nine selected treebanks indicate that the prediction quality is comparable with the state-of-the-art system, Stanza. COMBO training is, however, much faster than training of the pipeline-based systems, because it is an end-to-end system with jointly trained prediction modules. COMBO was designed and developed in cooperation with The Linguistic Engineering Group at ICS PAS. Its source code and some pre-trained models are available at https://github.com/ipipan/combo.

Spaceborne ship detection in synthetic aperture radar imagery using FPGA-accelerated deep learning

Jerzy Stefanowicz

The industrial Ph.D. program in which Jerzy Stefanowicz participates is conducted in cooperation between the Finnish-Polish synthetic aperture radar (SAR) satellite manufacturer ICEYE and the Warsaw University of Technology. The Ph.D. candidate's thesis subject revolves around the idea of putting artificial intelligence onboard ICEYE'S satellites. The main idea explored by Jerzy is utilizing the powerful Field-Programmable Gate Array (FPGA) chip used for digital signal processing in ICEYE's SAR to automatically detect ships in radar imagery. Historically, this task was performed by adaptive thresholding algorithms, which utilize local statistics of the SAR image to calculate the detection threshold. Currently, following the development of efficient deep learning methods for optical image object recognition, convolutional neural networks are the state-of-the-art method of ship detection in SAR imagery. Additionally, FPGAs are very well suited for the implementation of such data processing architectures.
During the presentation, the candidate will explain the topic in a broader context, share the progress of the work, and discuss the next steps to take to achieve the final goal.

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