# Institute of Control and Computation Engineering

# 2014 Annual Report

Warsaw University of Technology
Faculty of Electronics and Information Technology
Institute of Control and Computation Engineering
Nowowiejska 15/19, 00-665 Warsaw, Poland
http://www.ia.pw.edu.pl, sekretariat@ia.pw.edu.pl

## *From the Director*

The Institute of Control and Computation Engineering (ICCE; in Polish: Instytut Automatyki i Informatyki Stosowanej) was created 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 a broad area of information technology, concentrating on control and decision support systems, at three levels of education. At the first two levels (equivalent to B.Eng. and M.Eng.) the degree programs combine courses from the areas of computer science and control. In 2014 we have launched B.Eng. and M.Eng. programs in Automation and Robotics. The programs offer the opportunity to acquire all the knowledge and skills necessary for effective design of contemporary automation and robotics systems. We are also proud to offer interesting opportunities to our postgraduates, so that they can continue their study and research towards a Ph.D., either in Computer Science or in Control and Robotics. This standard educational offer has been supplemented by postgraduate studies in Management of Information Technology Resources and in Project Management organized by Dr. Andrzej Zalewski. There is a growing interest in this form of studies and above 140 attendees took part in these courses in the 2013/2014 edition.

The Robot Programming and Pattern Recognition Group is involved in a 7th Framework Program Project RAPP – Robotic Applications for Delivery Smart User Empowering Applications (ITC-2013.5.3, grant no.610947). The partners of the project are: Centre for Research and Technology Hellas (CERTH, Greece) – the coordinator, Institute National de Recherche en Informatique et en Automatique (INRIA, France), Warsaw University of Technology (WUT, Poland), Sigma Orionis S.A. (France), Ortelio Ltd (United Kingdom), Idryma Ormylia (Greece) and Fundation Instituto Gerontologico Matia-Ingema (Spain). The project focuses an utilization of cloud computing and robots in the process of social inclusion of people facing exclusion.

Moreover the Robot Programming and Pattern Recognition Group has been working on the design and implementation of controllers for a family of industrial robots created by the SORTER company based in Radom. The robots will be utilized mainly in the fruit processing industry for sorting.

Two R&D projects within the EU Innovative Economy Operational Programme have been continued. They are scheduled for the years 2013–2015. The Control Techniques Group headed by Prof. Piotr Tatjewski works on the project "Design and Construction of the Controller for the Air Water Heat Pump". The project is conducted with the industrial company PLUM, where the laboratory stands with heat pumps are installed and where the designed controllers will be produced. The aim of the project is to design advanced model-based controllers, able to increase efficiency of the AW Heat pumps operation. The Optimization and Decision Support Group headed by Prof. Włodzimierz Ogryczak carries out the project "Decision Support System for Large-Scale Periodic Vehicle Routing and Scheduling Problems with Complex Constraints" which is conducted with SMT Software S.A. The aim of the project is the development of algorithms for large-scale periodic time-dependent vehicle routing and scheduling problems with complex constraints supporting planning and management of mobile personnel tasks.

In 2014 the group lead by Dr. Tomasz Traczyk started the R&D project "Digital Document Repository CREDO" within the National Centre for Research and Development program Demonstrator+. The project is conducted with the industrial partners: Polish Security Printing Works S.A. and Skytechnology Ltd. The aim of the CREDO project is to design and launch a demonstrative version of a digital repository enabling short- and long-term archiving of large volumes of digital resources. By design the repository is to act both as a secure file storage and as a digital archive providing metadata management and including the resources in archival packages.

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 congratulate Prof. Włodzimierz Kasprzak who obtained the professor's title from the President of Poland. Moreover I congratulate Dr. Maciej Ławryńczuk who was awarded by the Technical Sciences Division of the Polish Academy of Sciences. I also compliment Prof. Ewa Niewiadomska-Szynkiewicz and Prof. Włodzimierz Ogryczak who were awarded the Golden Cross of Merit by the President of Poland.

*Cezary Zieliński*

# Contents

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Faculty of Electronics and Information Technology
Warsaw University of Technology
Nowowiejska 15/19, 00-665 Warsaw, Poland
http://www.ia.pw.edu.pl, sekretariat@ia.pw.edu.pl

Main Office, room 521
tel.: +48 22 825 09 95, +48 22 234 73 97, fax: +48 22 825 37 19

Students Office, room 22
tel.: +48 22 234 7750

Instytut Automatyki i Informatyki Stosowanej

# 1 General Information

The following information about organization of the Institute reflects the situation on December 31, 2014.

## 1.1 Directors

Professor Cezary Zieliński, Director
Professor Włodzimierz Ogryczak, 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, A. Czajka, M. Kamola, A. Karbowski, T. Kornuta, A. Kozakiewicz, T.J. Kruk, B. Kubica, J. Putz-Leszczyńska, W. Szynkiewicz, P. Wawrzyński, T. Winiarski, A. Woźniak |
| *Senior Lecturer:* | M. Warchoł (until Sept. 2014) |
| *Software Engineers:* | M. Walęcki |
| *Ph.D. Students:* | P.H. Ekes, K.S. Daniluk, J. Figat, M. Figat, W. Gutfeter, A. Igielski, M. Krzysztoń, K. Lasota, J.P. Olczak, B. Papis, K. Piech, P. Przybysz, D. Seredyński, K. Siudek, M. Stefańczyk, M. Walęcki, M. Trokielewicz |

Research of the division is conducted in 3 research groups:

**Complex Systems Group** (**E. Niewiadomska-Szynkiewicz**, K. Malinowski, P. Arabas, M. Kamola, A. Karbowski, A. Kozakiewicz, T.J. Kruk, B. Kubica, A. Woźniak, M. Warchoł, K. Daniluk, M. Krzysztoń, K. Lasota)

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**, A. Czajka, J. Putz-Leszczyńska, P. Wawrzyński, W. Gutfeter, J. Olczak, B. Papis, K. Piech, 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 and Pattern Recognition Group** (**C. Zieliński**, W. Kasprzak, T. Kornuta, W. Szynkiewicz, M. Walęcki, T. Winiarski, P.H. Ekes, J. Figat, M. Figat, P. Przybysz, D. Seredyński, K. Siudek, M. Stefańczyk )

Research of the group is concerned with robot motion planning and control systems, autonomous mobile robot localization and navigation, robot programming methods, computer vision systems and speach recognition systems. In the robot control systems area research is focused on new motion and force/position control algorithms for multi-robot systems. Special emphasis is given to the sensor-based motion planning and control of single and multiple articulated or mobile robots. In the computer vision and signal processing (speech analysis) area the research is concentrated on autonomous navigation, transportation and security relevant environments. All of this research is centered around service robots, i.e. two-handed devices using visual servoing, force control, and speech recognition to fulfill tasks that humans usually execute.

### Control and Software Engineering Division

| | |
|---|---|
| *Division Head:* | Professor P. Tatjewski |
| *Professors:* | K. Sacha, P. Tatjewski |
| *Assistant Professors:* | P. Domański, M. Ławryńczuk, P. Marusak, M. Szlenk, A. Zalewski, A. Ratkowski |
| *Senior Lecturers:* | J. Gustowski, U. Kręglewska (until Sept. 2014) |
| *Senior Engineer:* | W. Macewicz |
| *Ph.D. Students:* | P. Chaber, A. Hurkała, S. Kijas, W. Pikulski, M. Szumski, M. Romanowski, M. Wasilewski, A. Wojtulewicz, A. Wysocki |

Research of the division is conducted in 2 research groups:

**Control Engineering Group** (**P. Tatjewski**, P. Chaber, P. Domański, **M. Ławryńczuk**, P. Marusak, J. Gustowski, U. Kręglewska, M. Szumski, A. Wojtulewicz, A. Wysocki)

Research of the group encompasses control engineering techniques, in particular industrial process control. The focus is on predictive control algorithms, multilayer optimizing and supervisory control, and non-linear system control and analysis. Model-based predictive control algorithms for linear and nonlinear process modeling are developed and investigated. Soft computing methods for design and tuning of control systems are used, based first of all on neural nets and fuzzy systems. Theoretical considerations are combined with simulation analysis and investigations. Computer Control Systems Laboratory is equipped with programmable controllers, industrial computers and workstations with software tools, including Matlab with Toolboxes and SCADA systems.

**Software Engineering Group** (**K. Sacha**, M. Szlenk, W. Zalewski, A. Ratkowski, A. Hurkała, S. Kijas, W. Pikulski, M. Romanowski, M. Wasilewski)

The main area of interest is the development and quality evaluation of software. Topics include software processes, software analysis and design methods, and quality evaluation. A new research area, partially supported by the Polish Ministry of Science and Higher Education, is methodology for the development and evolution of service-oriented (SOA) systems. Part of this research is aimed at addressing security issues in distributed applications by means of trust management services.

### 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, M. Kaleta, K. Kołtyś, B. Kozłowski, A. Krzemienowski, P. Pałka, K. Pieńkosz, G. Płoszajski, A. Stachurski, T. Śliwiński, I. Żółtowska |
| *Senior Lecturer:* | J. Sobczyk |
| *Ph.D. Students:* | J. Hurkała, T. Jastrzębski, R. Karpuk, A. Mościcka, P. Modliński, P. Olender, A. Połomski, M. Przyłuski, K. Sędrowicz, K. Szymański, G. Zalewski |

Research of the division is conducted in 2 research groups:

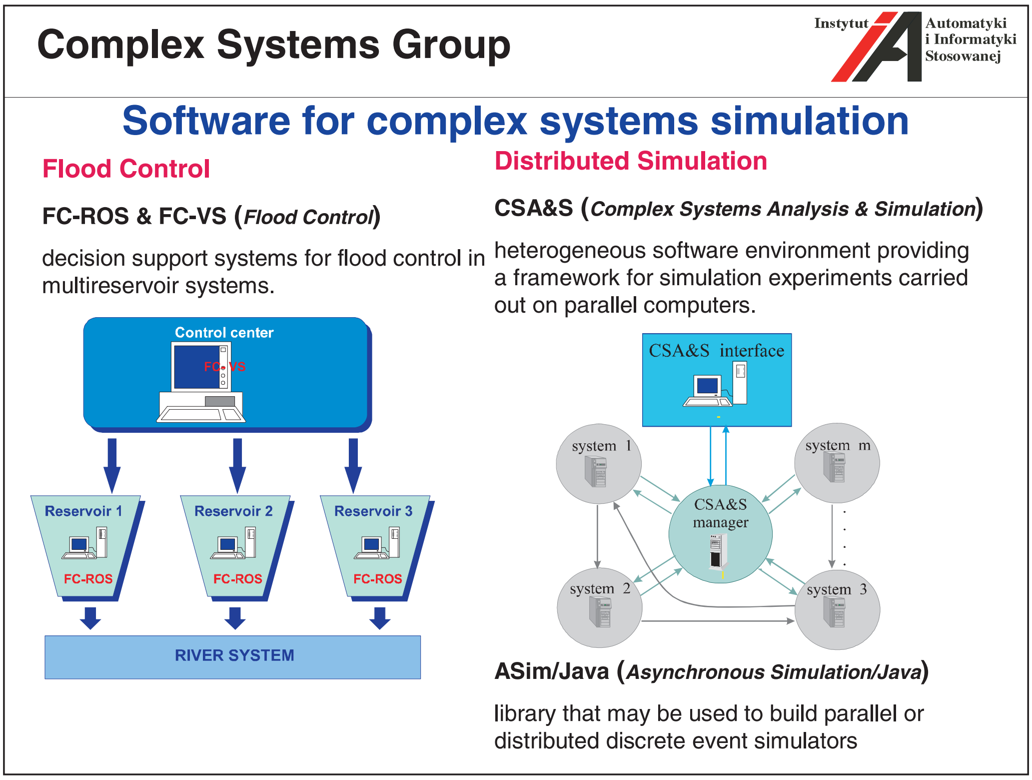
**Operations Research and Management Systems Group** (**E. Toczyłowski**, M. Kaleta, K. Kołtyś, P. Pałka, K. Pieńkosz, G. Płoszajski, K. Sędrowicz, T. Traczyk, I. Żółtowska, R. Karpuk, P. Modliński, K. Szymański)

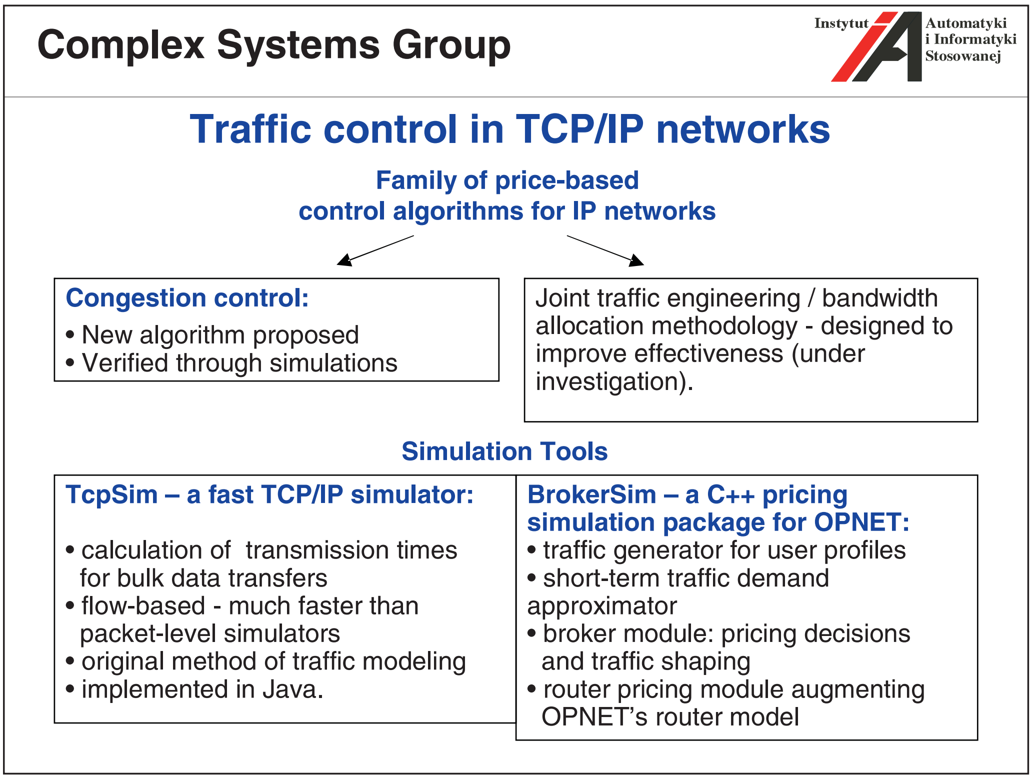
Research of the group is concerned with operation research and structural discrete optimization methods for control and management of discrete processes, including applications in the network structure development, deregulated electric power industry, IP networks, computer integrated manufacturing, etc. 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, J. Hurkała, A. Mościcka, P. Olender, A. Połomski, M. Przyłuski, 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

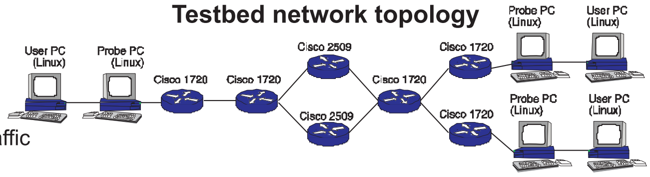
Instytut Automatyki i Informatyki Stosowanej

### Dynamic contracting of IP services

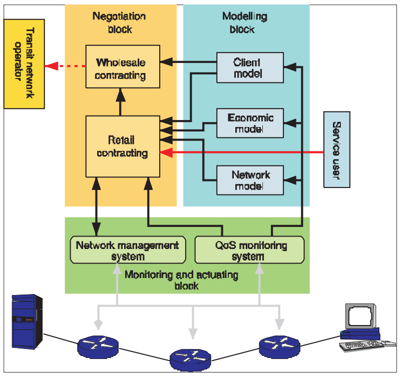
**System features:**

- small latency guarantees for RT traffic
- bandwidth guarantees for nRT traffic

**Testbed network topology**




**System architecture**




**Implementation - technologies:**

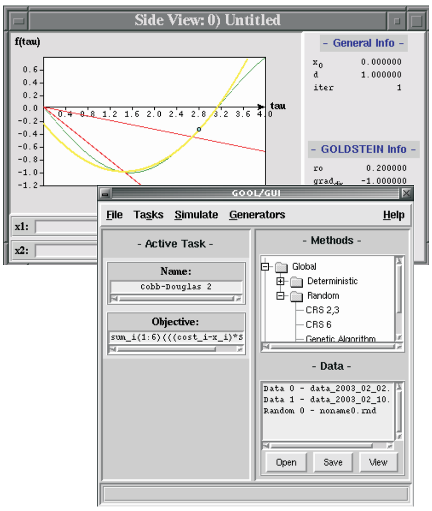
- Cisco *CBWFQ* (class-bases weighted fair queuing), *shaping*, *policing* used
- Monitoring and actuating block implementated in *PERL* using *command-line* access
- a dedicated control and measurements network used, *Precision Time Protocol* applied
- traffic generation and measurements tools: *bulk*, improved *DBS*

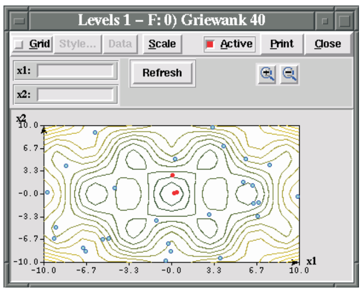
## Complex Systems Group

Instytut Automatyki i Informatyki Stosowanej

### Global optimization

**GOOL - Global Optimization Object–Oriented Library**




**GOOL**

library of random search generators and optimization algorithms for convex and nonconvex, unconstrained and constrained problems

## Complex Systems Group

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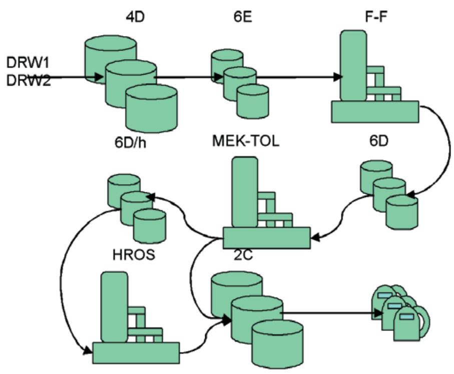
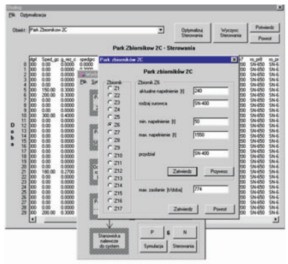
### Operations scheduling using Constraint Programming

**Solution of a scheduling problem in an Oil Refinery Division**




Oil Refinery Division



Simulation and optimization system

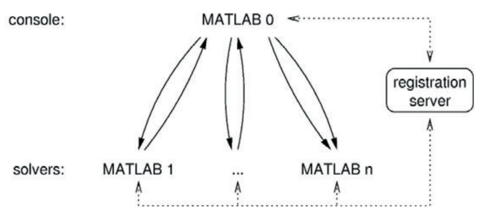
Goals:
- Simulation of an Oil Refinery Division
- Finding all feasible solutions
- Meeting all technical requirements
- Constraint scheduling methods
- Very fast computations

## Complex Systems Group

Instytut Automatyki i Informatyki Stosowanej

### Parallel and distributed computations

- research on price and Benders method of decomposed optimization
- research on parallel implementation of global optimization algorithms
- development of new software tools for parallel and distributed computations
- a monograph published in 2009





**New software tools:**
- **jPar** – a software environment for parallelizing Matlab calculations on multicores and in clusters without file communication
- **parAMPL** – a library for parallelizing AMPL calculations on multicores and in clusters

## Complex Systems Group

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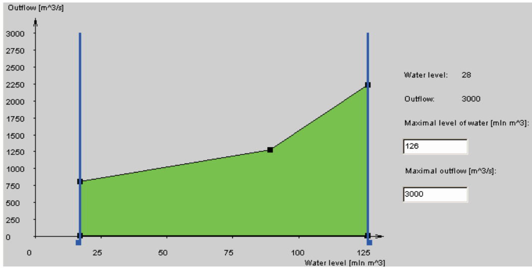
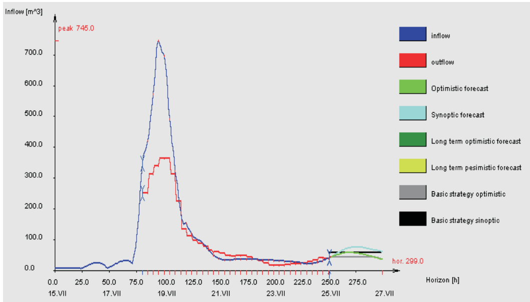
### Optimal control and closed-loop design

- development of OO libraries for calculation of optimal control in general nonlinear deterministic problems with constraints
- development of OO libraries for calculation of optimal closed-loop policies in general stochastic problems
- development of Decision Support Systems for flood control in single and multireservoir systems
- theoretical studies on optimal control in various conditions eg. with stochastic scenarios, fuzzy systems, worst-case, different risk measures, etc.
- theoretical and simulation studies on real-time control in computer networks at different levels




## Complex Systems Group

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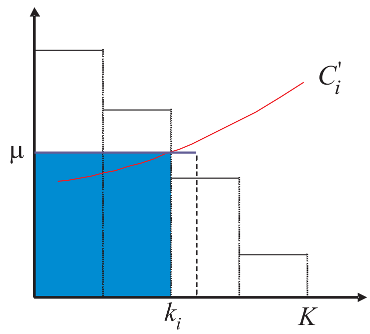
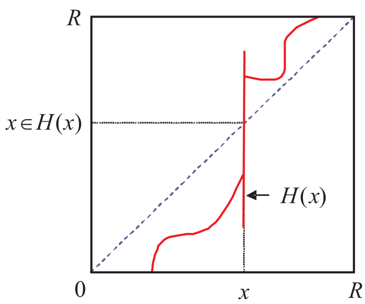
### Game theory and mechanism design

- auction and market design
- computation of equilibrium bidding strategies
- incentive regulation in telecommunication




- resource allocation under imperfect information
- principal-agent problems in optimal contract design
- best response dynamics and stability of Nash equilibria

## Complex Systems Group

Instytut Automatyki i Informatyki Stosowanej

# Interval computations for nonlinear problems

Instead of single numbers (points), we can perform calculations on intervals (possibly multidimensional).

Rules of interval arithmetic (and other interval functions) are designed so that:

$$a \in \boldsymbol{a} = [\underline{a}, \overline{a}], \quad b \in \boldsymbol{b} = [\underline{b}, \overline{b}],$$
$$\diamond \in \{+, -, \cdot, /\} \Rightarrow a \diamond b \in \boldsymbol{a} \diamond \boldsymbol{b}$$

Such an approach allows to describe the uncertainty of parameters and also to deal with numerical inaccuracy.

For example we have the following rules for addition and multiplication:

$$[\underline{a}, \overline{a}] + [\underline{b}, \overline{b}] = [\underline{a}+\underline{b}, \overline{a}+\overline{b}]$$
$$[\underline{a}, \overline{a}] \cdot [\underline{b}, \overline{b}] = [\min(\underline{a}\underline{b}, \underline{a}\overline{b}, \overline{a}\underline{b}, \overline{a}\overline{b}), \max(\underline{a}\underline{b}, \underline{a}\overline{b}, \overline{a}\underline{b}, \overline{a}\overline{b})]$$

Interval (inclusion) function:

$$f(x) = x^2 + 2x + 1$$
$$\mathrm{f}(\boldsymbol{x}) = \boldsymbol{x}^2 + 2\,\boldsymbol{x} + 1$$
$$x \in \boldsymbol{x} = [\underline{x}, \overline{x}] \Rightarrow f(x) \in \mathrm{f}(\boldsymbol{x})$$
$$\mathrm{f}([-5, 1]) = [-5, 1]^2 + 2 \cdot [-5, 1] + 1 = $$
$$= [-9, 28] \supseteq [0, 16]$$

Interval tools:

- the branch-and-bound method
- monotonicity test
- interval Newton operators
- constraint propagation
- ...

Problems that can be solved:

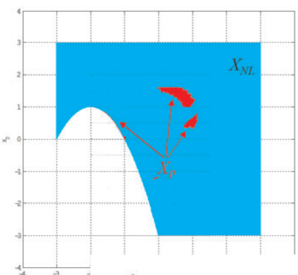
- systems of nonlinear equations
- constraint satisfaction problems
- global optimization problems
- multicriterial optimization problems (convex and nonconvex)

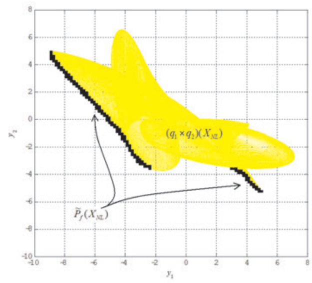
## Complex Systems Group

Instytut Automatyki i Informatyki Stosowanej

# Interval computations seek the Pareto-front of nonlinear multicriterial problems

```
compute (q(), x0, ey, ex)
// L is the list of quadruples
// (y, L_in, L_bound, L_unchecked),
// where L's are lists of qes x
y0 = q(x0);
enqueue(L, (y0, {}, {}, {x0}));
while (a quadruple in L,for which
        wid(y)>ey)
   pop this quadruple
        (y,L1,L2,L3) from L;
   if (L1?{}) then
       delete sets dominated by y;
   end if
   if (wid(y) > ey) then
        bisect y;
        invert resulting sets;
        enqueue results;
   end if
end while
end compute
```



# Biometrics and Machine Learning Group

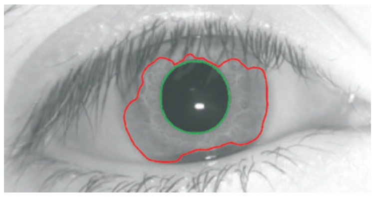
Instytut Automatyki i Informatyki Stosowanej

## Biometrics

### Iris recognition

- **Methods**
  - fast Zak-Gabor transform for calculation of the unique iris features
  - active contours for flexible iris segmentation
  - randomization of the iris stripes for replay attack prevention
- **System prototyping**
  - iris cameras: real-time. automatic iris capture and processing with various configuration of illuminants
  - iris recognition software development kit (SDK) for C/C++ (Windows and Linux versions)
  - assessment of device interoperability

**IrisCUBE:** iris recognition system developed in our labs.



Human eye imaged in infrared light and segmented with the use of Active Contours

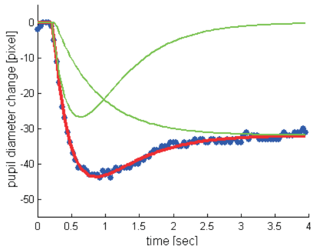

# Biometrics and Machine Learning Group

Instytut Automatyki i Informatyki Stosowanej


## Biometrics

### Iris recognition reliability

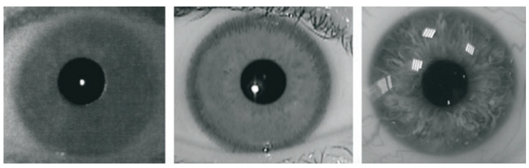
- **Liveness detection**
  - use of static 2D and 3D images, frequency spectrum analysis, assessment of near-infrared light absorbance by the eye tissues, thermal imaging
  - use of image sequences, pupil dynamics (US patent 8,061,842), detection of stimulated light reflections from the cornea
  - co-hosting of the LivDet-Iris international competitions (2013, 2015) evaluating iris liveness detection methods (http://livdet.org)
- Assessment of how the eye **diseases** impact iris recognition
- Understanding of the **eye aging** and its influence on the reliability of long term iris recognition


### Liveness detection

**Upper right:** Comparison of the observed (blue dots) and modeled (red line) pupil reaction to light changes allows constructing a subterfuge detection mechanism.

**Bottom:** example eye imitations used in our labs in evaluation of the liveness detection methods (from left to right: paper printout, printed contact lens, prosthetic eye)



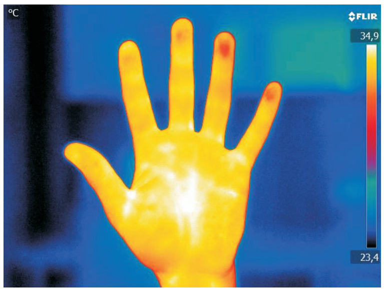
# Biometrics and Machine Learning Group

Instytut Automatyki i Informatyki Stosowanej

## Biometrics

### Thermal imaging in biometrics

- **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)

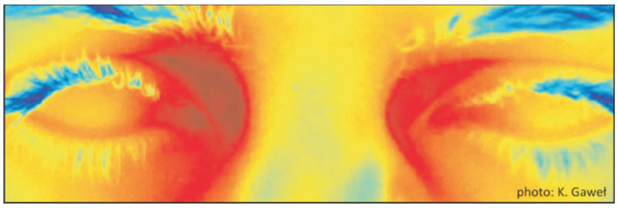



**Hand thermal image**

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.




# Biometrics and Machine Learning Group

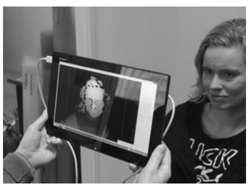
Instytut Automatyki i Informatyki Stosowanej

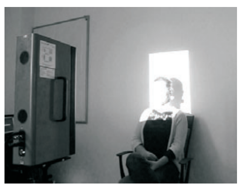
## Biometrics

### 3D face recognition

- Exploring new techniques of collecting face images
  - Developing system for mobile 3D face acquisition and identification.
  - Comparing data from different types of depth sensors and high-resolution 3D scanner.
- Spatial data processing
  - Structures for storing and processing point clouds containg information about face in context of biometric recognition
- Methods of recognition
  - Analysis of feature selection for classification: surface and color face characteristics

**Collecting 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.





## Biometrics and Machine Learning Group

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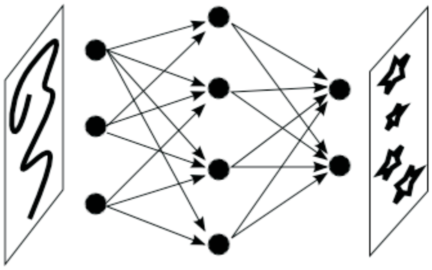
### Machine Learning

**Towards parameterless on-line learning algorithms**

Most on-line learning are based on stochastic steepest descent.
This methodology requires preliminary experiments to determine proper step-size.
We develop methods to automatize stochastic steepest descent.
We successfully tested several approaches to autonomous learning in deep neural networks.



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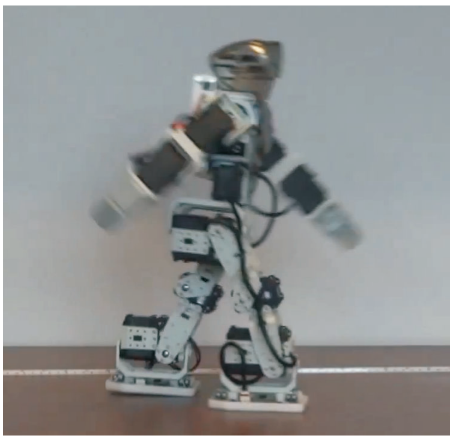
### Machine Learning

**Project on humanoid robots learning of physical activities**

In cooperation with the Faculty of Mechatronics we run a project on learning in humanoid robots.

The immediate objective of the project is to design algorithms that enable the robots to learn to walk and adroitly run.



# Biometrics and Machine Learning Group

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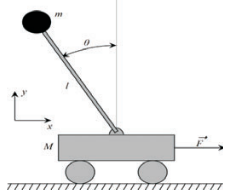
## Machine Learning

### Reinforcement Learning

- NADA (Neighbourhood Ambiguity Driven Abstraction): A state abstraction approach
  - Identification of state variables
  - Quantized and continuous, discrete-time domains
  - Handles about a dozen of variables
  - „State abstraction in Reinforcement Learning" Ph. D. dissertation, 2015

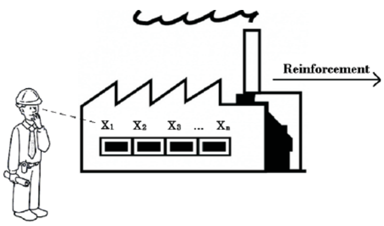
**Cart-Pole Swing-Up**

A typical task for RL algorithms evaluation. Enhanced to a 10-dimensional version for the purpose of demonstrating the capabilities of the state abstraction algorithm. Other tasks include 20-dimensional version of Mountain Car environment.



**Stimulus discrimination**

The approach is inspired by the way animals are able to focus on a subset of relevant stimuli

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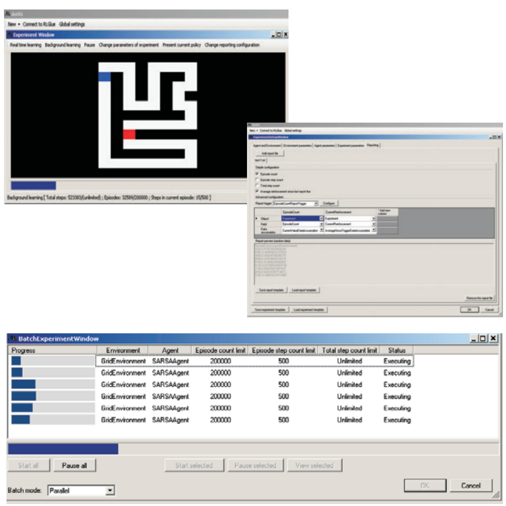
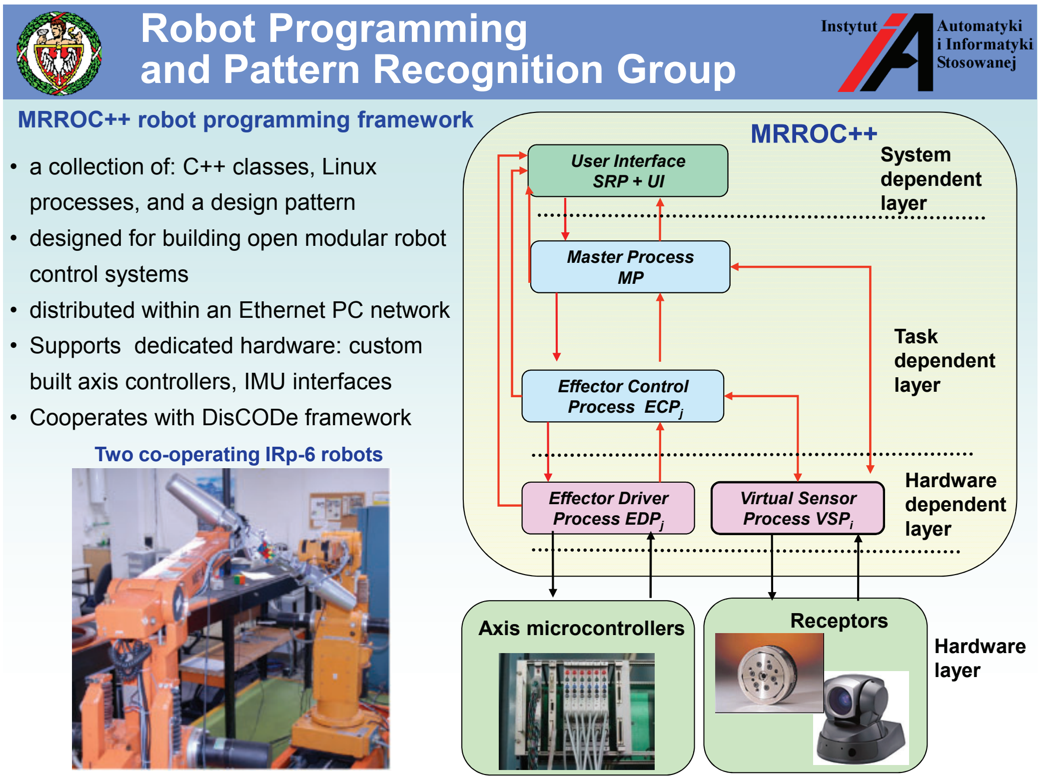
## Machine Learning

### Reinforcement Learning

- dotRL: Platform for rapid RL algorithms development and testing
  - Implemented classes automatically integrate with the solution
  - Built-in mechanisms for algorithm parameters and reporting
  - Many state-of-art environments and agents already implemented
  - Integrated with commonly used RL-Glue protocol
  - Multithreaded batch evaluation of multiple instances of the same experiment
  - Loosely coupled modules supporting reusability of agents and environments

.RL




Robot Programming
and Pattern Recognition Group
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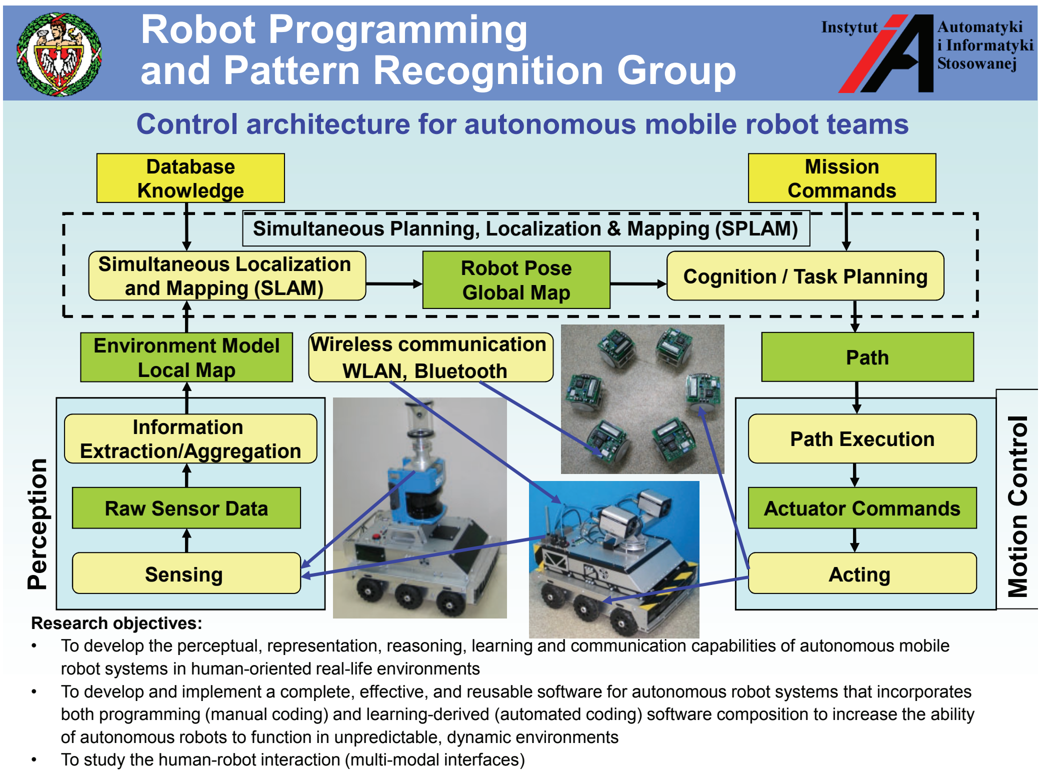
MRROC++ robot programming framework
• a collection of: C++ classes, Linux processes, and a design pattern
• designed for building open modular robot control systems
• distributed within an Ethernet PC network
• Supports dedicated hardware: custom built axis controllers, IMU interfaces
• Cooperates with DisCODe framework
Two co-operating IRp-6 robots
MRROC++
User Interface
SRP + UI
System dependent layer
Master Process
MP
Task dependent layer
Effector Control Process ECP$_j$
Effector Driver Process EDP$_j$
Virtual Sensor Process VSP$_i$
Hardware dependent layer
Axis microcontrollers
Receptors
Hardware layer


Robot Programming
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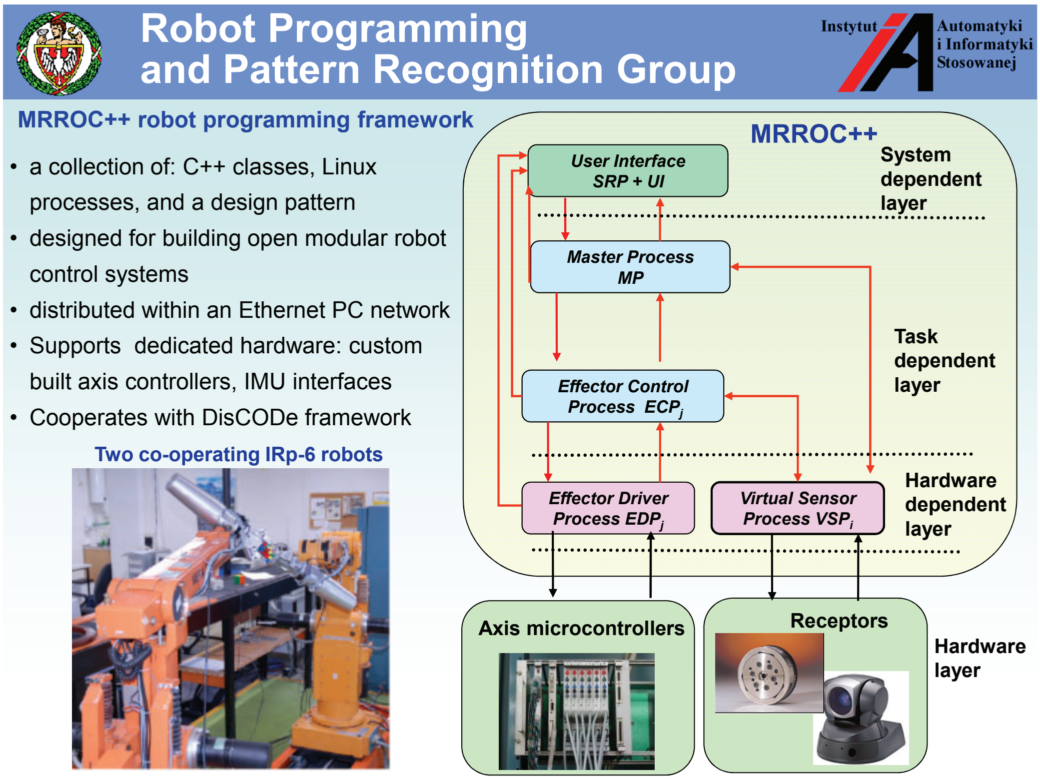
Control architecture for autonomous mobile robot teams
Database Knowledge
Mission Commands
Simultaneous Planning, Localization & Mapping (SPLAM)
Simultaneous Localization and Mapping (SLAM)
Robot Pose Global Map
Cognition / Task Planning
Environment Model Local Map
Wireless communication WLAN, Bluetooth
Path
Information Extraction/Aggregation
Path Execution
Raw Sensor Data
Actuator Commands
Sensing
Acting
Perception
Motion Control
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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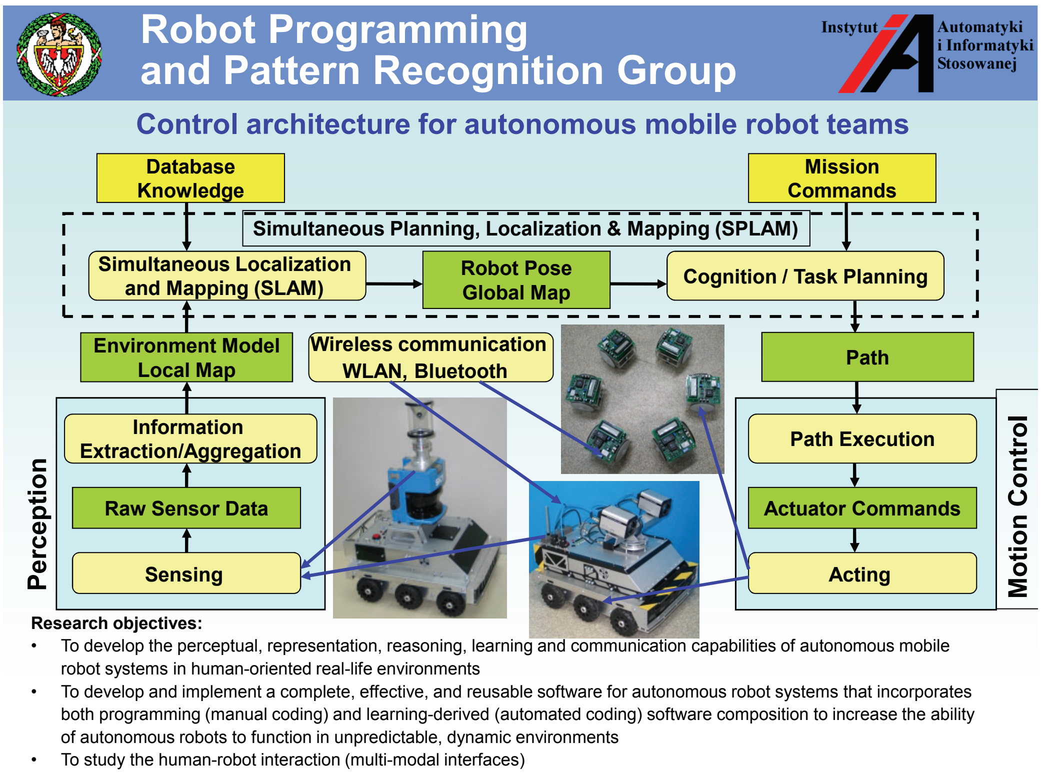
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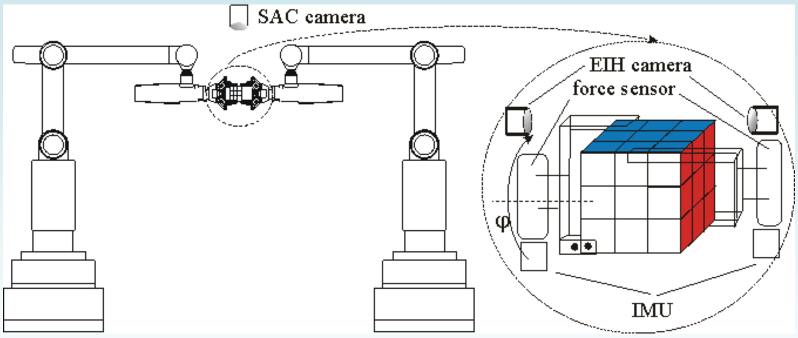
### Sensor based two-handed manipulation




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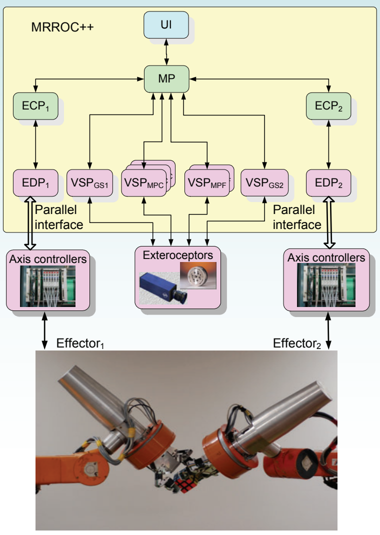
### Two-handed Service Robot Controller Capable of Solving a Rubik's Cube Puzzle




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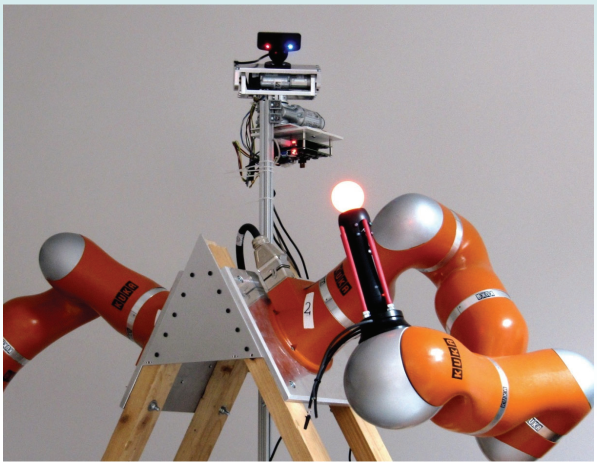
# Velma: two arm robotic system with redundant manipulators and active head



### 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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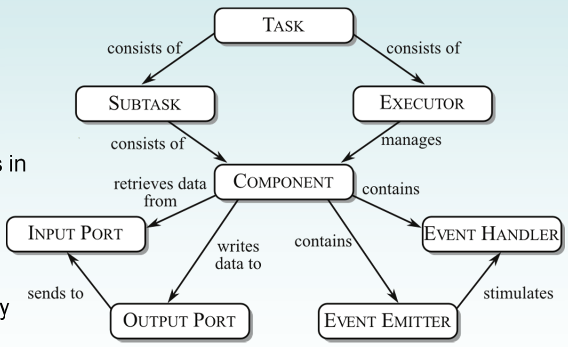
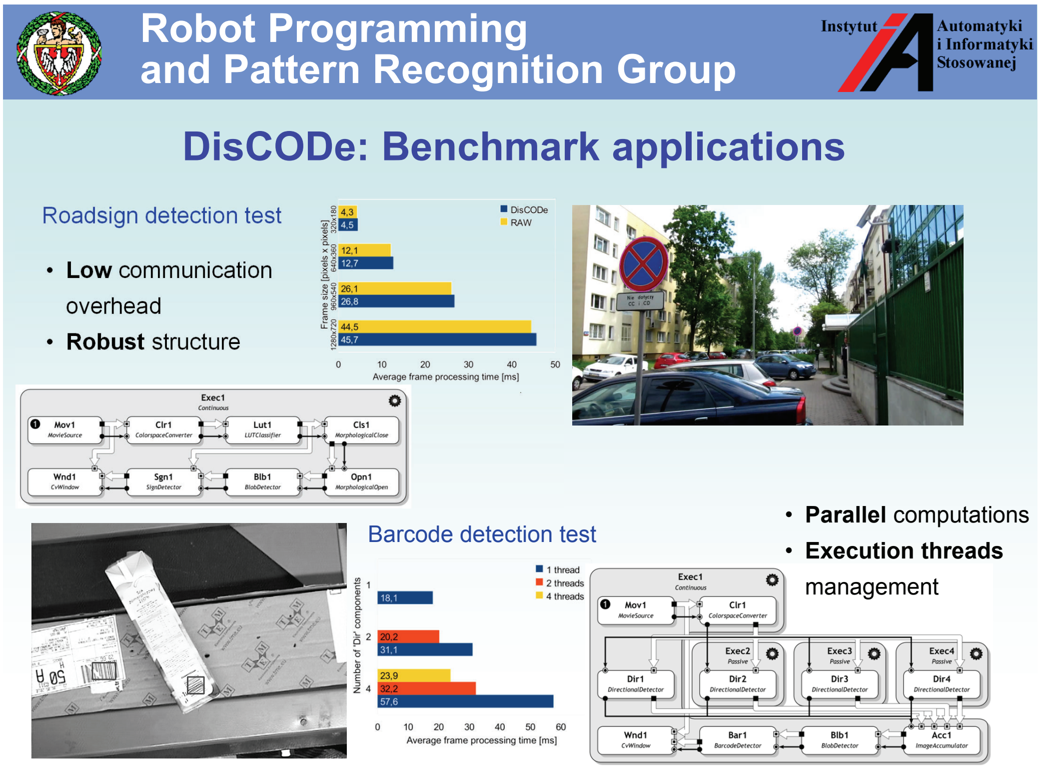
# DisCODe: Distributed Component Oriented Data Processing

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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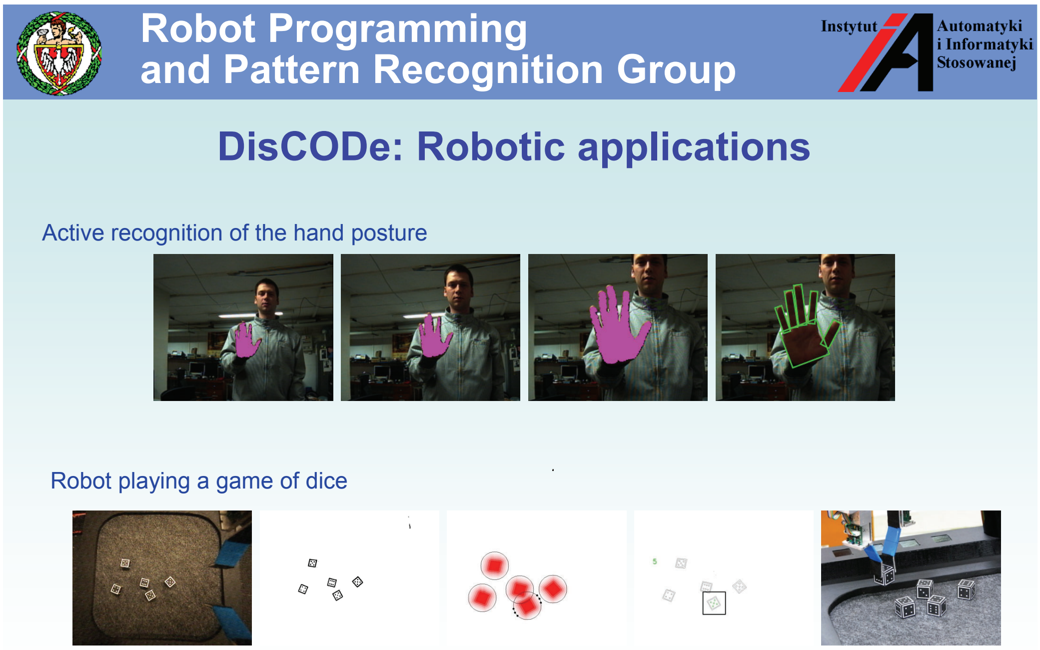
DisCODe: Benchmark applications
Roadsign detection test
• Low communication overhead
• Robust structure
DisCODe
RAW
Frame size [pixels x pixels]
320x180
640x360
960x540
1280x720
4,3
4,5
12,1
12,7
26,1
26,8
44,5
45,7
Average frame processing time [ms]
Exec1
Mov1
Clr1
Lut1
Cls1
Wnd1
Sgn1
Blb1
Opn1
Barcode detection test
1 thread
2 threads
4 threads
Number of 'Dir' components
18,1
20,2
31,1
23,9
32,2
57,6
Average frame processing time [ms]
• Parallel computations
• Execution threads management
Exec1
Mov1
Clr1
Exec2
Exec3
Exec4
Dir1
Dir2
Dir3
Dir4
Wnd1
Bar1
Blb1
Acc1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DisCODe: Robotic applications
Active recognition of the hand posture
Robot playing a game of dice

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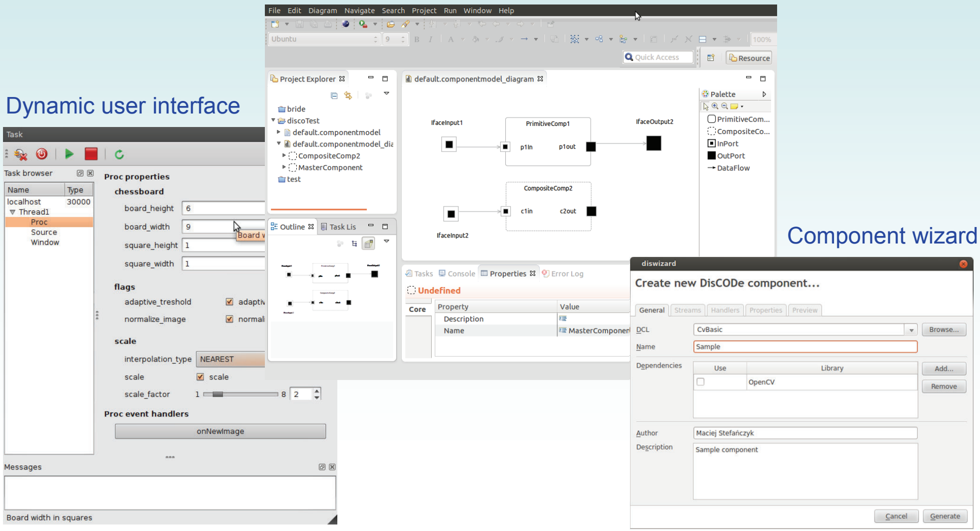
# DisCODe: Graphical tools

Metamodel-based task editor

Dynamic user interface

Component wizard



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# Active Perception and Active Vision

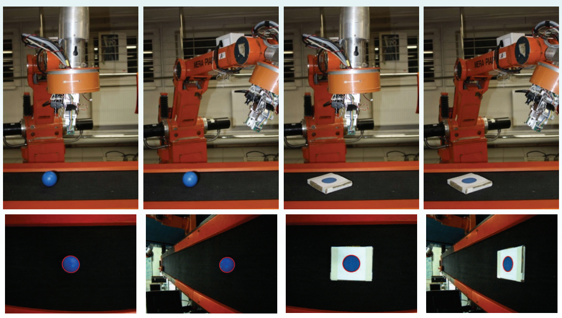
Concept:

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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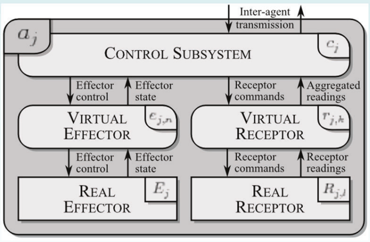
## Embodied Agent: a robot control system design method

### 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**.

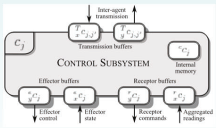
### Embodied Agent:

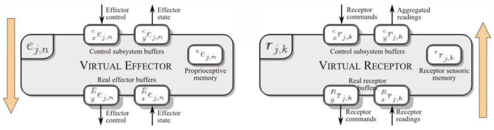



- **Embodied Agent** - any device or program having the ability to perceive its surroundings to subsequently influence the environment state, can communicate with other agents and has an internal imperative to achieve its goal.

### 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

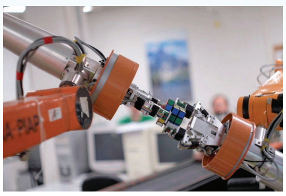
### Main concepts:

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).

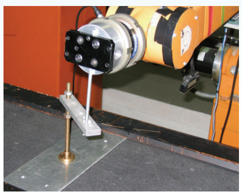
The existing manipulator control can be classified taking into account the proposed behaviors.

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

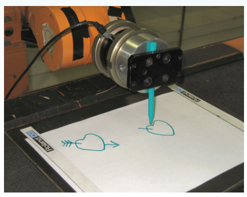


Rubik's cube solver

Following an unknown contour



Rotating a crank



Copying drawings

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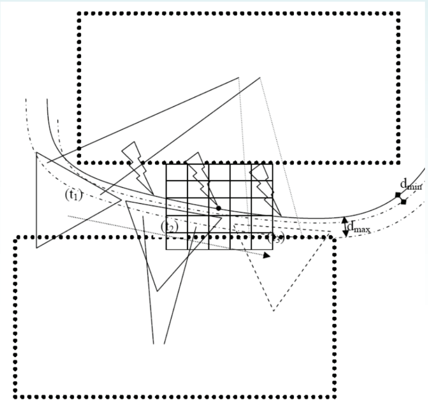
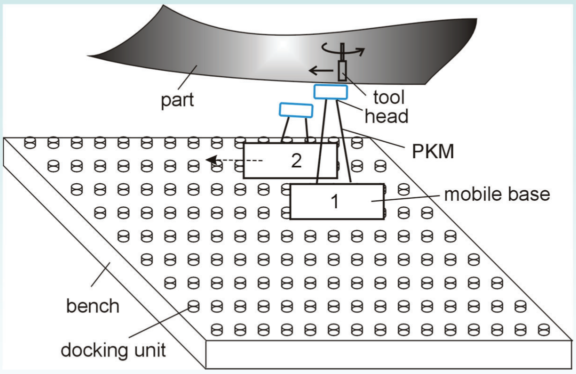
### Programming and control of a swarm of mobile fixtures

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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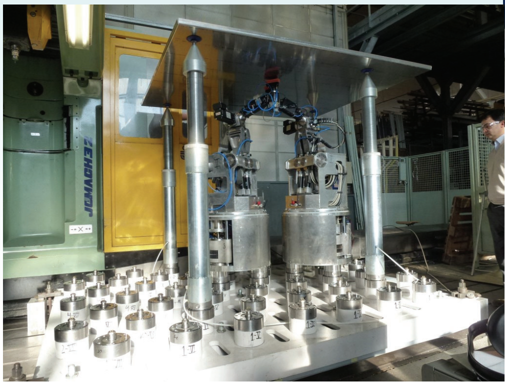
### Mobile supports replacing static fixtures

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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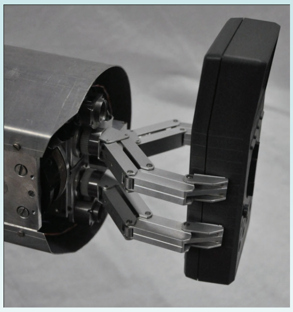
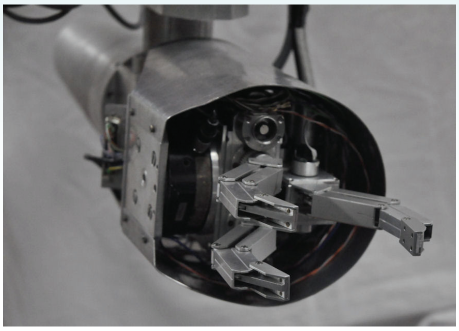
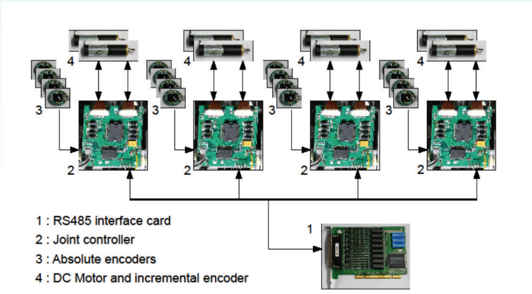
### Three finger gripper

- 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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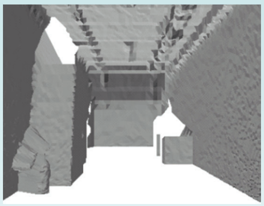
### Computer Vision in mobile and service robotics

Environment map generation,

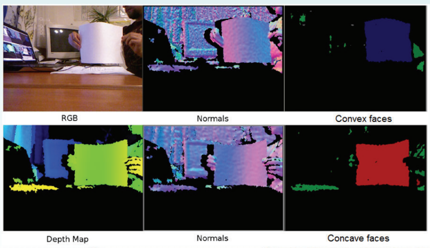
obstacle avoidance.

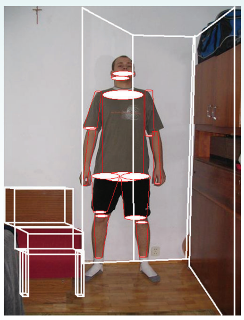


Depth-map and

color image

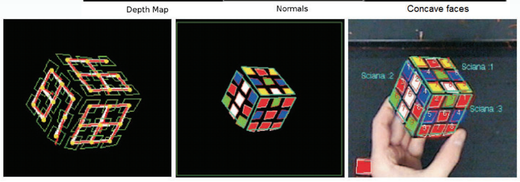
Segmentation

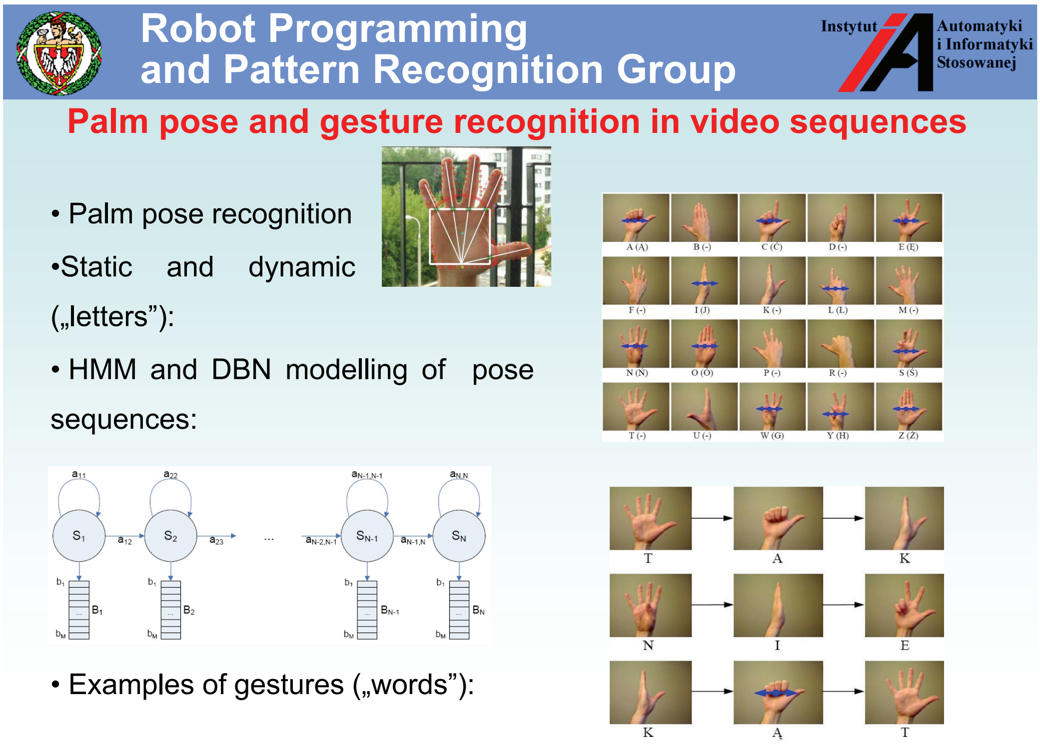


3D object

recognition

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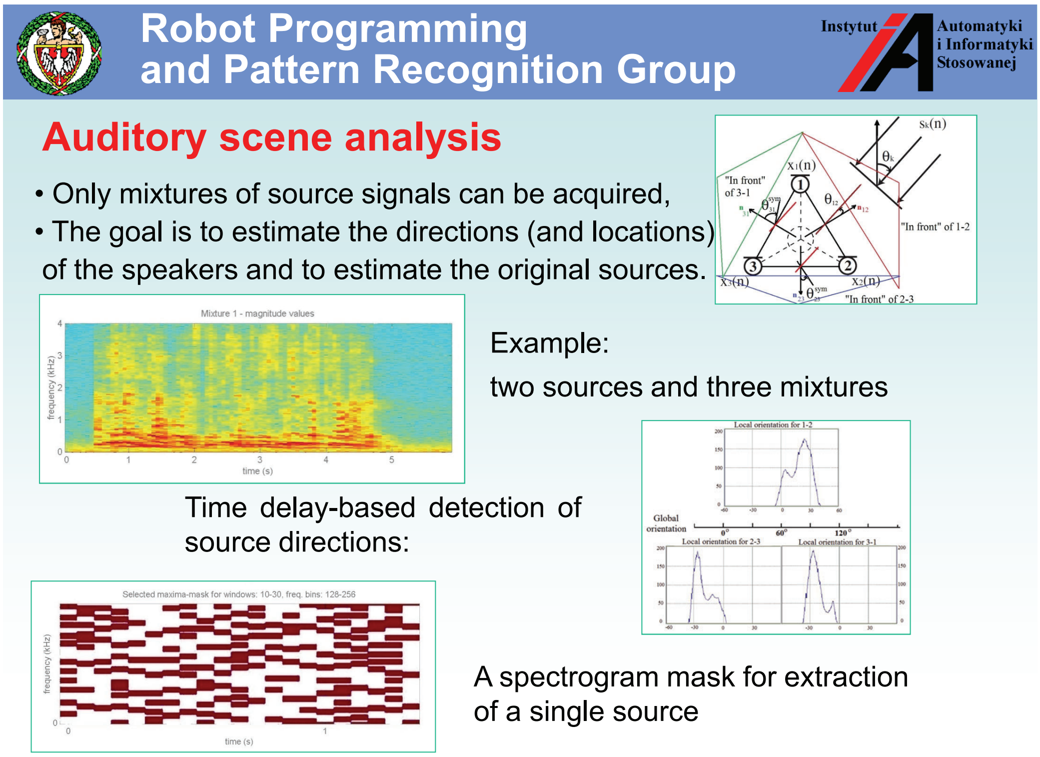
Palm pose and gesture recognition in video sequences
• Palm pose recognition
•Static and dynamic („letters”):
• HMM and DBN modelling of pose sequences:
• Examples of gestures („words”):
T A K
N I E
K A T


Robot Programming
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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.
Mixture 1 - magnitude values
Example:
two sources and three mixtures
Time delay-based detection of source directions:
Selected maxima-mask for windows: 10-30, freq. bins: 128-256
A spectrogram mask for extraction of a single source

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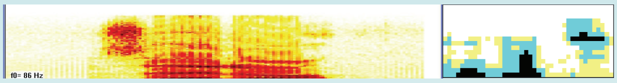
### Spoken sentence recognition

- Spectral analysis
- Acoustic-phonetic features
- Word recognition

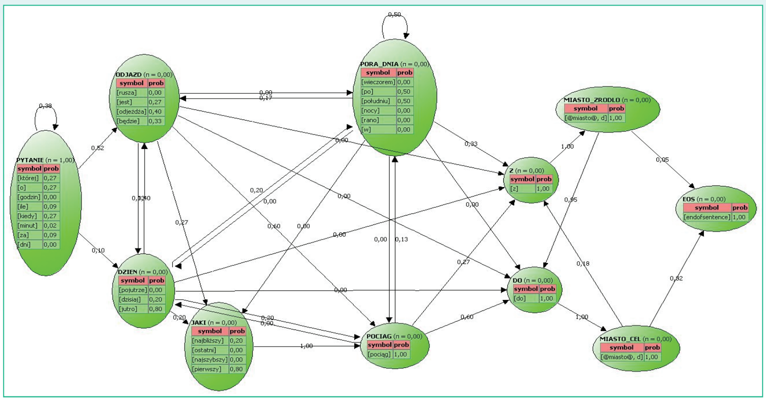


- A N-gram language model

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

- HMM-based sentence recognition

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



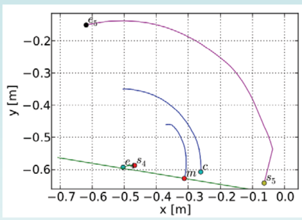
## Robot Programming and Pattern Recognition Group

Instytut Automatyki i Informatyki Stosowanej

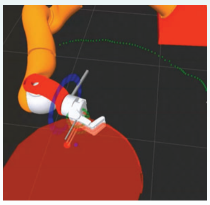
### Door opening

- 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

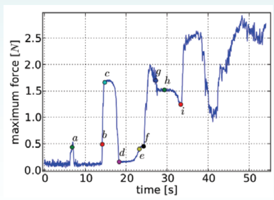
Velma robot opening the door




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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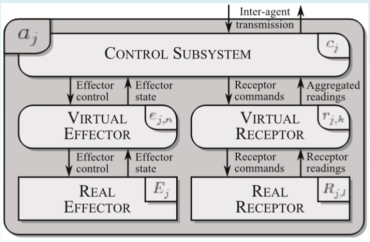
# Embodied Agent: a robot control system design method

### 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**.

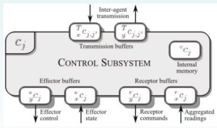
### Embodied Agent:

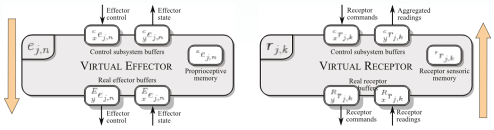



- **Embodied Agent** - any device or program having the ability to perceive its surroundings to subsequently influence the environment state, can communicate with other agents and has an internal imperative to achieve its goal.

### 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.

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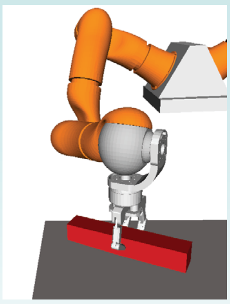
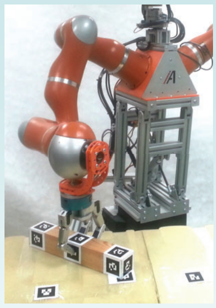
# Grasping

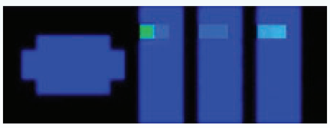
- Impedance control of humanoid robot
- Visual markers
- Feedback from tactile sensors used for grasp evaluation
- Full environment model
- Planning collision free motion of the manipulators
- Task oriented grasp planning based on analytical contact forces analysis



Velma robot grasping a cuboid (simulation)



Velma robot grasping a cuboid



The visualisation of tactile sensors readings

## Robot Programming and Pattern Recognition Group

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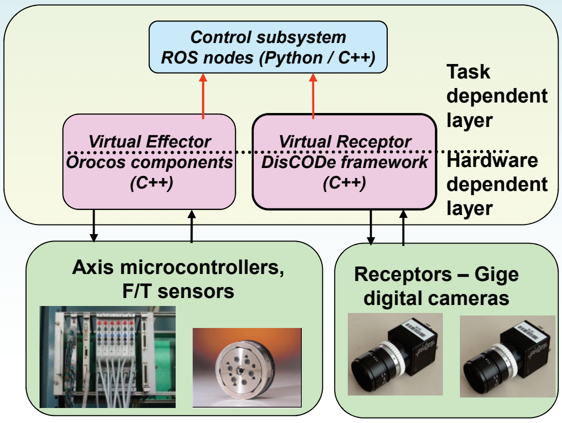
### IRPOS robot programming framework

Two co-operating IRp-6 robots

- 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

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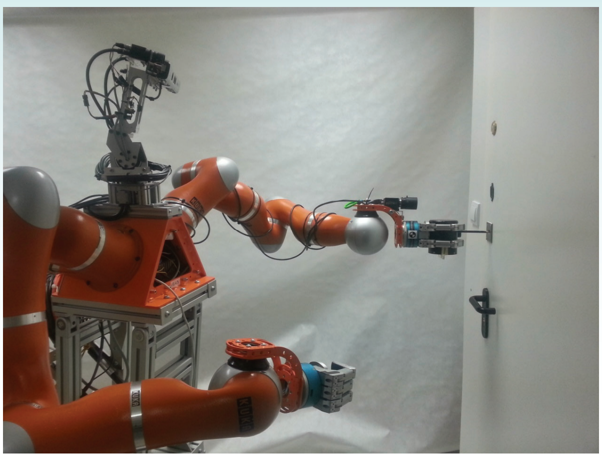
### Velma: two arm robotic system with redundant manipulators, grippers, active head and torso



**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

# Robot Programming and Pattern Recognition Group

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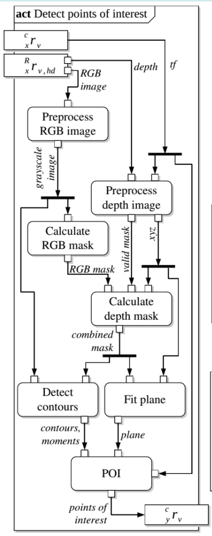
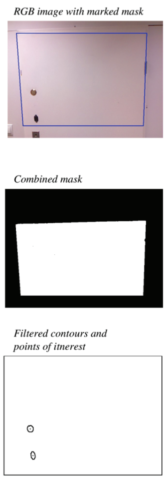
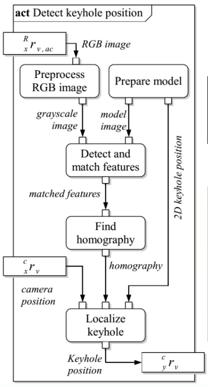
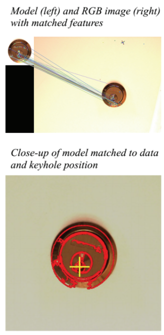
## Localization and inspection of door locks

- comprehensive strategy of door locks examination as a paradigm of active sensing
- initial region of interest is localized using the RGB-D low resolution camera mounted on the robot head
- it is then inspected using 2D camera mounted on the robot arm



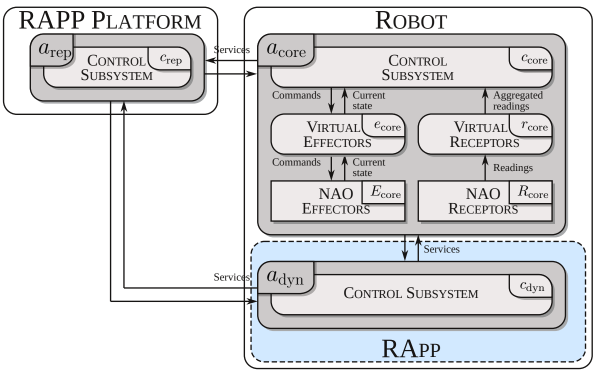




Activity diagrams of important system behaviors

## 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

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

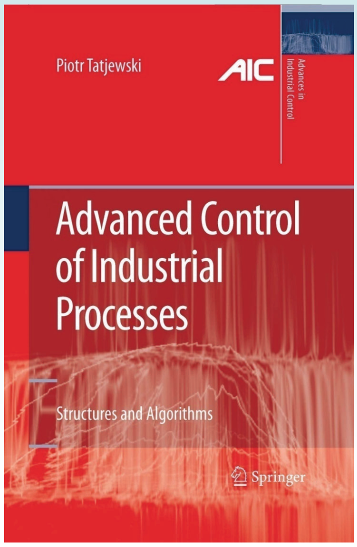
FP7 Collaborative Project RAPP (Grant no 610947), European Commission, 2013–2016

## 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

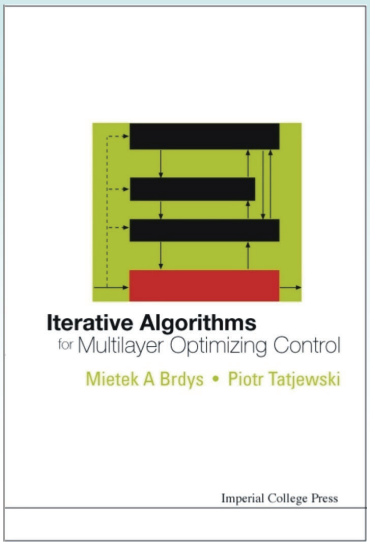



## Control Engineering Group

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

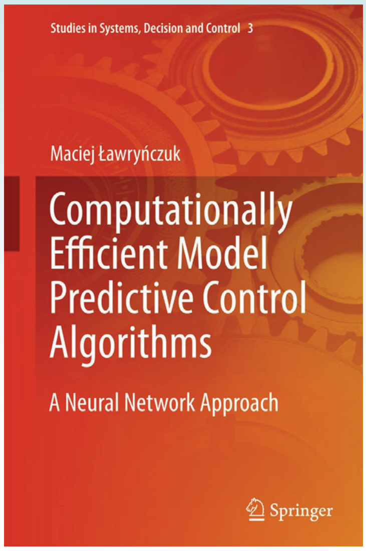


## Control Engineering Group

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

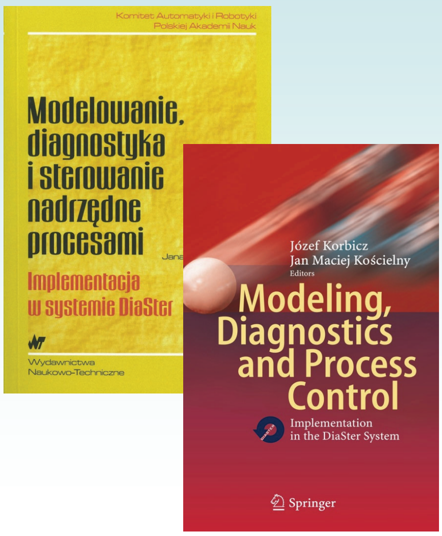



## Control Engineering Group

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



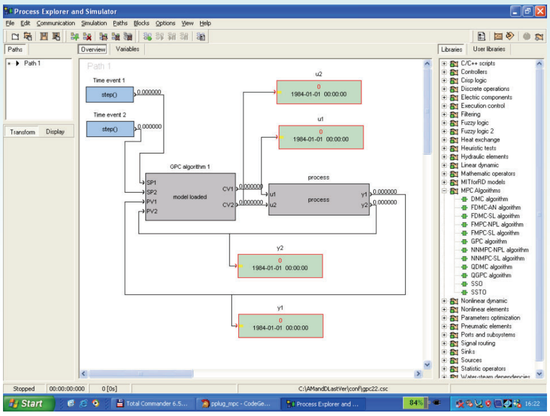
## Control Engineering Group

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

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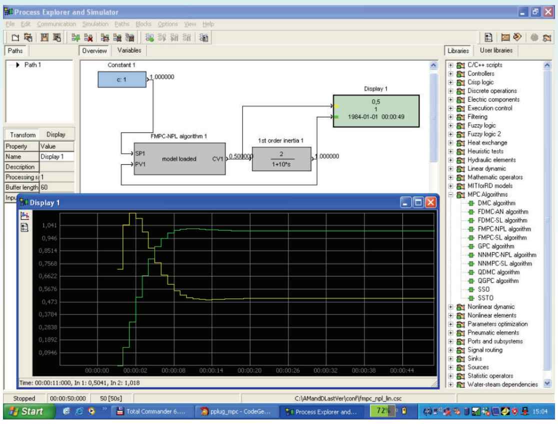
### DiaSter (Diagnostic and Control) software system

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

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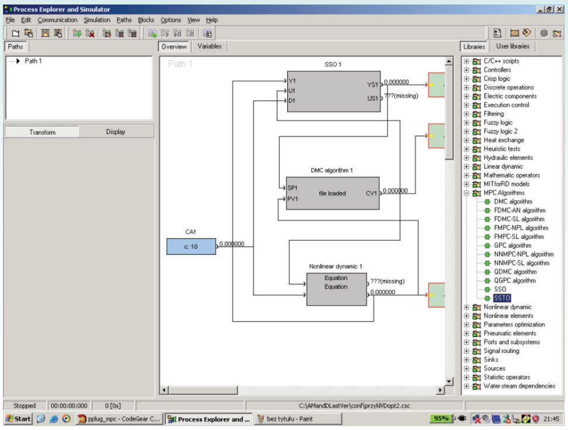
### DiaSter (Diagnostic and Control) software system

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

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### 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

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### The anti-smoke ventilation control in 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

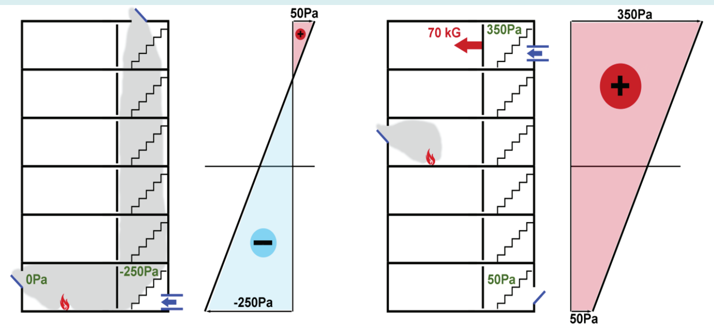

The controller is on the market (manufactured by ***Plum*** company)

## Control Engineering Group

Instytut Automatyki i Informatyki Stosowanej

### 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 manufactured by ***Plum*** company)

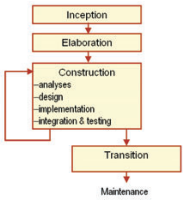
## Software Engineering Group

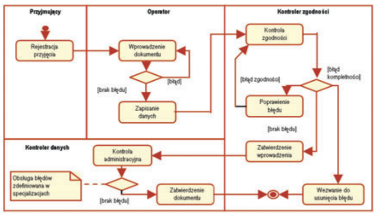
Instytut Automatyki i Informatyki Stosowanej

### Software development

**Research topics:**

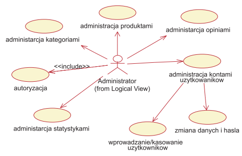
Business process modeling
Requirements engineering
Software development methods
Technologies and tools
Acceptance testing
Software processes
Project management

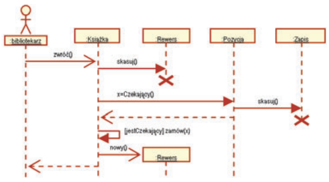



***Systems and tools* :**

Rational Rose
Rational RequisitePro
Structured Architect





## Software Engineering Group

Instytut Automatyki i Informatyki Stosowanej

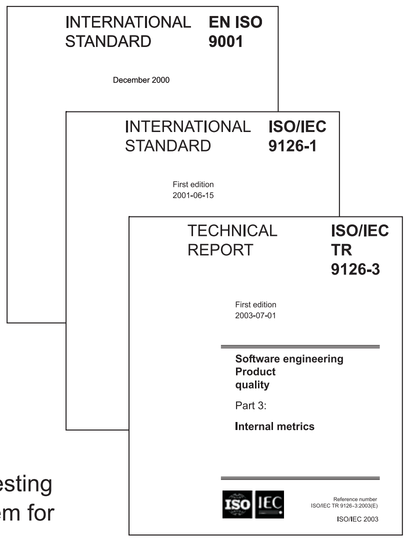
### Evaluation of the software quality

**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

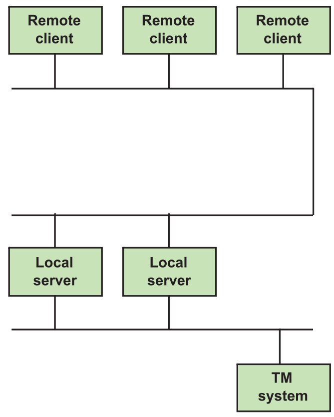
### Distributed Open Systems

**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




**Languages and Conceptual Tools:**

Ø BPMN, BPEL

Ø $RT_0$, $RT_1$, $RT_2$, $RT^T$

Ø Architecture Decision Models

## Operations Research and Management Systems Group

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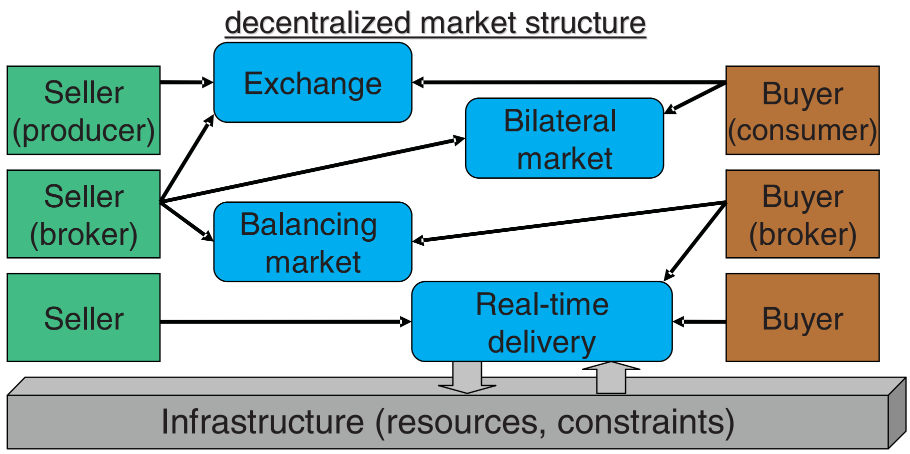
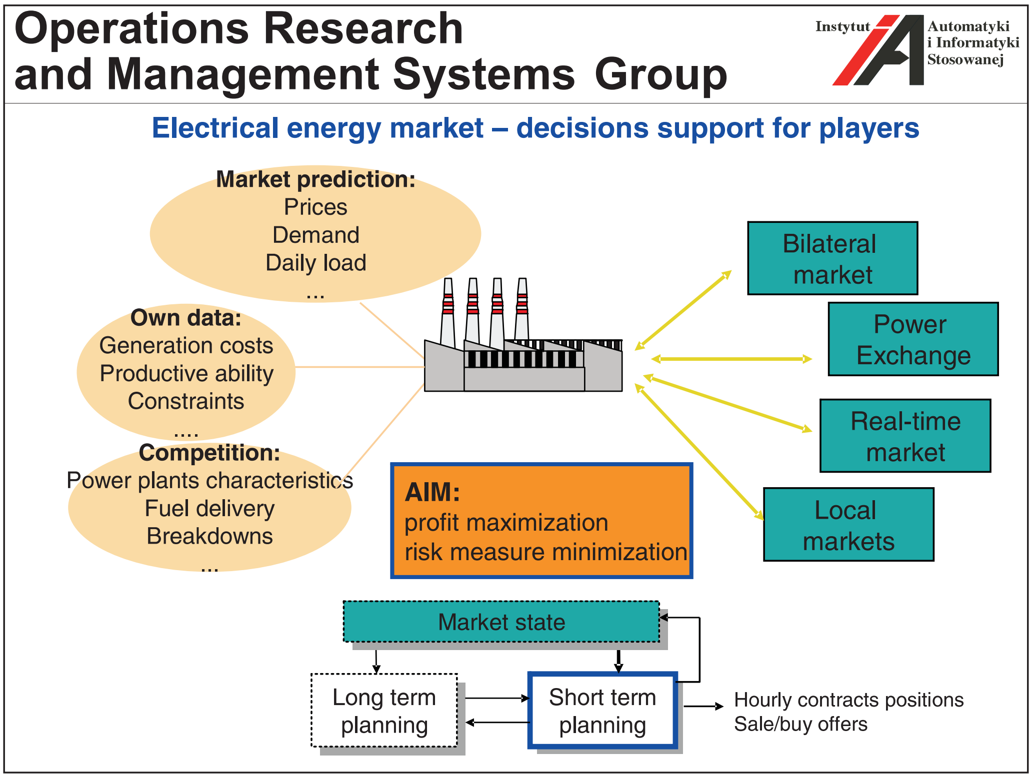
### Designing of infrastructure markets under constraints




- **Object and subject market structure**
- **Market rules designing**
- **Strategic and tactical market planning**
- **Real-time operational control**
- **Market operator decisions support tools**
- **XML-based description of market**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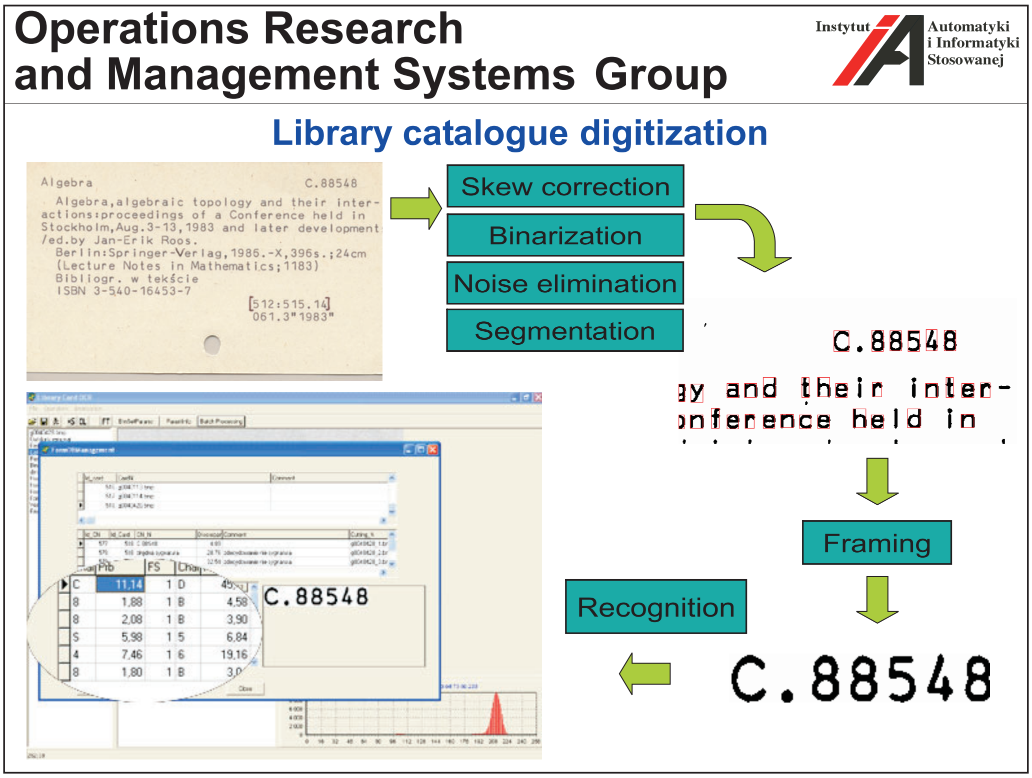
Electrical energy market – decisions support for players
Market prediction:
Prices
Demand
Daily load
...
Own data:
Generation costs
Productive ability
Constraints
....
Competition:
Power plants characteristics
Fuel delivery
Breakdowns
...
Bilateral market
Power Exchange
Real-time market
Local markets
AIM:
profit maximization
risk measure minimization
Market state
Long term planning
Short term planning
Hourly contracts positions
Sale/buy offers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/ed.by Jan-Erik Roos.
Berlin:Springer-Verlag,1986.-X,396s.;24cm
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# Operations Research and Management Systems Group

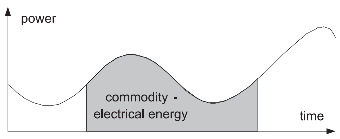
Instytut Automatyki i Informatyki Stosowanej

## M³ Multicommodity Market Model

**M³ is a flexible and universal market data and communication model**
**http://www.openm3.org**

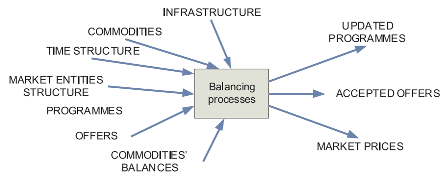
**M³** is mainly (but not only) designed for

- **Centralized** (auctions, exchanges) and **distributed, multicommodity** markets
- **Infrastructure** markets
- „**Real-time**" markets on which commodities
  - are non-storable, localized in time and space,
  - delivered too late become worthless, their storage is limited
  - are integrals of some instantaneous values




**M³** consists of several layers: formal mathematical model, conceptual data model, expressed in form of UML class diagrams, exemplary relational database structure, XML schemas for static data, communication models and XML schemas for messages and Web Services definitions.

**Conceptual model of M³** describes the inputs and outputs of elementary balancing process:



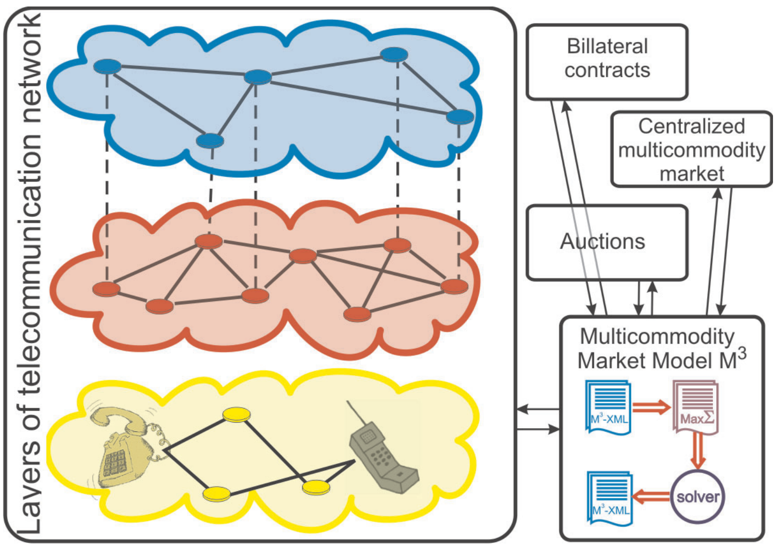

**M³** helps markets' development by providing

- flexible framework both for real-world market systems and for research projects
- possibilities for integration of software components
- possibilities for organizing benchmark data repository

# Operations Research and Management Systems Group

Instytut Automatyki i Informatyki Stosowanej

## Design of Multicommodity Market Model – M³
## Application of M³ on the Communication Bandwidth Market




**M³ model:**

- may be used in information systems for market balancing in various infrastructure networks

- is a set of formal data models, which results in XML-derived information interchange specification

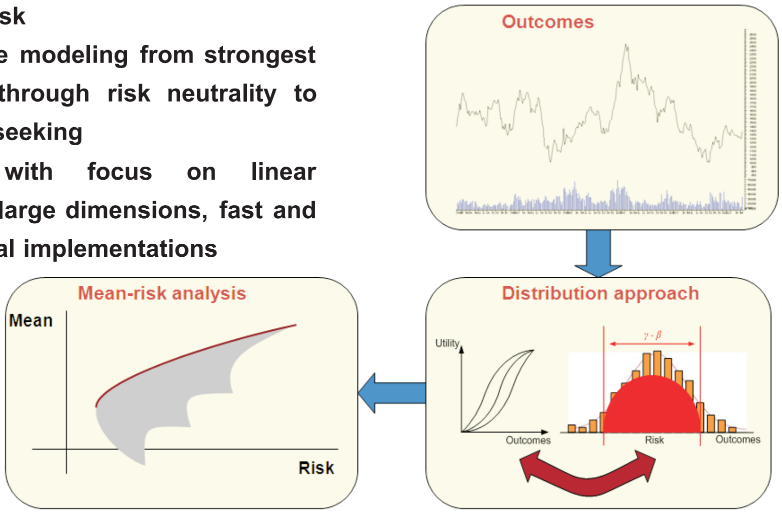
- may be used in a wide range of market-oriented network systems and may significantly facilitate communication, coordination and modelling procedures

## 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

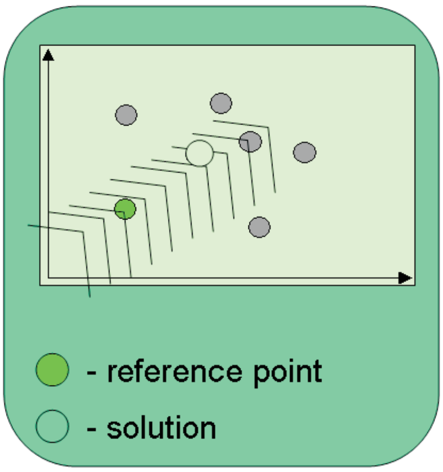



## Optimization and Decision Support Group

Instytut Automatyki i Informatyki Stosowanej

### Reference Point Method

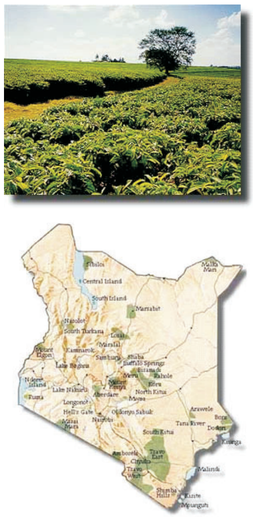
- interactive method for multicriteria model analysis
- guiding information by specification of the reference points
- a Pareto-optimal solution is selected for a given reference point

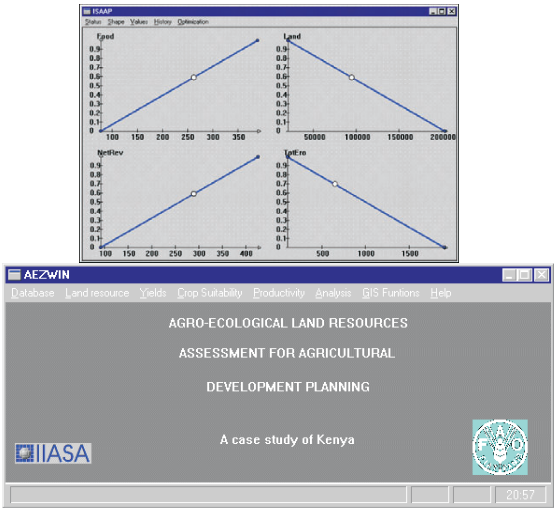


## Optimization and Decision Support Group

Instytut Automatyki i Informatyki Stosowanej

### Application of the reference point method for land resource assessment



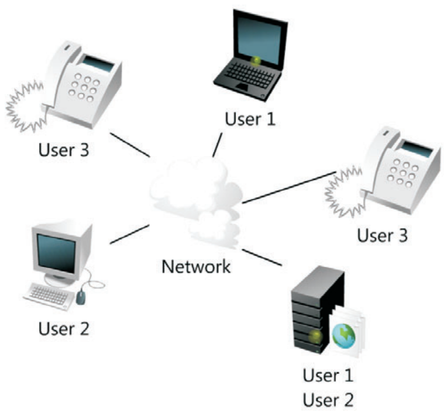



## Optimization and Decision Support Group

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 | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|
| | persons | FTE | persons | FTE | persons | FTE |
| **Academic Staff** | 47 | 40 | 44 | 38.5 | 43 | 38 |
| by titles/degrees | | | | | | |
| Professors | 7 | 7 | 7 | 7 | 8 | 8 |
| D.Sc.-s | 4 | 4 | 6 | 6 | 5 | 5 |
| Ph.D.-s | 29 | 25 | 28 | 23.5 | 28 | 23.5 |
| M.Sc.-s | 7 | 4 | 3 | 2 | 2 | 1.5 |
| by positions | | | | | | |
| Professors | 9 | 9 | 9 | 9 | 9 | 9 |
| Readers | 2 | 2 | 1 | 1 | 1 | 1 |
| Assistant Professors | 28 | 24.5 | 30 | 26 | 31 | 26.5 |
| Senior Lecturers | 5 | 3 | 4 | 2.5 | 2 | 1.5 |
| Lecturers | 0 | 0 | 0 | 0 | 0 | 0 |
| Assistants | 3 | 1.5 | 0 | 0 | 0 | 0 |
| **Ph.D. Students** | 19 | | 28 | | 27 | |
| **Technical Staff** | 8 | 4.6 | 5 | 3.25 | 6 | 5 |
| **Administrative Staff** | 9 | 8 | 7 | 5 | 9 | 7 |

$FTE$ – Full Time Employment units,
$+$ – corrections due to persons on long-term leave of absence

| ACTIVITIES | 2012 | 2013 | 2014 |
|---|---|---|---|
| **Teaching activities** | | | |
| standard teaching potential, hours | 9 453.15 | 9 242.40 | 9 086.00 |
| # hours taught | 11 906.29 | 12 415.10 | 12 246.40 |
| **Degrees awarded** | | | |
| Professor | 1 | 0 | 1 |
| D.Sc | 1 | 2 | 0 |
| Ph.D. | 4 | 4 | 1 |
| M.Sc. | 52 | 46 | 46 |
| B.Sc. | 76 | 57 | 45 |
| **Research projects** | | | |
| granted by WUT | 6 | 4 | 5 |
| granted by State institutions | 12 | 13 | 12 |
| granted by international institutions | 3 | 4 | 1 |
| other | 8 | 6 | 8 |
| **Sci.-Tech. publications** | | | |
| monographs (authored or edited) | 4 | 4 | 7 |
| chapters in books and proceedings | 57 | 39 | 61 |
| papers in journals | 50 | 36 | 32 |
| **Reports, abstracts and other papers** | 24 | 42 | 33 |
| **Conferences** | | | |
| participation (# of conferences) | 66 | 34 | 22 |
| participation (# of part. from ICCE) | 84 | 41 | 43 |

| RESOURCES | 2012 | 2013 | 2014 |
|---|---|---|---|
| **Space (sq.m.)** | | | |
| laboratories | 585 | 585 | 585 |
| library + seminar room | 74 | 74 | 74 |
| faculty offices | 724 | 724 | 724 |
| **Computers** | | | |
| personal computers | 226 | 172 | 175 |
| **Library resources** | | | |
| books | 3 036 | 3 127 | 3 141 |
| booklets | 2 444 | 2 544 | 2 635 |
| 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, 2013.

## 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).

**Radosław Ładziński** Professor (retired January 1998)

**Systems Control Division, Complex Systems Group**
R.Ladzinski@ia.pw.edu.pl

*Born 1927, 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 and Pattern Recognition Group**
**room 523, tel. 22 234 7791**
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**
**room 530, tel. 22 234 7922**
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**
**room 523, tel. 22 234 7791**
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**
**room 573, tel. 22 234 7126**
P.Arabas@elka.pw.edu.pl

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

With WUT since 2002.

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

**Adam Czajka** Assistant Professor (part-time)

**Systems Control Division, Biometrics and Machine Learning Group**
**room 558, tel. 22 234 7805**
A.Czajka@ia.pw.edu.pl, www.ia.pw.edu.pl/~aczajka

*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 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). 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 and a member of the NASK Research Council (2006–). 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–). Expert of the ISO/IEC SC37 and CEN TC224 WG18 on Biometrics. 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:* Interest: Biometrics (methods, devices and applications, security of biometrics, quality of biometric data, biometric standardization), pattern recognition.

**Paweł Domański** Assistant Professor

**Control and Software Engineering Division, Control Engineering Group**
**room 553, tel. 22 234 7121**
P.Domanski@ia.pw.edu.pl

*M.Sc. 1991, Ph.D. 1996 from WUT.*

With WUT since 1991.

*Interests:* Adaptive control, intelligent control, fuzzy logic.

**Janusz Granat** Assistant Professor

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 23, tel. 22 234 6191**
J.Granat@ia.pw.edu.pl, www.ia.pw.edu.pl/~janusz

*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

**Control and Software Engineering Division, Control Engineering Group**
**room 525, tel. 22 234 7699**
J.Gustowski@ia.pw.edu.pl

*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

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 561, tel. 22 234 7123**
M.Kaleta@ia.pw.edu.pl

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

With WUT since 2003.

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

**Mariusz Kamola** Assistant Professor (part-time)

**Systems Control Division, Complex Systems Group**
**room 573, tel. 22 234 7126**
M.Kamola@ia.pw.edu.pl, www.ia.pw.edu.pl/~mkamola

*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

**Systems Control Division, Complex Systems Group**
**room 572, tel. 22 234 7632**
A.Karbowski@ia.pw.edu.pl, www.ia.pw.edu.pl/~karbowsk

*M.Sc. 1983, Ph.D. 1990 from WUT. D.Sc. 2012*

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.

**Włodzimierz Kasprzak** Professor

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 565, tel. 22 234 7866**
`W.Kasprzak@elka.pw.edu.pl`, `www.ia.pw.edu.pl/~wkasprza`

*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.

**Kamil Kołtyś** Assistant Professor (part-time)

**Operations and Systems Research Division.**
**Operations Research and Management Systems Group**
**room 526, tel. 22 234 7125**
`K.J.Koltys@elka.pw.edu.pl`

*M.Sc. 2007, Ph.D. 2012 from WUT*

With WUT since 2011.

*Interests:* Operations research, bandwidth auctions, mechanism design, multicommodity trade.

**Tomasz Kornuta** Assistant Proffesor

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 031, tel. 22 234 5842**
**room 556, 22 234 7649**
`T.Kornuta@elka.pw.edu.pl`, `http://tkornuta.googlepages.com`

*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)

**Systems Control Division, Complex Systems Group**
**room 573a, tel. 22 234 7860**
`akozakie@elka.pw.edu.pl`

*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

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 25, tel. 22 234 7297**
B.Kozlowski@elka.pw.edu.pl

*M.Sc. 2004 from WUT.*

With WUT since 2010.

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

**Urszula Kręglewska** Senior Lecturer (part-time, until Oct. 2013)

**Control and Software Engineering Division, Control Engineering Group**
**room 553, tel. 22 234 7121**
U.Kreglewska@ia.pw.edu.pl, www.ia.pw.edu.pl/~ukreglew

*M.Sc. 1973 from WUT.*

With WUT in 1973–1993 and from 1994 to present, with Digital Equipment Poland 1993–1994.

*Interests:* Computer interfaces design.

**Tomasz J. Kruk** Assistant Professor

**Systems Control Division, Complex Systems Group**
**room 530, tel. 22 234 7922**
T.Kruk@ia.pw.edu.pl, www.ia.pw.edu.pl/~tkruk

*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

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 25A, tel. 22 234 7640**
A.Krzemienowski@ia.pw.edu.pl

*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.

**Bartłomiej Kubica** Assistant Professor

**Systems Control Division, Complex Systems Group**
**room 573a, tel. 22 234 7860**
bkubica@elka.pw.edu.pl

*M.Sc. 2001, Ph.D. 2006 from WUT.*

With WUT since 2005.

*Interests:* Interval mathematics, optimization, numerical computations, parallel computing, multi-threaded programming, real-time systems.

**Maciej Ławryńczuk** Assistant Professor (Leader of the Group)

**Control and Software Engineering Division, Control Engineering Group**
**room 567, tel. 22 234 7673**
M.Lawrynczuk@ia.pw.edu.pl

*M.Sc. 1998, Ph.D. 2003, D.Sc. 2013 from WUT.*

With WUT since 2003. Winner 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)

**Systems Control Division, Complex Systems Group**
**room 517, tel. 22 234 7397 and 22 825 0995**
K.Malinowski@ia.pw.edu.pl, www.ia.pw.edu.pl/~malinows

*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). Corresponding Member of the Polish Academy of Sciences (PAN) (since 1998), Member of the Warsaw Scientific Society (TNW), Chairman of the Committee of Automation and Robotics of Polish Academy of Sciences (PAN), Professor in the Research and Academic Computer Network Institute (NASK), Vice-Chairman of the Scientific Council of NASK (2011–), Chairman of Task Group of Ministry of Science and Higher Education for assessment of applications for funding large scale research equipment and constructions (2011–), 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.

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

**Piotr Marusak** Assistant Professor

**Control and Software Engineering Division, Control Engineering Group**
**room 567, tel. 22 234 7673**
P.Marusak@ia.pw.edu.pl, www.ia.pw.edu.pl/~pmarusak

*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.

**Ewa Niewiadomska-Szynkiewicz** Professor (Leader of the Group)

**Systems Control Division, Complex Systems Group**
**room 572a, tel. 22 234 3650**
E.Niewiadomska@ia.pw.edu.pl, www.ia.pw.edu.pl/~ens

*M.Sc. 1986, Ph.D. 1995, D.Sc. 2005 from WUT.*

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, secretary of the Committee of Automation and Robotics of Polish Academy of Sciences (PAN).

**Włodzimierz Ogryczak** Professor (Leader of the Group, Deputy Director of the Institute)

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 24, tel. 22 234 6190**
W.Ogryczak@ia.pw.edu.pl, www.ia.pw.edu.pl/~wogrycza

*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)

**Systems Control Division, Biometrics and Machine Learning Group**
**room 522, tel. 22 234 7733**
A.Pacut@ia.pw.edu.pl, www.ia.pw.edu.pl/~pacut

*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**
**room 554, tel. 22 234 7648**
P.Palka@ia.pw.edu.pl, http://www.ia.pw.edu.pl/~ppalka

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

With WUT since 2009.

*Interests:* Multi-agent systems, mechanism design, incentive compatibility.

**Krzysztof Pieńkosz** Assistant Professor

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 560a, tel. 22 234 7864**
K.Pienkosz@ia.pw.edu.pl

*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.

**Grzegorz Płoszajski** Assistant Professor (part time)

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 560a, tel. 22 234 7864**
G.Ploszajski@ia.pw.edu.pl

*M.Sc. 1968 from WUT, M.Sc. in Mathematics 1974 from Warsaw University, Ph.D. 1974 from WUT.*

With WUT since 1969. Deputy Director for Information Technology of the Main Library of WUT since 1996. Committee Member of 'Kasa Mianowskiego' since 2004.

*Interests:* Information retrieval, text algorithms, operation research, digitalization standards, library automation, classification.

**Joanna Putz-Leszczyńska** Assistant Professor (part-time)

**Systems Control Division, Biometrics and Machine Learning Group**
**room 558, tel. 22 234 7805**
jputz@elka.pw.edu.pl

*M.Sc. 2004, Ph.D. 2010 from WUT.*

Since 1999 she is with Warsaw University of Technology, presently being an assistant professor at the Institute of Control and Computation Engineering. Since 2003 she works as a research assistant at Biometric Laboratory of Research and Academic Computer Network NASK.

*Interests:* Biometrics, identification, security and global optimization heuristics

**Andrzej Ratkowski** Assistant Professor

**Control and Software Engineering Division, Software Engineering Group**
**room 555, tel. 22 234 7997**
A.Ratkowski@ia.pw.edu.pl

*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 (Leader of the Group)

**Control and Software Engineering Division, Software Engineering Group**
**room 562, tel. 22 234 7756**
K.Sacha@ia.pw.edu.pl, www.ia.pw.edu.pl/~sacha

*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. 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 Lingby, Denmark (1993), Project Manager in Alerton (1999–2002), Advisor to the President of Social Insurance Institution (2005–2009). Head of the Institute of Software Engineering at Vistula University, Warsaw, Poland. Member of the Council of the National Centre for Research and Development (2010–2014). Expert in maintaining and evaluating software projects. Member of IEEE Computer Society.

*Interests:* Software engineering, software quality evaluation, software security, trust management, real-time systems.

**Jerzy Sobczyk** Senior Lecturer (part-time)

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 519, tel. 22 234 7863**
J.Sobczyk@ia.pw.edu.pl, www.ia.pw.edu.pl/~jurek

*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

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 25a, tel. 22 234 7640**
A.Stachurski@ia.pw.edu.pl, www.ia.pw.edu.pl/~stachurs

*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 macroeconomy 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.

**Marcin Szlenk** Assistant Professor

**Control and Software Engineering Division, Software Engineering Group**
**room 555, tel. 22 234 7997**
M.Szlenk@ia.pw.edu.pl

*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

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 572, tel. 22 234 7632**
W.Szynkiewicz@ia.pw.edu.pl

*M.Sc. 1985, Ph.D. 1996 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**
**room 26, tel. 22 234 7862**
T.Sliwinski@ia.pw.edu.pl

*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)

**Control and Software Engineering Division, Control Engineering Group**
**room 524, tel. 22 234 7397 and 825 0995**
P.Tatjewski@ia.pw.edu.pl, www.ia.pw.edu.pl/~tatjewsk

*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 since 1991, 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, since 2007 Chair of the Automatic Control Systems Section of this Committee, 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–).

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

**Eugeniusz Toczyłowski** Professor (Head of Division)

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 516, tel. 22 234 7950**
E.Toczylowski@ia.pw.edu.pl

*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)

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 22, tel. 22 234 7750**
T.Traczyk@ia.pw.edu.pl, www.ia.pw.edu.pl/~ttraczyk

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

With WUT since 1984.

*Interests:* Applications of DBMS in management and control, information systems, Web-based systems, XML language and its applications, variant configuration, long-term digital archives.

**Michał Warchoł** Senior Lecturer, part-time (until Oct. 2014)

**Systems Control Division, Complex Systems Group**
**room 570, tel. 22 234 7665**
M.Warchol@ia.pw.edu.pl, www.ia.pw.edu.pl/~warchol

*M.Sc. 1991, Ph.D. 2002 from WUT.*

With WUT since 1991.

*Interests:* Predictive control, synthesis of control systems, symbolic calculations, operating systems.

**Paweł Wawrzyński** Assistant Professor

**Systems Control Division, Biometrics and Machine Learning Group**
**room 560, tel. 22 234 7120**
P.Wawrzynski@elka.pw.edu.pl, http://staff.elka.pw.edu.pl/~pwawrzyn

*M.Sc. 2001 from WUT and 2004 from Warsaw University, Ph.D. 2005 from WUT.*

With WUT since 2005.

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

**Tomasz Winiarski** Assistant Professor

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 566, 012, tel. 22 234 7649, 22 234 7117**
tmwiniarski@gmail.com, http://robotics.ia.pw.edu.pl/tomaszwiniarski

*M.Sc. 2002, Ph.D. 2009 from WUT.*

With WUT since 2004.

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

**Adam Woźniak** Assistant Professor

**Systems Control Division, Complex Systems Group**
**room 570, tel. 22 234 7665**
A.Wozniak@ia.pw.edu.pl, www.ia.pw.edu.pl/~wozniak

*M.Sc. 1970, Ph.D. 1975 from WUT.*

With WUT since 1970. Advisor to the Dean of Faculty for Departmental Libraries (1987–1993 and 1999–2002), Member of WUT Library Council (1999–2012), Member of WUT Committee for Student Admissions (2001–2002), Dean's Coordinator for Graduate Distance Learning (2005–2008).

*Interests:* Control of complex systems, servomechanisms, robot control, multi-criteria optimization, game theory, multiagent systems including mechanism design and auctions, decision support systems.

**Andrzej Zalewski** Assistant Professor

**Control and Software Engineering Division, Software Engineering Group**
**room 555, tel. 22 234 7997**
A.Zalewski@ia.pw.edu.pl

*M.Sc. 1997, Ph.D. 2003 from WUT.*

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.

**Cezary Zieliński** Professor (Director of the Institute, Leader of the Group)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 518A, tel. 22 234 5102**
C.Zielinski@ia.pw.edu.pl, www.ia.pw.edu.pl/~zielinsk

*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). Senior Member of IEEE (2002–). 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–). 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.

**Izabela Żółtowska** Assistant Professor

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 554, tel. 22 234 7648**
I.Zoltowska@elka.pw.edu.pl, home.elka.pw.edu.pl/~imilenko

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

With WUT since 2005.

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

## 2.3 Supporting Faculty and Staff

**Konrad Banachowicz** Software Engineer

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 012, tel. 22 234 7117**
konradb3@gmail.com

*M.Sc from WUT.*

With WUT since 2014.

**Jan Mikołaj Figat** Software Engineer (part time)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 571, tel. 22 234 7861**
J.Figat@stud.elka.pw.edu.pl,methill@gmail.com

*M.Sc from WUT.*

With WUT since 2014.

**Maksym Figat** Software Engineer (part time)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 571, tel. 22 234 7861**
M.Figat@stud.elka.pw.edu.pl,maksym.figat44@gmail.com

*M.Sc from WUT.*

With WUT since 2014.

**Jarosław Hurkała** Software Engineer (part-time)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 563, tel. 22 234 7124**
jhurkala@gmail.com

*M.Sc from WUT.*

With WUT since 2013.

**Włodzimierz Macewicz** Senior Software Engineer

**Control and Software Engineering Division, Software Engineering Group**
**room 525, tel. 22 234 7699**
W.Macewicz@ia.pw.edu.pl

*M.Sc. from WUT.*

With WUT since 1983.

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

**Maciej Stefańczyk** Software Engineer (part time)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 032, tel. 22 234 5842**
M.Stefanczyk@ia.pw.edu.pl, stefanczyk.maciek@gmail.com

*M.Sc. from WUT.*

With WUT since 2013.

**Michał Walęcki** Software Engineer (part time)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 012, tel. 22 234 7117**
mw@mwalecki.pl, M.Walecki@elka.pw.edu.pl

*M.Sc from WUT.*

With WUT since 2010.

*Interests:* Design of microprocessor-based control and measurement systems, automatic control.

## 2.4 Ph.D. Students

**Patryk Józef Chaber** Ph.D. Student (since March 2014)

**Control and Software Engineering Division, Control Engineering Group**
**room 563, tel. 22 234 7124**
pjchaber@gmail.com

*Supervisor:* Maciej Ławryńczuk

**Krzysztof Daniluk** Ph.D. Student

**Systems Control Division, Complex Systems Group**
**room 573, tel. 22 234 7126**
k.daniluk@stud.elka.pw.edu.pl

*Supervisor:* Ewa Niewiadomska-Szynkiewicz

**Piotr Hubert Ekes** Ph.D. Student (until Oct. 2014)

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 571, tel. 22 234 7861**
ekes.piotr@gmail.com

*Supervisor:* Włodzimierz Kasprzak

**Jan Mikołaj Figat** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 571, tel. 22 234 7861**
J.Figat@stud.elka.pw.edu.pl, methill@gmail.com

*Supervisor:* Włodzimierz Kasprzak

**Maksym Figat** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 571, tel. 22 234 7861**
M.Figat@stud.elka.pw.edu.pl,maksym.figat44@gmail.com

*Supervisor:* Cezary Zieliński

**Weronika Gutfeter** Ph.D. Student

**Systems Control Division, Biometrics and Machine Learning Group**
**room 558/559, tel. 22 234 7805**
W.Gutfeter@stud.elka.pw.edu.pl,gutfeter@wp.pl

*Supervisor:* Andrzej Pacut

**Adam Jan Hurkała** Ph.D. Student

**Control and Software Engineering Division, Software Engineering Group**
**room 563, tel. 22 234 7124**
AHurkala@gmail.com

*Supervisor:* Krzysztof Sacha

**Jarosław Hurkała** Ph.D. Student

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room 563, tel. 22 234 7124**
JHurkala@gmail.com

*Supervisor:* Włodzimierz Ogryczak

**Tomasz Jastrzębski** Ph.D. Student

**Operations and Systems Research Division, Operations Research and Management Systems Group**
**room 526, tel. 22 234 7125**
t_jastrzebski@gazeta.pl,t.jastrzebski@stud.elka.pw.edu.pl

*Supervisor:* Eugeniusz Toczyłowski

**Radian Karpuk** Ph.D. Student

**Operations and Systems Research Division, Operations Research and Management Systems Group**
**room 526, tel. 22 234 7125**
R.Karpuk@stud.elka.pw.edu.pl,radian.karpuk@gmail.com

*Supervisor:* Eugeniusz Toczyłowski

**Szymon Kijas** Ph.D. Student

**Control and Software Engineering Division, Software Engineering Group**
**room 563, tel. 22 234 7124**
S.Kijas@ia.pw.edu.pl

*Supervisor:* Krzysztof Sacha

**Jan Kurnatowski** Ph.D. Student

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

*Supervisor:* Eugeniusz Toczyłowski

**Mateusz Mariusz Krzysztoń** Ph.D. Student (since Oct. 2014)

**Systems Control Division, Complex Systems Group**
**room ?, tel. ?**
mateusz.krzyszton@gmail.com

*Supervisor:* Ewa Niewiadomska-Szynkiewicz

**Krzysztof Lasota** Ph.D. Student

**Systems Control Division, Complex Systems Group**
**room 573a, tel. 22 234 7860**
K.Lasota@ia.pw.edu.pl

*Supervisor:* Ewa Niewiadomska-Szynkiewicz

**Tomasz Leś** Ph.D. Student

**Control and Software Engineering Division, Software Engineering Group**

*Supervisor:* Krzysztof Sacha

**Piotr Modliński** Ph.D. Student

**Operations and Systems Research Division**
**Operations Research and Management Systems Group**
**room 526, tel. 22 234 7125**
P.Modlinski@ia.pw.edu.pl

*Supervisor:* Eugeniusz Toczyłowski

**Anna Mościcka** Ph.D. Student

**Operations and Systems Research Division, Optimization and Decision Support Group**
A.Moscicka@stud.elka.pw.edu.pl

*Supervisor:* Włodzimierz Ogryczak

**Paweł Olender** Ph.D. Student

**Operations and Systems Research Division, Optimization and Decision Support Group**
P.Olender@stud.elka.pw.edu.pl

*Supervisor:* Włodzimierz Ogryczak

**Jan Piotr Olszak** Ph.D. Student (until Oct. 2014)

**Systems Control Division, Biometrics and Machine Learning Group**
janekolszak@gmail.com,j.olszak@stud.elka.pw.edu.pl

*Supervisor:* Andrzej Pacut

**Bartosz Kazimierz Papis** Ph.D. Student (until Oct. 2014)

**Systems Control Division, Biometrics and Machine Learning Group**
**room 560, tel. 22 234 7120**
B.Papis@stud.elka.pw.edu.pl

*Supervisor:* Andrzej Pacut

**Krzysztof Piech** Ph.D. Student

**Systems Control Division, Biometrics and Machine Learning Group**
**room 560, tel. 22 234 7120**
K.Piech@stud.elka.pw.ediu.pl,kpiech.work@gmail.com

*Supervisor:* Andrzej Pacut

**Wojciech Pikulski** Ph.D. Student

**Control and Software Engineering Division, Software Engineering Group**
W.Pikulski@ia.pw.edu.pl

*Supervisor:* Krzysztof Sacha

**Adam Połomski** Ph.D. Student (until Feb. 2014)

**Operations and Systems Research Division, Optimization and Decision Support Group**
A.Polomski@elka.pw.edu.pl

*Supervisor:* Włodzimierz Ogryczak

**Paweł Przybysz** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 563, tel. 22 234 7124**
P.Przybysz@ia.pw.edu.pl

*Supervisor:* Włodzimierz Kasprzak

**Michał Przyłuski** Ph.D. Student

**Operations and Systems Research Division, Optimization and Decision Support Group**
M.Przyluski@ia.pw.edu.pl

*Supervisor:* Włodzimierz Ogryczak

**Michał Romanowski** Ph.D. Student

**Control and Software Engineering Division, Software Engineering Group**

*Supervisor:* Krzysztof Sacha

**Dawid Seredyński** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 571, tel. 22 234 7861**
dawid.seredynski@gmail.com,d.seredynski@stud.elka.pw.edu.pl

*Supervisor:* Cezary Zieliński

**Kamil Sędrowicz** Ph.D. Student

**Operations and Systems Research Division, Operations Research and Management Systems Group**
**room 526, tel. 22 234 7125**
kamil.sedrowicz@gmail.com

*Supervisor:* Eugeniusz Toczyłowski

**Katarzyna Siudek** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 563, tel. 22 234 7124**
katarzyna.siudek@gmail.com

*Supervisor:* Włodzimierz Kasprzak

**Maciej Stefańczyk** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 032, tel. 22 234 5842**
M.Stefanczyk@ia.pw.edu.pl,stefanczyk.maciek@gmail.com

*Supervisor:* Włodzimierz Kasprzak

**Maciej Szumski** Ph.D. Student

**Control and Software Engineering Division, Control Engineering Group**
**room 567, tel. 22 234 7673**
M.Szumski@ia.pw.edu.pl

*Supervisor:* Piotr Tatjewski

**Karol Szymański** Ph.D. Student (since March 2014 until Oct. 2014)

**Operations and Systems Research Division, Operations Research and Management Systems Group**
**room ?, tel. ?**

*Supervisor:* Krzysztof Pieńkosz

**Mateusz Michał Trokielewicz** Ph.D. Student (since Oct. 2014)

**Systems Control Division, Biometrics and Machine Learning Group**
**room 558/559, tel. 22 224 7805**
`M.Trokielewicz@stud.elka.pw.edu.pl`

*Supervisor:* Andrzej Pacut

**Michał Walęcki** Ph.D. Student

**Systems Control Division, Robot Programming and Pattern Recognition Group**
**room 012, tel. 22 234 7117**
`M.Walecki@ia.pw.edu.pl`

*Supervisor:* Cezary Zieliński

**Marcin Andrzej Wasilewski** Ph.D. Student (since March 2014)

**Control and Software Engineering Division, Software Engineering Group**
**room 563, tel. 22 234 7124**
`marcin\_wasilewski@wp.pl`

*Supervisor:* Krzysztof Sacha

**Andrzej Wojtulewicz** Ph.D. Student (since Oct. 2014)

**Control and Software Engineering Division, Control Engineering Group**
**room 563, tel. tel. 22 234 7124**
`?, ?`

*Supervisor:* Maciej Ławryńczuk

**Antoni Wysocki** Ph.D. Student

**Control and Software Engineering Division, Control Engineering Group**
**room 563, tel. 22 234 7124**

*Supervisor:* Piotr Tatjewski

**Grzegorz Maksymilian Zalewski** Ph.D. Student (since Oct. 2014)

**Operations and Systems Research Division, Optimization and Decision Support Group**
**room ,** `zaleszczako@gmail.com`

*Supervisor:* Włodzimierz Ogryczak

## 2.5 Administrative and Technical Staff

**Teresa Bortkiewicz** Manager, Finances (until Nov. 2014).

**room 556, tel. 22 234 6096**
`T.Bortkiewicz@elka.pw.edu.pl`

**Elżbieta Matyjasiak** Secretary, Main office.

**room 521, tel. 22 234 7397, 22 825 0995**
`E.Matyjasiak@ia.pw.edu.pl`

*M.Sc. 2002 from Warsaw School of Management and Marketing.*

**Jolanta Niedbało** Office support.

**room 521, tel. 22 234 7397**
`J.Niedbalo@ia.pw.edu.pl`

**Agnieszka Paprocka** Finances support.

**room 556, tel. 22 234 7122**
`A.Paprocka@ia.pw.edu.pl`

*M.Sc. 2008 from Cardinal Stefan Wyszyński University in Warsaw.*

**Sylwia Piskorska** R&D Specialist.

**room 530, tel. 22 234 6156**
`S.Piskorska@elka.pw.edu.pl`

*M.Sc. 2012 from Technical University of Gdańsk.*

**Dodota Podniesińska** Menager finances (since Sep. 2014).

**room 556, tel. 22 234 7122**
`D.Podniesinska@elka.pw.edu.pl`

*M.Sc. 2007 The M.Skłodowska-Curie Warsaw Academy*

**Agnieszka Słojewska** Finances specialist.

**room 556, tel. 22 234 6096**
`A.Slojewska@ia.pw.edu.pl`

*baccalaureate 2005 from Leon Kozmiński Academy of Entrepreneurship and Management*

**Alicja Trojanowska** Secretary, Student affairs.

**room 22, tel. 22 234 7750**
`A.Trojanowska@ia.pw.edu.pl`

*baccalaureate 2012 from WUT.*

**Beata Woźniak** Manager, Administration.

**room 521a, tel. 22 234 7397**
`B.Wozniak@ia.pw.edu.pl`

*M.Sc. 1993 from Warsaw University.*

# 3 Teaching Activities – Academic Year 2013/2014

## 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 (fall) |
| Administration of UNIX and TCP/IP | ASU | 2 – 1 – | OSK,OT, MERJ | J.Sobczyk (spring/fall) |
| Algorithms and Data Structures | AISDI | 2 – 1 – | sem.3 | A.Zalewski (spring) |
| Artificial Intelligence | EAI | 2 – – – | ANGL, OT | W Kasprzak (spring) |
| Artificial Intelligence Methods | MSI | 2 – – 1 | ISO, PZ-P OT, PZ | W Kasprzak (spring) |
| Fundamental of Automatics | PODA | 2 – 1 – | PSTER, OT, PSYIA | P.Tatjewski (spring) K.Malinowski (fall) |
| Biometric Identity Verification | BIT | 2 – 1 – | OT, SIDJ,PP-SID | A.Czajka (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 | W Kasprzak (fall) |
| Control | ECONT | 2 1 1 – | ANGL, OT | P.Domański (spring/fall) |
| Data Bases 2 | BD2 | 2 – – 1 | BDSI, OT, SIDJ, PP-SID | T.Traczyk (fall) |
| Decisions in Competition Environment | DWW | 2 – – 1 | | A.Woźniak (spring) |
| 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 | EDYSY | 2 – 2 – | ANGL, OT | M.Ławryńczuk, (spring) P.Marusak (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) G.Płoszajski (fall) |
| Fundamentals of Optimization | POPTY | 2 – 2 – | MKPWD, OT, PP-SID | A.Stachurski (spring/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 | J.Putz-Leszczyńska (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) |
| 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) |
| Management IT Systems | SIZ | 2 – – 2 | MKPWD, OT, SWDJ | J.Granat (spring/fall) |
| Mobile Robots | EMOR | | ANGL, ECETC, OT | W.Szynkiewicz (spring) |
| Modeling and Control of Manipulators | EMOMA | 3 1 – – | Emaro | C.Zieliński (fall) |
| Operating System | EOPSY | 2 1 1 – | ANGL, OT | T.Kruk (fall) |
| Optimization Techniques | EOPT | | Emaro | W.Ogryczak (spring) |

| **Course Title** | **Course code** | **Hours per week** | **Class** | **Lecturer** |
|---|---|---|---|---|
| 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) |
| Principles of Computer Science | EPCOS | 2 – – – | ANGL, OT | W.Kasprzak (fall) |
| Process Control | STP | 2 1 1 – | OT, PSTER | M.Ławryńczuk (fall) |
| Process Management and Scheduling | ZAH | 2 – 2 – | MKPWD, OT, MUS, PP-SID, SWDJ | E.Toczyłowski (spring/fall) |
| Programmable Controllers | SP | 2 – 1 – | MUS, OT, METJ | J.Gustowski (spring/fall) |
| Real-time Systems | ERTS | 2 – – 1 | EMARO | B.Kubica (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 |
| Synthesis of Decision Rules | SRD | 2 – 2 – | MKPWD, OT, PP-SID, SIDJ | K.Malinowski (spring) |
| System Architecture and Integration | AIS | 2 – 1 – | PZ-OWJ, PZ-OTI | A.Ratkowski (spring/fall) |
| Programming Fundamentals | EPFU | 2 1 1 – | ANGL, OT | M.Kaleta (spring/fall) |
| Distributed Operating Systems | RSO | 2 – 1 – | PZ-OWJ, PZ-SID, OT | T.Kruk (spring) |
| Intelligent Robotic System | ISR | 2 – 1 – | PZ-AIR, PZ-OWJ, PZ-SID, PZ-A, OT | C.Zieliński (fall) |
| Object Programming | PROI | 2 – 2 – | MPRIA, OT | M.Warchoł (fall) |
| Modelling and Identification | MODI | 2 1 – 1 | PODAA, PZ-AIR, OT | A.Woźniak (fall) |
| Neural Networks | SNR | 2 – – 2 | PZ-OTJ, PZ, OT | A Pacut (fall) |
| Automation and Robotics Equipment | APA | 2 – 1 – | PODAA, OT | T.Winiarski (spring) |
| Networks and Systems Control | SST | 2 – – 1 | PZ-AIR, PZ-A, PZ, OT | K.Malinowski (spring) |
| Advanced Process Control Techniques | TAP | 2 – – 2 | PZ-AIR, PZ-A, PZ, OT | P.Tatjewski (spring) |

## 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 **Engineering of Management Information Systems and Decision Support Systems** are intended for IT specialists, who want to broaden their skills in field of MIS and DSS. The programme contains: management information systems (with special attention on SAP system and ABAP language), modeling of processes and data structures, engineering of information systems, decision support and business intelligence systems, data management systems, aplications of MIS and DSS (including service science and MRP). The classes take form of lectures and laboratories.

Postgraduate studies **IT Systems Security and Biometrics** are aimed at providing knowledge related to the most important aspects of IT systems security, in particular including access control, physical security, cryptography, applications and operational security, biometrics, security evaluation and certification, security management and auditing, as well as legal, ethical and social aspects of biometrics and security. Lectures are supplemented by laboratory classes, organized in recently renewed Biometrics and Machine Learning Laboratory, lavishly equipped with topical biometric systems, measurement devices and software.

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: 01.12.2013–30.11.2016.

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).

Project coordinator from WUT: Cezary Zieliński.

Investigators from WUT: Wojciech Szynkiewicz, Włodzimierz Kasprzak, Tomasz Michał Kornuta, Tomasz Winiarski, Michał Walęcki, Maciej Stefańczyk.

Aim of the project: RAPP (Robotic Applications for Delivering Smart User Empowering Applications) will provide a software platform in order to support the creation and delivery of robotics applications (RAPPs) targeted to people at risk of exclusion, especially older people. The open-source software platform will provide 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 stack with added functionalities suitable for different kinds of robots. RAPP will expand the computational and storage capabilities of robots and enable 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 will assist developers is creating improved applications for different types of robots that target to 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 will be 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.

Expected results: Provide an infrastructure for developers of robotic applications, so they can easily build and include machine learning and personalization techniques to their applications Create a repository, from which robots can download Robotic Applications (RApps) and upload useful monitoring information Develop a methodology for knowledge representation and reasoning in robotics and automation, which will allow unambiguous knowledge transfer and reuse among groups of humans, robots, and other artificial systems Create RApps based on adaptation to individuals and taking into account the special needs of elderly people, while respecting their autonomy and privacy Validate 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] NCBiR Grant No. DOBR/0071/R/ID1/2012/03: **Development of a system enabling digitization, long-term storage, management and making available in secure electronic form of documents and archival materials**.
Granting period: 20.12.2012–19.12.2014.
Principal investigator: Tomasz Piotrowski (NASK)
Principal investigator from WUT: Ewa Niewiadomska-Szynkiewicz, Adam Kozakiewicz.
Investigators: Mariusz Kamola, Paweł Szałachowski, Krzysztof Daniluk.

Aim of the project: Development of a modern, fully functional solution supporting the process of digitization, long-term archivization and secure access to classified documents. Detailed goals: preparation of procedures for the process of digitization of documents and archival materials: research and deployment of hardware-software solutions supporting the process of digitization, design and development of a system supporting the process of digitization automating the acquisition of metadata of the digitized objects, implementation of a system with the functionality of a long--term storage archive with advanced mechanisms for making available, searching and access control, design and practical exploitation in the developed software of methods for secure storage of digital content employing advanced cryptographical algorithms, preparation of a long-term storage policy, encompassing the issues of medium and data format migration, implementation of methods and algorithms ensuring authenticity and integrity od both individual resources and the archive as a whole, preparation and execution of integration of the developed system with existing systems for flow, processing and storage of documents and digital resources, design of rooms for hardware infrastructure for digitization and storage of classified documents and digital materials, design and extension of workstations and network for sharing of classified archival documents and archival materials, testing and demonstration of the prototype of the system in operational conditions, training of the system's users.

Expected results: The planned final result of the project will be the development of a complete hardware-software solution supporting the process of digitization, long-term archiving and secure sharing of documents, ready to be deployed in all institutions maintaining archives of classified documents and complying with all regulations applicable to this kind of archives. The software developed as part of the project will comprise of the following elements: a module supporting the process of digitization, automating the acquisition of metadata of the objects being digitized, a module providing the function of a long-term storage archive, equipped with advanced sharing, search and access control mechanisms, a module integrating the archive with existing document and digital materials flow, processing and storage systems. Digitization support will include both the ability of selective entry of individual documents and mass import. This will make the system capable of fast data import on startup as well as regular entry of newly created documents. The main characteristics of the module implementing the function of a long-term storage archive will include: support for execution of procedures specified in the protection of classified information act regarding periodic review of stored classified materials, security of stored data, ability to retrieve the complete history of documents, ability to search the archive based on both metadata values and document content, capability of remote access to any group of documents, following the security policies in force, scalability and stability.

Keywords: digitization, archiving, long-term storage, classified documents, cryptography.

[PR3] NCBiR Project No. PBS1/A3/8/2012: RobREx: **Autonomy for rescue and exploration robots**. Granting period: 12.12.2012–30.11.2015.
Partners: Industrial Research Institute for Automation and Measurements – PIAP, Warsaw University of Technology, Łódź University of Technology, Wrocław University of Technology, Poznań University of Technology, Institute of Computer Science of the Polish Academy of Sciences. Principal investigator from WUT: Cezary Zieliński.

Investigators: Włodzimierz Kasprzak, Wojciech Szynkiewicz, Tomasz Winiarski, Tomasz Kornuta, Michał Walęcki, Maciej Stefańczyk.

Aim of the project: Development of technologies enabling the creation of autonomous robots, specifically for rescue and exploration tasks. Current rescue and exploration robots (RERs), including those manufactured by PIAP, are teleoperated, what significantly limits their operating range and requires constant human supervision. The conducted market analysis shows that in the near future the demand for autonomous devices will dominate. The goal of the project is to produce a set of technologies and an adequate architecture necessary for the production of autonomous RERs, or in general service and field robots. In particular, the project will deliver technologies enabling: perception of the environment; navigation and control of mobile platforms and manipulators; impedance control of manipulators and grippers; intelligent two-handed manipulation; active sensing and the use of ontology common to people and robots. The results will be demonstrated on two robots: a mobile manipulator SCOUT/GRYF manufactured by PIAP and a two-handed robot manipulator. The team from the Institute of Control and Computation Engineering of the Faculty of Electronics and Information Technology of Warsaw University of Technology is responsible for creation of technologies for intelligent two-handed manipulation and active sensing.

Expected results: A set of technologies enabling the creation of autonomous robots, specifically for rescue and exploration tasks.

Keywords: rescue robots, exploration robots, robot autonomous behaviors, two-handed manipulation, active sensing, perception

[PR4] NCN grant No N N514 672940: **Methods and tools for ad hoc network design and control**.
Granting period: 04.04.2011–03.04.2014.
Principal Investigator: Ewa Niewiadomska-Szynkiewicz.
Investigators Krzysztof Malinowski, Andrzej Sikora, Michał Marks, Mariusz Kamola, Piotr Arabas, Adam Woźniak, Krzysztof Daniluk, Krzysztof Lasota.

Aim of the project: The ad hoc networking is an ultimate technology in wireless communication that allows wireless devices located within their transmission range to communicate directly to each other without the need for established fixed network infrastructure. It is a new area of research that has become extremely popular over the last decade and is rapidly increasing its advance into different areas of technology. Ad hoc networks are growing rapidly in both size and complexity, and it is becoming increasingly difficult to develop and investigate such large and complex systems. The project concerns the important problems related to ad hoc networks design and development. Two types of networks are considered: WSN – Wireless Sensor Networks and MANET ℓ Mobile Ad hoc Networks. The focus is on three key aspects of the design: accurate localization of devices that form a network, reliable and energy aware inter-node communication and managing the mobility of an ad hoc network. The main goal of the project is to design and develop new methods, algorithms and protocols for ad hoc network applications. The second objective is to develop a software tool for ad hoc networks simulation and create laboratory for testing solutions for wireless sensor networks.

Expected results: The project will deliver novel protocols for reliable and energy-aware inter-node communication and the localization system for calculating the geographic position of devices that form a network. The effectiveness of both new solutions will be tested through simulation and in a testbed network. A comprehensive approach for design of cooperative, fully connected self-organizing networks will be provided. The novel algorithm for efficient calculating of motion trajectories for wireless devices will be developed and evaluated. Moreover, the software platform for parallel and distributed simulation, and computer-aided design of self-organizing mobile networks will be delivered. Finally, the wireless sensor network laboratory will be built in which demonstration tests will be conducted. The results of the project will be described in the research papers, a book devoted to ad hoc network design and development, and presented on conferences. Both network simulator and WSN laboratory will be used for research and education.

Keywords: ad hoc network, wireless sensor network (WNS), MANET, localization system, mobility model, topology control, energy-efficient communication, optimization, simulation.

[PR5] NCBiR Grant No. POIG.01.03.01–00–071/12: **Development and construction of the controller for the air-water heat pump**, Project financed from EU funds within the Operational Program Innovative Economy (POIG).

Granting period: 01.04.2013–31.03.2015.

Coordinator: Warsaw University of Technology. Partner: Plum Sp. z o.o.

Project coordinator from WUT: Piotr Tatjewski.

Investigators from WUT: Piotr Marusak, Maciej Ławryńczuk, Marian Rubik, Piotr Ziętek.

Aim of the project: Development of the industrial feedback controller for air-water heat pumps, maximizing operation efficiency. The problem is of economic and also ecological importance, leading to reduction of usage of conventional energy sources. The control of air-water heat pumps is more difficult than other types of heat pumps (ground-water or water-water pumps), due to significant changes of air temperature and humidity, including also frost effects during winter. The following tasks are planned within the grant: detailed development of design specifications to be achieved, construction and identification of adequate models of the heat pump, development of feedback control algorithms with special focus on adaptive and predictive-type algorithms, development of the control algorithms and supervisory optimization for cascade structure of heat pumps, verification of constructed controllers, preparation of tuning procedures. The design of a multivariable controller is planned (with two input and two output variables).

Expected results: Feedback control algorithms for air-water heat pumps, including cascade configuration of pumps, are to be developed. Measurements, model verification and controller implementation and testing will be carried out on a research stand constructed by the industrial partner, the Plum company. The industrial partner will develop and implement to production the industrial microprocessor based controller for the air-water heat pumps, implementing the designed algorithms.

Keywords: renewable energy, air-water heat pump, model identification, feedback control, microprocessor control.

[PR6] NCBiR Grant No. POIG.01.03.01–14–076/12: **Decision Support System for Large-Scale Periodic Vehicle Routing and Scheduling Problems with Complex Constraints.**

Project financed from EU funds within the Operational Program Innovative Economy (POIG).

Granting period: 23.05.2013–30.06.2015.

Coordinator: Warsaw University of Technology. Partners: SMT Software S.A. Wrocław.

Project coordinator from WUT: Włodzimierz Ogryczak.

Principal Investigators from WUT: Tomasz Śliwiński, Jarosław Hurkała, Mariusz Kaleta, Piotr Pałka.

Aim of the project: Development of algorithms for large-scale periodic time-dependent vehicle routing and scheduling problems with complex nonuniform constraints with respect to frequency, time windows, working time, etc. With additional fast adaptive procedures for operational rescheduling of plans in presence of various disturbances. Application of algorithms within a system supporting planning and management of mobile personnel (sales representatives and others).

Expected results: Advanced decision support system for large-scale periodic time-dependent vehicle routing and scheduling problems with complex constraints supporting planning and management of mobile personnel tasks.

Keywords: decision support, optimization, vehicle routing, scheduling, algorithm.

[PR7] NCBiR Grant DEMONSTRATOR+ No. WND–DEM–1–385/00: **Digital Document Repository CREDO.**

Granting period: 01.11.2013–31.03.2016.

Coordinator: Polska Wytwórnia Papierów Wartościowych. S.A, Partners: Warsaw University of Technology, Skytechnology sp. z o.o.

Principal investigator from WUT: Tomasz Traczyk.

Investigators from WUT: Grzegorz Płoszajski, Bartosz Kozłowski, Piotr Pałka.

Aim of the project: The goal of the CREDO project is to design and launch a demonstrative version of a digital repository enabling short- and long-term archiving of large volumes of digital resources. By design the repository is to act both as a secure file storage and as a digital archive providing metadata management and including the resources in archival packages.

Expected results: One of the system's primary functions will be the support for various currently available data carriers: hard drives, solid state drives, tapes. The repository will ensure a high level of security for the information stored through, among other things, advanced access rights management methods and the capability to encrypt the resources stored. Reliability of information readouts will be ensured by the data recording replication mechanisms in the repository's file system, as well as the distributed nature of the system that will enable storing copies of the resources in more than one locations. The repository's architecture will be multi-tiered and it will enable (together with the emergence of new technologies) replacement and continuous upgrades of the individual components. This solution has been designed for institutions that store large digital resources for long periods of time, e.g. cultural institutions, mass media, state administration offices, and health care institutions. The system designed is to have the features of a product ready to be offered to users.

Keywords: digital resources, long-term archiving, long-term storage, metadata.

[PR8] NCN OPUS Grant No. 2012/07/B/HS4/03076: **Construction of robust investment portfolios by means of the generalized ordered weighted averages.**

Granting period: 01.07.2013–30.06.2016.

Principal investigator: Włodzimierz Ogryczak.

Investigators: Adam A. Krzemienowski, Tomasz Śliwiński, Michał Przyłuski, Jarosław Hurkała.

Aim of the project: The basis of the portfolio selection is to determine the share of each financial asset. From a mathematical point of view, this issue boils down to portfolio optimization. This is a typical optimization problem solved by the Markowitz method, which maximizes the expected rate of return and minimizes risk defined as the variance. The assumptions of the Markowitz model should ensure that the optimal portfolios are stable over time, i.e., they should be characterized by the absence of fluctuations in their shares, or in other words, the risk and the expected return should correspond to those estimated from the historical data. In practice, these assumptions are not met. The aim of the project is to develop and analyze a new method that selects robust portfolios, stable over time in terms of their composition for the assumed set of financial assets. The method is supposed to bring out-of-sample results no worse than in-sample results for some performance measures for a given tolerance level.

Expected results: Development and analysis of a portfolio optimization procedure suited for risk measures consistent with the axiomatic models for choice under risk. One of the scientific objectives of the project is to develop and analyze risk measures based on the generalized ordered weighted average operators with reach preference modeling capabilities. There is also planned to develop and empirically analyze efficient algorithms for portfolio optimization models incorporating developed risk measures. In particular, the performance of the risk measure called Multivariate Conditional Value-at-Risk (MCVaR) applied to a portfolio optimization problem with the multivariate robust distribution.

Keywords: portfolio optimization, portfolio mangement, financial engineering, operations research, robustness, risk, decision support.

[PR9] NCN SONATA Grant No. 2012/05/D/ST6/03097: **Methodology of design and implementation of multi-sensory robotic systems for service purposes.**

Granting period: 01.02.2013–31.01.2016.

Principal investigator: Tomasz Winiarski.

Investigators: Cezary Zieliński, Tomasz Kornuta, Michał Walęcki, Maciej Stefańczyk, Łukasz Żmuda, Konrad Banachowicz, Dawid Seredyński, Karol Katrżawa, Michał Laszkowski.

Aim of the project: The aim of the research is to develop a method of design and implementation of intelligent service robots. It has been established that in order to execute the tasks formerly exclusively performed by humans, such a system requires sensors corresponding to human senses such as sight and perception of force as well as appropriate processing algorithms. In this project we focus on developing the algorithms and the technology necessary for creating a working robotic system, able to locate and classify objects, generate an appropriate plan of approaching those objects and, in the final phase, their classification and manipulation using appropriate tool assuming that the object have internal degrees of freedom.

Expected results: The societies of developed countries have been prospering for many years, but at the same time they have to face the problem of aging. In consequence, there is a great demand for services for people (especially elders), but those services are invariably time-consuming, and involving other people. It's arguable whether acquiring cheap workforce is a solution to that problem. An alternative solution is automating the work formerly done by economic emigrants. This challenge has been taken by roboticists who developed service robotics. Their work resulted in creating vacuuming or lawn-mowing robots. However, commercially built robots do not have manipulation skills which are essential to performing useful tasks in human environment. The proposed research project focuses on manipulation and developing technologies for aiding manipulation (such as multi-sensory perception). This remains in agreement with current trends in service robotics while at the same time attempting to evolve it in a direction that is arguably crucial.

Keywords: robotics, manipulation, control systems.

[PR10] Industrial research agreement No. 501/E/1031/112 with SORTER SJ: **Fruit sorting robot controller.**

Granting period: 10.06.2013–30.06.2015.

Principal investigator: Cezary Zieliński.

Investigators: Włodzimierz Kasprzak, Wojciech Szynkiewicz, Tomasz Winiarski, Tomasz M. Kornuta, Michał Walęcki, Maciej Stefańczyk, Dawid Seredyński.

Aim of the project: Design of the robot controller and the creation of a programming language, in which the user will be able to express the task that the robot has to execute.

Expected results: The robot will be controlled using position-force mode, utilizing trajectory generation both in operational and configuration space. It will have separate perception units, effector control drivers and a control subsystem responsible for edition and interpretation of the user program (task).

Keywords: universal robot controller, fruit sorting robot.

[PR11] Industrial research agreement No. 501/E/1031/0113 with SORTER SJ: **Vision based fruit inspection and sorting.**

Granting period: 10.06.2013–31.12.2014.

Principal investigator: Włodzimierz Kasprzak.

Investigators: Cezary Zieliński, Wojciech Szynkiewicz, Tomasz Winiarski, Tomasz Michał Kornuta, Michał Walęcki, Maciej Stefańczyk, Piotr Pałka.

Aim of the project: The project concentrates on the vision subsystem, which will cooperate with the aforementioned robot controller. The vision subsystem should evaluate the quality and an optimal grasp location of a fruit (e.g. an apple) being transferred by a conveyor. Low grade fruits should be discarded, while those of appropriate quality should be grasped in such a way that they can be placed in the box with the most attractive side facing the top (e.g. in the case of multi-coloured apples, the red side should face the top).

Keywords: universal robot controller, vision system, fruit sorting robot.

[PR12] Statutory Grant No. 504G036300: **Development of methodology of control, decision support and production management**.
Granting period: 28.03.2013–31.10.2014 and 19.05.2014–31.10.2015.
Principal investigators: Ewa Niewiadomska-Szynkiewicz, Andrzej Pacut, Włodzimierz Ogryczak, Krzysztof Sacha, Piotr Tatjewski, Eugeniusz Toczyłowski, Cezary Zieliński.

[PR13] Rector's Grant No. 540020200082 **Bionikalia 2014 robotic tournament.**

Granting period: 14.05.2014–31.12.2014.

Principal investigator: Tomasz Winiarski.

Aim of the project: The aim of the project was to plan and perform robotic competition "Bionikalia 2014". There were two concurrencies planed, basing on the LEGO bricks: Sumo and follow the line.

Expected results: There were tens of teams from the whole Poland participating in the show. The organizers gathered valuable skills, both in performance organization and interpersonal interaction.

Keywords: Lego robots, follow the line robots, sumo robots.

[PR14] Dean's Grant No. 504/01446/1031 **Tools for generation of three-dimensional models of objects for the purpose of perception of service robots.**

Granting period: 28.06.2014–31.12.2014.

Principal investigator: Tomasz Michał Kornuta.

Aim of the project: The aim of the work was to develop algorithms and tools enabling generation of three-dimensional models of objects. The main achievement of the grant is developement of methods and algorithms enabling combination of cloud of points into three-dimensional models of objects. We purchased sensors for acquisition of views in the form of RGB-D images, prepared a rotating board on which objects can ber put during the acquisition of the the collection of views and implemented algorithms for determination of the board poses wrt sensor and for extraction of object masks. To store the models and views of objects and scenes we used a non-relational database MongoDB and developed interfaces between the database and DisCODe programming framework. We also implemented a web client enabling to access the database through web browsers.

Expected results: The main achievement of the grant is developement of methods and algorithms enabling combination of cloud of points into three-dimensional models of objects. We purchased sensors for acquisition of views in the form of RGB-D images, prepared a rotating board on which objects can ber put during the acquisition of the the collection of views and implemented algorithms for determination of the board poses wrt sensor and for extraction of object masks. To store the models and views of objects and scenes we used a non-relational database MongoDB and developed interfaces between the database and DisCODe programming framework. We also implemented a web client enabling to access the database through web browsers.

Keywords: Robot perception, computer vision, point clouds, three-dimensional models of objects, point-cloud registration, ICP, mongoDB.

[PR15] Dean's Grant No. 504/01444/1031: **Automatic clustering of handwritten historical documents.**

Granting period: 09.06.2014–31.12.2014.

Principal investigator: Joanna Putz-Leszczyńska.

Aim of the project: Verification how effective can be automatic clustering by author of handwritten historical documents.The historical archives stores large databases of handwritten documents. very often now scanned and stored in electronic form. There are among them many documents that are not signed or associated with any author, and which link them to other documents existing in the archives facilitate the work of historians.

Expected results: The result of the work would be an algorithm, and is implementation in programing language used to segregate handwritten documents. Author has a collection of approx. 500 letters – secret messages from the Majdanek concentration camp. If the results achieved on this basis will be satisfied, the author plans to start up a cooperation with centres that store historical materials to support their work.

Keywords: Handwritten verification, off-line signature.

[PR16] Dean's Grant No. 504/01445/1031: **Creation of the laboratory equipment for the acquisition of three-dimensional models of objects to be used by object recognition system.**

Granting period: 09.06.2014–31.12.2014.

Principal investigator: Maciej Stefańczyk.

Aim of the project: Creation of the automatic turntable, able to work with objects of daily use. Moreover, preparation of a variety of additional auxiliary elements, like camera lighting and rigs and lighting units itself. Whole system will be integrated with ROS framework and will be able to trigger cameras and lighting.

Expected results: Making of the database containing object images with additional information about their displacement (rotation), read from rotary encoder. This will enable more thorough analysis and removes one of the uncertainty sources, compared to manual data collection.

Keywords: Photography turntable, 3D data acquisition.

[PR17] Dean's Grant No. 504/01689/1031 **Generalized force perception system for Velma service robot.**

Granting period: 03.11.2014–31.10.2015.

Principal investigator: Michał Walęcki.

Aim of the project: The aim of the project is to extend Velma robot control system with acquisition and processing of generalized force. The system will be verified in a task of manually leading a manipulator's end effector with set reduced stiffness and damping.

Expected results: Result of this work will supplement the existing machines and technology, used in research in the field of service robotics by Robot Control and Pattern Recognition Group. This will help in the future to declare and conduct a wide range of research without the time-consuming preparation of the experimental setup.

Keywords: Service robotics, robot, manipulator, force sensing, control system, force control.

[PR18] Research agreement No. 501H/1031/0117 with ZUS: **An expert's opinion concerning the sourcing of the maintenance serviced for computer systems, which supports social security agency in Poland.**

Granting period: 18.02.2014–21.02.2014.

Principal investigator: Andrzej Zalewski.

Aim of the project: An expert's opinion concerning the sourcing of the maintenance serviced for computer systems, which supports social security agency in Poland (ZUS).

[PR19] Research agreement No. 501E/1031/0119 with CMS Cameron: **An opinion for the court proceedings, which concern public procurements of IT systems.**

Granting period: 20.03.2014–28.03.2014.

Principal investigator: Andrzej Zalewski.

Aim of the project: An opinion for the court proceedings, which concern public procurements of IT . On the commission of CMS Cameron McKenna Dariusz Greszta Spółka Komandytowa.

[PR20] Research agreement No. 501210100821 with Sąd Okręgowy w Warszawie, II Wydział Cywilny: **An analysis on the expansion of the scope of the project in the development of document management system commissioned.**

Granting period: 01.12.2014–31.05.2015.

Principal investigator: Andrzej Zalewski.

Aim of the project: An analysis on the expansion of the scope of the project in the development of document management system commissioned by one of the Polish ministries prepared on the commision of district court in Warsaw.

[PR21] Research agreement No. 501E/1031/0120 with Sąd Okręgowy w Warszawie, II Wydział Cywilny: **An analysis on the expansion of the scope of the project in the development of document management system commissioned.**

Granting period: 01.06.2014–10.06.2014.

Principal investigator: Andrzej Zalewski.

Aim of the project: An analysis on the expansion of the scope of the project in the development of document management system commissioned by one of the Polish ministries prepared on the commision of district court in Warsaw.

[PR22] Industrial research agreement No. 501210100824 with Plum Ltd.: **Mathematical modelling, development and validation of adaptive control algorithms in active noise control systems**.

Granting period: 04.11.2013–31.05.2015.

Principal investigator: Piotr Tatjewski.

Investigators: Patryk Chaber, Maciej Ławryńczuk, Piotr Marusak, Antoni Wysocki.

Aim of the project: Reduction of noise generated by fans used in typical ventilation systems. The general objective of the project is to reduce noise generated by fans used in typical ventilation systems in industrial and residential buildings. In order to achieve that objective a mathematical model of the ventilation system has been first developed. Next, a model-based adaptive control algorithm has been developed. Effectiveness of the algorithm has been assessed using a specially designed laboratory ventilation system. The developed algorithm reduces the level of the noise to an acceptable level.

Expected results: Development of a mathematical model of the process, development and validation of an adaptive control algorithm (a noise control algorithm).

Keywords: active noise control, mathematical modelling, adaptive control.

The project is partially financed by Regional Operational Programme for Podlaskie Voivdship for years 2007–2013. (“Active noise control in ventilation systems”, other participants: Plum Ltd., Silesian University of Technology Gliwice).

# 5 Degrees Awarded

## 5.1 Ph.D. Degrees

Advisor: **prof. dr hab. inż. Piotr Tatjewski**

MACIEJ SZUMSKI
*Adaptacyjne algorytmy regulacji predykcyjnej w zastosowaniu do układów wentylacji przeciwpożarowej*
Thesis defended on December 9, 2014

## 5.2 M.Sc. Degrees

Advisor: **Paweł Domański**

M. Więcławski
*Making computations with a graphic control card: modern computation technologies in time series prediction*
Degree awarded on October 2014

Advisor: **Piotr Garbat (IMiO)**

M. Hendiger
*Rekonstrukcja tomograficzna i analiza strumieni cieczy oraz gazów w przestrzeni 3D*
Degree awarded on October 2014

Advisor: **Janusz Granat**

P. Mydłowski (OKNO)
*Analiza modelu substytucji dóbr w łańcuchu dostaw po stronie odbiorcy*
Degree awarded on March 2014

P. Koczkodaj
*Wykorzystanie przetwarzania w chmurze (Cloud Computing) do analizy dużych ilości danych*
Degree awarded on March 2014

P. Łyszczarz
*Wykorzystanie aproksymacji stochastycznej do wykrywania sytuacji nietypowych w strumieniach danych*
Degree awarded on October 2014 (with honors)

K.Sienicki
*Modele wykrywania zmian w strumieniach danych*
Degree awarded on October 2014

M.Michniewicz
*Analiza przestrzenna w wyborze lokalizacji punktów obsługi klienta*
Degree awarded on October 2014

Advisor: **Jerzy Gustowski**

M. Cieślak
*Stanowisko laboratoryjne regulacji ciągłej opartej na serwerze OPC*
Degree awarded on March 2014

Advisor: **Mariusz Kaleta**

M. Olszewski
*Rozwój systemu informatycznego dla aukcji wielotowarowych*
Degree awarded on June 2014

M. Nogala
*Metody impementacji programów na systemach testowych SAP*
Degree awarded on March 2014

J. Wilczak
*Metody integracji zewnętrznych algorytmów harmonogramowania z systemem Microsoft Project 2013*
Degree awarded on March 2014

P. Menio
*Metoda procesowego opisu Agenta i Systemu Agentowego z wykorzystaniem notacji BPMN*
Degree awarded on October 2014

K. Woś
*Język skryptowy w systemie zarządzania projektami - Microsoft Project 2013*
Degree awarded on October 2014

Advisor: **Mariusz Kamola**

J. Krzemień
*Eksploracja i sugerowanie zainteresowań oparte o analizę danych z Facebook Socjal Graph*
Degree awarded on October 2014

Advisor: **Andrzej Karbowski**

A. Kostrzewa
*Dekompozycja i zrównoleglenie mieszanych zadań sterowania optymalnego sieciami wodociągowymi*
Degree awarded on July 2014 (with honors)

Advisor: **Tomasz Kornuta**

M. Pruchniak
*Ekstrakcja cech SIFT z wykorzystaniem OpenCl*
Degree awarded on June 2014

Advisor: **Adam Kozakiewicz**

P. Zawada
*Optymalizacja konfiguracji central klimatyzacyjnych*
Degree awarded on September 2014 (with honors)

Advisor: **Bartosz Kozłowski**

M. Radzikowski
*Wykorzystanie wzorców w procesie modelowania oprogramowania na etapie wytwarzania interfejsu graficznego*
Degree awarded on October 2014

Advisor: **Tomasz Kruk**

D. Jagodziński
*Automatyczna kategoryzacja i wykrywanie treści niedozwolonych*
Degree awarded on September 2014

Advisor: **Artur Krystosik (II)**

T. Żewłakow
*Wykorzystanie metod eksploracji danych statystycznych do zbadania wpływu czynników rankingowych na pozycję strony w wyszukiwarce Google*
Degree awarded on October 2014

Advisor: **Bartłomiej Kubica**

P. Darmofalski
*Porównanie narzędzi do budowy aplikacji RIA*
Degree awarded on March 2014

M. Ptasińska
*Struktury danych w języku UPC i ich wykorzystanie w algorytmie Lanczosa do wyznaczania wartości własnych macierzy*
Degree awarded on March 2014

B. Jurek
*Badanie mechanizmów wysokiej dostępności w OpenStacku i możliwości ich zastosowania na przykładzie projektowania systemu rozliczeniowego*
Degree awarded on October 2014

J. Maciejewski
*Konwenter CUDA do OpenCl z wykorzystaniem technologii kompilacji source - to source*
Degree awarded on October 2014

Advisor: **Maciej Ławryńczuk**

P. Chaber
*System regulacji predykcyjnej*
Degree awarded on February 2014

Advisor: **Wojciech Mazurczyk (TELE)**

M. Karaś (OKNO)
*Steganografia w transmisji wideo usługi SKYPE*
Degree awarded on October 2014

Advisor: **Jacek Naruniec (IRE)**

M. Kowalski
*Detekcja twarzy i jej punktów charakterystycznych w przypadku braku założenia normalizacji pozy*
Degree awarded on February 2014

Advisor: **Ewa Niewiadomska-Szynkiewicz**

A. Szpoton
*Biblioteka algorytmów do analizy sieci społecznych realizowana na platformie GPU*
Degree awarded on March 2014

F. Nabrdalik
*Hierarchiczny protokół bezpiecznej i energooszczędnej transmisji w sieciach sensorowych*
Degree awarded on September 2014

M. Szumielewicz
*Zastosowanie algorytmów SERP I DYMO do bezpiecznej i energooszczędnej transmisji w bezprzewodowych sieciach sensorowych*
Degree awarded on September 2014

Advisor: **Joanna Putz-Leszczyńska**

A. Pranskevicius (OKNO)
*Bezpieczne przechowywanie danych biometrycznych*
Degree awarded on June 2014

Advisor: **Andrzej Ratkowski**

J. Nawalany
*Praktyczne badanie koncepcji semantycznej architektury usługowej*
Degree awarded on October 2014

K. Gawryś
*Zastosowanie architektury SOA w Internecie przedmiotów*
Degree awarded on October 2014

Advisor: **Dominik Ryżko (II)**

S. Szymczyk
*Rozpoznawanie emocji w postach portalu społecznościowego Twitter*
Degree awarded on October 2014

Advisor: **Krzysztof Sacha**

A. Bartnikiewicz
*Tłumaczenie reguł produkcyjnych z języka naturalnego do formatu RIF*
Degree awarded on October 2014

Advisor: **Andrzej Stachurski**

Ł. Bogusz
*Optymalizacja koszyka zakupów w handlu elektronicznym*
Degree awarded on March 2014

Advisor: **Marcin Szlenk**

D. Zieliński
*Automatyczna weryfikacja zgodnści instancji z modelem w języku Alloy*
Degree awarded on April 2014

M. Maj
*Zastosowanie software transactional memory do budowy systemów typu low latency*
Degree awarded on October 2014

Advisor: **Eugeniusz Toczyłowski**

Ł. Owczarz
*Alokacja usług sieciowych w systemach wieloagentowych*
Degree awarded on March 2014

Advisor: **Paweł Wawrzyński**

J. Pawłot
*Uczenie impulsowych sieci neuronowych przez zaburzenie wag*
Degree awarded on March 2014 (with honors)

A. Pilaszkiewicz
*Long Short- Term Memory oraz Echo State Networks w zastosowaniu do zadań prognozowania*
Degree awarded on December 2014

Advisor: **Tomasz Winiarski**

T.Pokorski
*Robot IRp-6 grający w kości w systemie ROS/OROCOS*
Degree awarded on November 2014

Advisor: **Piotr Witoński (IMiO)**

P. Ciołak (OKNO)
*System wspomagający zarządzanie placówką medyczną*
Degree awarded on July 2014

M. Jadczak (OKNO)
*Porównanie platform JEE i .NET wspierających tworzenie aplikacji sieciowych*
Degree awarded on October 2014

Advisor: **Andrzej Zalewski**

M. Ivanou
*Zastosowanie metody ALMA do analizy modyfikalności systemów o architekturze opartej na usługach*
Degree awarded on October 2014

Advisor: **Cezary Zieliński**

Sz. Piątek
*Planowanie działań robota przy wykorzystaniu metod sztucznej inteligencji*
Degree awarded on March 2014

## 5.3 B.Sc. Degrees

Advisor: **Piotr Arabas**

P. Bartoszuk
*Narzędzie do analizy i agregacji ruchowych danych telefonicznych CDR*
Degree awarded on February 2014

Advisor: **Andrzej Ciemski (II)**

M. Jastrzębski
*Zaprojektowanie oraz implementacja hurtowni danych w obszarze sprzedażowym*
Degree awarded on September 2014

Advisor: **Jarosław Dawidczyk (IMiO)**

J. Świątkowski
*Aplikacja trójwarstwowa do wspierania pracy przychodni medycznej*
Degree awarded on February 2014

M. Ziółek
*System rezerwacji wizyt lekarskich - aplikacja w architekturze trójwarstwowej*
Degree awarded on September 2014

Advisor: **Paweł Domański**

T. Janiuk
*Metodology for providing high efficiency in process performance*
Degree awarded on June 2014

Advisor: **Janusz Granat**

A. Smoleń
*System analizy odporności modeli decyzyjnych*
Degree awarded on September 2014

Advisor: **Jerzy Gustowski**

A.Papros
*Baza danych do archiwizacji zmiennych procesowych pozyskiwanych z profesjonalnego programu typu SCADA (WinCC firmy Siemens)*
Degree awarded on February 2014

M. Ruszczak
*Wizualizacja pracy i sytuacji awaryjnych stanowiska dydaktycznego napełniania butelek*
Degree awarded on February 2014

W. Niespodziany
*Model stanowiska odwróconego wahadła fizycznego dla potrzeb testowania algorytmów regulacji*
Degree awarded on September 2014

Advisor: **Mariusz Kaleta**

P. Barcikowski
*Metody alokacji kosztów na rynku przepustowości telekomunikacyjnych na potrzeby zestawiania VPN*
Degree awarded on February 2014

A. Liberadzki
*Sterowanie zachowaniem agenta software'owego za pomocą modeli BPMN*
Degree awarded on February 2014

Advisor: **Mariusz Kamola**

J. Tarasiewicz
*Komunikator preferencji*
Degree awarded on September 2014

Advisor: **Tomasz Kornuta**

M. Laszkowski
*Rozpoznawanie obiektów w obrazach RGB-D w oparciu o cechy SIFT*
Degree awarded on February 2014

K. Katerżawa
*Wykorzystanie wnioskowania probabilistycznego w percepcji robota usługowego*
Degree awarded on February 2014

J. Krasnodębska
*Wykorzystanie cech ekstrahowanych z obrazów RGB-D w rozpoznawaniu obiektów*
Degree awarded on November 2014

Advisor: **Adam Kozakiewicz**

P. Zapaśnik
*Narzędzie do wizualizacji algorytmów równoległych i rozproszonych*
Degree awarded on February 2014

P. Hejman
*Anonimowe rozproszone obliczenia z wykorzystaniem Onion Routingu Anonymous distributed computing with Onion Routing*
Degree awarded on February 2014

Advisor: **Bartosz Kozłowski**

M.Suchecki
*Finance manager – tree – tier web application*
Degree awarded on February 2014

Advisor: **Tomasz Jordan Kruk**

N. Busch
*Warstwy pośrednie heterogenicznego dostępu do środowisk przetwarzania w chmurze*
Degree awarded on February 2014

W. Skomra
*Platforma do testowania algorytmów odśmiecania pamięci*
Degree awarded on February 2014

Advisor: **Adam Krzemienowski**

J. Ładysz
*Rozkłady odporne w planowaniu inwestycji giełdowych opartych na anomaliach czasowych na Giełdzie Papierów Wartościowych w Warszawie*
Degree awarded on February 2014

J. Król
*Optymalizacja portfela akcji z wykorzystaniem koncepcji odporności i modelu CAMP*
Degree awarded on February 2014

Advisor: **Maciej Ławryńczuk**

M. Statkiewicz
*Zastosowanie karty graficznej (biblioteki CUDA) w optymalizacji globalnej*
Degree awarded on February 2014

K. Czerski
*Implementacja komórkowego algorytmu ewolucyjnego z wykorzystaniem technologii CUDA*
Degree awarded on September 2014

Advisor: **Ewa Niewiadomska-Szynkiewicz**

N. Biaduń
*Biblioteka algorytmów wyszukiwania grup w sieciach społecznych*
Degree awarded on February 2014

Advisor: **Piotr Pałka**

P. Turbiński
*Implementacja gry pomiedzy uczestnikami hurtowego rynku energii elektrycznej*
Degree awarded on October 2014

Advisor: **Joanna Putz-Leszczyńska**

P. Kurowski
*Wpływ podłoża tabletu graficznego na jakość pobieranego podpisu odręcznego*
Degree awarded on September 2014

Advisor: **Andrzej Ratkowski**

M. Maciorowski
*Narzędzie wspomagające projektowanie procesów w języku BPEL w architekturze SOA*
Degree awarded on February 2014

Advisor: **Krzysztof Sacha**

M. Sopliński
*Zaprojektowanie systemu zarządzania elektroniczną dokumentacją medyczną dla małych placówek i gabinetów lekarskich*
Degree awarded on July 2014

Advisor: **Piotr Salata (II)**

P. Burchardt
*Zastosowanie innowacyjnych technik interfejsu użytkownika do przeglądania zasobów multimedialnych*
Degree awarded on May 2014

Advisor: **Jerzy Sobczyk**

J. Such
*Uniwersalne narzędzia tworzenia aplikacji WWW dla urządzeń mobilnych*
Degree awarded on February 2014

Advisor: **Andrzej Stachurski**

L.Zhu
*Selecting the optimal route in Chinese Road system*
Degree awarded on February 2014

A.Kaleta
*Problem okablowania Steinberga jako kwadratowe zadanie przydziału*
Degree awarded on September 2014

Advisor: **Wojciech Szynkiewicz**

A. Sowińska
*Algorytmy planowania ruchu dla zamkniętych łańcuchów kinematycznych*
Degree awarded on September 2014

Advisor: **Eugeniusz Toczyłowski**

P. Kalinowski
*Projekt i realizacja prototypu akademickiej platformy e-learning*
Degree awarded on February 2014

N.T. Nguyen
*Production Planning and Control in Companies*
Degree awarded on September 2014

Advisor: **Paweł Wawrzyński**

A. Ziemek
*Sterownik do kwadrokoptera*
Degree awarded on February 2014

M. Mikulski
*Sztuczna inteligencja do gry w Blackjack*
Degree awarded on June 2014

A. Rogowiec
*Efektywna implementacja sieci neuronowych na kartach graficznych – porównanie technologii ATI Stream, Nvidia CUDA, OpenCl*
Degree awarded on September 2014

Advisor: **Tomasz Winiarski**

H. Świtalski
*Stanowisko do badania algorytmów sterowania pozycyjno- siłowego manipulatora IRp-6*
Degree awarded on February 2014

A. Latoszewski
*Robot mobilny operujący w hali sportowej*
Degree awarded on February 2014

P. Łukaszewicz
*Sterowanie napędami dla robota mobilnego elektron*
Degree awarded on September 2014

M. Kojdecki
*Podejmowanie pionów za pomocą robota manipulacyjnego IRp-6 korzystającego z chwytaka podciśnieniowego*
Degree awarded on September 2014

Advisor: **Adam Woźniak**

A. Stelmaski
*Rozwiązywnanie sytuacji przetargowych*
Degree awarded on October 2014

Advisor: **Cezary Zieliński**

D. Kaczmarek
*Zastosowanie stereowizji do lokalizacji obiektów przeznaczonych do chwytania przez robota*
Degree awarded on September 2014

# 6 Publications

## 6.1 Scientific or Technical Books


[B1] W. Kasprzak: *Inteligentne Techniki Obliczeniowe*. Warszawa: OKNO Politechnika Warszawska, 2014.

[B2] M. Ławryńczuk: *Computationally Efficient Model Predictive Control Algorithms*. Springer, 2014.

[B3] P. Tatjewski: *Numerical Methods*. Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej, 2014.

[B4] P. Wawrzyński: *Podstawy sztucznej inteligencji*. Warszawa: Oficyna Wydawnicza PW, 2014.

[B5] K. Malinowski, J. Józefczyk, J. Świątek (Eds.): *Aktualne problemy automatyki i robotyki*. Warszawa: Akademicka Oficyna Wydawnicza Exit, 2014.

[B6] K. Tchoń, C. Zieliński (Eds.): *Postępy robotyki tom I*. Warszawa: Oficyna Wydawnicza PW, 2014.

[B7] K. Tchoń, C. Zieliński (Eds.): *Postępy robotyki tom II*. Warszawa: Oficyna Wydawnicza PW, 2014.


## 6.2 Scientific and Technical Papers in Journals


[J1] P. P. Arabas, P. Jaskóła: "Model energetyczny rutera programowego – pomiary i identyfikacja", *Przegląd Telekomunikacyjny – Wiadomości Telekomunikacyjne*, nr 8–9, pp. 1014–1020, 2014.

[J2] J. Hurkała, T. Śliwiński: "Threshold accepting heuristic for fair flow optimization in wireless mesh networks", *Journal of Applied Mathematics*, vol. 2014, Article ID 108673, pp. 1–11, 2014.

[J3] P. Jaskóła, P. P. Arabas, A. Karbowski: "Optymalny ruting i przydział pasma w energooszczędnej sieci TCP/IP", *Przegląd Telekomunikacyjny – Wiadomości Telekomunikacyjne*, nr 8–9, pp. 1045–1048, 2014.

[J4] T. Jastrzębski, E. Toczyłowski: "Mechanizm aukcji w koordynacji łańcucha dostaw", *Gospodarka Materialowa & Logistyka*, nr XI.2014, pp. 9–12, 2014.

[J5] M. Kaleta, P. Pałka, I. Żółtowska: "Rola i funkcje agregatora z perspektywy europejskich projektów sieci inteligentnych", *Rynek Energii*, nr 3(112), pp. 26–31, 2014.

[J6] M. Kamola: "Energooszczędne trasowanie ruchu w sieci IP z OSPF", *Przegląd Telekomunikacyjny – Wiadomości Telekomunikacyjne*, vol. 87, pp. 1049–1055, 2014.

[J7] M. Kamola, P. P. Arabas: "Network resilience analysis: Review of concepts and a country-level case study", *Computer Science*, vol. 15 nr 3, pp. 311–327, 2014.

[J8] R. Karpuk, E. Toczyłowski: "Planistyczne i rozliczeniowe bilansowanie pozycji handlowych odbiorców rynku energii elektrycznej", *Rynek Energii*, nr 1(110), pp. 35–39, 2014.

[J9] W. Kasprzak, W. Szynkiewicz, D. Zlatanov, T. Zielińska: "A hierarchical CSP search for path planning of cooperating self-reconfigurable mobile fixtures", *Engineering Applications of Artificial Intelligence*, vol. 34, pp. 85–98, 2014.

[J10] T. M. Kornuta, M. Stefańczyk: "Akwizycja obrazów RGB-D: czujniki", *Pomiary Automatyka Robotyka*, vol. 18 nr 2, pp. 92–99, 2014.

[J11] T. M. Kornuta, M. Stefańczyk, M. Laszkowski, M. Figat, J. Figat and C. Zieliński: "Obsługa asynchronicznego przepływu danych w komponentowych podsystemach percepcji robotów", *Pomiary Automatyka Robotyka*, vol. 5/2014, pp. 127–133, 2014.

[J12] M. Kruczkowski, E. Niewiadomska-Szynkiewicz: "Comparative study of supervised learning methods for malware analysis", *Journal of Telecommunications and Information Technology*, vol. 4/2014, pp. 24–33, 2014.

[J13] L. Kruś, J. Skorupiński, E. Toczyłowski: "Analysis of incentive compatible decisions in a multicriteria auction", *Operations Research and Decisions*, vol. 3/2013, pp. 23–33, 2014.

[J14] B. J. Kubica: "Excluding regions using sobol sequences in an interval branch-and-prune method for nonlinear systems", *Reliable Computing*, vol. 19 nr 4, pp. 385–397, 2014.

[J15] M. Ławryńczuk: "Explicit nonlinear predictive control algorithms with neural approximation", *Neurocomputing*, vol. 129, pp. 570–584, 2014.

[J16] R. Mansini, W. Ogryczak, M. Grazia Speranza: "Twenty years of linear programming based portfolio optimization", *European Journal of Operational Research*, vol. 234 nr 2, pp. 518–535, 2014.

[J17] M. Marks, E. Niewiadomska-Szynkiewicz, J. Kołodziej: "An integrated software framework for localization in wireless sensor network", *Computing and Informatics*, vol. 33 nr 2, pp. 369–386, 2014.

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