Institute of Control and Computation Engineering

2017 Annual Report

Warsaw University of Technology
Faculty of Electronics and Information Technology
Institute of Control and Computation Engineering
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From the Director

The Institute of Control and Computation Engineering (ICCE; in Polish: Instytut Automatyki i Informatyki Stosowanej) was founded in 1955 as the Chair of Automatic Control and Telemechanics by Professor Władysław Findeisen. It was reorganized in 1970 to become the Institute of Automatic Control. Rapid development of microprocessor technology and its impact on the field of control in recent years directed the interest of the research staff and students towards computational and algorithmic aspects of control, decision support, man-machine interfaces, network communications etc. This resulted in 1994 in the creation of new educational profiles offered by the Institute and a change of its name to the present one.

The Institute offers courses in Computer Science as well as in Automatic Control and Robotics, both at three levels of education (undergraduate, postgraduate, Ph.D.). It is necessary to point out that the undergraduate and postgraduate courses in Automatic Control and Robotics, which were launched in 2014 and 2013, respectively, are of great interest of the candidates. In particular, considering the whole Warsaw University of Technology (WUT), the undergraduate course twice had the highest average number of applications. We are also proud to offer interesting opportunities to our postgraduates, so that they can continue their study and research towards a Ph.D. It is important that our postgraduate and Ph.D. courses are open for candidates with different educational background. Our courses attract more and more candidates who graduated from various universities and with degrees in different fields, not only in Computer Science or in Automatic Control and Robotics. During the last few years we made an effort to organize and equip new laboratories located in a new part of our building. Currently, all our students benefit from new laboratories, without which it would be impossible to offer a few new courses. This standard educational offer has been supplemented by postgraduate studies: Management of Information Technology Resources and Project Management organized by Dr. Andrzej Zalewski as well as Designing Information Systems with Databases organized by Dr. Tomasz Traczyk. There is a growing interest in this form of studies and about 200 attendees took part in these courses in the 2016/2017 edition.

The Biometrics and Machine Learning Group has been involved in the Marie Skłodowska-Curie European Training Network (Horizon 2020) project enhAnced Mobile BiomEtRics (AMBER). The partners of the project are: University of Kent (The United Kingdom) – the coordinator, Universidad Carlos III De Madrid (Spain), Otto von Guericke Universität Magdeburg (Germany) and WUT (Poland). The project focuses on addressing a range of current issues facing biometric solutions on mobile devices. Furthermore, the Biometrics and Machine Learning Group with the Machine Perception Group have been involved in the National Centre for Research and Development project Design and construction of a system for recognition of persons (offenders) based on face images captured on photograph or video material (BIOWIZ). The project led by prof. Andrzej Pacut is coordinated by WUT while involving also NASK-PIB, AGH University of Science and Technology and Polish Platform for Homeland Security.

The Complex Systems Group has been involved in the National Centre for Science grant Energy-aware computer system for HPC computing. This research project, led by prof. Ewa Niewiadomska-Szynkiewicz, addresses the vital problem of energy efficient high performance distributed and parallel computing. Its objective is to acquire new knowledge on the stochastic dynamics of data processing in High Performance Computing (HPC) systems and to develop adaptive resource management algorithms which efficiently exploit new power control capabilities of contemporary computer hardware. The research objective is to provide contributions to development of future generations of computing and operating systems. Furthermore, the Complex Systems Group with the Machine Perception Group

and the Robot Programming Group have been involved in the National Centre for Research and Development project National cybersecurity platform (NPC). The project led by prof. Ewa Niewiadomska-Szynkiewicz is coordinated by NASK-PIB while involving also National Institute of Telecommunications and National Centre for Nuclear Research. The goal of the Project is to develop a comprehensive, integrated system for continuous monitoring, detection, and warning of threats identified in a near real-time in the State's cyberspace.

Research is a vital part of our activities, directly affecting both the Institute's recognition in Poland and abroad, and the quality of teaching. Description of research programs conducted by the faculty of the Institute can be found in this report. I express my sincere appreciation to the faculty and staff of the Institute for their efforts and contributions to our achievements in teaching and research. In particular, I would like to compliment Dr. Tomasz Kruk who won the Best Lecturer students' award.

It is my pleasure to congratulate Prof. Piotr Tatjewski who was awarded the Knight's Cross of the Order of Polonia Restituta. I also congratulate Dr. Tomasz Traczyk on being awarded with the Medal of the Commission of National Education.

Włodzimierz Ogryczak

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1 General Information

The following information about organization of the Institute reflects the situation on December 31, 2017.

1.1 Directors

Professor Włodzimierz Ogryczak, Director
Professor Maciej Ławryńczuk, Deputy Director for Research
Dr. Tomasz Traczyk, Deputy Director for Academic Affairs

1.2 Organization of the Institute

Systems Control Division

Division Head:	Professor K. Malinowski
Professors:	W. Kasprzak, K. Malinowski, E. Niewiadomska-Szynkiewicz, A. Pacut, C. Zieliński
Professors, retired:	W. Findeisen, R. Ładziński, J. Szymanowski
Assistant Professors:	P. Arabas, M. Kamola, A. Karbowski, M. Karpowicz, T. Kornuta, A. Kozakiewicz, T.J. Kruk, W. Szynkiewicz, T. Winiarski
Software Engineers:	D. Seredyński, M. Trokilewicz
Assistant:	M. Stefańczyk, M. Azimi, J. Nourmohammadi Khiarak, W. Dudek
Ph.D. Students:	W. Dudek, J. Figat, M. Figat, W. Gutfeter, M. Krzysztoń, J. Panasiuk, D. Seredyński, B. Świstak, M. Trokielewicz, E. Bartuzi, R. Czerwiński, M. Klimczak, K. Roszczewska

Research of the division is conducted in 3 research groups:

Complex Systems Group (**E. Niewiadomska-Szynkiewicz**, P. Arabas, M. Kamola, A. Karbowski, M. Karpowicz, A. Kozakiewicz, T.J. Kruk, M. Krzysztoń, K. Malinowski)

The main area of interest are problems of modeling, design, control, optimization and simulation of various types of complex real systems, including networks, ad hoc networks, social networks, economic systems and the environment. Research in the field of optimization and control are focused on developing the theory and methodology in applying model predictive control, hierarchical control structures in nonlinear systems with uncertainty, developing methods for solving continuous and discrete time optimization problems (including evolutionary optimization methods and using the arithmetic of intervals), game theory and design theory of complex systems of rules (so-called theory of mechanisms). Research in the field of computer simulation and parallel processing of information concerning such departments as: distributed operating systems, programming of parallel machines in computer networks, clusters, grids and GPUs, the creation of systems for computer-aided design and management. Particular attention is devoted to issues of modeling, management and security in computer networks, including sensor networks and mobile ad hoc networks.

Biometrics and Machine Learning Group (**A. Pacut**, E. Bartuzi, W. Gutfeter, J. Panasiuk, K. Roszczewska, M. Trokielewicz)

Research of the group is centered on biologically inspired information processing and control, including biometrics, machine learning, uncertainty modeling, and biological modeling. Biometrics consists in using personal characteristics for identity recognition. Our research is focused mainly on safety of biometrics software, systems, and applications. In particular, safety issues are investigated for iris, fingerprints, and finger veins. Safety of biometric data storage and exchange and data encryption using biometrics are investigated. Original recognition methodology is developed for iris hand-written signature, 3D face and EEG. Machine learning research is focused on reinforcement learning, applied to adaptive control and multi-agent systems including very large systems and adaptive network routing. Also, learning in neural networks and modeling granularity is investigated.

Robot Programming Group (**C.Zieliński**, W.Dudek, M.Figat, M.Klimczak, T.Kornuta, D.Seredyński, B.Świstak, W.Szynkiewicz, T.Winiarski)

Research of the group is concerned with robot control system design and in particular robot programming methods. The group focuses on robot system architectures, their specification and implementation. Service robots are at the centre of interest. The research encompasses manipulation and grasping, especially two handed manipulation, utilizing force and impedance control. It also deals with mobile robot localization and navigation. Special emphasis is placed on sensor-based motion planning and control of single and multiple robots.

Machine Perception Group (**W. Kasprzak**, M. Stefańczyk, J. Figat, P. Przybysz)

The research interests are in pattern recognition and machine learning techniques and their applications to image and speech analysis. Lately, the focus in image analysis is on bridging the semantic gap between object recognition in images/video and ontology-based image and scene representation. For this purpose RGB-D images and 3-D point clouds are intensively being processed. Machine learning techniques are applied for object detection and recognition in images and video, as well as for speech- and speaker

recognition. Besides robot perception systems, the eyed application fields are multimodal human-machine interfaces, automatic surveilance data analysis and biometrics – suitable gesture recognition- and speech/speaker recognition methods are developed and implemented.

Control and Software Engineering Division

Division Head:	Professor P. Tatjewski
Professors:	M. Ławryńczuk, K. Sacha, P. Tatjewski
Assistant Professors:	P. Domański, P. Marusak, S. Plamowski, A. Ratkowski, M. Szlenk, A. Zalewski
Assistant:	A. Wojtulewicz
Senior Lecturer:	J. Gustowski
Senior Engineer:	W. Macewicz
Ph.D. Students:	P. Chaber, K. Czerwiński, A. Hurkała, M. Wasilewski, A. Wojtulewicz, W. Niespodziany, M. Okulski

Research of the division is conducted in 2 research groups:

Control Engineering Group (**M. Ławryńczuk**, P. Chaber, P. Domański, J. Gustowski, P. Marusak, S. Plamowski, P. Tatjewski, A. Wojtulewicz, W. Niespodziany, M. Okulski)

Research of the group concentrates on advanced control engineering techniques and their applications in control of industrial process and in embedded systems. The focus is on model predictive control algorithms, multilayer optimizing and supervisory control, fault detection and fault-tolerant control. Among others, soft computing methods are used in the considered algorithms (neural networks, fuzzy systems and genetic algorithms). The Advanced Control Systems Laboratory offers the possibility to verify developed theoretical solutions. The laboratory is equipped with a set of test processes. For control of industrial process, a Distributed Control System (DCS) cooperating with a Supervisory Control and Data Acquisition (SCADA) software platform and Programmable Logic Controllers (PLC) are used. For control of embedded systems, microcontrollers equipped with numerous sensors and actuators are used.

Software Engineering Group (**A. Zalewski**, A. Hurkała, W. Macewicz, K. Sacha, M. Szlenk, A. Ratkowski, M. Wasilewski)

The main area of interest is the development and maintenance of software. Topics include software processes, software analysis and design methods, and the methods for software quality evaluation. New approaches to the assessment of high-level system architecture in the earliest phases of software development are investigated. Methods for architectural decision modeling during the evolution of service-oriented (SOA) systems are developed. Part of the research is aimed at security and trust management issues in distributed open applications.

Operations and Systems Research Division

Division Head:	Professor E. Toczyłowski
Professors:	W. Ogryczak, E. Toczyłowski
Professors, retired:	W. Traczyk, A. P. Wierzbicki
Readers:	T. Traczyk
Assistant Professors:	J. Granat, B. Kozłowski, A. Krzemienowski, P. Pałka, K. Pieńkosz, A. Stachurski, T. Śliwiński, I. Żółtowska
Senior Lecturers:	J. Sobczyk, M. Kaleta
Ph.D. Students:	A. Mościcka, G. Zalewski

Research of the division is conducted in 2 research groups:

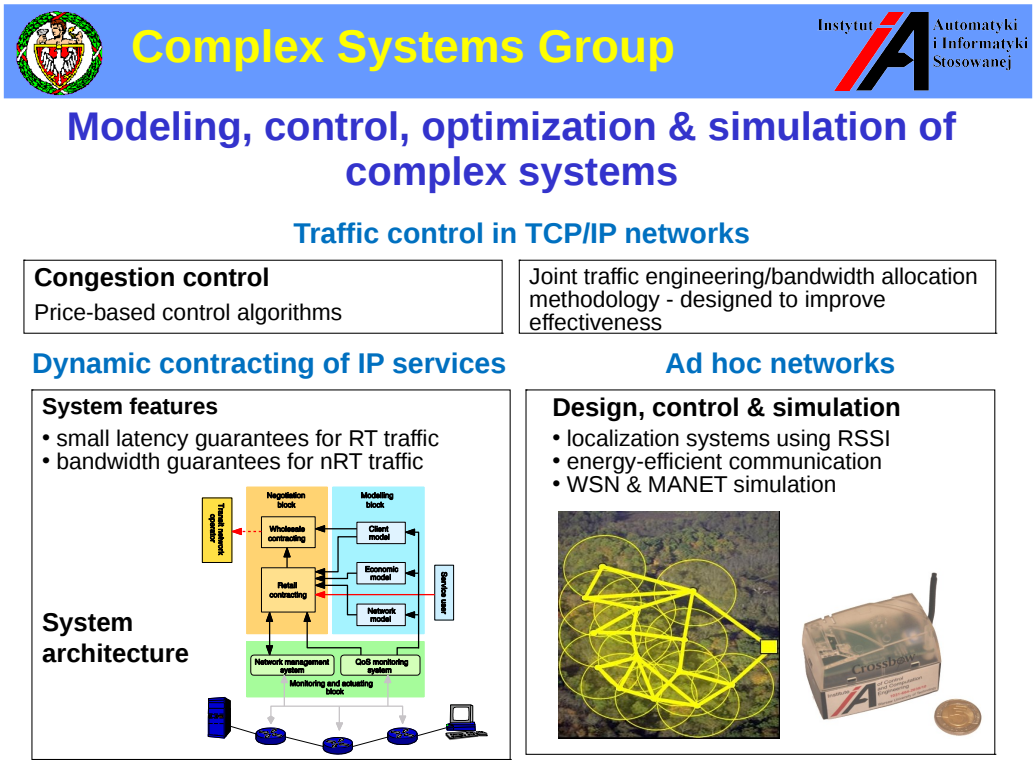
Operations Research and Management Systems Group (**E. Toczyłowski**, M. Kaleta, P. Pałka, K. Pieńkosz, T. Traczyk, I. Żółtowska)

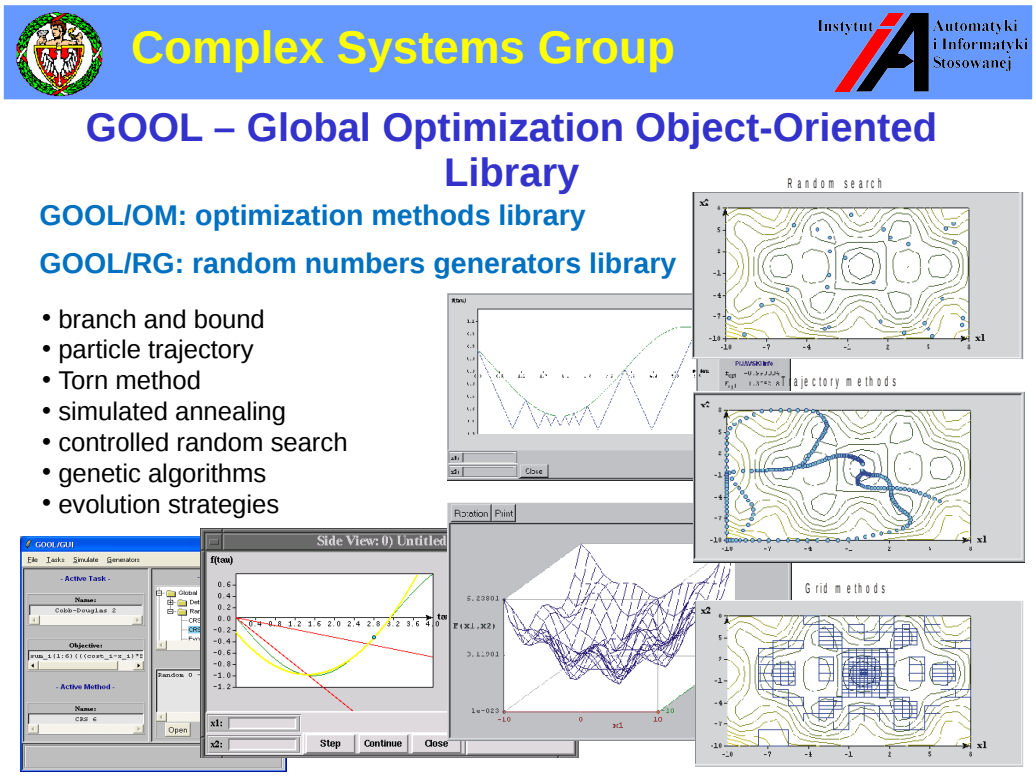
Research of the group is concerned with operation research and structural discrete optimization methods for control and management of discrete processes, including applications in the network structure development, deregulated electric power industry, IP networks, computer integrated manufacturing, etc. The research is focused on market and auctions design, scheduling techniques, efficient structural-based optimization algorithms, time-table generation, strategic and tactical planning, detailed scheduling, and real-time operational control. Also, the object oriented and relational database management systems and CASE methods are investigated to design of the distributed multi-functional heterogeneous information systems.

Optimization and Decision Support Group (**W. Ogryczak**, J. Granat, B. Kozłowski, A. Krzemienowski, J. Sobczyk, A. Stachurski, T. Śliwiński, A. Mościcka, G. Zalewski)

Research of the group is focused on the theory of distributed and parallel computational methods, and software for optimization. The theory covers a whole area of linear and non-linear, dynamic, stochastic and multiple criteria problems, and deals with such topics as the sensitivity aspects and the parametric aspects. Another area covers the decision theory, including the multi-person decisions and the game theory, and deals with software building for decision support and organization and management of computer networks.

1.3 Research Areas





Complex Systems Group

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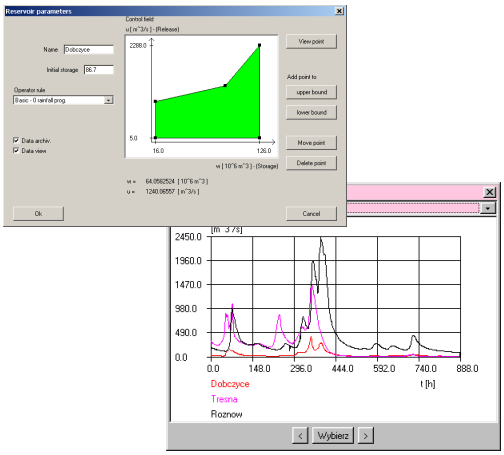
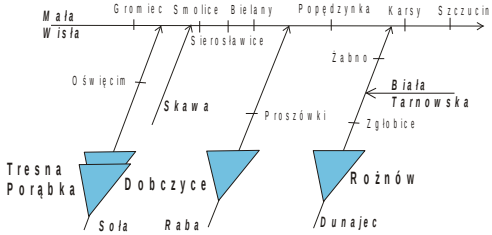
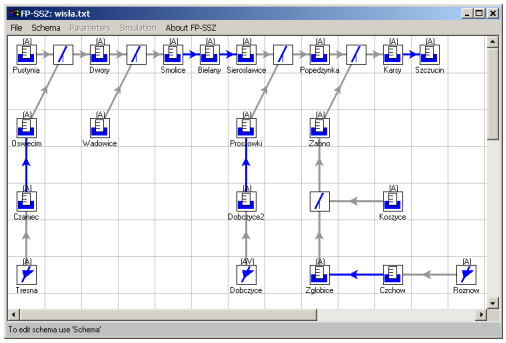
Flood Control

- **FP-SOZ: Flood Control – Reservoir Operation System**
- **FP-SGW: Flood Control – Upper Vistula System**







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Parallel and distributed computations

New software tools:

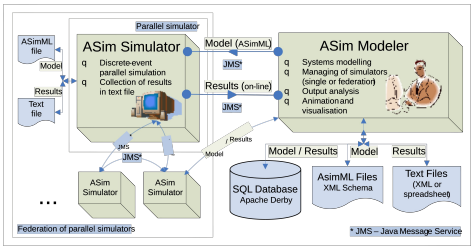
jPar – software environment for parallelizing Matlab calculations

parAMPL – library for parallelizing AMPL calculations

AsimJava – library for parallel simulation of dicrete event systems

MobAsim – software environment for ad hoc network simulation

- parallel optimization algorithms
- parallel and distributed simulation
- new software tools for parallel and distributed computations
- monographs published in 2001 & 2009



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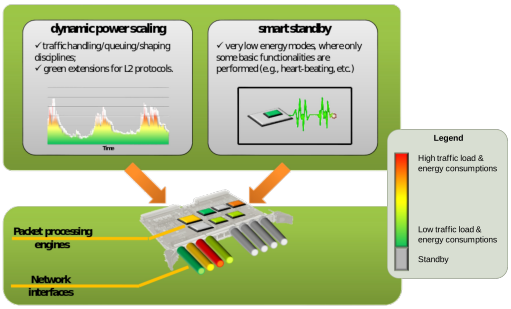
low Energy Consumption NETwork

ECO net

7 Frame Programme UE grant
ICT-2009.1.1: The Network of the Future

The ECONET project aims at introducing:

- novel network-specific HW/FW technologies to optimize the power management features
- local and distributed frameworks for dynamic optimization of the trade-off between energy consumption and network performance
- Green Abstraction Layer for interfacing the novel low-level green capabilities
- novel energy-aware device prototypes



Complex Systems Group

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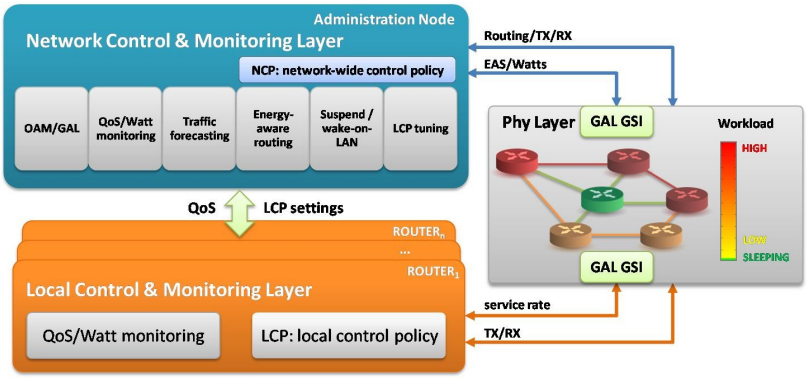
ECO net

low Energy Consumption NETwork

System architecture

- GAL – Green Abstraction Layer – ETSI standardised network devices energy management interface
- NCP – energy-aware traffic engineering
- LCP – node energy aware control



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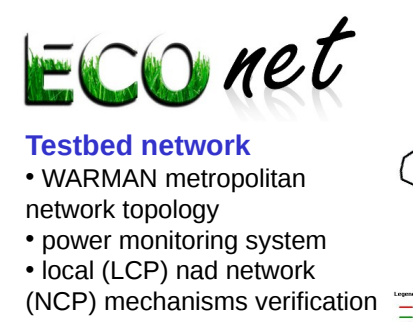
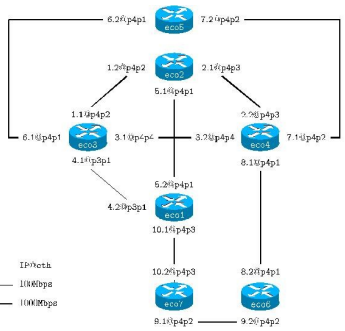
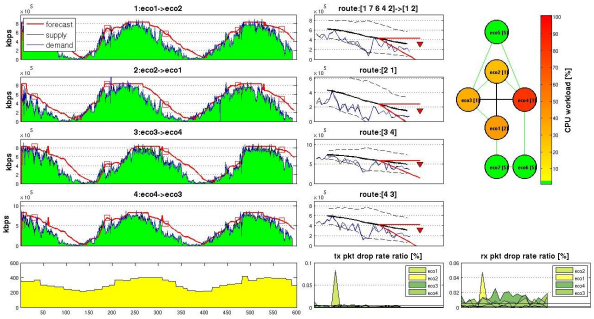
ECO net

Testbed network

- WARMAN metropolitan network topology
- power monitoring system
- local (LCP) nad network (NCP) mechanisms verification







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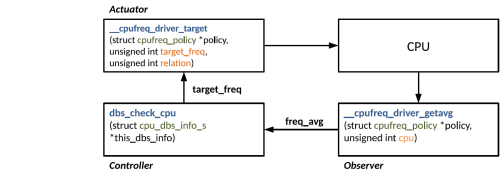
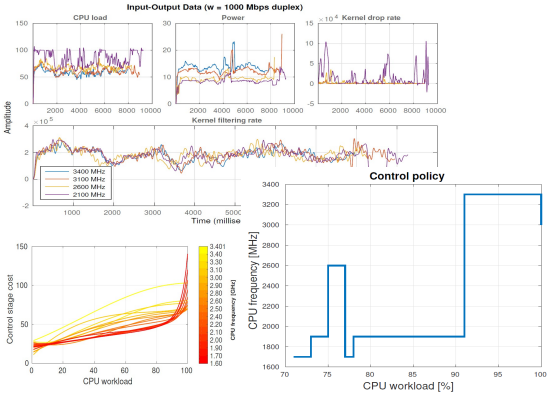
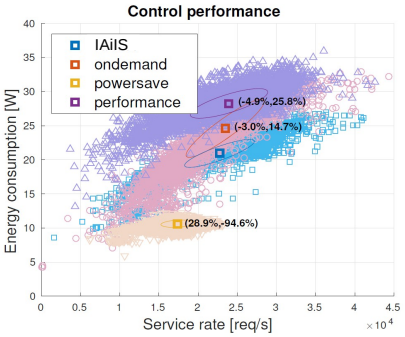
Energy-saving CPU frequency governor



- Application specific power consumption model
- RFC2544-based identification methodology
- Customized frequency scalling governor





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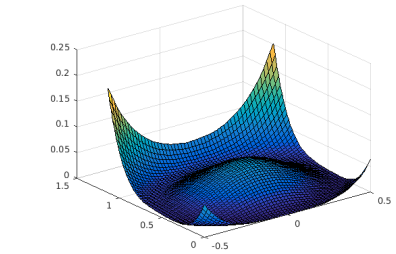
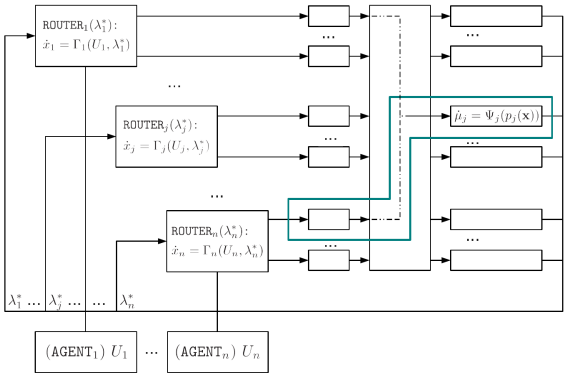
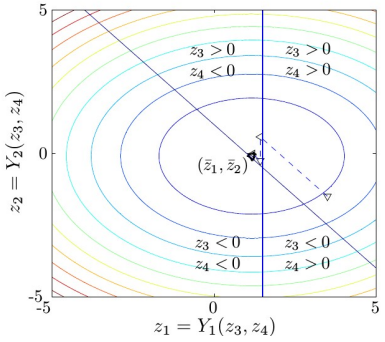
Game theory and mechanisms design

- Nash equilibria design
- Robust TCP/AQM design
- Stability analysis in noncooperative games







Complex Systems Group

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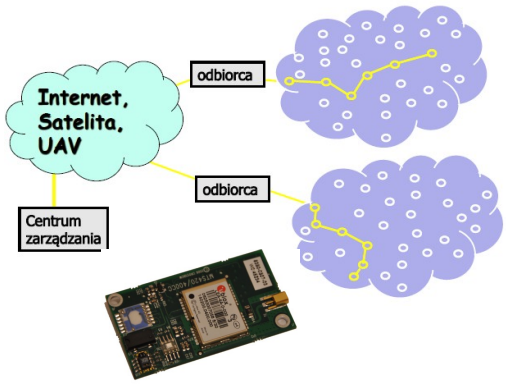
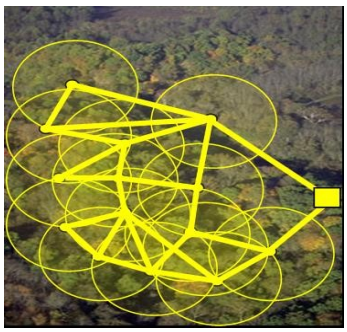
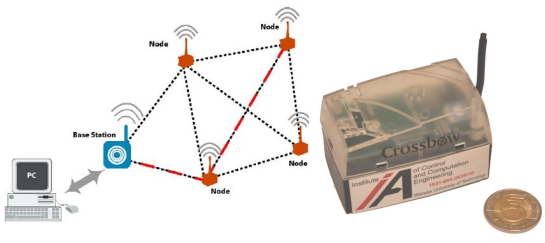
Energy-saving communication in wireless sensor network





- Transmitted signal power control
  Power Control (PC)
- Node activity control
  Activity Control (AC)



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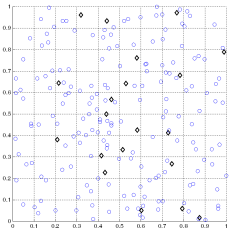
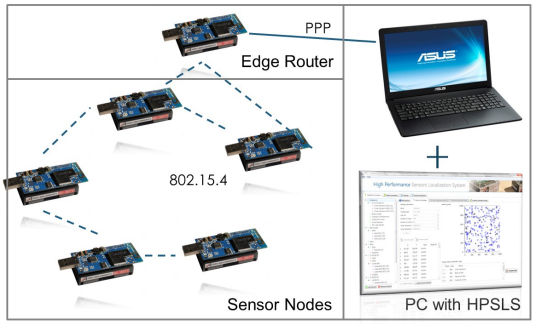
Localization of wireless sensor network nodes

Two phase method

1: Trilateration
2: Stochastic optimization
- Simulated annealing
- Genetic algorithm





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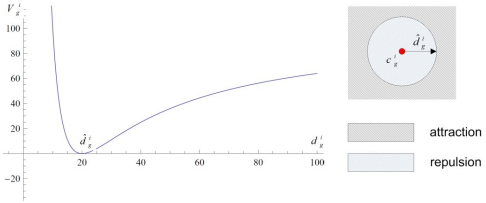
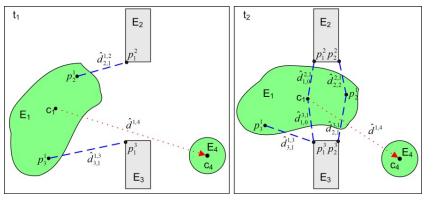
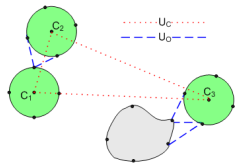
MANET nodes mobility modelling

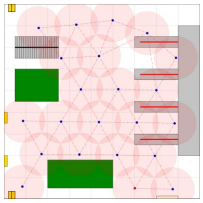
Artificial potential function mobility model

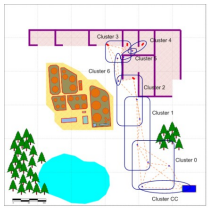


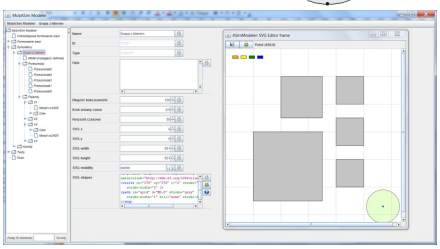




Connected network design
Monitoring nodes location optimization







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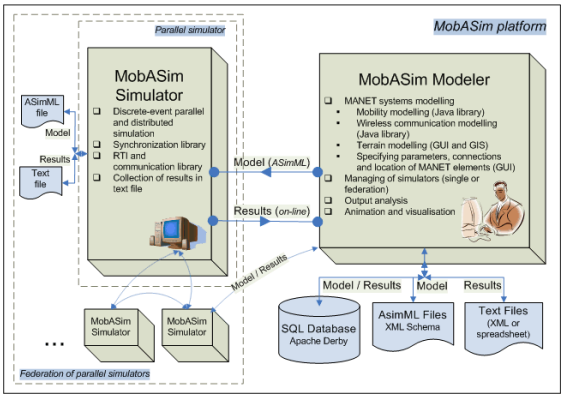
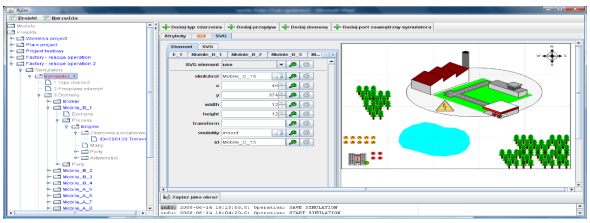
Asim/Java Simulation Library

- **Complex systems simulation**
- **Technology:**
  - Java
  - distributed
- **Implemented simulators:**
  - Frame Relay network
  - MobAsim – mobile wireless network – IEEE 802.11 b/g
  - WPAN (Wireless Personal Area Network) – IEEE 802.15.4





Complex Systems Group

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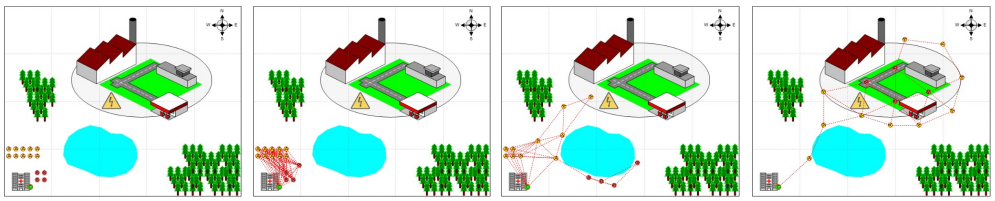
MobAsim

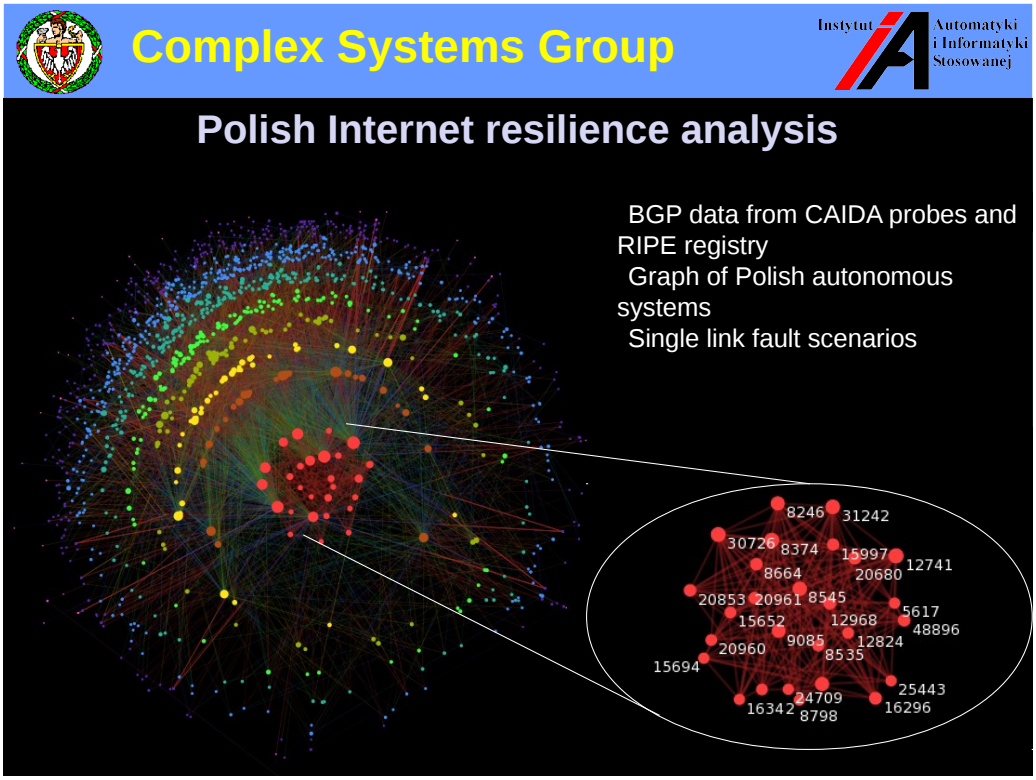
Network simulation

- Library of synchronization routines
- Comunication library for federated simulators

Network modelling

- Wireless transmission and mobility,
- Terrain modelling (SVG/GIS),
- SQL database persistency,
- Distributed management for federated simulators,
- SVG (Scalable Vector Graphics) animations.




Complex Systems Group
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Polish Internet resilience analysis
BGP data from CAIDA probes and RIPE registry
Graph of Polish autonomous systems
Single link fault scenarios
8246
31242
30726
8374
15997
12741
8664
20680
20853
20961
8545
5617
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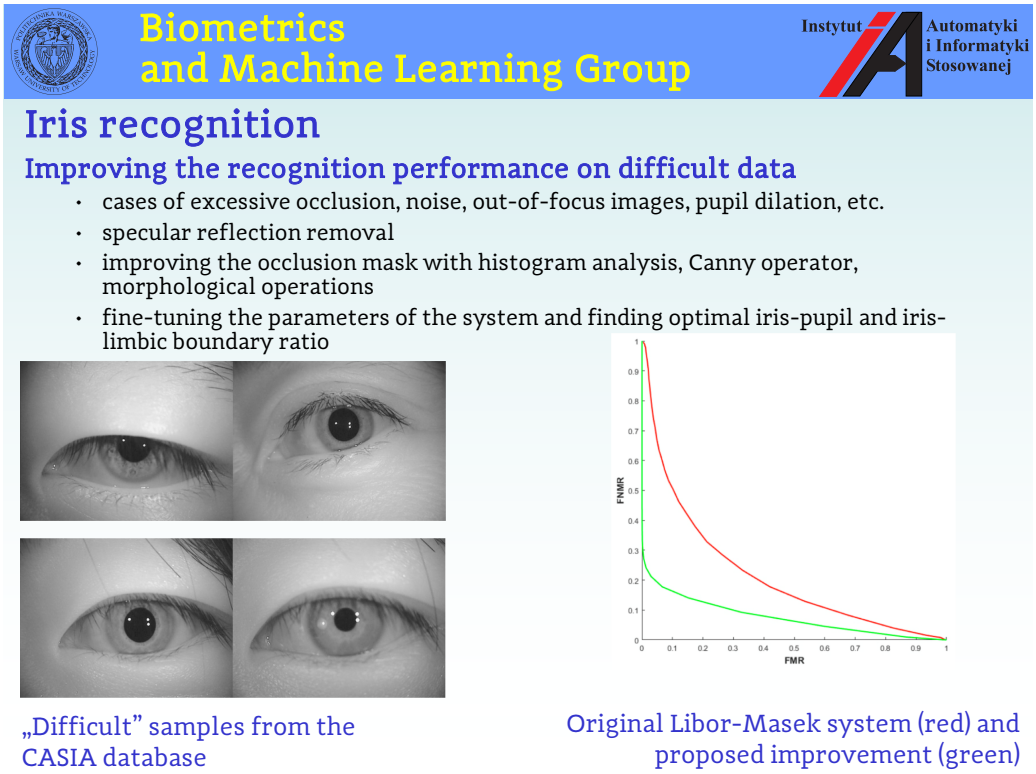
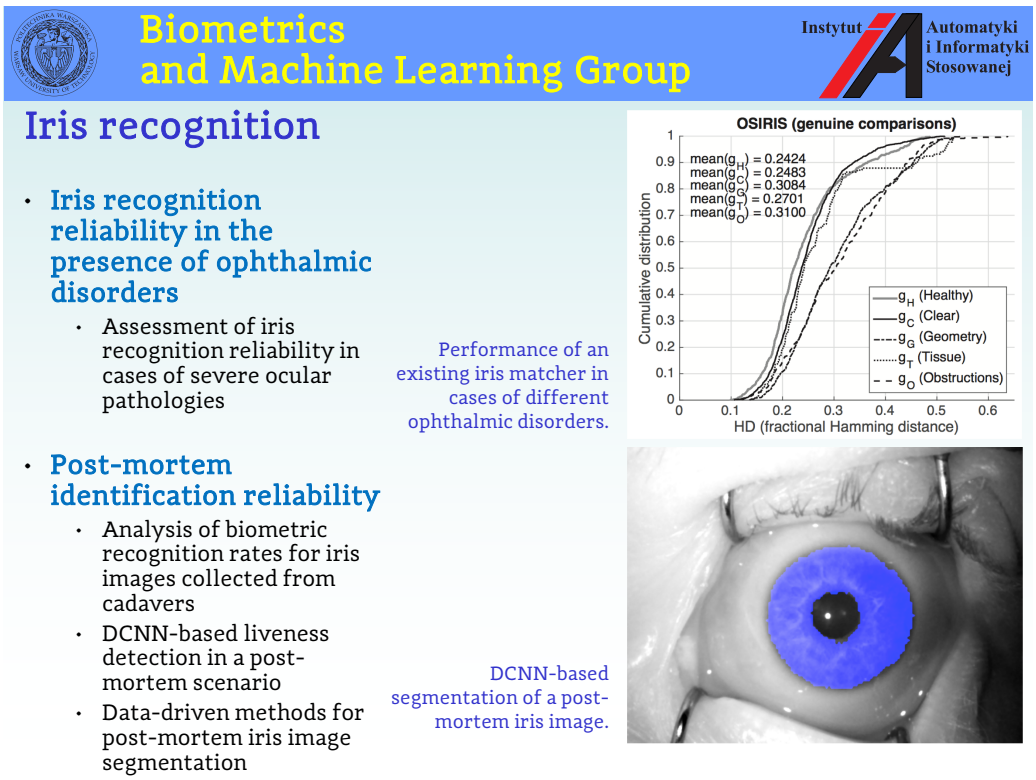

Biometrics
and Machine Learning Group
Instytut Automatyki i Informatyki Stosowanej
Iris recognition
Improving the recognition performance on difficult data
cases of excessive occlusion, noise, out-of-focus images, pupil dilation, etc.
specular reflection removal
improving the occlusion mask with histogram analysis, Canny operator, morphological operations
fine-tuning the parameters of the system and finding optimal iris-pupil and iris-limbic boundary ratio
FNMR
FMR
„Difficult" samples from the CASIA database
Original Libor-Masek system (red) and proposed improvement (green)


Biometrics
and Machine Learning Group
Instytut Automatyki i Informatyki Stosowanej
Iris recognition
Iris recognition reliability in the presence of ophthalmic disorders
Assessment of iris recognition reliability in cases of severe ocular pathologies
Performance of an existing iris matcher in cases of different ophthalmic disorders.
OSIRIS (genuine comparisons)
mean(g_H) = 0.2424
mean(g_H) = 0.2483
mean(g_C) = 0.3084
mean(g_G) = 0.2701
mean(g_O) = 0.3100
g_H (Healthy)
g_C (Clear)
g_G (Geometry)
g_T (Tissue)
g_O (Obstructions)
Cumulative distribution
HD (fractional Hamming distance)
Post-mortem identification reliability
Analysis of biometric recognition rates for iris images collected from cadavers
DCNN-based liveness detection in a post-mortem scenario
Data-driven methods for post-mortem iris image segmentation
DCNN-based segmentation of a post-mortem iris image.

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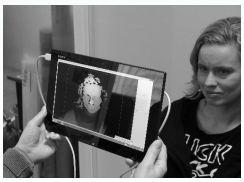
Face recognition

- **New techniques of 3D face imaging**
  - Comparison of various depth sensors and a high-resolution 3D scanner. Analysis of noise and resolution factors.
  - Development of structures for storing and processing of point clouds which contain face information for biometric recognition
- **Face recognition**
  - Feature selection for classification: surface and color face characteristics.
  - Application of deep convolutional neural networks for face recognition.
  - Investigation of initial face image transformations for neural networks recognition.

Collecting the images for 3D face database
Comparing data obtained with mobile depth sensor and structural light scanner. Selecting parameters for feature extraction from images with different resolutions and levels of noise.



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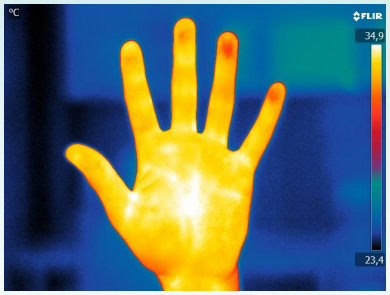
Thermal imaging

- **Hand recognition**
  - use of **temperature of the inner part of the hand** to calculate individual biometric features
  - use of **thermal cameras** (contactless acquisition)
  - **unconstrained environment:** on-the-fly image acquisition: no pegs, no constraints, almost no user training
- **Liveness detection**
  - use of temperature distribution to detect imitations of the authentic biometric characteristics (eye, hand, face)

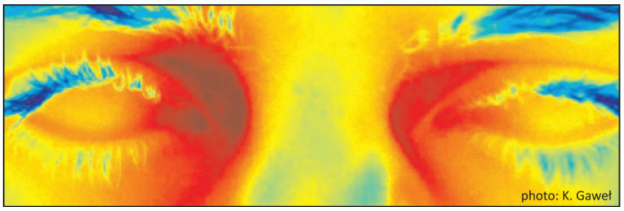


Thermal hand image

Temperatures of the inner part of a hand are unique and can be used in biometric recognition.

Eye thermal images

Temperatures of the eye and their surroundings are difficult to be copied by the attackers.



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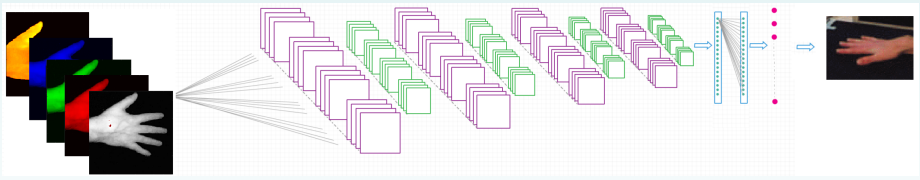
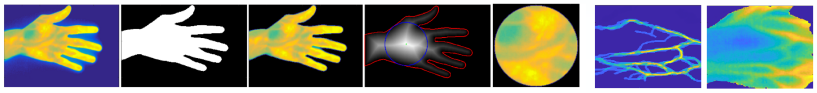
Hand recognition

- **Identity recognition based on hand images**
  - Feature extraction using texture descriptors (LBP, BSIF, Gabor wavelets)
  - Application of a convolutional neural network



- **Hand segmentation and statistical analuysos**
  - Input data format: images in visible light, near-infrared images, thermal images
  - Comparison of hand segmentation methods
  - Implementation methods of image enhancement and object alignment
  - Correlation between veins pattern and thermal stability maps



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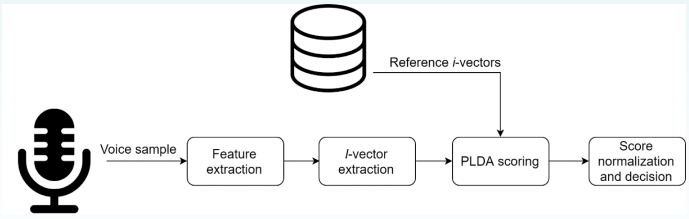
Speaker recognition

- **Text-independent *i*-vector/PLDA speaker recognition**
  - Every speech sample mapped to a vector in a low-dimensional total variability subspace
  - Inferences about identity made with probabilistic linear discriminant analysis



- **Score normalization techniques**
  - PLDA scores follow a non-central generalized chi-squared distribution with no closed-form solution for the density function
  - Score distributions for various people are different, hence the need for reliable score normalization
  - The best performing method – successive standarization of score arrays

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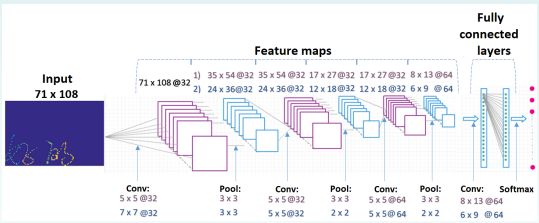
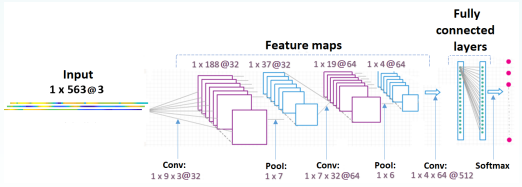
On-line signature recognition

- **Warped least squares models**
  - A new method of using the false signatures in training
  - A new method of model optimization
  - Use of Convolutional Neural Networks
- **Deep convolutional neural network models**
  - 3D input image: pressure vs. pen position (time not included);
  - 3D function graph (pressure, horizontal position and vertical position) vs time





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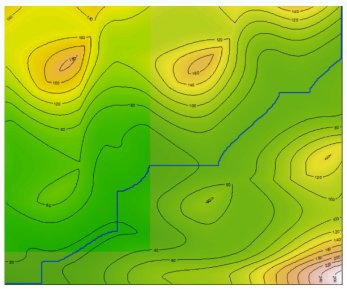
On-line Signature recognition

Mobile devices solution

- On-line handwriting data (pen position, pressure) collected with a mobile phone
- various warped least squares/hidden signature models for signature verification
- Android OS development target
- Efficient mobile implementation

MIPPA-based enrollment template
(K. Stachyra, BSc Thesis)



Finding the optimal warping path with a heatmap-like representation of the signature matrix

(K. Stachyra, BSc Thesis)

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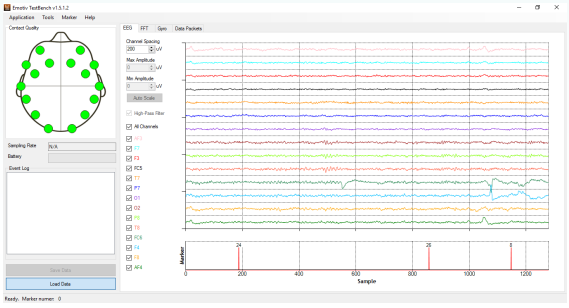
EEG-based verification

- Person recognition using visual evoked potentials
- Exploring optimal channel selection and signal correlation between individual channels
- Encouraging results obtained for intra-session comparisons

Emotiv Epoc portable EEG measurement device



Sample EEG signals recorded from multiple channels (K. Badowska, BSc Thesis)

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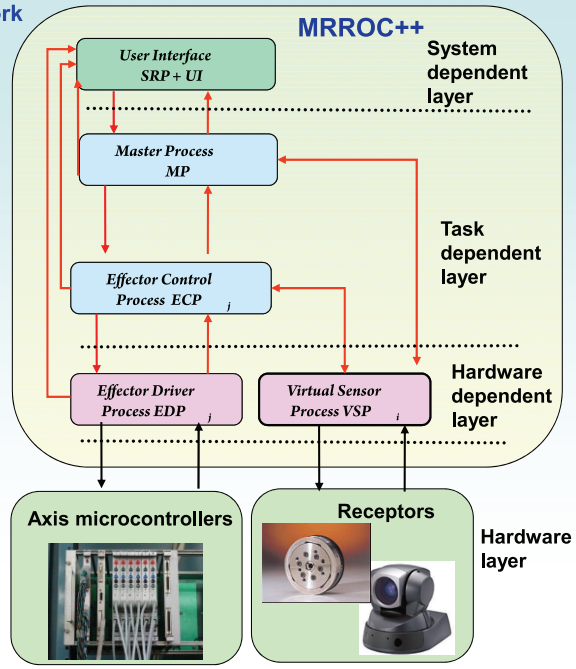
MRROC++ robot programming framework

- a collection of: C++ classes, Linux processes, and a design pattern
- designed for building open modular robot control systems
- distributed within an Ethernet PC network
- Supports dedicated hardware: custom built axis controllers, IMU interfaces
- Cooperates with DisCODe framework

Two co-operating IRp-6 robots



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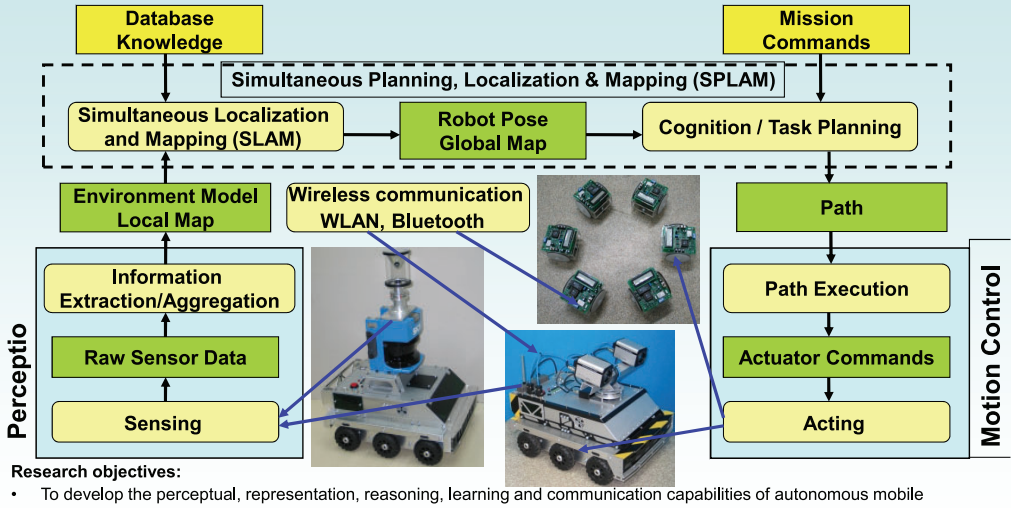
Control architecture for autonomous mobile robot teams



Research objectives:

- To develop the perceptual, representation, reasoning, learning and communication capabilities of autonomous mobile robot systems in human-oriented real-life environments
- To develop and implement a complete, effective, and reusable software for autonomous robot systems that incorporates both programming (manual coding) and learning-derived (automated coding) software composition to increase the ability of autonomous robots to function in unpredictable, dynamic environments
- To study the human-robot interaction (multi-modal interfaces)

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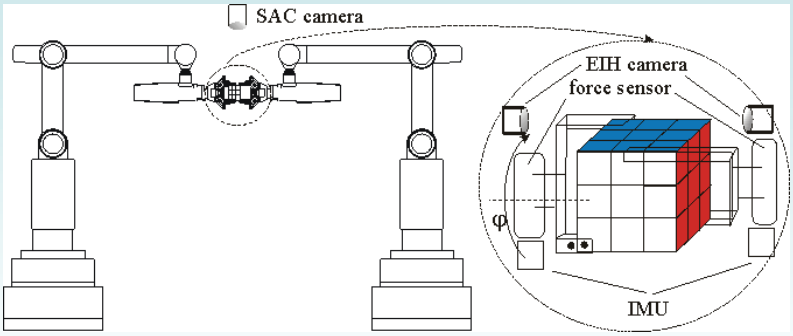
Sensor based two-handed manipulation



Solution of the benchmark task requires:

- **Two-handed manipulation skill to efficiently turn the faces of the cube**
- **Visual sensing capability to locate the cube and identification of its initial state**
- **Visual servomechanism to approach the cube and to get hold of it**
- **Using force sensors supported by inertial measurement units (IMU) to avoid jamming of the cube while rotating the faces**
- **Fusion of deliberative and behavioural control to work out the plan of motions solving the puzzle and to adapt quickly to sudden changes in the environment (e.g., jamming)**
- **Ability to recognize spoken commands and to synthesize replies and queries**

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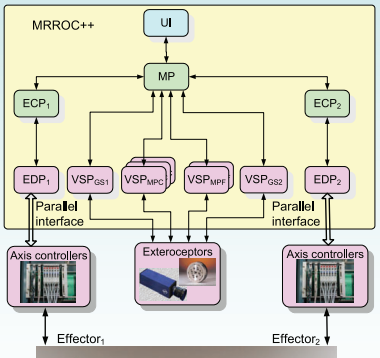
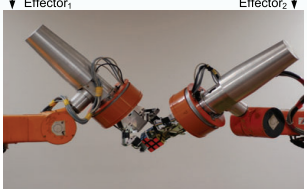
Two-handed Service Robot Controller Capable of Solving a Rubik's Cube Puzzle





Components:

MP – Master Process (produces the solution of the puzzle and generates the nominal motion trajectories for the two arms)

ECP – Effector Control Process (transmits the macro-steps generated by the MP to the EDP)

VSP – Virtual Sensor Process (aggregates data from sensors, i.e. cameras, enabling the localisation of the cube and identification of its state)

EDP – Effector Driver Process (divides the macro-step into steps and executes each step using the Task Frame Formalism for position-force control)

UI – User Interface (operator console and status and error reporting)

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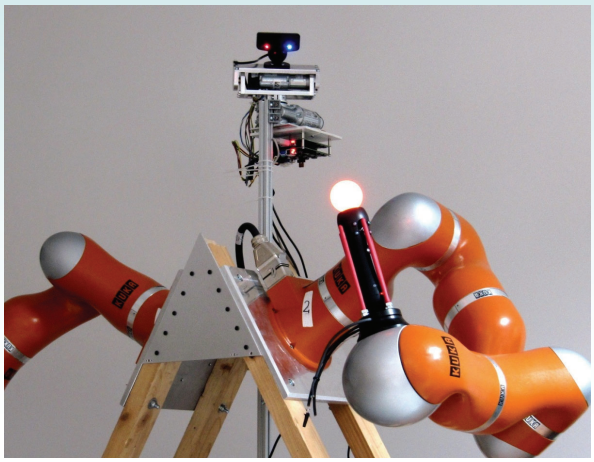
Velma: two arm robotic system with redundant manipulators and active head



14 DOF two arm system

- Torque controllers in joints
- Full dynamic control
- Redundant kinematic structure
- Antropomorfic form
- Lightweight (30 kg)
- Controlled by ROS, OROCOS software

2DOF active head

- Custom hardware
- Internal trajectory generation
- High precision servocontrol
- Fast motion
- Constructed as a platform for various sensors: 3D structured light camera, sterovision system
- Controlled by ROS, OROCOS software

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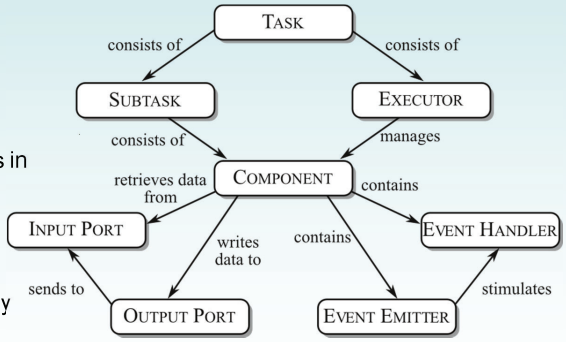
DisCODe: Distributed Component Oriented Data Processing

Major concepts:

- **Facilitation** of the development and testing of diverse, multi-step sensory processing algorithms
- **Utilization** of implemented algorithms in robotic tasks: drivers for hardware, ready-to-use communication mechanisms with robotic frameworks
- **Reusability** of components created by users – core separated from the component libraries



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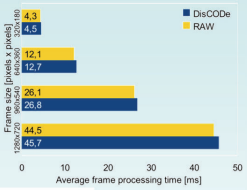
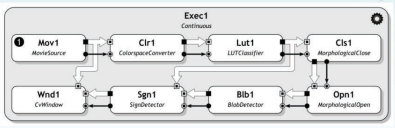
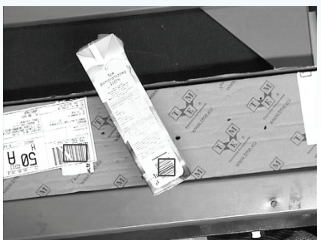
DisCODe: Benchmark applications

Roadsign detection test

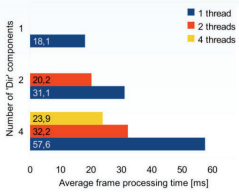
- **Low** communication overhead
- **Robust** structure

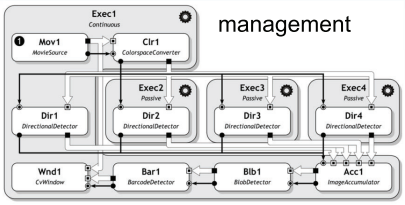






Barcode detection test





- **Parallel** computations
- **Execution threads** management

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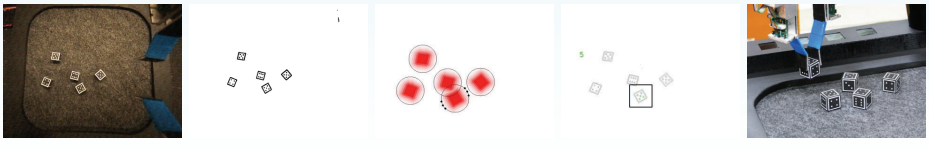
DisCODe: Robotic applications

Active recognition of the hand posture

Robot playing a game of dice



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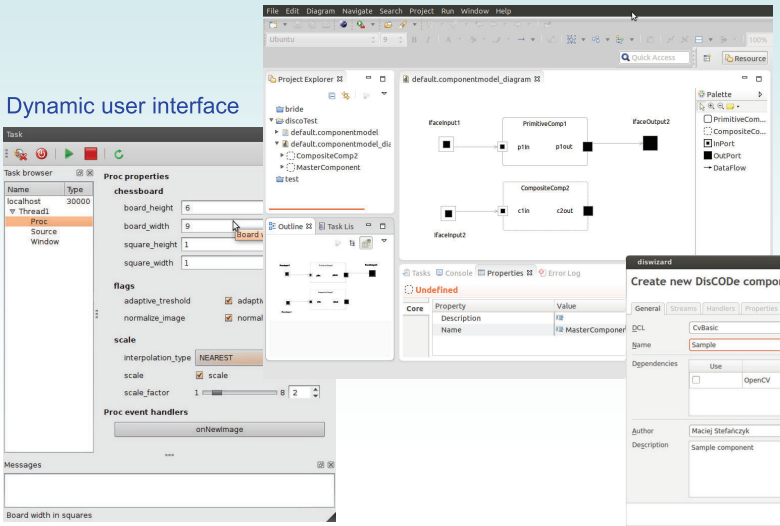
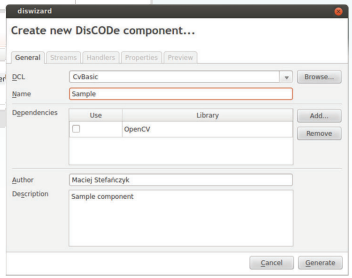
DisCODe: Graphical tools

Metamodel-based task editor



Dynamic user interface

Component wizard



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Active Perception and Active Vision

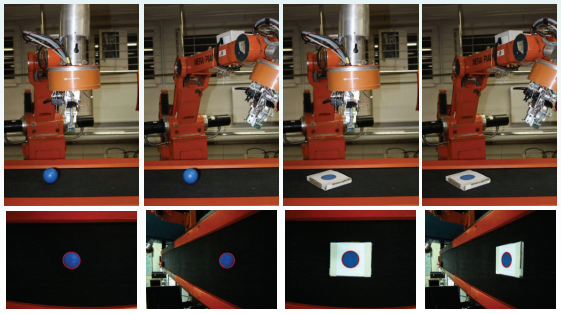
Concept:

Active perception means for a perceptual system to actively seek for the information and not just rely passively on information falling accidentally on the sensor. This also means that the system must be mobile and can interact with the environment.

Active vision:

In the case of a static observer, identification of a distant or partially occluded object can be very difficult and sometimes even impossible. Those problems can be overcomed by the introduction of an active observer, able to perform actions facilitating the gathering and interpretation of perceptual information.

Example: determination of object convexity



Major system concepts:

- **Embodied Agent** based decomposition of the control system into subsystems
- Utilization of **Transition functions** for description of subsystem behaviours
- **Combination** of several behaviours of enabling the successfull realisation of the task

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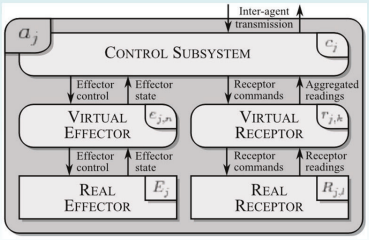
Embodied Agent: a robot control system design method

Concept:

- Design of robot control systems requires a specification method that would facilitate its subsequent implementation.
- The postulated approach bases on decompostion of a system into **Embodied Agents** and description of their **Behaviours** in terms of **Transition Functions**.

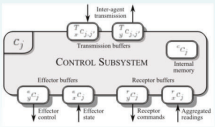
Embodied Agent:



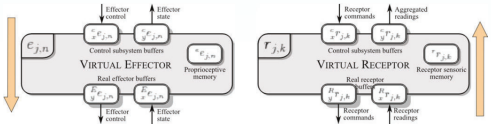
- **Embodied Agent -** any device or program having the ability to perceive its surroundings to subsequently influence the environment state, can communicate with other agents and has an internal imperative to achieve its goal.

Subsystems and transition functions:

- Five types of internal subsystems: its **effector**, **receptor**, **virtual effector**, **virtual receptor** and a **control subsystem**
- The former two form the agent's **corporeal body**, whereas the latter three its **control system**.



- The evolution of the state of each of those subsystems is defined in terms of a transition function, transforming the values taken from input buffers and internal memory into the values written to output buffers (and back to the internal memory as well) and sent subsequently to the associated subsystems.



11

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Elementary behaviours of robot manipulators

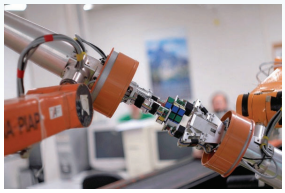
Main concepts:

Three elementary behaviors can be distinguished. They suffice to implement all possible cases of interaction between a manipulator and the environment. Those behaviors are:

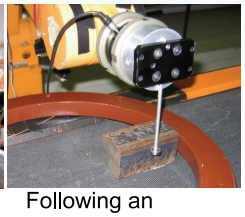
- unconstrained motion with the assumption that no contact with obstacles will be encountered – where pure position control suffices
- contact with the environment – where pure force control is used,
- intermediate or transitional behavior – where initially unconstrained motion is expect to result in eventual contact, or vice versa – for this purpose some form of parallel position–force control has to be utilized (e.g., stiffness, damping or impedance control).

The existing manipulator control can be classified taking into account the proposed behaviors.

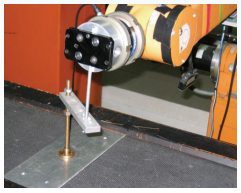
In terms of those behaviors complex tasks can be specified formally and implemented.



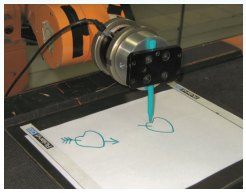
Rubik's cube solver



Following an unknown contour



Rotating a crank



Copying drawings

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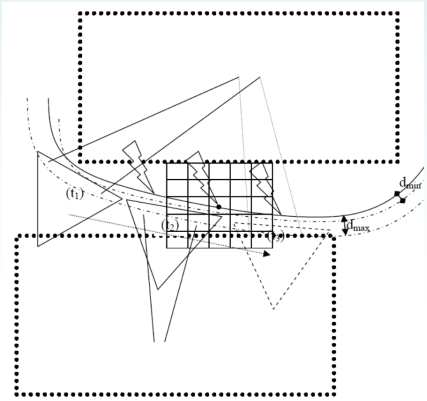
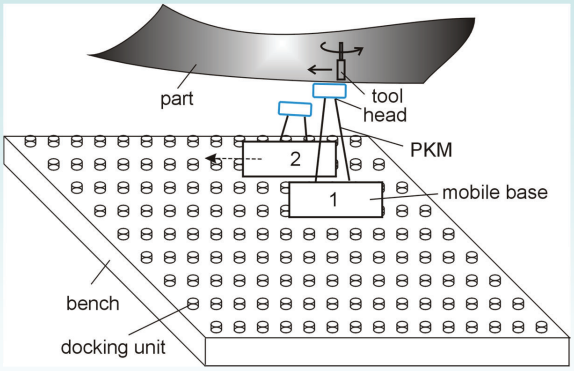
Programming and control of a swarm of mobile fixtures

Seventh Framework Program
Theme [NMP-2007-3.2-1]
Project: **SwarmItFIX - Self Reconfigurable Intelligent Swarm Fixtures**





Active mobile fixture system for drilling and milling processes:
a bench with docking units, 2 mobile bases with PKM manipulators and heads.

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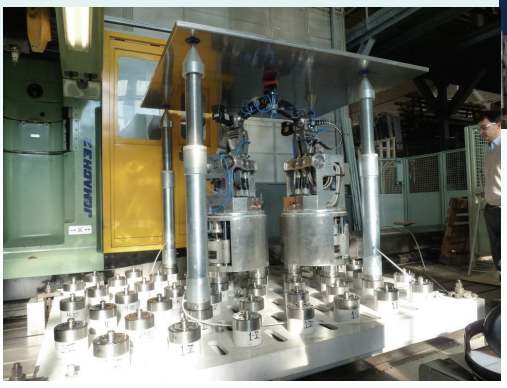
Mobile supports replacing static fixtures

Instead of fixtures manufactured to support a single workpiece, robots can support many shapes, thus making production cost effective.

Standard fixture



The SwarmItFIX system

Project partners:University of Genova,Piaggio Aero, Exechon, ZTS VVU Kosice, Centro Ricerche FIAT, Warsaw University of Technology

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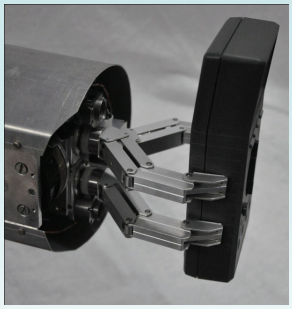
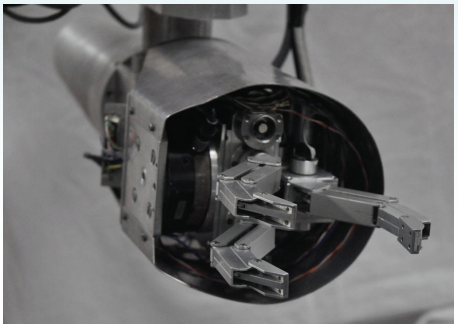
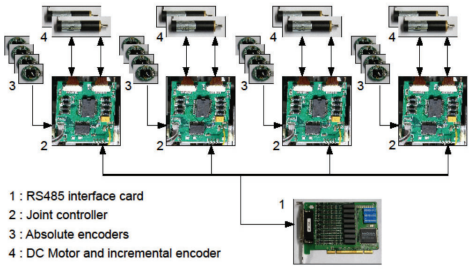
Three finger gripper

- 8 active joints in 3 fingers
- Force sensing in 6 joints
- Force compliance to deal both with hard and soft objects
- Ultra compact motion controllers mounted on board
- Cascade controller with external position/force (torque) control loop and optional, internal current control loop
- RS-485 interface to PC Computer with master controller







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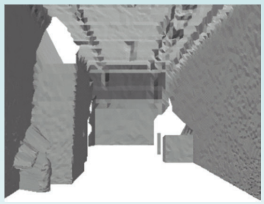
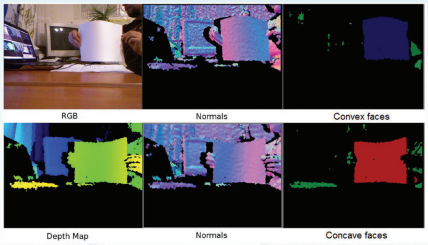
Computer Vision in mobile and service robotics

Environment map generation, obstacle avoidance.



Depth-map and color image Segmentation



3D object recognition

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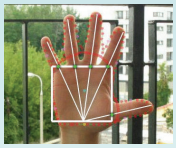
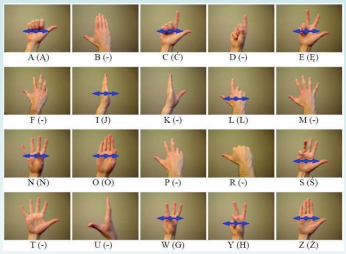
Palm pose and gesture recognition in video sequences

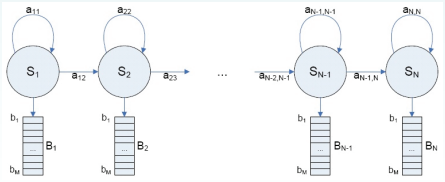


• Palm pose recognition

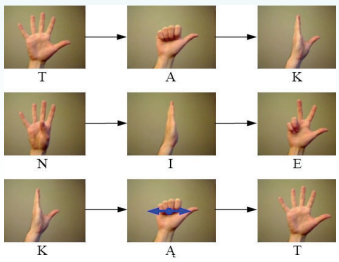
•Static and dynamic („letters”):



• HMM and DBN modelling of pose sequences:



• Examples of gestures („words”):



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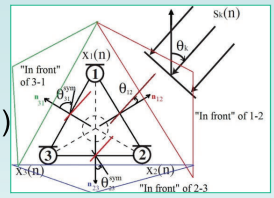
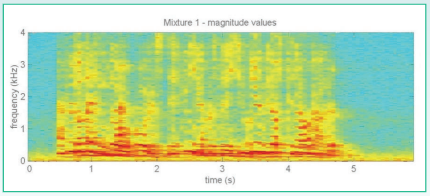
Auditory scene analysis



• Only mixtures of source signals can be acquired,

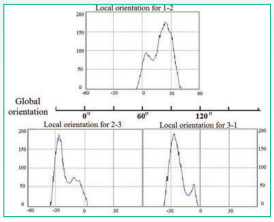
• The goal is to estimate the directions (and locations) of the speakers and to estimate the original sources.

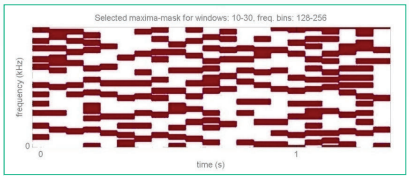


Example:

two sources and three mixtures

Time delay-based detection of source directions:





A spectrogram mask for extraction of a single source

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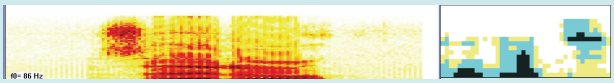
Spoken sentence recognition

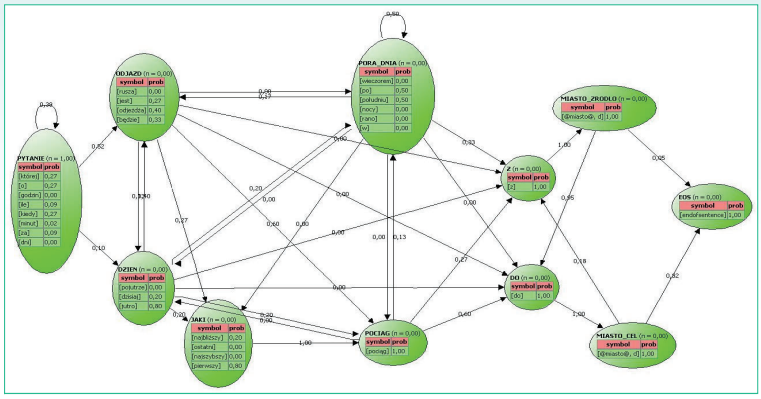
- Spectral analysis
- Acoustic-phonetic features
- Word recognition
- A N-gram language model



$$P(w_i \mid w_{i-N+1} w_{i-N+2} \ldots w_{i-1}) = \frac{C(w_{i-N+1} w_{i-N+2} \ldots w_i)}{C(w_{i-N+1} w_{i-N+2} \ldots w_{i-1})}$$

- HMM-based sentence recognition

Example of a semantic" HMM for the recognition of train connection questions:



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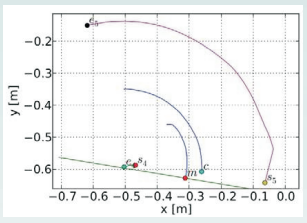
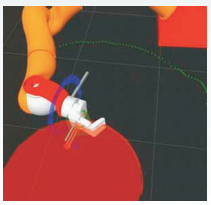
Door opening

- Impedance control of humanoid robot
- Estimation of the door pose based on visual markers
- Tactile sensors on finger tips used for active sensing for better pose estimation
- Unknown door model
- Door parameters (radius, position of the handle) are obtained during the task execution
- Visualisation of the robot state and the environment state

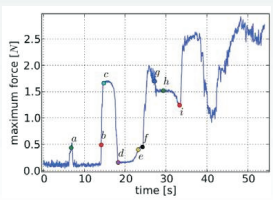
Velma robot opening the door



The plot of measured and commanded trajectories



The visualisation of the robot and environment state



The plot of total force acting on the tactile sensors

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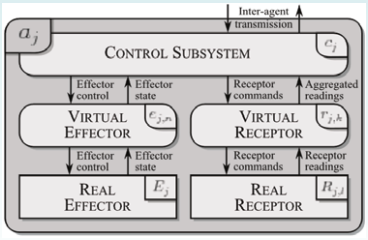
Embodied Agent: a robot control system design method

Concept:

- Design of robot control systems requires a specification method that would facilitate its subsequent implementation.
- The postulated approach bases on decompostion of a system into **Embodied Agents** and description of their **Behaviours** in terms of **Transition Functions**.

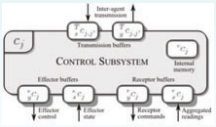
Embodied Agent:

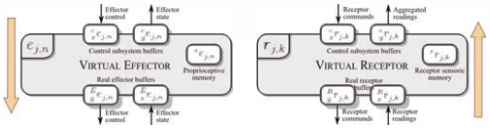


- **Embodied Agent -** anydevice or program having the ability to perceive its surroundings to subsequently influence the environment state, can communicate with other agents and has an internal imperative to achieve its goal.

Subsystems and transition functions:

- Five types of internal subsystems: its **effector**, **receptor**, **virtual effector**, **virtual receptor** and a **control subsystem**
- The former two form the agent's **corporeal body**, whereas the latter three its **control system**.
- The evolution of the state of each of those subsystems is defined in terms of a transition function, transforming the values taken from input buffers and internal memory into the values written to output buffers (and back to the internal memory as well) and sent subsequently to the associated subsystems.





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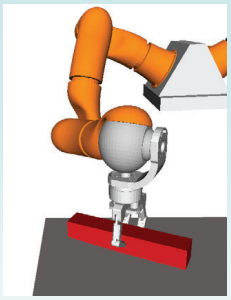
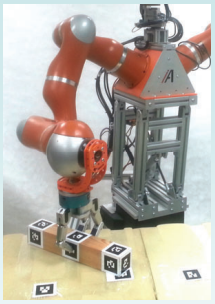
Grasping

- Impedance control of humanoid robot
- Visual markers
- Feedback from tactile sensors used for grasp evaluation
- Full environment model
- Planning collision free motion of the manipulators
- Task oriented grasp planning based on analytical contact forces analysis



Velma robot grasping a cuboid (simulation)



Velma robot grasping a cuboid

The visualisation of tactile sensors readings

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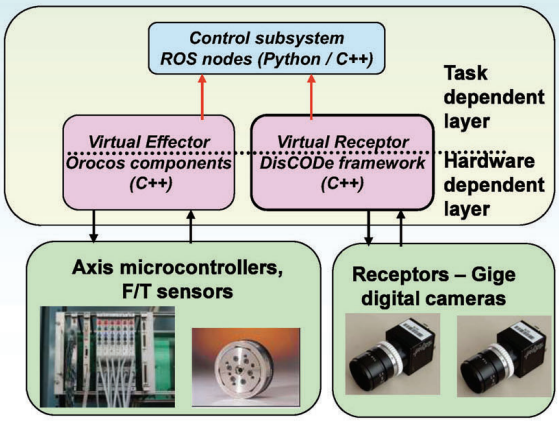
IRPOS robot programming framework

- a collection of: C++ Orocos components, Python/C++ ROS nodes, and an embodied agent inspired design pattern
- designed for building open, modular manipulator control systems
- Supports dedicated hardware: custom built axis controllers, Force/Torque sensors
- Cooperates with DisCODe framework computing a visual data from Gige digital cameras
- Unified, three behavioral Position/force, external space control with inner loop position joint control

Two co-operating IRp-6 robots



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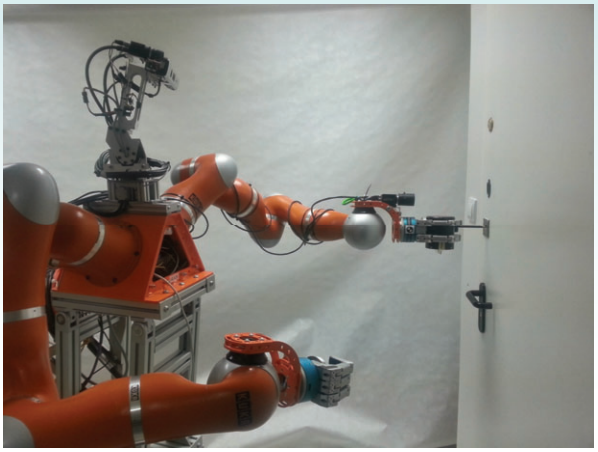
Velma: two arm robotic system with redundant manipulators, grippers, active head and torso



16 DOF two arm system

- Torque controllers in joints
- Full dynamic control
- Redundant kinematic structure
- Antropomorfic form
- 2 DOF active torso
- Controlled by ROS, OROCOS software
- 3 figered barrett hand grippers with tactile sensing

2DOF active head

- Custom hardware
- Internal trajectory generation
- High precision servocontrol
- Fast motion
- Constructed as a platform for various sensors: 3D structured light camera, sterovision system
- Controlled by ROS, OROCOS software

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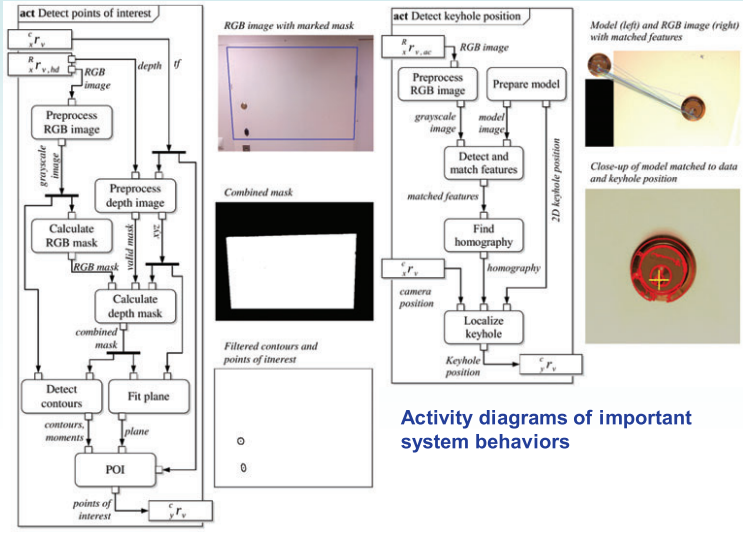
Localization and inspection of door locks

- omprehensive strategy of door locksexamination as a paradigm of active sensing
- nitial region of interestis localized using the RGB-D low resolution camera mounted on the robot head
- tiis theninspected using 2D camera mountedon the robot arm



Activity diagrams of important system behaviors

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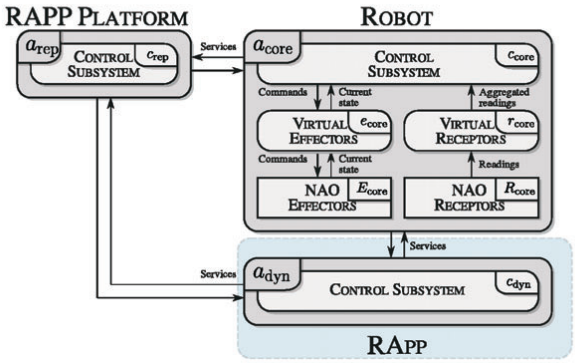
Variable structure robot control system

Robotic Applications for Delivering Smart User Empowering Applications
RAPP: Robots enabling societal inslusion



Observations:

- limited robot controller capabilities
- unlimited capabilities of the cloud

Conclusion:

- downloadable application part
- switchable supervisor

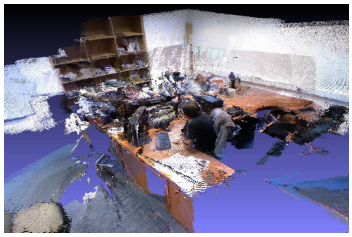
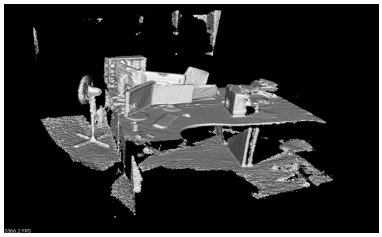
- a_{core} – robot control + system composition (fixed)
- a_{dyn} – user task executor (exchangeable)
- a_{rep} – application software and service provider

FP7 Collaborative Project RAPP (Grant no 610947), European Commission, 2013–2016

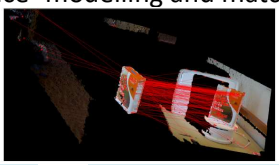
Machine Perception Group

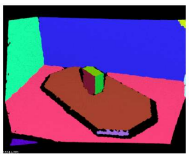
Robot Vision

Surfel map creation (from RGB-D images)

Point- and surface- modelling and matching:



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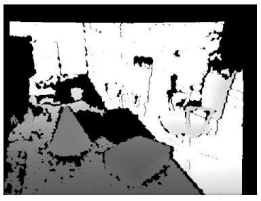
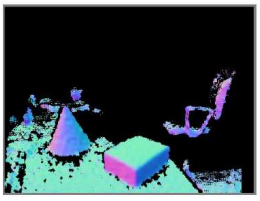
Machine Perception Group

3D object recognition

RGB image | Associated depth map | Surface normal vector map


Surface segments | Detected basic objects

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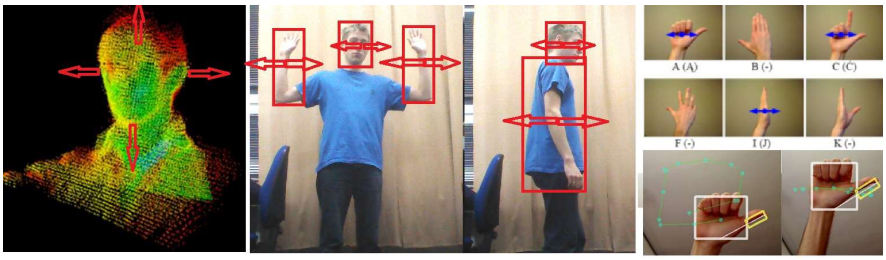
Machine Perception Group

Human gesture recognition

Human-Machine Communication:

modelling and recognition of human gestures given by pose change, hand- and head motion in RGB-D or RGB image sequences.



Pose tracking in 3D (RGB-D) Pose tracking / gestures (RGB) Hand poses and gestures

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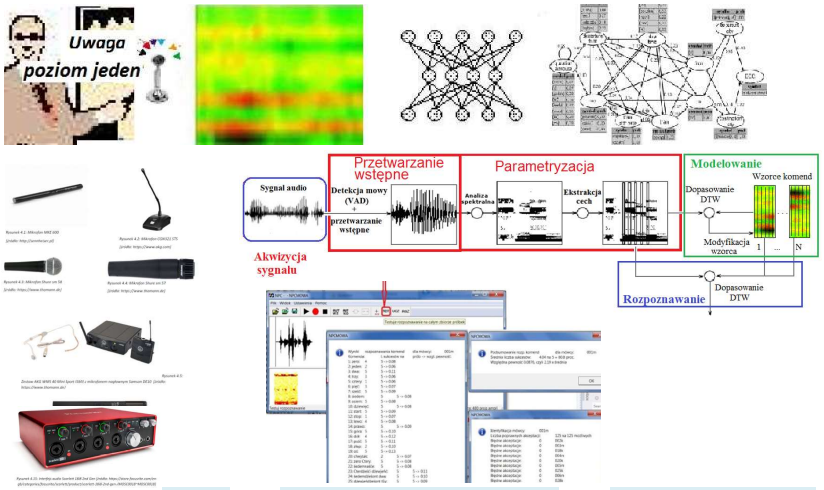
Speech- and speaker recognition



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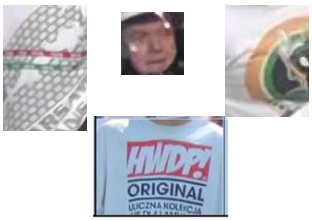
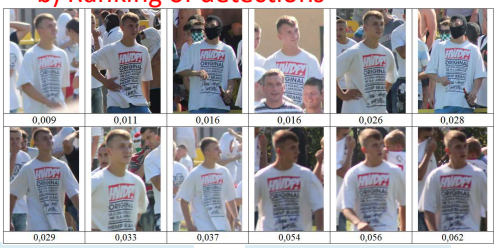
Surveilance video analysis

Patterns:



a) Best detection per pattern

b) Ranking of detections

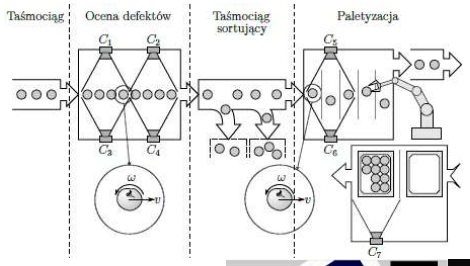


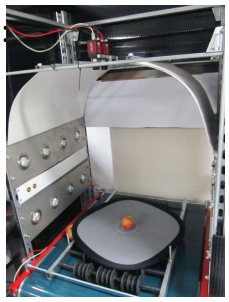
ICCE WUT | Machine Perception Group | 6

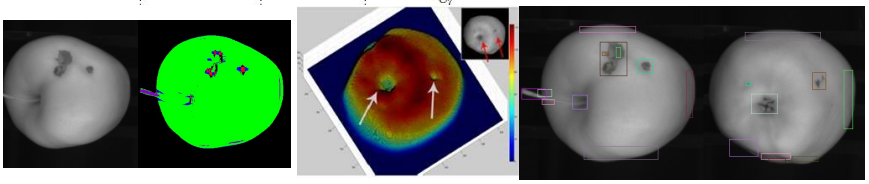
Machine Perception Group

Industrial vision

Apple classification and distortion detection:







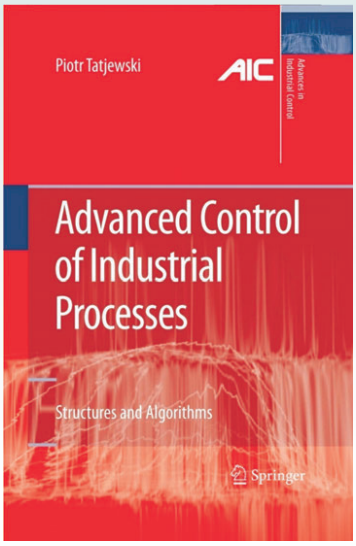
ICCE WUT | Machine Perception Group | 7

Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

Advanced control of industrial processes

- Non-linear process modeling using fuzzy logic and neural networks, design of fuzzy controllers
- Algorithms and structures of MPC (Model-based Predictive Control) with linear and nonlinear process models (quick control laws, precise optimization-based algorithms)
- Supervisory control and set-point optimization
- Fault-tolerant control
- Software for development and testing of advanced control systems



Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

Optimization of industrial processes and large-scale systems

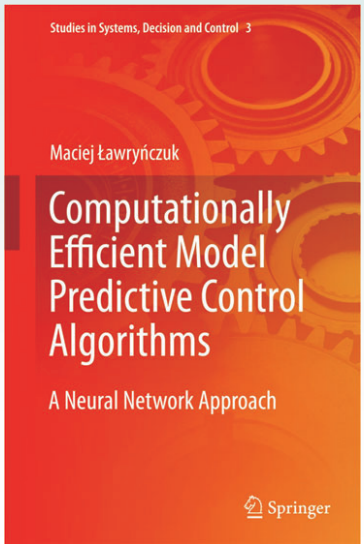
- Algorithms for optimization of steady-states of industrial processes
- On-line measurement-based set-point optimization under uncertainty
- Hierarchical (multilevel) optimization methods for large-scale systems
- Multilevel algorithms for on-line set-point optimization of interconnected processes under uncertainty

Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

Computationally efficient model predictive control algorithms: a neural network approach

- Thorough presentation of MPC algorithms based on different kinds of neural models
- Comparison of different on-line model and trajectory linearisation techniques
- The MPC algorithms with neural approximation with no on-line linearisation
- The MPC algorithms with guaranteed stability and robustness
- Cooperation between the MPC algorithms and set-point optimisation



3

Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

DiaSter (Diagnostics and Control) software system (co-authors)

- Model building and identification (linear and nonlinear models, including fuzzy and neural)
- Diagnostics
- Design of classical control algorithms (PID)
- Design of advanced control algorithms (fuzzy, MPC)
- Development of set-point optimization
- Simulation

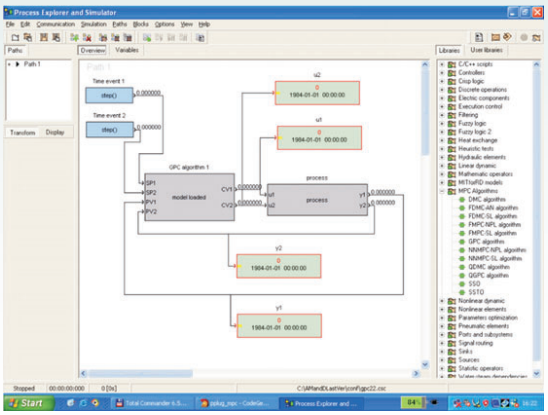
Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

DiaSter (Diagnostic and Control) software system

Model Predictive Control (MPC) algorithms based on *linear models*:

- Dynamic Matrix Control (DMC) algorithm based on step-response models
- Generalized Predictive Control (GPC) algorithm based on input-output models



Two version of DMC and GPC algorithms:

- *Explicit algorithms*: the control law is designed off-line
- *Numerical algorithms*: on-line control optimization based on quadratic programming is used

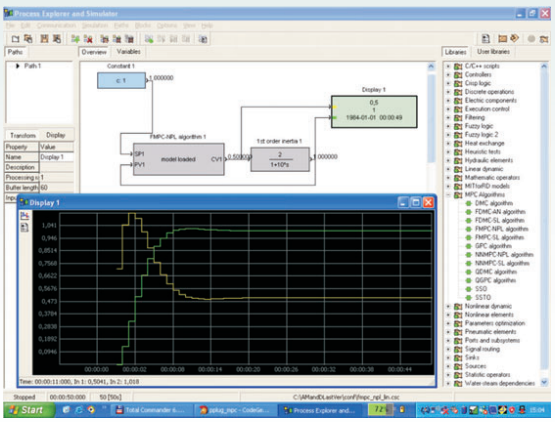
Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

DiaSter (Diagnostic and Control) software system

Model Predictive Control (MPC) algorithms based on *nonlinear models*:

- MPC algorithm with on-line Successive Linearization (MPC-SL)
- MPC algorithm with on-line Nonlinear Prediction and Linearization (MPC-NPL)



- The MPC algorithms are *computationally efficient* because quadratic programming is used on-line rather than difficult nonlinear optimization
- Neural and fuzzy models can be used for prediction

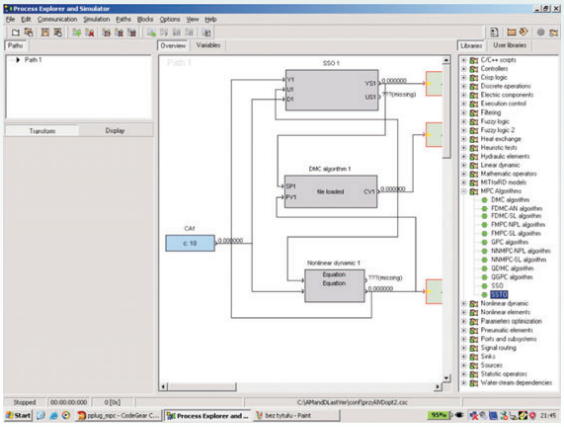
Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

DiaSter (Diagnostic and Control) software system

Set-point optimization structures which cooperate with MPC algorithms:

- Steady-State Optimization structure
- Steady-State Target Optimization structure with on-line model linearization



The set-point optimization structures are *computationally efficient* because linear programming is used on-line rather than difficult nonlinear optimization

Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

R&D project: MPC Controller for the burning process in small furnaces used for house/water heating

- Benefits of advanced control algorithms (MPC – Model-based Predictive Control):
  - Good control accuracy
  - High process efficiency
  - Increase of economic profits
  - Ecology - the process is friendly for the environment
- The controller is on the market (manufactured by ***Plum*** company)

Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

R&D project: The anti-smoke ventilation control in high buildings

The fire smoke is most dangerous: to save people air pressure and flow must be quickly controlled in rescue areas – highly demanding nonlinear feedback control problem

Classical PID control unable to fulfill the requirements

Nonlinear MPC algorithm with **on-line model adaptation** designed, featuring:

- computational efficiency (quadratic programming is used on-line)
- very fast operation
- control accuracy satisfying demanding requirements

Therefore: increase of fire safety

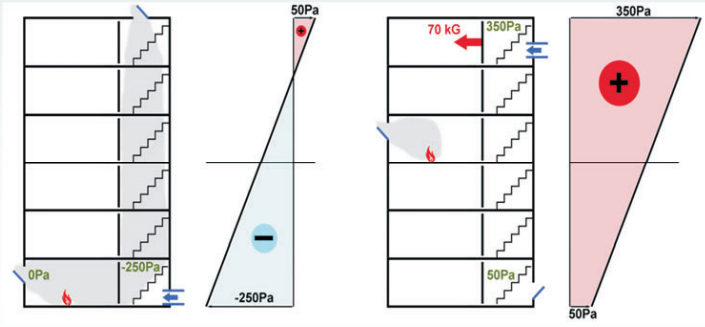
The controller is on the market (manufactured by ***Plum*** company)

Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

R&D project: The anti-smoke ventilation control in high buildings

In high buildings the anti-smoke control is much more difficult due to chimney effect – multivariable control with two actuators (high power ventilators) required



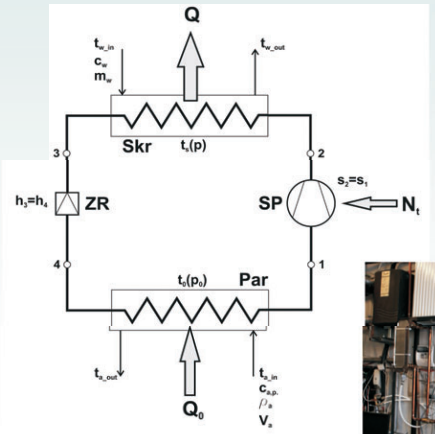
Nonlinear MPC algorithm with **on-line model adaptation** designed (the controller is manufactured by ***Plum*** company)

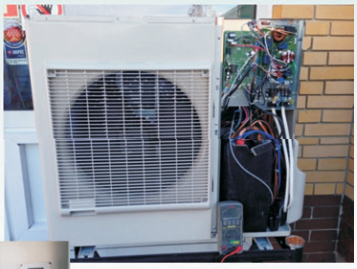
Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

R&D project: Control of air-water heat pump

The heat pump absorbs heat from a cold space and transfers it to a warmer one





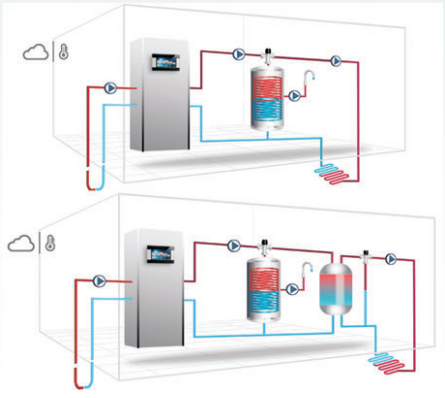
Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

R&D project: Control of air-water heat pump

The controller:

- Maximises the Coefficient of Performance (COP)
- Minimises energy consumption
- Automatically adapts to changing environmental conditions



The controller is on the market (manufactured by ***Plum*** company)

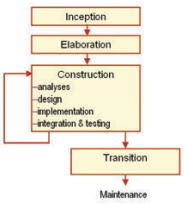
Software Engineering Group

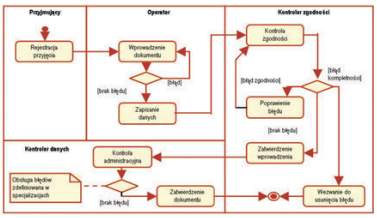
Instytut Automatyki i Informatyki Stosowanej

Software development

Research topics:

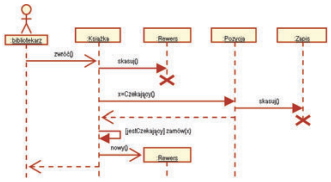
- Business process modeling
- Requirements engineering
- Software development methods
- Technologies and tools
- Acceptance testing
- Software processes
- Project management





***Systems and tools* :**

- Rational Rose
- Rational RequisitePro
- Structured Architect



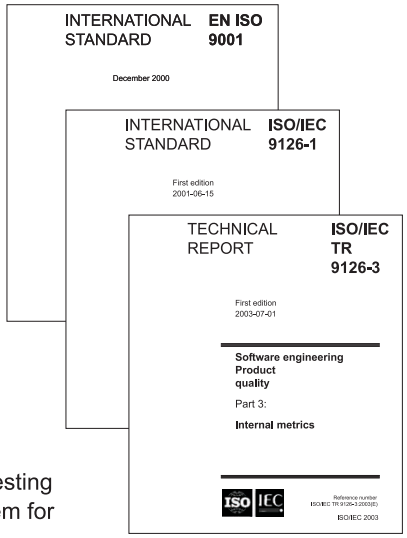
Software Engineering Group

Instytut Automatyki i Informatyki Stosowanej

Evaluation of the software quality

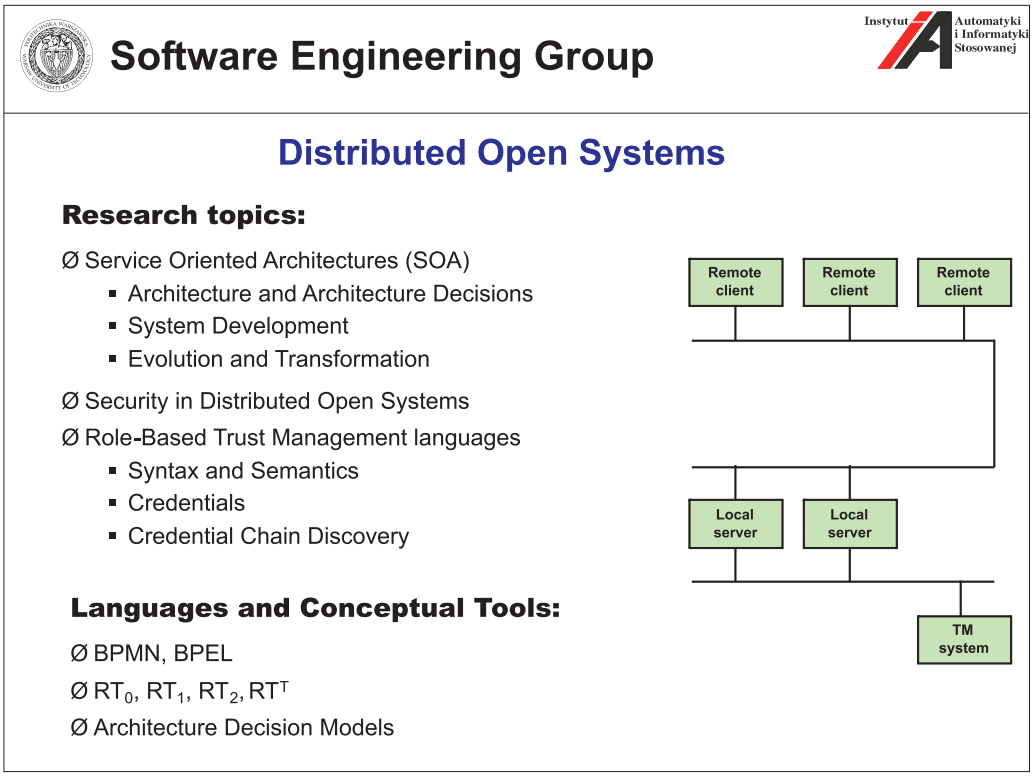
Research topics:

- Quality of the software process
- Quality of the software products
- Evaluation method:
  - Defining the set of quality criteria
  - Defining the set of questions
  - Evaluation and ranking
  - Threats and recommendations



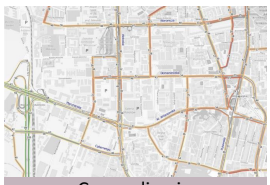
Sample projects:

- Evaluation of the expected quality of software developed for IACS (support system for EU Common Agriculture Policy in Poland)
- Supervision and evaluation of the acceptance testing of the integrated management and control system for the post delivery service in Poland

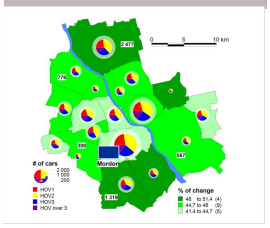

Software Engineering Group
Instytut Automatyki i Informatyki Stosowanej
Distributed Open Systems
Research topics:
Ø Service Oriented Architectures (SOA)
▪ Architecture and Architecture Decisions
▪ System Development
▪ Evolution and Transformation
Ø Security in Distributed Open Systems
Ø Role-Based Trust Management languages
▪ Syntax and Semantics
▪ Credentials
▪ Credential Chain Discovery
Remote client
Remote client
Remote client
Local server
Local server
TM system
Languages and Conceptual Tools:
Ø BPMN, BPEL
Ø RT_0, RT_1, RT_2, RT^T
Ø Architecture Decision Models

Multi-commodity Market Oriented Programming

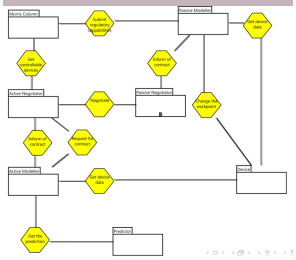
Method to solve problems by creation of artificial economy and solving the equilibrium using Multi-agent Systems and market mechanisms



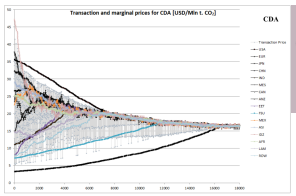
Carpooling in „Mordor of Warsaw”



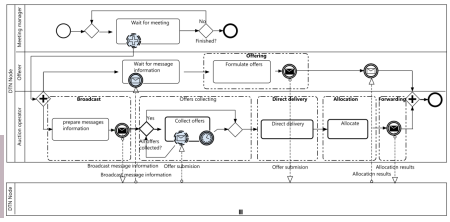
Balancing Energy shortages and surpluses in microgrid



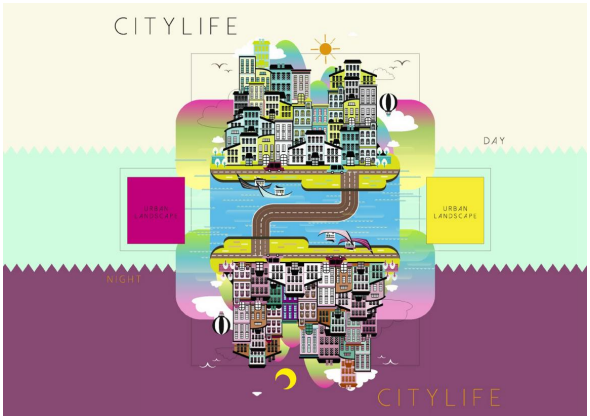
Auction-Based Routing Algorithm for Delay and Disruptive Tolerant Networks



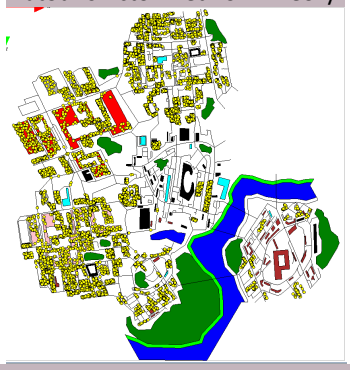
Greenhouse Gases Emission Trading simulation



Gamification, Geoparticipation, Urban planning, Multi-Agent Systems in Smart Cities



Smart City Growth based on Latour’s Actor-Network Theory



Cooperation with: conuncta

interdisciplinary group of: scientists, artists, sociologists, cartographers, IT-specialists

EqDb – Equipment Database for NICA MPD

- Goals
  - intended to support construction, assembly & operation of MPD equipment
  - can be used also as a calibration database for the detector
  - may become a backbone for slow control system
- Highly flexible solution
  - generic (definable, metadata-driven) data structures & applications
  - easily customizable to support any other complex equipment
- Technology
  - conceptually object-oriented
  - implemented using proven Oracle relational database
  - highly scalable

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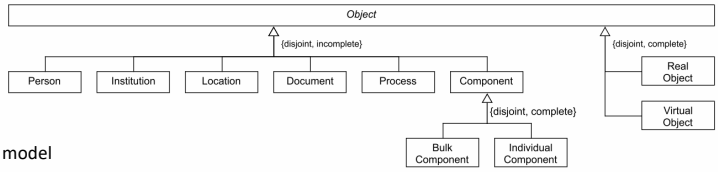
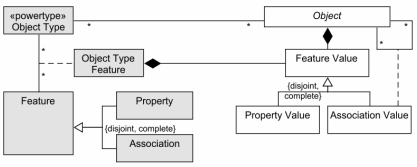
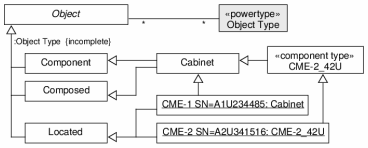


EqDb data model

- Generic object-oriented data model
- Several predefined subclasses
  - for common object categories, e.g. persons, institutions, components
- Definable (generic) object types
  - with definable properties and associations
  - to represent type-specific features, e.g.
    - parameters of a given component model
    - results of specific measurements
- Definable hierarchies of types
  - inheritance of properties and associations
  - multiple inheritance allowed
  - object instances can inherit directly from many types





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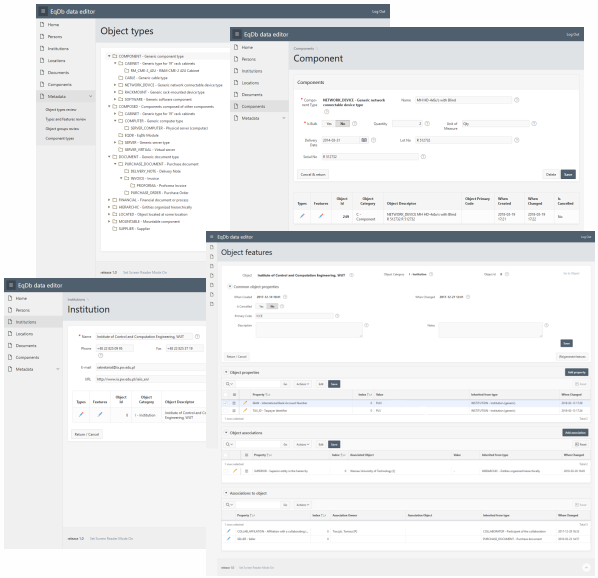
EqDb modules

- EqDb Inventory
- EqDb Extension for Cabling
- EqDb Extension for Equipment Assembly
- EqDb Integration with Slow Control System

EqDb applications

- System Data Editor
- Metadata Editor
- Data Editor (generic)
- Specialized applications for cabling & interface to R&M intelliPhy
- Imports from external data sources (e.g. measurements)
- Interface to slow control system

etc.



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What can EqDb be used for?

- Detector construction
  - support for equipment assembly
  - tracking assembly of components & utilization of parts
  - support for cabling
  - storage for component measurements/test results
- Logistics
  - support for parts ordering
  - repository of documents
  - inventory of parts and components
  - directory of involved persons and institutions
    - relating persons/institutions to documents, components, processes, etc.
- Equipment operation
  - tracking equipment modifications
  - monitoring cabling changes
  - storage for calibration data
  - setting parameters for slow control systems
  - storage for data received from slow control / SCADA systems
- etc.

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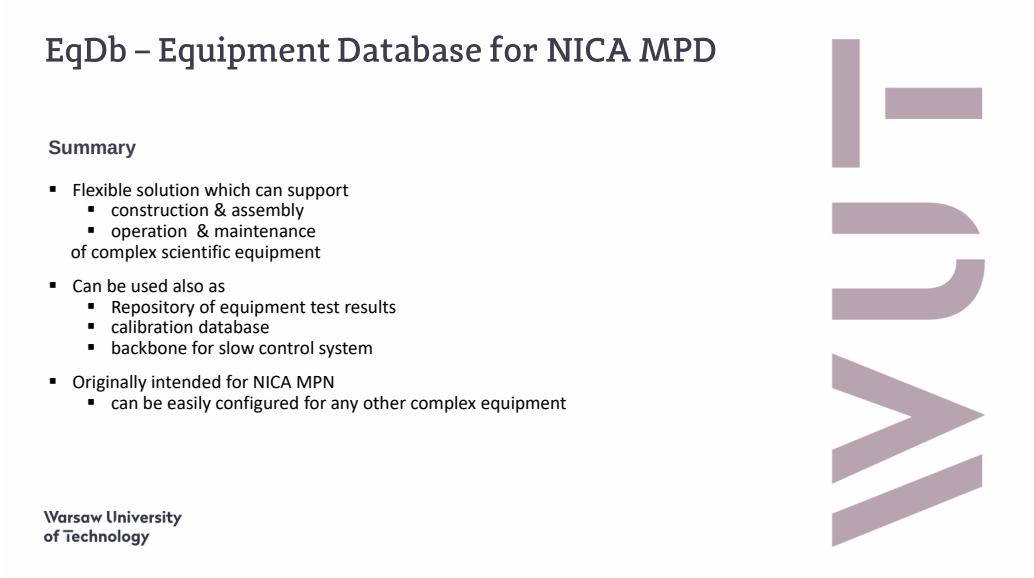
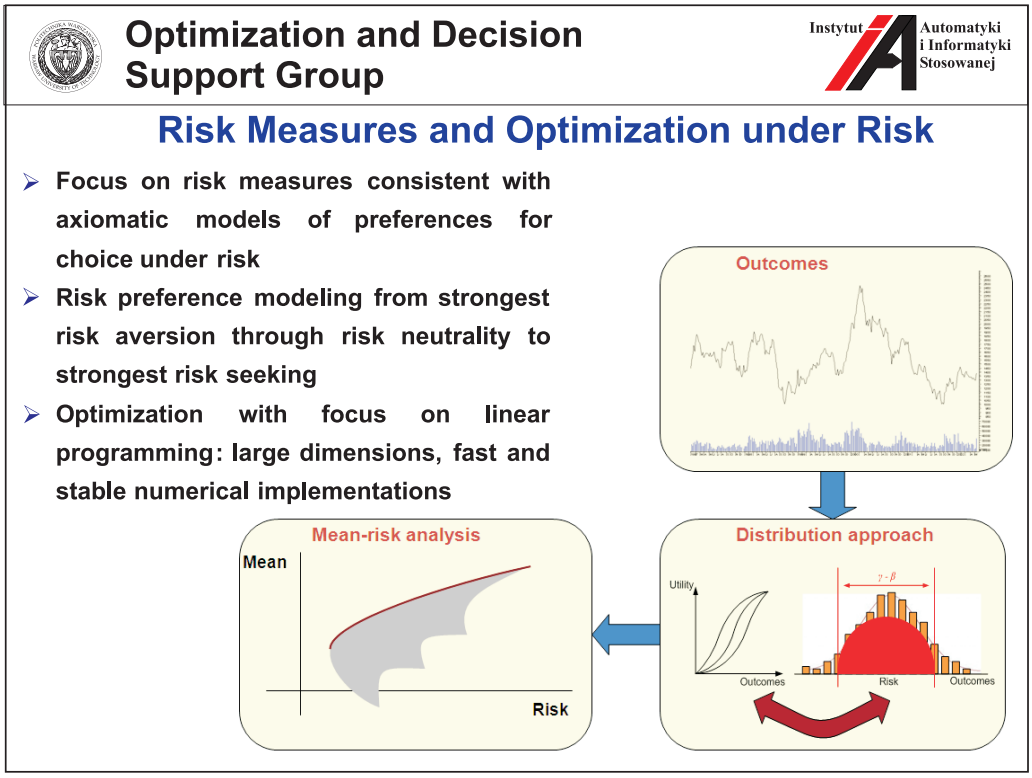
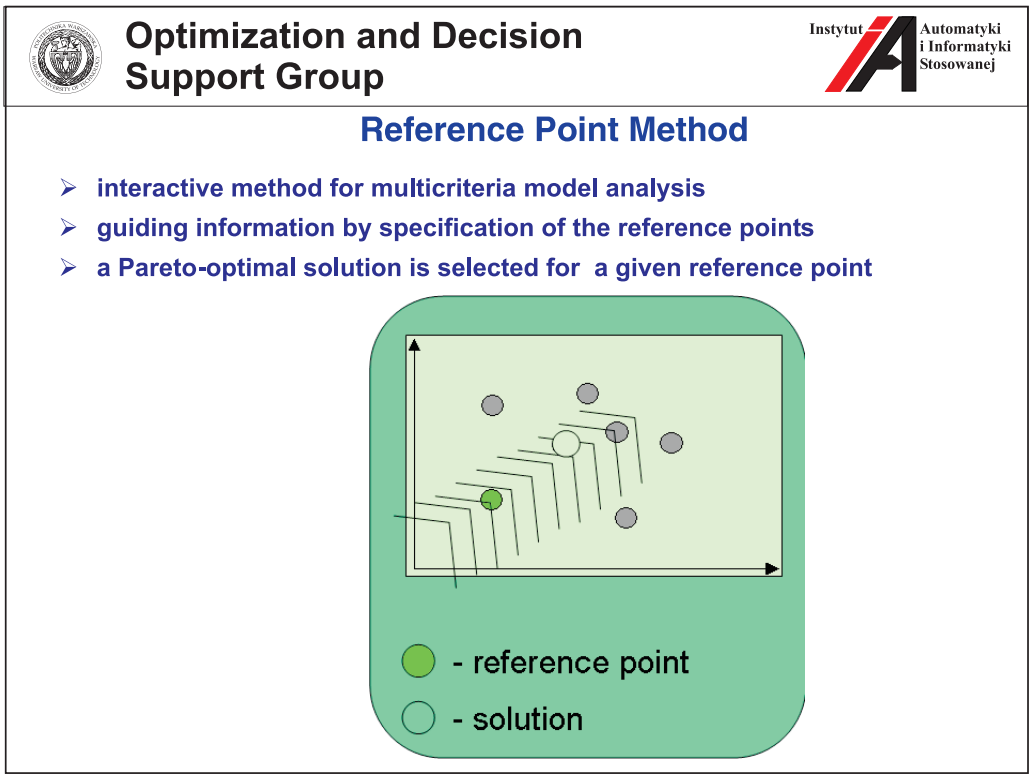

EqDb – Equipment Database for NICA MPD
Summary
Flexible solution which can support
construction & assembly
operation & maintenance
of complex scientific equipment
Can be used also as
Repository of equipment test results
calibration database
backbone for slow control system
Originally intended for NICA MPN
can be easily configured for any other complex equipment
Warsaw University
of Technology


Optimization and Decision Support Group
Instytut Automatyki i Informatyki Stosowanej
Risk Measures and Optimization under Risk
Focus on risk measures consistent with axiomatic models of preferences for choice under risk
Risk preference modeling from strongest risk aversion through risk neutrality to strongest risk seeking
Optimization with focus on linear programming: large dimensions, fast and stable numerical implementations
Outcomes
Mean-risk analysis
Mean
Risk
Distribution approach
Utility
Outcomes
Risk
Outcomes

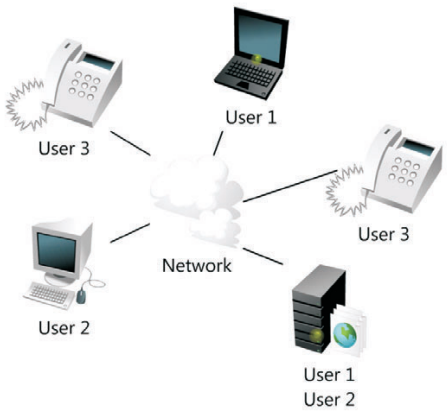

Optimization and Decision Support Group
Instytut Automatyki i Informatyki Stosowanej
Reference Point Method
interactive method for multicriteria model analysis
guiding information by specification of the reference points
a Pareto-optimal solution is selected for a given reference point
- reference point
- solution

Optimization and Decision Support Group

Instytut Automatyki i Informatyki Stosowanej

Fair network design and optimization

- Optimization of networks (systems) which serve many users
- User = demand between a pair of nodes
- Shared resources (node/link capacities)
- Elastic demand – user can consume any bandwidth assigned
- The goal: resource assignment that is effective and fair (acceptable for all users)



1.4 Statistical Data

FACULTY and STAFF	2015 persons	2016 persons	2017 persons
Academic Staff	37(+3)	39(+3)	41(+2)
by titles/degrees			
Professors	8	9	9
D.Sc.-s	6	6	6
Ph.D.-s	21(+3)	18(+3)	17(+2)
M.Sc.-s	2	6	7
Others			2
by positions			
Professors	10	10	10
Readers	1	1	1
Assistant Professors	24(+3)	21(+3)	21(+2)
Senior Lecturers	2	3	3
Assistants	0	2	6
Ph.D. Students	27	19	19
Technical Staff	9(+1)	5	4
Administrative Staff	7	7	7

\+ – corrections due to persons on long-term leave of absence

ACTIVITIES	2015	2016	2017
Teaching activities			
standard teaching potential, hours	9 754,50	9 187,80	9 494,20
# hours taught	13 995,20	14 107,40	14 962,00
Degrees awarded			
Professor	0	0	1
D.Sc	1	2	0
Ph.D.	5	0	1
M.Sc.	48	36	51
B.Sc.	40	49	37
Research projects			
granted by WUT	5	5	7
granted by State institutions	11	6	5
granted by international institutions	1	1	2
other	8	8	6
Sci.-Tech. publications			
monographs (authored or edited)	5	3	1
chapters in books and proceedings	50	60	29
papers in journals	31	32	30
Reports, abstracts and other papers	21	16	7
Conferences			
participation (# of conferences)	34	14	14
participation (# of part. from ICCE)	54	39	27

RESOURCES	2015	2016	2017
Space (sq.m.)			
laboratories	995	644	644
library + seminar room	74	182	182
faculty offices	724	821	821
Computers			
personal computers	192	185	172
Library resources			
books	3 151	3 154	3 154
booklets	2 724	2 809	2 959
journals subscribed	9	9	9

2 Faculty and Staff

Presentation of our faculty starts with Professors Emeriti and continues with Senior Faculty, Supporting Faculty, Ph.D. Students, and Administrative Staff. Senior Faculty includes Professors, Readers, Assistant Professors, and Senior Lecturers. By Supporting Faculty we understand Lecturers, Assistants, Research Associates, and Software Engineers, as well as Technical Staff. The personal information below regards the period of January 1 – December 31, 2015.

2.1 Professors Emeriti

Władysław Findeisen Professor (retired July 1999)

Systems Control Division, Complex Systems Group

room 524, **tel. 22 234 7397 and 825 0995**

W.Findeisen@ia.pw.edu.pl

M.Sc. 1949, Ph.D. 1954. Full Professor since 1962.

Founder and Director of ICCE (1955–1981), elected and re-elected Rector of WUT (1981–1985). Member of Polish Academy of Sciences (PAN) since 1971. Doctor Honoris Causa of The City University in London (1984), Warsaw University of Technology (1996), Gdańsk University of Technology (1997), Technische Universität Ilmenau (1998). Chairman of the Social Council to the Primate of Poland (1986–90), Vice-President of the Polish Academy of Sciences (PAN)(1990–1992), Senator of the Republic of Poland (1989–93), President of "Kasa Mianowskiego" (a foundation which sponsors foreign scientists in Poland) (1991–2009). Honored with the Order of the White Eagle (2012).

Radosław Ładziński Professor (retired January 1998)

Systems Control Division, Complex Systems Group

R.Ladzinski@ia.pw.edu.pl

M.Sc. 1952, Ph.D. 1957 from WUT; the title of Professor of Technical Sciences awarded in 1968.

With WUT since 1949. Vice-Dean of the Faculty of Electronics, (1964–1969), head of the Ph.D. Program in Control Engineering and Computer Science (1977–1981), chairman of the Electronics and Information Technology Committee for Ph.D. Degree in Control and Computer Engineering (1991–1996). As Professor Emeritus author of the programme and the first lecturer of the two basic Undergraduate Courses: *Dynamic System* and *Control*, both taught in English (1998–2007). Parallel working with Institute of Electrical Engineering of Polish Academy of Sciences (PAN) (1955–1962), and with Institute of Automatic Control of PAN (1963–1968). Post-Doctoral Scholar, Royal Institute of Technology, Stockholm, Sweden (1957), British Council Scholar, University of Cambridge, England (1959–60), Visiting Lecturer, Department of Mathematics, University of Ghana, Accra, Ghana (1962–63), Professor of Engineering Science, University of Mosul, Iraq (1970–74), Professor of Engineering Mathematics, Rivers State University of Science and Technology, Port Harcourt, Nigeria (1981–87), Member of Magdalene College, University of Cambridge, England.

Interests: Dynamic systems, control theory, and applied mathematics.

Jerzy Pułaczewski Senior Engineer (retired since October 2003)

Systems Control Division, Robot Programming Group

J.Pulaczewski@ia.pw.edu.pl

M.Sc. 1958, Ph.D. 1965 from WUT.

With WUT since 1956, Deputy Director of ICCE (1972–80 and 1993–96), Deputy Dean of the Faculty of Electronics (1981–87), Chairman of the Departmental Curriculum Committee (1981–90), member of the Senate of Warsaw University of Technology (1987–90). Scholarship in Moscow Electroenergy University (1958–59), the British Council scholarship at Cambridge University, UK (1965–66), visiting researcher at Minneapolis University, Minneapolis, MN (1980–81).

Interests: Digital control algorithms, process modeling and simulation, process control.

Jacek Szymanowski Professor (retired January 2000)

Systems Control Division, Complex Systems Group

J.Szymanowski@ia.pw.edu.pl

M.Sc. 1962, Ph.D. 1966, D.Sc. 1983 from WUT.

With WUT since 1968. Visiting Professor, Laboratoire d'Automatique de Nantes, Ecole Centrale de Nantes, France, 1992, 1994, 1995, 1996, 1997. Retired since January 2000.

Interests: Simulation of control systems, linear and nonlinear programming, control applications of optimization techniques, operating systems.

Wiesław Traczyk Professor (retired January 2010)

Operations and Systems Research Division, Optimization and Decision Support Group

W.Traczyk@ia.pw.edu.pl

M.Sc. 1959, Ph.D. 1964, D.Sc. 1969 from WUT, the title of Professor awarded 1983.

With WUT since 1957, Vice-Dean of the Faculty of Electronics (1971–1975), Deputy Director (1975–1981) and Director of ICCE (1981–1984). Member of the Senate of Warsaw University of Technology (1981-1984), Chairman of the Senate Committee of Finances (1981-84). Professor of the University in Port Harcourt, Nigeria (1984-1987), Professor of the Institute of Telecommunications (1997–2006). Chairman of FEIT Committee for Ph.D. Degrees in Automatic Control and Computer Sciences (1990–2005). Head of ICCE Optimization and Decision Support Division (1997-2002).

Interests: Knowledge engineering, expert systems, artificial intelligence.

Andrzej P. Wierzbicki Professor (retired March 2004)
Operations and Systems Research Division, Optimization and Decision Support Group
A.Wierzbicki@ia.pw.edu.pl

M.Sc. 1960, Ph.D. 1964, D.Sc. 1968 from WUT, titles of Professor awarded in 1975 and 1992.

With WUT since 1961, half time since March 1997. Deputy Director of the ICCE (1971-1975), Deputy Dean (1971-1972) and then Dean of FEIT (1975-1978) member of the Senate (1975-1978), member or chairman of many university commissions.

Since 1978 working with the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria and served (1979-1984) as the chairman of the Systems and Decision Sciences Program. Visiting prof. at the University of Minnesota, Minneapolis, MN, Brown University, Providence, RI (1970–1971), Kyoto University, Japan (1989-1990), Fernuniversitaet Hagen (1985) and Japan Advanced Institute of Science and Technology (2004-2007).

Director of the National Institute of Telecommunications in Poland (1996-2004). Chairman of the Commission of Applied Research of the State Committee for Scientific Research (KBN) (1991–1994). Chairman of the Consulting Panel for Promotion and Policy of Science of State Committee for Scientific Research (KBN) (1994-2000), Member of the Consulting Panel for Computer Infrastructure of Science KBN (1994-2000), Chairman of the Consulting Panel for International Scientific Cooperation of State Committee for Scientific Research (KBN) (2000-2004). Chairman of the Scientific Council of the Industrial Institute for Automation and Measurements (PIAP) (1991-2004), chairman of the Scientific Council of Scientific and Academic Computer Network NASK (1994-2004), and member of the Scientific Council of Institute of System Research (IBS PAN) (1992-2004). Member of the Committee of Automation and Robotics of Polish Academy of Sciences (PAN) (1970-2004). Member of the Committee for Future Studies "Poland 2000+" PAN (since 1986, deputy chairman since 2000). Member and deputy chairman of the Panel for Cooperation with IIASA of PAN.

Member of the Polish Association for the Club of Rome. Member of Polish Mathematical Society (PTM) (since 1975) and of Society of Polish Electrical Engineers (SEP) (1970–2004). Member of the Information Society Technology Advisory Group (ISTAG) of the European Commission (2000-2002). Recipient of George Cantor Award of the Int. Soc. of Multi-Criteria Decision Making for his results in multi-criteria optimization theory and decision support methodology (1992). Recipient of Tomasz Hofmokl Award of NASK for the promotion of informational society, 2005. Recipient of Best Paper Award at the Hawaii International Conference of Systems Science, 2005 for the paper: "Knowledge Creation and Integration: Creative Space and Creative Environments".

Interests: Optimization theory and algorithms, decision theory, decision support systems, negotiation methods and experiences, applications in telecommunication, information society issues, knowledge creation and engineering.

2.2 Senior Faculty

Piotr Arabas Assistant Professor (part-time)

Systems Control Division, Complex Systems Group

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M.Sc 1996, Ph.D. 2004 from WUT

With WUT since 2002.

Interests: Hierarchical systems, predictive control, management of telecommunication services.

Patryk Józef Chaber Research Assistant Lecturer

Control and Software Engineering Devision, Control Engineering Group

room 571, tel. 22 234 7861

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M.Sc. 2014 from WUT.

Interests: Neural networks, microcontrollers, control algorithms, modelling.

Adam Czajka Assistant Professor (on leave until August 2017)

Systems Control Division, Biometrics and Machine Learning Group

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M.Sc. 2000, Ph.D. 2005 from WUT

Received his M.Sc. in Computer Control Systems in 2000 and Ph.D. in Biometrics in 2005 from Warsaw University of Technology (both with the highest honours). Since 2003 he is with Warsaw University of Technology, and since 2002 with Research and Academic Computer Network (NASK). Visiting Associate Professor at the Department of Computer Science and Engineering of the University of Notre Dame, IN, USA (fall 2014 and since spring 2016). Chair of the Biometrics and Machine Learning Laboratory at the Institute of Control and Computation Engineering. Head of the Postgraduate Studies on Security and Biometrics (2011-). V-ce Chair of the NASK Biometrics Laboratory (2006-) and a member of the NASK Research Council (2006–2015). Member (2009-) and Chair (2014-) of the Technical Committee on Biometrics of Polish Normalization Committee (PKN). Member of the PKN Technical Committee No. 182 on Information Security in IT Systems (2007-2016). Expert of the ISO/IEC SC37 and CEN TC224 WG18 on Biometrics. Associate Editor for IET Biometrics and IEEE Access. Member of the Main Council of the Research Institutes (2015-2016). Associate Member (2002–2005), Member (2006–2011) and Senior Member (2012-) of the IEEE (Institute of Electrical and Electronics Engineers, Inc.). Active Member of the EAB (European Association for Biometrics, 2012-).

Interests: Biometrics, computer vision, machine learning.

Paweł Domański Assistant Professor
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M.Sc. 1991, Ph.D. 1996 from WUT.

With WUT since 1991.

Interests: Adaptive control, intelligent control, fuzzy logic.

Wojciech Dudek Assistant (since Nov. 2017)
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M.Sc 2015 from WUT

With WUT since 2017

Interests: Mobile robots, navigation, distributed architectures, cloud computing.

Janusz Granat Assistant Professor
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M.Sc. 1986, Ph.D. 1997 from WUT.

With WUT since 1987, chairman of IFIP Working Group TC 7.6, Optimization-Based Computer Modeling and Design

Interests: Decision support systems, multicriteria decision analysis, data warehouses, decision support in telecommunication industry.

Jerzy Gustowski Senior Lecturer
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M.Sc. 1979 from WUT.

With WUT since 1979.

Interests: Low level software for computer control, interfacing, single-chip microcomputers, PLC controllers.

Mariusz Kaleta Assistant Professor (Until Feb. 2017) Senior Lecturer (since Mar. 2017)
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Operations Research and Management Systems Group
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M.Sc. 2000, Ph.D. 2005, from WUT

With WUT since 2003.

Interests: Discrete optimization, operations research and management, decision support in energy market.

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M.Sc. 1997, Ph.D. 2004 from WUT.

With WUT since 2002.

Interests: Modeling and simulation, optimization, parallel computation, data networks, social networks.

Andrzej Karbowski Assistant Professor
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M.Sc. 1983, Ph.D. 1990. D.Sc. 2012 from WUT

With WUT since 1983. Research visitor: Politecnico di Milano and Universita di Genova, 1992, Edinburgh Parallel Computing Centre, 2000. Member of IEEE.

Interests: Large scale systems, distributed computations, optimal control and management in risk conditions, decision support systems, neural networks, environmental systems management, control and decision problems in computer networks.

Michał Karpowicz Assistant Professor (part time)
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M.Sc. 2005, Ph.D. 2010 from WUT

With WUT since 2014

Interests: Control theory, game theory, computer networks

Włodzimierz Kasprzak Professor

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M.Sc. 1981, Ph.D. 1987 from WUT, Dr-Ing. 1997 from Univ. of Erlangen-Nuremberg, D.Sc. 2001 from WUT, the title od Professor awarded in 2014.

With WUT since 1997, Professor since 2005. Member of Polish Section of IAPR.

Interests: Computer vision, speech recognition, pattern classification, signal analysis, artificial intelligence.

Tomasz Kornuta Assistant Professor (on leave)

Systems Control Division, Robot Programming Group

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M.Sc. 2005, Ph.D 2013 from WUT.

With WUT since 2008.

Interests: Robot programming methods, behavioral control, computer vision, pattern classification, artificial intelligence.

Adam Kozakiewicz Assistant Professor (part time)

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M.Sc. 2001, Ph.D. 2008 from WUT

With WUT since 2006.

Interests: Computer networks, distributed computation, network and systems security.

Bartosz Kozłowski Assistant Professor (on leave)

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M.Sc. 2004 from WUT.

With WUT since 2010.

Interests: Computer networks, data bases, operating systems, programming languages, text processing.

Tomasz Jordan Kruk Assistant Professor

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M.Sc. 1994 from Technical University of Gdańsk. Ph.D. 1999 from WUT.

With WUT since 1999.

Interests: Operating systems, computer and network security, distributed systems.

Adam Krzemienowski Assistant Professor
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Ph.D. 2007 from WUT.

With WUT since 2007. Visiting Lecturer at the University of Leeds, United Kingdom (2007–2008).

Interests: Optimization and decision support under risk, risk measures, stochastic programming.

Maciej Ławryńczuk Professor (Leader of the Group), (Deputy Director of the Institute)
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M.Sc. 1998, Ph.D. 2003, D.Sc. 2013 from WUT.

With WUT since 2003. Twice awarded of "Gold chalk" („Złota kreda") award. The coordinator of B.Sc. and M.Sc. studies in automation and robotics since 2011.

Interests: advanced process control algorithms, in particular Model Predictive Control (MPC) algorithms, set-point optimisation algorithms, artificial intelligence and soft computing techniques, in particular neural networks, modelling and simulation.

Krzysztof Malinowski Professor (Head of Division)
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M.Sc. 1971, Ph.D. 1974, D.Sc. 1978, the title of Professor of Technical Sciences awarded in 1989, appointed to ordinary professorship in 1994.

With WUT since 1971. Director of ICCE (1984–1996), Dean of the FEIT (1996–1999). Member of the Senate of the Warsaw University of Technology (1993–2002), Chairman of the Senate Committee on Academic Staff (1993–1996 and 1999–2002), Chairman of Senate Committee on Research (1996–1999). Member of the Polish Academy of Sciences (PAN) (Corresponding Member 1998–2016, Full Member 2016–), Member of the Warsaw Scientific Society (TNW), Chairman of the Committee of Automation and Robotics of Polish Academy of Sciences (PAN) (2007–2014, Professor in the Research and Academic Computer Network Institute (NASK), Vice-Chairman of the Scientific Council of NASK (2011–2015), Chairman of Task Group of Ministry of Science and Higher Education for assessment of applications for funding large scale research equipment and constructions (2011–2015), Chairman of the Scientific Council of the Industrial Institute for Automation and Measurements (PIAP), Member of the IFAC Technical Committees on Optimal Control and on Large Scale Systems, Chair of the Council of Provost, Division IV: Engineering Science, Polish Academy of Sciences (2015–).

Interests: Hierarchical control, model-based predictive control of nonlinear systems, applications of optimization, management and control of computer networks.

Piotr Marusak Assistant Professor
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M.Sc. 1997, Ph.D. 2003 from WUT.

With WUT since 2002.

Interests: Predictive control of nonlinear systems, digital control algorithms, process modeling and simulation, fuzzy control.

Mohammadreza Azimi Assistant (since Oct. 2017)
Systems Control Division, Biometrics and Machine Learning Group
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With the Faculty of Electronics and Information Technology at Warsaw University of Technology since 2017

Interests: Biometric systems, Speech and Audio Processing, Computational Modeling.

Jalil Khiarak Nourmohammadi Assistant (since Dec. 2017)
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B.Sc. 2011, M.Sc. 2015

M.Sc. degree in Artificial Intelligence from the Faculty of Electrical & Computer Engineering, University Of Tabriz, Tabriz, Iran in 2015.

Interests: Biometric, Machine Learning, Computer Vision, Deep learning, and Neural Networks.

Ewa Niewiadomska-Szynkiewicz Professor (Leader of the Group)
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M.Sc. 1986, Ph.D. 1995, D.Sc. 2005 from WUT, the title of Professor of Technical Science awarded in Feb. 2017.

Research Assistant at the Institute of Geophysics of Polish Academy of Sciences in (1987–1988), with WUT since 1988, NASK since 2001, NASK Director for Research since 2009, IEEE Member.

Interests: Large scale systems, computer simulation, computer aided control systems design, environmental systems management, distributed computations, global optimization, telecommunication systems, ad hoc networks. Member of of the Scientific Council of NASK since 2002 (Vice-Chairman 2008–2009). Ekspert of the Polish Accreditation Committee, Member of the Committee of Automation and Robotics of Polish Academy of Sciences (PAN).

Włodzimierz Ogryczak Professor (Director of the Institute, Leader of the Group)
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M.Sc. 1973, Ph.D. 1983 in Mathematics from Warsaw University, D.Sc. 1997 in Computer Science from PAN, the title of Professor of Technical Sciences awarded in 2011.

With Warsaw University, Institute of Informatics 1973–2000, with WUT since 2000. H.P. Kizer Eminent Scholar Chair in Computer Science at Marshall University, USA (1989–1992), visiting professor at Service de Mathématique de la Gestion of Université Libre de Bruxelles, Brussels, Belgium (1994–1995). Member of INFORMS, International Society of MCDM, GARP, Expert of The Polish Accreditation Committee.

Interests: Computer solutions and interdisciplinary applications in the area of operations research, optimization and decision making with the main stress on: multiple criteria analysis and decision support, decision making under risk, linear, network and discrete programming, location and distribution problems.

Andrzej Pacut Professor (Leader of the Group)
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M.Sc. 1969, Ph.D. 1975, D.Sc. 2000 from WUT, the title of Professor of Technical Sciences awarded in December 2010.

With Warsaw University of Technology since 1969, first with the Institute of Mathematics (until 1978) then with ICCE. Visiting Assistant Prof. at Lefschetz Center for Dynamical Systems of Brown University, Providence, RI (1980–1981), Visiting Associate Prof. at Oregon State University, Corvallis, OR (1984 and 1986–1991). Deputy Director of ICCE 1985–1986 and 1993–2005. Senior Member of IEEE. Vice Chairman (2001–2005) and Chairman (2006–2009) of the IEEE Poland Section, Chair of Tech. Committee No. 309 on Biometrics (2010–) and expert of Tech. Committee No. 182 on Information Security in IT Systems (2003–) of Polish Normalization Committee (PKN). Head of the NASK Biometric Laboratories (2003–), member of NASK Research Council (2007–), vice-chair (2009–2011). Member of Scientific Council of Central Laboratory of Criminology (2011–).

Interests: Learning systems, system identification, biometrics, neural modeling, neural networks.

Piotr Pałka Assistant Professor

Operations and Systems Research Division,
Operations Research and Management Systems Group

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M.Sc. 2005, Ph.D. 2009 from WUT.

With WUT since 2009. Member of the Rector's Team for the Innovative Forms of Education (2014-). Expert of Ministry of Economic Development on Industry Transformation (2016-).

Interests: multi-agent systems, distributed decision systems, auction theory, IoT, wearables, innovative forms of education, problem based learning, design thinking.

Krzysztof Pieńkosz Assistant Professor

Operations and Systems Research Division,
Operations Research and Management Systems Group

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M.Sc. 1984, Ph.D. 1992, D.Sc. 2011 from WUT.

With the Research Institute of Polish Gas and Oil Company 1984–1986, with WUT since 1986.

Interests: Operations research in particular discrete optimization, combinatorial algorithms, production planning and scheduling in manufacturing systems.

Sebastian Plamowski Assistant Professor

Control and Software Engineering Division

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S.Plamowski@ia.pw.edu.pl

M.Sc. 2000, Ph.D. 2006 from WUT.

With WUT since 2015.

Interests: Modeling and simulation, optimization, diagnostics, predictive control, SCADA and DCS systems.

Andrzej Ratkowski Assistant Professor

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M.Sc. 2005, Ph.D. 2011 from WUT.

With WUT since 2009.

Interests: Software engineering, Service Oriented Architecture, performance engineering, TT architectures.

Krzysztof Sacha Professor

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M.Sc. 1973, Ph.D. 1976, D.Sc. 1996 from WUT, the title of Professor of Technical Sciences awarded in 2011.

With WUT since 1976, Full Professor since 2012. Designer in Minicomputer Research and Development Centre ERA (1973), Software Engineering Consultant for Industrial Automation Enterprise PNEFAL (1987–90), Visiting Researcher at the University of Groningen, The Netherlands (1991–1992), and Technical University of Denmark (1993), Senior Designer in Alerton Polska (1999–2002), Auditor evaluating software projects for public organizations and for the industry (2002-2005), Advisor to the President of Social Insurance Institution (2005–2009). Member of the Council of the National Centre for Research and Development (2010-2014), Chairman of Strategic Research Programs Committee (2012–2014). Professor at Vistula University, Warsaw, Poland (2002–2015). Member of the Supervisory Board of Atena Usługi Informatyczne i Finansowe S.A. (since 2015). Member of IEEE.

Interests: Software engineering, real-time systems, software architecture and architectural decisions, software quality, trust management.

Jerzy Sobczyk Senior Lecturer

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M.Sc. 1985 from WUT.

With WUT since 1984. FEIT Network Administrator.

Interests: Computer networks, system and network administration, programming languages, web applications, parallel and distributed programming, multi-criteria optimization.

Andrzej Stachurski Assistant Professor

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M.Sc. 1976, Ph.D. 1980, D.Sc 2013 from WUT.

Senior Assistant (1979–80) and then Assistant Professor (1980–92) at the Institute of System Research (IBS PAN), with WUT since 1992. Visiting Professor at the Calabria University, Italy, 1984, Äbo Swedish Academy in Turku, 1987, Jyväskylä University, Finland, 1988, JSPS invitee at the Department of Control Engineering, Osaka University, Japan, 1988–89. Member of Polish Society of Operations and Systems Research. Author and co-author of many scientific papers and reports on optimization algorithms, identification, applications of optimizations in macro-economy modeling and optimal design problems in structural engineering. Co-author of a textbook 'Podstawy optymalizacji'

('Foundations of Optimization') published in 1999. Reviewer of Control & Cybernetics, Optimization, Archives of Control Science, SIAM J. on Optimization, IEEE Concurrency.

Interests: Interests: nonlinear programming, large-scale optimization, applications to the optimal design problems in structural engineering, parallel and distributed calculations in Mathematical Programming.

Maciej Stefańczyk Assistant (since Oct. 2017)

Systems Control Division, Machine Perception Group

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M.Sc 2011

With WUT since 2011

Interests: Computer vision, computer graphics.

Marcin Szlenk Assistant Professor

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M.Sc. 2000, Ph.D. 2006 from WUT.

With WUT since 2005.

Interests: Software modelling and verification, formal methods in software engineering.

Wojciech Szynkiewicz Assistant Professor

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M.Sc. 1985, Ph.D. 1996 from WUT, D.Sc. 2016 from WUT.

With WUT since 1985. Deputy Director of the Research Center for Control and Information-Decision Technology (1999–2003).

Interests: Robotics, multiple robots coordination, robot sensor-based manipulation and motion planning, autonomous navigation, real-time systems.

Tomasz Śliwiński Assistant Professor

Operations and Systems Research Division, Optimization and Decision Support Group

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M.Sc. 1999, Ph.D. 2007 from WUT.

With WUT since 2004.

Interests: Discrete optimisation, operations research, decision support.

Piotr Tatjewski Professor (Head of Division)

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M.Sc. 1972, Ph.D. 1976, D.Sc. 1988, the title of Professor of Technical Sciences awarded in 2003, appointed to ordinary professorship in 2006

With Warsaw University of Technology since 1972. Head of Control Engineering Group 1991–2015, Deputy Director of ICCE for Academic Affairs (1987–1991), Director of ICCE 1996–2008. Vice Dean for Research of the Faculty since 2012. Head of Control and Software Engineering Division, Head of the Undergraduate Degree Program in Computer Control Systems (1994–1996). DAAD scholarship in 1978 (TU Hanover), SERC research fellow at the City University, London (1986), visiting professor at the University of Birmingham (1992/1993). Member of Committee of Control and Robotics of Polish Academy of Sciences since 2004, Chair of the Automatic Control Systems Section of this Committee (2007–2015), Member of the Control and Robotics Section of the Scientific Research Council (KBN) 1997–2004. Member of Programme Committee of Int. Journal of Applied Mathematics and Computer Science, Journal of Automation, Mobile Robots and Intelligent Systems, Member of Advisory Board of ISA Transactions (2011–), Expert of Ministry of Education and Science for Educational Standards (2005–2006). Member of EUCA (European Union Control Association) Administrative Council (2008–2011), member of IFAC Technical Committees TC 2.1 and TC 5.4, Vice-Chairman of the Control Committee of POLSPAR (2010–), Vice-chairman of the Scientific Council of Systems Research Institute of Polish Academy of Sciences (2011–). Member of the Polish Central Commision for Degrees and Titles (2017–2020).

Interests: Advanced process control and optimization, model based predictive control, multi-layer control systems, decomposition methods in optimization and control, soft computing methods.

Eugeniusz Toczyłowski Professor (Head of Division)

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M.Sc. 1973, Ph.D. 1976, D.Sc. 1989 from WUT, the title of Professor of Technical Sciences awarded in 2004.

With WUT since 1973. Head of Operations Research and Management Systems Division, Vice-Dean of the Faculty of Electronics at WUT (1990–1993), chairman of the Rector's Committee for University Computerization (1993–1999), Advisor to the Dean on Strategic Planning (1993–1996). Head of the Undergraduate Program in Information Systems for Decision Support (1992–2004). Member of the Section on Decision Support (since 1992) and the Section on Knowledge Engineering and Operations Research (2003–) of the Committee of Automation and Robotics of Polish Academy of Sciences, Member of the Scientific Council of the Systems Research Institute (IBS PAN) (since 2002), Member of Consulting Council EnergoProject S.A. (2003–2004), Member of Steering Committee of the Energy Market (2003–2004). Member of the Polish National Council for CO_2 Reduction Emission Program, and Head of the Energy Market Group (2009–), Member of the European Commission DG Advisory Group for Energy Roadmap 2050 (2011–).

Interests: Structural approaches to discrete optimization, operations research and management, management information systems, auction theory, competitive market design under constraints, low carbon economy design.

Tomasz Traczyk Reader (Deputy Director of the Institute)

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Interests: Applications of databases in management and control, software for high-energy physics, long-term digital archives.

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Interests: Reinforcement learning, neural networks; learning robots, adaptive control, computational neuroscience.

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Interests: Robot control systems, artificial intelligence, mobile robots, impedance control, manipulator force control.

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Interests: Control theory, FPGA, microcontoller.

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With WUT since 2002. Member of Information Systems Audit and Control Association (ISACA).

Interests: Software engineering, real-time systems, timing requirements, concurrent systems, performance analysis for computer systems, IT project economics.

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M.Sc. 1982, Ph.D. 1988, D.Sc. 1996 from WUT, the title of Professor of Technical Sciences awarded in 2012.

With WUT since 1985. Research visitor at Loughborough University of Technology, UK (1990, 1992), Senior Fellow at Nanyang Technological University, Singapore (1999–2001), Secretary of Priority Research Program in Control, Information Technology, and Automation (PATIA) (1994–1999). Member of the Forecast Committee of the Polish Academy of Sciences: Poland 2000 Plus (2003–2007, 2015–). Senior Member of IEEE (2002–), Vice Chairman of the Scientific Committee of the Industrial Research Institute for Automation and Measurement PIAP (2016–2017). Vice Dean for Research and International Cooperation FEIT (2002–2005), Head of ICCE Robot Programming and Pattern Recognition Group since 1996. Member of the board of EURON (European Robotics Network of Excellence, 2004–2008). Deputy Director of ICCE for Research (2005–2008), Director of ICCE (2008–2016), Vice Dean for General Affairs (2016–). Member of the Control and Robotics Committee of the Polish Academy of Sciences (2007–).

Interests: Robot programming methods, open-structure robot controllers, behavioral control, digital and microprocessor systems.

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Interests: Operations, planning and economics of electric energy systems, optimization theory and its applications.

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3 Teaching Activities – Academic Year 2016/2017

3.1 Undergraduate and Graduate Studies

Course Title	Course code	Hours per week	Class	Lecturer
Adaptive and Learning Systems	SAU	2 – 1 –	PP-SID SIDJ	P. Wawrzyński (spring/fall)
Administration of UNIX and TCP/IP	ASU	2 – 1 –	OSK,OT, MERJ	J.Sobczyk (fall)
Advanced Process Control Techniques	TAP	2 – – 2	PZ-AIR, PZ-A, PZ, OT	P. Tatjewski (spring)
Algorithms and Data Structures	AISDI	2 – 1 –	sem.3	A.Zalewski (spring)
Optimization Algorithms and Methods	AMO	2 – – 2	OT, PZ, PZ-A, PZ-AIR, PZ-OTJ	A.Stachurski (spring/fall)
Anatomy of Robots	ANRO	1 – 2 –	OT, PODAA	C.Zieliński (spring/ fall)
Systems Architecture and Integration	AIS	2 – 1 –	PZ-OWJ, PZ-OTI	A. Ratkowski (spring/fall)
Artificial Intelligence	EAI	2 – – –	ANGL, OT	placeW Kasprzak (spring).
Automation and Robotics Equipment	APA	2 – 1 –	PODAA, OT	T. Winiarski (spring/fall)
Basics In Automatics	PODA	2 – 1 –	PSTER, OT, PSYIA	P.Marusak (spring) K.Malinowski (fall)
Biometric Identity Verification	BIT	2 – 1 –	OT, SIDJ,PP-SID	A.Pacut (spring/ fall)
Commercial Data Bases 2	KBD2	2 – – 2	BDSI, OT	T.Traczyk (fall)
Computer Networks	ECONE	2 1 1 –	ANGL, OT	J. Sobczyk (spring)
Computer Networks (I)	SKM	2 – 1 1	SKOR, OT	J.Sobczyk (spring/fall)
Computer Vision	ECOVI	2 1 – –	Emaro	placeW Kasprzak (fall)
Control Theory	TST	2 1 – 1	OT, PZ, PZ-A, PZ-AIR	M.Karpowicz (fall)
Data Bases 2	BD2	2 – – 1	BDSI, OT, SIDJ, PP-SID	T.Traczyk (spring/fall)
Decision Support	WDEC	2 – 2 –	MKPWD, OT, PP-SID	J.Granat (spring/fall)
Decision Support Under Risk Conditions	WDWR	2 – – 1	PZ-I, OT, MKPWD,PZ, PZ-OWJ, PP-SID	A. Krzemienowski (spring)
Distributed Operating Systems	RSO	2 – 1 –	PZ, OT, PZ-I, PZ-SID, PZ-ISI	T.Kruk (spring)
Dynamic systems and control	EDYCO	2 1 1 –	ANGL, CIRCAB, ECETC, OT	P. Domański (spring/fall)
Event programming (I)	PROZ	2 – – 1	ATP, OT	M.Kamola (fall)
Fundamentals of Artificial Intelligence	PSZT	2 – – 1	ISO, OT, PINJ, PP-SID	P. Wawrzyński (spring/fall)
Fundamentals of Digital Technology	PTCY	2 – 2 –	sem. 2	C.Zieliński (fall)
Fundementals of Operation Research	POBO	2 – 1 –	Sem. 4	K.Pieńkosz (spring) E.Toczyłowski (fall)
Fundamentals of Parallel Computation	PORR	2 – – 2	SKOR, PZ-A, PZ-I	E. Niewiadomska-Szynkiewicz (fall)
Fundamentals of Programming	PRI	2 1 2 –	Sem.1	T. Śliwiński (spring)
Image and Speech Recognition	EIASR	2 1 – 1	ANGL. OT	W.Kasprzak (fall)
Information Project Management	ZPI	2 – – 1	BDSI, OT, METJ	K.Pieńkosz (spring/fall)
Intelligent Robotic System	ISR	2 – 1 –	PZ-AIR, PZ-OWJ, PZ-SID, PZ-A, OT	C. Zieliński (fall)
Introduction to Robotics	WR	2 – 2 –	MUS, SCRJ, OT	W. Szynkiewicz (spring/fall)
Numerical Methods (J)	MNUM	2 – – 1	PSTER, OT, PP-SID, SIDJ, MATA, MKPWD	P.Tatjewski (spring/fall)
Numerical Methods	ENUME	2 – – 2	ANGL, OT	P. Marusak (fall)

Course Title	Course code	Hours per week	Class	Lecturer
Management IT Systems	SIZ	2 – – 2	MKPWD, OT, SWDJ	J.Granat (spring/ fall)
Methods for Identification	MI	2 – – 1	OT, PZ, PZ-A, PZ-AIR	P. Domański (fall)
Mobile Robots	EMOR		ANGL, ECETC, OT	W.Szynkiewicz (spring)
Modeling and Control of Manipulators	EMOMA	3 1 – –	Emaro	C. Zieliński (fall)
Modelling and Identyfication	MODI	2 1 – 1	PODAA, PZ-AIR, OT	P. Domański (fall/spring)
Modeling and Control of Robots	MORO	2 – – 1	OT, PZ, PZ-A, PZ-AIR	C. Zieliński (fall)
Modeling and Computer Simulation	MISK	2 – -2	OT, PZ, PZ-A, PZ-OTA	E. Niewiadomska--Szynkiewicz (spring)
Multi-Agent decision support systems	WSD	2 – – 2	OT, PZ, PZ-OWJ	P. Pałka (fall)
Networks Systems Control	SST	2 – – 1	PZ-AIR, PZ-A, PZ, OT	K. Malinowski (spring)
Object Programming	PROI	2 – 2 –	MPRIA, OT	T. Śliwiński (fall)
Operating System	EOPSY	2 1 1 –	ANGL, OT	T.Kruk (spring/ fall)
Optimization Techniques	EOPT		Emaro	W. Ogryczak (spring)
Operating Systems	SOI	2 – 2 –	OSK, OT	T.Kruk (fall)
Optimization and Decision Support	OWD	2 – – 1	PZ-A, PZ-I, OT	W.Ogryczak (fall)
Parallel Numerical Methods	EPNM	2 – – 2	ANGL, CSNAD, ECEEL, OT	A.Stachurski (spring)
Process Control	STP	2 1 1 –	OT, PSTER	M. Ławryńczuk (fall) P. Marusak (spring)
Process Management and Scheduling	ZAH	2 – 2 –	MKPWD, OT, MUS, PP-SID, SWDJ	E.Toczyłowski (spring/fall)
Programming Fundamentals	EPFU	2 1 1 –	ANGL, OT	M. Kaleta (spring/fall)
Programmable Controllers	SP	2 – 1 –	MUS, OT, METJ	J.Gustowski (spring/fall)
Real-time Systems	ERTS	2 – 2 1	EMARO	T.Kruk (fall)
Real-time Systems	SCZR	2 – 2 –	PSTER, OT, PINJ, PP-SID	K.Sacha (spring/fall)
Robot Programming Methods	EPRM		Emaro	C.Zieliński (spring)
Signal Processing	ESPRO	2 1 – –	EMARO	W Kasprzak (fall)
Software Engineering	IOP	2 – 1 –	OSK, OT, PINJ, PP-SID	K.Sacha (spring/fall)
Software Specyfication and Design	SPOP	2 – 1 –	OSK, PZ-SID, PZ-I, OT	M. Szlenk (spring/fall)
Soft Computing in Process Control	SZAU	2 – – 2	OT, PZ, PZ-A, PZ-AIR	M. Ławryńczuk P. Marusak
Techniques for Social Network Analysis	TASS	2 – – 2	OT, PZ, PZ-OWJ	P.Arabas (fall)
Microprocessor control systems	SMS	2 – 2 –	INFAA, OT, PP-AIR	M. Ławryńczuk (spring/fall)
Development of process control systems – group project	PUST	– 1 1 2	OT, PODAB	M. Ławryńczuk (spring)
Neural Networks	SNR	2 – -2	OT, PZ, PZ-OWJ	A.Pacut (spring)
Machine Perception	PERM	2 – 1 –	OT, OTAB	W. Kasprzak (spring)
DCS and SCADA systems	DCS	2 – 2 –	OT, PODAB	S. Plamowski (fall)
Diagnostics of Industrial Processes	DIPR	1 – 1 –	OT, PODAB	S. Plamowski, P. Marusak (fall)

Table explanations

Hours per week

The digits in a four-digit code denote number of hours per week of, consecutively: lectures, tutorials, laboratory hours and project hours (for instance, [2 – 1 1] corresponds to two hours of lectures, no tutorials, one hour of laboratory and one hour of project per week).

Class

Symbol	Level	Description
ANGL	all levels	taught in English
ATP	B.Sc.	specialization in Programming Algorithms
BDSI	B.Sc.	specialization in Databases and Information Systems
ISO	B.Sc.	specialization in Intelligent Computation Systems
MKPWD	B.Sc.	specialization in Computer Methods of Decision Support
MUS	B.Sc.	specialization in Control Systems and Methods
OSK	B.Sc.	specialization in Computer System Programming
OT, ECETC	all levels	free electives
PSTER	B.Sc.	specialization in Control
PSYIA	B.Sc.	specialization in Computer, Networks and Systems
PP-SID	M.Sc., Ph.D.	fundamental classes, Decision and Information Systems
PZ-A	M. Sc., Ph.D.	advanced classes, control
PZ-I	M. Sc., Ph.D.	advanced classes, informatics
PZ-P	M. Sc., Ph.D.	advanced classes, fundamental
PZ-SID	M.Sc., Ph.D.	advanced classes, Decision and Information Systems
SCRJC	B.Sc., M.Sc.	specialization in Control Systems
SKOR	B.Sc.	specialization in Computer Networks and Distributed Computations
SYK	B.Sc.	specialization in Computer Systems

3.2 Extramural Graduate Studies

Postgraduate studies **IT Resources Management: architectures, processes, standards, quality** are designed to provide students with current knowledge necessary for successful management of IT in modern organizations. The programme comprises: IT project management, quality standards and assurance systems, development methodologies, system testing, IT audit, business process modeling, system architectures and managerial skills. The classes take form of lectures, workshops, exercises and laboratories.

Postgraduate studies **Project Management: Standards, Practice, Techniques and Tools** merge theoretical knowledge with practical skills necessary for successful project management. The program encompasses: business case and project efficiency assessment, basic project management standards: PMBoK, PRINCE2, IPMA, specialized project management methods e.g. for IT (software development methods including agile approaches), automotive or construction industries, soft-skills like facilitation, negotiations, conflict management, public relations for project management, hard skills like project planning, scheduling, budgeting.

Postgraduate studies **Designing Information Systems with Databases** are intended for IT specialists, who want to acquire new skills in field of design and development of databases and information systems based on them. The programme contains: modeling of processes and data structures, basics of databases usage, engineering of information systems, data management systems, development of applications in systems with databases. The classes take form of lectures and laboratories.

3.3 Graduate Distance Learning

Starting from academic year 2005/2006 our institute is involved in graduate distance learning programme of WUT (named **OKNO**). We coordinate two specializations: Engineering of Internet Systems and Decision and Management Support Systems. The graduates of the first one are prepared for designing, implementing and taking care of complex information technology and computing systems using possibilities offered by contemporary computer networks. They have also ability to manage the layers of technology involved in the next generation of massive system deployments. The graduates of the latter are prepared for designing and implementing software systems which assist in managing, planning and decision making. Their skills and knowledge enable to manage the layers of technology involved in the new generation of intelligent systems empowering every aspect of business operations. First Ms.Sc. degree was awarded in the year 2008.

4 Projects

[PR1] 7 FP EU grant No. FP7–ICT–2013–10, FP7–ICT–2013.5.3: **RAPP – Robotic Applications Store for Delivering Smart User Empowering Applications.**

Granting period: 01.12.2013–31.01.2017.

Coordinator: Centre for Research and Technology Hellas/Informatics and Telematics Institute (Greece).

Partners: Institute National de Recherche en Informatique et Automatique (France), Warsaw University of Technology (Poland), Sigma-Orionis (France), Ormylia Foundation (Greece), Ingema Foundation (Spain), Ortelio Ltd. (UK), Aristotel University (Greece).

Project coordinator from WUT: Cezary Zieliński.

Investigators from WUT: Wojciech Szynkiewicz, Włodzimierz Kasprzak, Tomasz Michał Kornuta, Tomasz Winiarski, Michał Walęcki, Maciej Stefańczyk, Jan Figat, Maksym Figat, Marcin Szlenk, Konrad Banachowicz, Teresa Zielińska.

Aim of the project: RAPP (Robotic Applications for Delivering Smart User Empowering Applications) produced a software platform to supporting the creation and delivery of robotics applications (RAPPs) targeted at people at risk of exclusion, especially elderly people. The open-source software platform provides an API that contains the functionalities for implementing RAPPs and accessing the robot's sensors and actuators using higher level commands, by adding a middleware with added functionalities suitable for different kinds of robots. RAPP expands the computational and storage capabilities of robots and enables machine learning operations, distributed data collection and processing, and knowledge sharing among robots in order to provide personalized applications based on adaptation to individuals. The use of a common API assists developers is creating improved applications for different types of robots that target people with different needs, capabilities and expectations, while at the same time respect their privacy and autonomy, thus the proposed RAPP Store will have a profound effect in the robotic application market. The results of RAPP were evaluated through the development and benchmarking of social assistive RAPPs, which exploit the innovative features (RAPP API, RAPP Store, knowledge reuse, etc.) introduced by the proposed paradigm.

Results: Creation of an infrastructure for developers of robotic applications, so they can easily build and include machine learning and personalization techniques to their applications. Creation of a repository, from which robots can download Robotic Applications (RApps) and upload useful monitoring information. Development of a methodology for knowledge representation and reasoning in robotics and automation, which allows unambiguous knowledge transfer and reuse among groups of humans, robots, and other artificial systems. Creation of RApps based on adaptation to individuals, taking into account the special needs of elderly people, while respecting their autonomy and privacy. Validation of this approach by deploying appropriate demos to demonstrate the use of robots for health and motion monitoring, and for assisting technologically illiterate people or people with mild memory loss.

Keywords: elderly, social robots, assistive robots, robotic framework, smart user empowering robotic applications, mobility assistance and health monitoring, technology illiterate

[PR2] EU Grant No. 675087: **AMBER – enhAnced Mobile BiomEtRics.**

Granting period: 01–01–2017 31–12–2020.

Principal investigator from WUT: Andrzej Pacut.

Investigators: Mateusz Trokielewicz, Sylwia Piskorska.

Aim of the project: AMBER is a Marie Skłodowska-Curie Innovative Training Network addressing a range of current issues facing biometric solutions on mobile devices. AMBER will comprise ten integrated Marie Skłodowska-Curie Early Stage Researcher (ESR) projects across five EU universities. The Network has the direct support of seven Industrial Partners. The aim of the Network is to collate Europe-wide complementary academic and industrial expertise, train and equip the next generation of researchers to define, investigate and implement solutions, and develop solutions and theory to ensure secure, ubiquitous and efficient authentication whilst protecting privacy of citizens. Keywords: biometrics, mobile platforms, usability performance, privacy, security and confidence

[PR3] NCN Grant OPUS 9 no: UMO-2015/17/B/ST6/01885 **Energy-aware computer system for HPC computing**

Granting period: 18.02.2016–17.02.2019

Principial investigators: Ewa Niewiadomska-Szynkiewicz, Michał Karpowicz, Michał Marks

The project aim is to provide theoretical and engineering results that will support the ICT community with design patterns of energy-aware resource and job management systems capable of introducing guarantees for power consumption and application performance in data centers. Contributions in the area of energy-efficient computing will also support growth of the market of environment-friendly cloud services. The expected results may improve competitiveness of Polish ICT solutions as well as the involvement in the mainstream EU Exascale computing project. The project addresses the problem at the nexus of computer science, stochastic optimal control, control engineering, and communication, proving its interdisciplinarity. The obtained results will be validated numerically (AMPL, Matlab) and experimentally [H2]. Selected algorithms will be implemented (C/C++) and published as an open source software modules of the Linux kernel and SLURM cluster management system. The results of theoretical studies will be published in high impact journals and conference proceedings. Dissemination of the project outcomes will include presentations and exhibitions. Moreover, the results of research will be utilized in habilitation dissertations of the project contractors.

[PR4] NCBiR Grant No. DOB-BIO7/18/02/2015 **Design and construction of a system for recognition of persons (offenders) based on face images captured on photograph or video material.**

Granting period: 20.12.2015–20.09.2018.

Principal investigator: Andrzej Pacut.

Investigators from WUT: Włodzimierz Kasprzak, Władysław Skarbek.

The goal of this project is to build a system for biometric identification of perpetrators of offences or criminals based on photographs and/or video materials. The biometric part of the system will consist of integrated modules, including face detection module, surveillance module, "biometric engines" for face and silhouette recognition, and fusion module generating biometric profiles. Biometric modules will be integrated with a

database, which will integrate the biometric data with the police records. The system is thought as an interactive tool and will be operating in various application scenarios, including face detection, isolation of video frames containing faces, surveillance in video materials and identification of persons marked on photo and video materials using the biometric profiles. Modular construction enables for easy supplementing the scenario list and actualization of biometric techniques. The system will be an indispensable tool for personal identification tasks.

Keywords: biometrics, identity identification, face detection, tracking, silhouette recognition.

[PR5] NCBiR Grant No. CYBERSECIDENT/369195/INCBR/2017: **National Cybersecurity Platform NPC.**

Granting period: 01–09–2017 31–08–2020.

Contractors: NASK-PIB (leader), Warsaw University of Technology, National Institute of Telecommunications, National Centre for Nuclear Research.

Principal investigator from WUT: Ewa Niewiadomska-Szynkiewicz.

Investigators from WUT: Adam Kozakiewicz, Michał Karpowicz, Piotr Arabas, Włodzimierz Kasprzak, Wojciech Szynkiewicz, Cezary Zieliński, Tomasz Winiarski, Maciej Stefańczyk, Wojciech Dudek, Maciej Węgierek, Maksym Figat, Jan Figat, Dawid Seredyński.

Aim of the project: The goal of the Project is to develop a comprehensive, integrated system for continuous monitoring, detection, and warning of threats identified in a near real-time in the State's cyberspace.

Expected results: A prototype of a National Cybersecurity Platform (NCP) comprised of an Operational Centre (OC) and components that integrate participants of the NCP with the OC will be the main outcome of the Project. The NCP prototype, proven in operational environment, will provide nationally coordinated actions to prevent, detect and mitigate the impact of incidents that violate the security of ICT systems vital to the functioning of the State. Moreover, the NPC platform will create opportunities for sharing cyber security awareness within the European Union.

Keywords: cybersecurity, cybersecurity data mining, visualization of threats, risk assesment, NIS.

[PR6] Statutory Grant No. 504G036300: **Development of methodology of control, decision support and production management**.

Granting period: 4.05.2016–31.12.2017 and 12.06.2017–31.10.2018

Principal investigators: Ewa Niewiadomska-Szynkiewicz, Andrzej Pacut, Włodzimierz Ogryczak, Krzysztof Sacha, Maciej Ławryńczuk, Eugeniusz Toczyłowski, Cezary Zieliński, Włodzimierz Kasprzak.

[PR7] Rector's Grant No. 540020200082: **Didactic and research environment to analyze manipulation robot operation.**

Granting period: 31–05–2017 31–12–2017.

Principal investigator: Tomasz Winiarski. Investigators: Konrad Banachowicz, Maciej Bogusz, Wojciech Dudek, Kamil Foryszewski, Tomasz Gałecki, Adam Kowalewski, Bartłomiej Kozakiewicz, Piotr Matysiak, Marta Pacuszka, Maciej Pawliński, Jakub Postępski, Michał Romanowski, Dawid Seredyński, Marcin Skrzypkowski, Maciej Stefańczyk, Michał Stolarz, Maciej Węgierek, Konrad Winnicki, Tomasz Ziemnicki.

Aim of the project: The aim of the project was to build a didactic and research environment to analyze manipulation robot operation. The environment was designed to be used by students to learn control system architectures, low level programming and acquaint themselves with 3d print and modeling technologies.

Expected results: As a part of the project a small 3D printed, 3 DOF manipulator was created. Stepper motors has been used as a part of the drives. It was also equipped with control electronics. The second part of the project was a variable stiffness joint construction.

Keywords: robot, 3d print, manipulation, didactic, variable stiffness.

[PR8] Dean's Grant No. 504/03069/1031: **Design method for safe control system of a service robot.**

Granting period: 18–05–2017 28–02–2018. Principal investigator: Seredyński Dawid.

Aim of the project: Research on safe control system prototype for service robot.

Expected results: Design of tool for control system structure generation besed on formal specification. Implementation and running the developed control system of service robot.

Keywords: service robot, control system, safety.

[PR9] Dean's Grant No. 504/03070/1031: **Automatic code generation of advanced predictive control algorithms destined for microcontroller: performance and reliability tests.**

Granting period: 18–05–2017 31–12–2017. Principal investigator: Patryk Chaber.

Aim of the project: Design, implementation and verification of system for effective prototyping of model predictive control algorithms using automatic code generation for microcontrollers.

Expected results: Creation of algorithms for automatic generation of effective controller's code, which will be then used on the platform with limited resources – microcontroller, what will make a significant contribution to the development of the doctor's thesis.

Keywords: Microcontroller, model predictive control, automatic code generation.

[PR10] Dean's Grant No. 504/03067/1031: **Iris recognition using convolutional neural networks.**

Granting period: 17–05–2017 31–03–2018. Principal investigator: Mateusz Trokielewicz.

Aim of the project: The aim if this project is to evaluate a possibility of employing deep convolutional neural networks for the purpose of iris recognition after death, and also for liveness testing (presentation attack detection).

Expected results:

- exploring a possibility to build an iris image classifier based upon deep convolutional neural networks that would operate in an end-to-end manner, and/or a liveness detector that would decide whether a biometric sample is coming from a living organ
- delivering a unique database of iris images with corresponding masks denoting useful regions of an iris; the database would include "difficult" iris images, such as those coming from eyes of deceased subjects, or those with severe ocular disorders present; such a dataset can be then anonymized and shared with the scientific community

- preparing an article divulging the experiments and results and submitting it for an international conference or to a JCR journal
- sustaining the cooperation with the Department of Ophthalmology of the Medical University of Warsaw that enables us to proceed with many cutting-edge and highly novel studies regardning biological aspects of iris recognition.

Keywords: biometrics, iris recognition, neural networks, deep learning.

[PR11] Dean's Grant No. 504/03068/1031: **Multidimensional numerical predictive control in Field Programmable Gate Arrays.**

Granting period: 17–05–2017 31–12–2017. Principal investigator: Andrzej Wojtulewicz.

Aim of the project: Implementation of custom calculation blocks, project of testbench stands, apply optimization.

Expected results: Opening a doctoral thesis, two science publications

Keywords: Dynamic Matrix Control, Generalized Predictive Control, Regulacja predykcyjna, FPGA-Field Programmable Gate Array

[PR12] Research agreement No. 501210101424 with Emerson Process Management sp. z o.o **Development of laboratory exercises on single-input single-output and multiple-input multiple-output process control, development of software for laboratory exercises, development of 2 laboratory stands.**

Granting period: 01.11.2016–15.02.2017

Principal investigator: Maciej Ławryńczuk.

[PR13] Research agreement No. 501230102529 with CaSolutions Sp. z o.o. **Expert opinion on the completeness of the functionality of a software system.**

Granting period: 27.07.2016–30.11.2017

Principal investigator: Andrzej Zalewski.

[PR14] Research agreements with Sąd Okręgowy w W-wie, Sąd Okręgowy w Lublinie: **Expert opinions on the information systems and servises.**

Principal investigator: Andrzej Zalewski.

[PR15] Research agreement No. 08626319/17817004–74 with Joint Institute for Nuclear Research, Dubna, Russia **Software for Equipment Database adaptation and putting into operation for NICA MPD.**

Granting period: 2017–07–11 2018–01–11. Principal investigator from WUT: Tomasz Traczyk.

Aim of the project: The objective of the work is to launch the EqDb software for NICA MPD experiment. The delivered version has been adapted for NICA MPD needs.

Equipment Database (EqDb) is a software tool supporting processes of construction, assembly, operation and maintenance of complex scientific equipment, particularly detectors in High Energy Physics experiments. EqDb is originally intended to be used for MPD (Multi-Purpose Detector) of NICA at JINR (Dubna, Russia). Thanks to EqDb generic, highly flexible data structure, the system can however be quite easily configured to support almost every type of complex scientific experiment. As EqDb can store information on all devices used in the experiment, it can become a backbone of the slow control system, and can also be used as a calibration database for the experiment.

[PR16] Research agreement No. 1/PZ/04/2016 with Yield Planet SA: **Design of mathematical models (algorithms) and data analysis for forecasting and optimization of hotel room pricing.**

Granting period: 01–05–2016 30–04–2018. Principal investigator: Andrzej Pacut.

Investigators: Włodzimierz Ogryczak, Janusz Granat, Izabela Żółtowska, Piotr Arabas, Mariusz Kamola, Tomasz Śliwiński, Piotr Pałka, Jakub Szczepański.

Aim of the project: Design of database structures, mathematical models, algorithms, and programs for data analysis, forecast, price elasticity and optimization of hotel room pricing. Expected results: Mathematical models, algorithms and programs for data analysis, forecasting, price elasticity and hotel room price optimization, together with testing of the solutions, and data base structures design.

Keywords: big data analysis, forecasting, price elasticity, price policy, big data.

[PR17] Research agreement No. 501210101523 with Zakłady Azotowe Kędzierzyn, Grupa Azoty S.A.: **Modernization of the nitrogen fertilizer production line (ammonia production, nitric acid production and neutralization plant) – Phase I: Assessment and design support, under sector NCBR program INNOCHEM.**

Granting period: 15–05–2017 31–12–2017. Principal investigator from WUT: Paweł Domański.

Investigators from WUT: Maciej Ławryńczuk, Piotr Marusak.

Aim of the project: Comprehensive installation review has been performed. The analysis has been performed by expert team of all project stakeholders: technology owner, control system provider and research organization supporting the parties with scientific expertise. These activities have been done on-site and included historical data collection, review of plant documentation and P&ID drawings and meetings with the key personnel. The team has reviewed and analyzed all existing control logics and associated tuning parameters together with the site instrumentation (sensors and actuators).

Keywords: Control Performance Assessment, ammonia synthesis, nitric acid production, neutralization.

[PR18] Research agreement No. 501210101547 with Zakłady Azotowe Kędzierzyn, Grupa Azoty S.A.: **Modernization of the nitrogen fertilizer production line (ammonia production, nitric acid production and neutralization plant) – Phase III: Scientific supervision, under sector NCBR program INNOCHEM.**

Granting period: 13–06–2017 31–12–2017. Principal investigator from WUT: Paweł Domański.

Investigators from WUT: Maciej Ławryńczuk, Piotr Marusak.

Aim of the project: This taks has consisted of the project scientific supervision. The University yeam participated in the meetings and other activities associated with the design of the nitric fertilizers production. The scientific publications have been prepared and submitted.

Keywords: scientific supervision, ammonia synthesis, nitric acid production, neutralization.

[PR19] Research agreement No. 5012103000012 with Zakłady Azotowe Puławy, Grupa Azoty S.A. **Design and implementation of the Advanced Process Control (APC) for ammonia production under sector NCBR program INNOCHEM.**

Granting period: 13–01–2017 31–03–2019. Principal investigator from WUT: Paweł Domański.

Investigators from WUT: Maciej Ławryńczuk, Piotr Marusak.

Aim of the project: Comprehensive installation review has been performed. The analysis has been performed by expert team of all project stakeholders: technology owner, control system provider and research organization supporting the parties with scientific expertise. These activities have been done on-site and included historical data collection, review of plant documentation and P&ID drawings and meetings with the key personnel. The team has reviewed and analyzed all existing control logics and associated tuning parameters together with the site instrumentation (sensors and actuators). Next the team has participated in the process of the APC implementation as the advisory body.

Keywords: Control Performance Assessment, ammonia production, APC, MPC. Research agreements with Sąd Okręgowy w Warszawie, Sąd Okręgowy w Rzeszowie ans Sąd Okręgowy w Lublinie: Expert opinionson the information systems and services.

5 Degrees Awarded

5.1 Ph.D. Degrees

Advisor: **Prof. Maciej Ławryńczuk**

Antoni Wysocki
Perceptronowe rekurencyjne sieci neuronowe w modelowaniu procesów dynamicznych i regulacji predykcyjnej
Thesis defended on March 21, 2017

5.2 M.Sc. Degrees

Advisor: **Piotr Arabas**

K.Senkowski
Szerokozakresowy model poboru mocy przez komputer
Degree awarded on July 2017

P. Koprowski
Modelowanie natężenia ruchu drogowego z wykorzystaniem informacji pozyskanych z serwisów społecznościowych
Degree awarded on October 2017

Advisor: **Konrad Ciecierski (II)**

P.Mądzik (OKNO)
Bazy danych NoSQL w aplikacjach internetowych- analiza porównawcza wydajności w odniesieniu do systemu relacyjnego
Degree awarded on October 2017 (with honors)

Advisor: **Paweł Domański**

M.Falkowski
Identyfikacja nieliniowego modelu NARIMA kolumny atmosferycznej
Degree awarded on March 2017

Advisor: **Janusz Granat**

D.Sieciński
Analiza strumieni znakowych i liczbowych na przykładzie Twittera i danych giełdowych
Degree awarded on March 2017

M.Barański
System wspomagania decyzji w obszarze obrotu gotówkowego w banku
Degree awarded on April 2017

A.Czarny
Analiza wielokryterialna w analizie danych strumieniowych na przykładzie grupowania
Degree awarded on October 2017

M.Chojnacki
Wykorzystanie systemu Hadoop w obliczeniach wykorzystujących duże ilości danych
Degree awarded on October 2017

Advisor: **Jerzy Gustowski**

K.Saienko
Mechanizmy internetowe do nadzoru i diagnostyki systemów sterowania wykorzystujących sieć przemysłową Profinet
Degree awarded on March 2017

P.Pawlukiewicz
Hierarchiczny system sterowania inteligentnym domem
Degree awarded on October 2017 (with honors)

K.Skowrońska
Współpraca robota przemysłowego firmy KUKA ze sterownikiem SIMATIC S7-1500
Degree awarded on October 2017

Advisor: **Mariusz Kaleta**

K.Powązka (OKNO)
Projekt i implementacja asynchronicznej architektury CQRS
Degree awarded on June 2017

P.Barcikowski
Wspomaganie decyzji inwestora giełdowego z wykorzystaniem algorithmic trading
Degree awarded on September 2017

Advisor: **Mariusz Kamola**

J.Tarasiewicz
Analiza motywów doboru cytowań w publikacjach naukowych
Degree awarded on March 2017

Advisor: **Michał Karpowicz**

M.Zaborski
System automatycznego zawierania transakcji na rynku FOREX
Degree awarded on July 2017

P.Kurowski
Mechanizmy sterowania dla serwera Apache
Degree awarded on December 2017

Advisor: **Włodzimierz Kasprzak**

D.Kaczmarek
Algorytm oceniający jakość borówki amerykańskiej na podstawie kolorowych obrazów
Degree awarded on March 2017

Advisor: **Tomasz Kruk**

B.Domagała
Tworzenie efektywnych struktur współbieżnych przy użyciu operacji atomowych
Degree awarded on March 2017

M.Dębska
Wykorzystanie Android API przez złośliwe aplikacje
Degree awarded on October 2017

Advisor: **Maciej Ławryńczuk**

M.Szumski
Modelowanie i regulacja systemów ogrzewania: podejście termodynamiczne i czarnej skrzynki
Degree awarded on March 2017

M.Dobrzyński
Konstrukcja platformy sprzętowej oraz opracowanie komunikacji i sterowania autonomicznej platformy czterokołowej z wykorzystaniem zewnętrznego oraz pokładowego systemu wizyjnego
Degree awarded on October 2017

D.Bula
Konstrukcja platformy sprzętowej oraz opracowanie komunikacji i sterowania autonomicznej platformy czterokołowej z wykorzystaniem zewnętrznego oraz pokładowego systemu wizyjnego
Degree awarded on October 2017

Ł.Godziejewski
Konstrukcja platformy sprzętowej oraz opracowanie komunikacji i sterowania autonomicznej platformy czterokołowej z wykorzystaniem zewnętrznego oraz pokładowego systemu wizyjnego
Degree awarded on October 2017

W.Niespodziany
Modelowanie i zaawansowana regulacja wielowymiarowego procesu laboratoryjnego
Degree awarded on September 2017

Advisor: **Krzysztof Malinowski**

P.Paszota
Optymalizacja zużycia energii elektrycznej w stacji uzdatniania wody systemu wodociągowego
Degree awarded on March 2017

Advisor: **Tomasz Martyn (II)**

J.Rudzki
Implementacja wielowątkowego silnika fizyki gier 2D
Degree awarded on October 2017

Advisor: **Ewa Niewiadomska-Szynkiewicz**

M.Domagała
Wspomagana przez robota bezprzewodowa sieć czujników do monitorowania środowiska
Degree awarded on March 2017 (with honors)

J.Skomiał
Porównywanie systemów TinyOS i Contiki na przykładzie lokalizacji węzłów sieci sensorowej
Degree awarded on March 2017

Advisor: **Andrzej Pacut**

M.Pieniak
Ograniczona maszyna Boltzmanna w weryfikacji pojedynczego mówcy niezależnie od tekstu
Degree awarded on October 2017 (with honors)

Advisor: **Piotr Pałka**

B.Frączak
Przygotowanie miar oceny narzędzi służących do implementacji systemów wieloagentowych
Degree awarded on June 2017

K.Kamiński
Symulacja koordynacji niezależnych jednostek latających (dronów) przy wykorzystaniu algorytmów wieloagentowych
Degree awarded on September 2017

Advisor: **Sebastian Plamowski**

M.Ciok
Proces wdrażania przemysłowej, wielowymiarowej struktury sterowania do fizycznego symulatora wentylacji i ogrzewania
Degree awarded on October 2017

Advisor: **Andrzej Ratkowski**

K.Karpiesiuk (OKNO)
Metodyka badania platform rozproszonego przetwarzania danych klasy DDS
Degree awarded on March 2017

Ł.Gadawski
Badanie zastosowania silników reguł decyzyjnych w dziedzinie Internetu Przedmiotów
Degree awarded on October 2017

P.Rudnik
Zastosowanie mikroserwisów w Internecie of Things
Degree awarded on October 2017

Advisor: **Jerzy Sobczyk**

A.Khmelovskyi
Metody optymalnego przydziału studenów do grup zajęciowych
Degree awarded on October 2017

Advisor: **Andrzej Stachurski**

A.Sidor
Eksploracja danych przy wykorzystaniu mrówkowego algorytmu optymalizacji
Degree awarded on October 2017

I.Dziemianczyk
Odtwarzanie zdjęć zaburzonych
Degree awarded on October 2017

Advisor: **Marcin Szlenk**

J.Kitaj
Modelowanie aplikacji tworzonych na bazie systemu ROS (Robot Operating System)
Degree awarded on March 2017

W.Kaczmar
Algorytmiczne generowanie muzyki przy użyciu języka Haskell
Degree awarded on October 2017

Advisor: **Wojciech Szynkiewicz**

J.Gembiś
Aplikacje mobilne do sterowania robotem kołowym
Degree awarded on March 2017

P.Gawryszewska
Rozpoznawanie i pobieranie elementów przy wykorzystaniu robota przemysłowego
Degree awarded on June 2017 (with honors)

M.Kamionka
Budowa trójwymiarowej mapy zajętości środowiska zamkniętego
Degree awarded on October 2017

Advisor: **Piotr Tatjewski**

M.Urbanowicz
Efektywność algorytmów regulacji predykcyjnej z wielomianową reprezentacją trajektorii sterowania
Degree awarded on September 2017

Advisor: **Paweł Wawrzyński**

M.Klimczak
Zdalne sterowanie robotem dwunożnym
Degree awarded on March 2017

R.Dróżdż
Prognozowanie obłożenia w hotelach przy użyciu metod sztucznej inteligencji
Degree awarded on October 2017

Advisor: **Tomasz Winiarski**

A.Wujek
Robot IRp-6 w zadaniu rysowania
Degree awarded on March 2017 (with honors)

P.Łukaszewicz
Robot mobilny eskortujący ludzi
Degree awarded on March 2017

B.Kaczor
Układ elektroniczny do akwizycji danych z jednostki intercyjnej za pośrednictwem EtherCAT
Degree awarded on March 2017

Advisor: **Andrzej Zalewski**

M.Chmielowski
Metody dokumentowania procesu podejmowania decyzji przy konfiguracji rozwiązań klasy e-commerce
Degree awarded on March 2017

Advisor: **Izabela Żółtowska**

B.Konieczny (OKNO)
System wspomagania decyzji nieplanowanego zapotrzebowania energetycznego zarządcy floty pojazdów elektrycznych
Degree awarded on September 2017

5.3 B.Sc. Degrees

Advisor: **Andrzej Ciemski (II)**

J.Dudziak
Projekt i implementacja aplikacji podejmowania decyzji w obszarze sprzedaży usług telekomunikacyjnych
Degree awarded on February 2017

Advisor: **Piotr Gawkowski (II)**

P.Joński
System wspomagania pracy hufca harcerskiego z aplikacją web i mobilną oraz wykorzystaniem technologii NFC
Degree awarded on February 2017

Advisor: **Janusz Granat**

K.Bojarczuk
Wspomaganie decyzji przy wyborze czasu emisji reklam
Degree awarded on February 2017

T.Korzeniowski
Metody porównywania i grupowania serii czasowych w analizie Big Data
Degree awarded on September 2017

Advisor: **Mariusz Kaleta**

P.Koszelew
System nawigacji w budynku przy użyciu rzeczywistości rozszerzonej
Degree awarded on February 2017

M.Borkowski
Wspomaganie planowania pracy zmianowej w systemie Software as a Service
Degree awarded on September 2017

Advisor: **Mariusz Kamola**

M.Klimaszewski
Budowa repozytorium informacji o wydarzeniach lokalnych, wzbogaconego danymi z serwisów społecznościowych
Degree awarded on February 2017

A.Ziegart
Mobilna aplikacja społecznościowa: odbierz i podrzuć znajomemu po drodze przesyłkę z Paczkomatu
Degree awarded on February 2017

Advisor: **Michał Karpowicz**

M.Szulc
Mechanizm sterowania częstotliwością pracy CPU dla jądra systemu Linux
Degree awarded on September 2017

Advisor: **Włodzimierz Kasprzak**

J.Nietupski
Akwizycja modeli obiektów 3D
Degree awarded on September 2017

M.Leszczyński
Rozpoznawanie sylwetki człowieka w zapisie wideo
Degree awarded on September 2017

Advisor: **Henryk Kowalski (II)**

M.Dzięciołowski
Lokalna sieć Internetu Rzeczy z protokołem 6LoWPAN
Degree awarded on September 2017

Advisor: **Adam Kozakiewicz**

D.Danilenko
Wykrywanie modyfikacji i fałszowania pakietów w złożonych sieciach o ścisłych ograniczeniach czasowych
Degree awarded on June 2017

T.Madycki
Streaming wieloźródłowy z wykorzystaniem szyfru strumieniowego
Degree awarded on September 2017

Advisor: **Adam Krzemienowski**

K.Sznejder
Konstrukcja portfela odpornego z wykorzystaniem opcji do profilowania rozkładów stóp zwrotu aktywów finansowych
Degree awarded on June 2017

Advisor: **Maciej Ławryńczuk**

J. Kumor
Aplikacja graficzna do tworzenia prezentacji multimedialnych z użyciem klasy dokumentów Beamer LaTeX-a
Degree awarded on February 2017

G. Majchrzak
Zdalnie sterowany miniaturowy pojazd z autonomicznym systemem sterowania
Degree awarded on February 2017

J.Blak
Zdalnie sterowany miniaturowy pojazd z autonomicznym systemem sterowania
Degree awarded on February 2017

P.Jabłoński
Laboratoryjny proces lewitacji magnetycznej: regulacja i interfejs użytkownika
Degree awarded on September 2017

Advisor: **Jan Mulawka (II)**

D.Jaździkowski
Implementation of syllogistic logic using RDF (Resource Description Framework) based upton a non-sql database
Degree awarded on October 2017

Advisor: **Julian Myrcha (II)**

W.Szczepański
Gra na system Android z wykorzystaniem logiki rozmytej
Degree awarded on February 2017

Advisor: **Ewa Niewiadomska-Szynkiewicz**

K.Popławska
Archiwizacja i analiza danych termowizyjnych na potrzeby diagnostyki
Degree awarded on February 2017

Advisor: **Włodzimierz Ogryczak**

M.Moskała
Implementacja oraz badanie algorytmu MCTS na przykładzie sztucznej inteligencji do gry 7 cudów świata
Degree awarded on February 2017

Advisor: **Andrzej Pacut**

M.Jarosiewicz
Przewidywanie obłożenia hotelu z użyciem sieci neuronowych
Degree awarded on February 2017

Advisor: **Piotr Pałka**

O.Kowalski
Budowa i implementacja nasobnego systemu nawigacji osobistej opartego na mikrokontrolerze Arduino
Degree awarded on February 2017

F.Bielecki
System wieloagentowy wykorzystujący algorytmy głosowania w negocjacji terminu spotkania
Degree awarded on June 2017

J.Kierejsza
Wieloagentowy system wyboru miejsca spotkań na urządzenia mobilne
Degree awarded on September 2017

Advisor: **Krzysztof Pieńkosz**

M.Jarzębski
Symulator przepływowych oraz gniazdowych systemów obsługi
Degree awarded on September 2017

Advisor: **Andrzej Stachurski**

E.Jarosiński
Konwersja tabel LaTeX do formatu ODT i na odwrót
Degree awarded on February 2017

K.Zieliński
System wspomagający tworzenie harmonogramu konferencji naukowych
Degree awarded on February 2017

M.Paul
Aproksymacje w normie L1 w odtwarzaniu obrazów
Degree awarded on July 2017

Advisor: **Wojciech Szynkiewicz**

M.Barciński
Zastosowanie algorytmów sztucznej inteligencji w planowaniu zadań robotów
Degree awarded on September 2017

R.Cybulski
Budowanie dwuwymiarowej mapy przestrzeni przy wykorzystaniu stereowizji przez autonomiczne roboty mobilne
Degree awarded on September 2017 (Instytut Informatyki)

Advisor: **Tomasz Śliwiński**

K. Żukowski
Automatyzacja wytwarzania podstawowych aplikacji sieci Web opartych o biblioteki Spring
Degree awarded on March 2017

M.Skolimowski
Program do planowania pracy komiwojażera z oknami czasowymi i zmiennymi warunkami przejazdu
Degree awarded on September 2017

Advisor: **Paweł Wawrzyński**

R.Kołecki
Refaktoryzacja biblioteki DLL wspierającej proces uczenia maszynowego
Degree awarded on February 2017

M.Lipiński
System do testowania algorytmów uczenia się głębokich sieci neuronowych
Degree awarded on September 2017

Advisor: **Andrzej Zalewski**

P.Majkrzak
Zaprojektowanie i wdrożenie systemu ewidencji zleceń w małej firmie eksperckiej
Degree awarded on June 2017

6 Publications

6.1 Scientific or Technical Books and Chapters

[B1] T. Traczyk, W. Ogryczak, P. Pałka, and T. Śliwiński, Eds., *Digital Preservation: Putting It to Work*, ser. Studies in Computational Intelligence. Springer International Publishing, 2017, vol. 700.

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[B9] S. Plamowski, "Implementation of dmc algorithm in embedded controller – resources, memory and numerical modifications", in *Trends in Advanced Intelligent Control, Optimization and Automation*, ser. Advances in Intelligent Systems and Computing, W. Mitkowski, J. Kacprzyk, K. Oprzędkiewicz, and P. Skruch, Eds. Springer International Publishing, 2017, vol. 577, pp. 335–343.

[B10] G. Płoszajski, "Metadata in long-term digital preservation", in *Digital Preservation: Putting It to Work*, ser. Studies in Computational Intelligence, T. Traczyk, W. Ogryczak, P. Pałka, and T. Śliwiński, Eds. Springer International Publishing, 2017, vol. 700, pp. 15–61.

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6.2 Scientific and Technical Papers in Journals

[J1] A. Czajka, K. Bowyer, M. Krumdick, and R. Mata Vidal, "Recognition of image-orientation-based iris spoofing", *IEEE Transactions on Information Forensics and Security*, no. 66, pp. 1–13, 2017.

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[J17] M. Ławryńczuk and P. Domański, "Assessment of the gpc control quality using non-gaussian statistical measures", *International Journal of Applied Mathematics & Computer Science*, vol. 27, no. 2, pp. 291–307, 2017.

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6.3 Scientific and Technical Papers in Books and Conference Proceedings

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[R7] A. Wojtulewicz, "Wielowymiarowa numeryczna regulacja predykcyjna w programowalnych układach logicznych typu fpga", research report 2017–07, 2017.