

## Actualities

During the March session of the Division IV (Technical Sciences) the institutes of the Polish Academy of Sciences, the Systems Research Institute, the Institute of Computer Science, the Center for Laser Technology of Metals, the Institute of Theoretical and Applied Informatics, the Institute of Biocybernetics and Biomedical Engineering, presented their achievements and directions of development.

### Systems Research Institute of the Polish Academy of Sciences

Systems Research Institute (SRI) was established in 1976 as the successor of other institutes of the Polish Academy of Sciences such as Institute of Automatic Control, Institute of Applied Cybernetics, and Institute of Control and Management. From its very beginning SRI is the centre of interdisciplinary research in systems analysis, information technology, and automatic control. Research activities of SRI concentrate around the theoretical and practical problems of: control theory, optimization, fuzzy sets and systems, artificial intelligence, decision support systems, quality control, reliability and operation research.

SRI employs 19 professors, 11 associate professors, 32 assistant professors, 8 assistants, and 12 persons working as the technical staff. Altogether (with its administrative staff) SRI employs over 100 persons. They represent such scientific disciplines like computer science and information technology, control sciences, applied mathematics, econometrics, and others. Their expertise and experience is necessary in solving interdisciplinary problems, characteristic for the research area of SRI. However, following opinions of its advisory panels and as the result of the analysis of Institute's environment it has been decided to concentrate the research activities in four main areas:

- Information technology – especially in solving problems of Data Mining;
- Decision Support Systems that process uncertain (random) and imprecise (fuzzy) information – for example in the area of Reliability and Quality Control;
- Systems Analysis – especially in problems related to Environment;
- Methods of optimization and mathematical modeling of systems.

In these areas the scientists working at SRI have achieved many spectacular successes, both of theoretical and practical nature. For example, computer methods for automatic extraction of information from data bases have been proposed by the team of Prof. Janusz Kacprzyk. The

most successful industrial applications have been achieved by the team of Dr. Janusz Studziński in the area of modelling and control of municipal sewage systems.

SRI is involved in many research activities of international teams of scientists. First of all, it closely cooperates with the International Institute of Applied Systems Analysis (IIASA) located in Laxemburg near Vienna. It is worthy to note that SRI was established as the Polish counterpart of IIASA. Well established international relations result in many international conferences and workshops that have been organized or co-organized by SRI. Scientific teams from SRI take part in several international research programs, including programs of the EU.

SRI is the leading Polish center of the doctoral education in the area of information technology (computer sciences) and control engineering. The Institute has the right to confer the PhD (Dr.) and DSc (Dr.hab.) degrees in these areas. The scientific staff of SRI is deeply involved in education on a university level, especially in the Warsaw School of Information Technology (WIT), located in the premises of the Institute.

### Institute of Computer Science of the Polish Academy of Sciences

The Institute was established through a decision by the Presidium of the Polish Academy of Sciences on November 26, 1976 on the basis of the Computation Centre PAS, operating since 1961.

At present, the Institute employs about 70 people, including 49 research staff. The structure of the scientific part of the Institute consists of two Divisions: the Theoretical Foundations of Computer Science Division and the Artificial Intelligence Division, which are in turn subdivided in thematic teams.

The research areas practised by those teams include, among others: mathematical and logical aspects of IT systems and new computer architectures, distributed systems and collective information processing, databases and software engineering, computer-aided data analysis methods and decision support, linguistic engineering. The research works is carried out under statutory activity projects (about 20 annually) and under a number of domestic and international research projects (grants) won by the Institute.

The research carried out in the Institute yields about 170-190 publications yearly, including about 80 in refereed journals with an international range. The results contained in the publications are also presented at many conferences, mainly international ones.

An important class of research results is the prototype

software developed at the Institute (about 20 programs yearly), which is often implemented and used by other scientific centres and/or software companies.

The Institute participates in a very intensive way in the teaching processes on various levels and in various higher education establishments in Poland, as well as abroad (the Institute's employees provide about 5,000 hours of student teaching each year as well as supervise about 130 M.Sc. students). Contribution of the Institute to raising the qualifications of research workers, both the Institute's own and external, consists in conducting formal qualification procedures for professorial and habilitation (post-doctoral) degrees, as well as conferring the doctoral degrees in Computer Science, in the areas of technical as well as mathematical sciences. These tasks are carried out by the Institute's Scientific Board.

The Institute maintains a very broad cooperation with about 50 scientific centres throughout the world, and its staff includes 6 eminent foreign consultants. Over the recent period, the Institute has organized or co-organized 10 international conferences. Its employees participate in the work of Program Committees of about 85 conferences each year, referring about 250 papers for them. Moreover, our international cooperation results in about 20 common publications annually.

Another item worth noting is the activity of the Institute's library, which serves a broad academic and research community. The library is visited by about 2000 persons yearly, and is equipped in a computer-based catalogue of the books and 218 journals available to its users.

At the end, let us mention the Machine GRAPHICS and VISION quarterly with an international range which is published by the Institute, as well as the Institute's technical reports, which are distributed and find numerous readers not only in Poland but also abroad.

## Center for Laser Technology of Metals



The Center is a common agency of Kielce University of Technology and Polish Academy of Sciences. It was founded in July 1996 thanks to the efforts of the late Professor Henryk Frąckiewicz. The Center carries out teaching at the University of Technology and research, both fundamental and experimental. Its objectives are in particular:

- Education of students of Mechatronics and Machine Construction Department of Kielce University of Technology together with postgraduate education in the field of laser working of metals and other materials.
- Carrying out scientific research and development oriented at new technologies of laser working of metals and other materials.

The Center employs 22 members of the staff comprising 4 professors, 4 associate professors and 4 with doctorate in Engineering Sciences.

The main facilities of the Center's are 3 teaching and research laboratories:

- A large laser machining tool with 6.5 kW TRUMPH CO<sub>2</sub> laser source and a digitally controlled table.
- A medium sized 2.5 kW HEBR laser source.
- A 150 W Nd – YAG pulse laser.
- A KUKA KR15 industrial robot for handling and positioning of materials.

The Coordinated Research consists of fundamental and applied research in laser technologies for metals and materials oriented towards study of physical phenomena, which occur during laser working of metals. Also research in control of manipulators for handling work pieces during laser working. (total expenditure amounts – in year 2005 – 22.500 zł).

Individual research in 2005 includes

- Laser straightening and bending of slender metal pieces.
- Influence of the working parameters on the shape of the hardened zone and quality factors.
- Boring holes by CO<sub>2</sub> and Nd:YAG laser beams.
- Developing new methods of object identification for a hydraulic effector manipulator.
- The design of a robot grip driven by pneumatic muscle type effectors.
- Modelling and Experiments on Laser Forming of Structural Materials.

The research results of 2005 were published in 7 articles in journals and 13 scientific conference lectures.

In the academic year 2005/2006 the Team carried out 3800 hours of courses for the students of Kielce University of Technology including supervision of 12 successfully defended theses for promotion to the degree of Master of Engineering Sciences.

## Institute of Theoretical and Applied Informatics of the Polish Academy of Sciences

The activities of the Institute of Theoretical and Applied Informatics (IITiS PAN, staff: 25 researches including 8 professors) are grouped around three priority research axes: (i) analysis and implementation of new solutions

for Internet transport protocols, especially for multimedia transmission, (ii) computer vision, and (iii) nanoinformatics and quantum informatics. The first and second areas represent current trends and technical solutions in informatics, the third covers investigations which may contribute to the development of future, entirely different science of informatics.

- (i) In the performance analysis of computer and telecommunication networks, the current work of IITiS PAN concerns the development of mathematical tools and related software for better understanding of the shortcomings or even vulnerabilities of today Internet and to evaluate new solutions which will soon be incorporated in the next generation Internet. This new Internet will offer multimedia, mobility, quality-of-service and variable connectivity as standard services. However, the future high-speed wire-line and wireless access technologies provide instant high bandwidth connectivity making difficult to forecast traffic and thus to apply existing traffic engineering methods. In the exploding diversity of technologies, mastering such a heterogeneous environment becomes essential to the network designer. This requires investigation into new multi-technology architectures. IITiS PAN works on the enhancement of numerical algorithms, accelerated simulation techniques and exact/approximate analytic methodologies and their application in performance modelling, evaluation and congestion control of convergent multi-service heterogeneous networks. The institute is a member of EuroNGI (Design and Engineering of the Next Generation Internet – Towards convergent multi-service networks), a network of excellence involving 60 scientific institutions from 19 European countries.
- (ii) IITiS PAN pursues fundamental research in computer vision as well as applied projects for demanding application areas. In fundamental research, work is under way on representing arbitrary shapes in formats that will allow higher-level descriptions as well as incremental accumulation and fusion of partial data. The progress achieved so far includes multiple-view integration of geometric models, guided exploration of 3D space, oc-tree and graph representations of 3D scenes, surface type labelling in the RapidForm environment, and multi-camera stereo matching. An applied project which is being developed jointly with orthodontists and radiologists from the Silesian Medical Academy investigates multiple imaging and image processing techniques used to assess the structure of the craniofacial area in orthodontic patients. Its purpose is to analyze, record, and predict the complex changes that result from natural growth, pathological processes and medical intervention. By replacing some of the X-ray imaging (classical and CT) with visible-

light laser scanning, it is possible to reduce total radiation exposure, which is especially important for young patients.

- (iii) In the case of nanotechnical systems of informatics, the idea is to support a direct implementation of those systems in the production process for selected products, similarly to the processes existing in biological systems of informatics. Some other theoretical work concern relationships between decision algorithms, Bayes' theorem and flow graphs. In quantum systems, the research is concentrated on numerical simulation of quantum algorithms and protocols. "Quantum-octave" – a quantum computer simulator based on density matrices model has been developed. The simulator provides the capacity to prepare quantum mixed states, execute unitary and non-unitary evolution and perform quantum measurements. It makes possible to implement of a wide range of functions for quantum state analysis, such as state distances, fidelities and entanglement measures. New ways to describe quantum algorithms by high-level languages are investigated.

### **Institute of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences**

Institute of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences (IBBE PAS) was established in 1975. The organizer and first director of the Institute was Professor Maciej Nałęcz.

The structure of IBBE PAS consists of four departments: Department of Biomeasurements and Biocontrol, Department of Bioflows, Department of Biomedical Information Processing Methods and Department of Bionics as well as three research units: Research Unit of Clinical and Experimental Bioengineering and Research Unit of Rehabilitation Engineering and Biomechanics.

During last five years scientific workers published more than 180 papers in peer reviewed internationally recognized journals. The number of all publication, including conference papers and abstract, in the same period of time was about 1100.

On average, during last five years, annually, Institute receives for realization 25 national and international grants. Currently at the Institute four international grants, including three sponsored by EU, are being carried out.

The Institute is one of two institutions in Poland entitled to grand Ph.D. and D.Sc. degrees in the field of biocybernetics and biomedical engineering. The Institute publishes the "Journal Biocybernetics and Biomedical Engineering".

In 1988 the International Centre of Biocybernetics (ICB), in association with the Institute, began its activity. The main objectives of ICB are: stimulation of international scientific collaboration by organization of seminars

and conferences in selected areas of biomedical engineering, education of young researchers enabling them to take part in the meetings, presenting results of their investigations and taking part in discussions. Texts of meetings lectures are published in ICB Lecture Notes.

In the period 1988–2005 84 seminars were held including four workshops which were organized in collaboration with National Institutes of Health (Bethesda, USA), eight Polish-Japanese seminars and two Polish-Korean seminars. ICB collaborated with the Institute in organization of two Congresses of the European Society for Artificial Organs (17–19.10.1996 and 8–11.01.2004) as well as of the Congress of European Society for Engineering and Medicine (25–28.05.1997). In the ICB seminars took part over 5200 participants from 43 countries.

The Institute concentrates its research in two main areas pertaining to medical diagnosis and therapy:

1. Biomeasurements and computer data processing for improvement of medical diagnosis.
  - 1.1. Biomeasurements, especially noninvasive measurements (e.g. high-resolution electrocardiography, laser-Doppler flowmetry for perfusion monitoring, near infrared spectroscopy for tissue oxygenation monitoring, eye movement research) or minimally invasive methods (e.g. semiconductor sensors and systems for monitoring of chemical and biochemical quantities, so called labs on the chips).
  - 1.2. Computer data processing for improvement of

the medical diagnosis quality (e.g. computer aided image processing in cardiology, cytological images computer analysis systems, early recognition of urinary bladder cancer cells, signal and image analysis using chaos theory and fractal geometry).

2. Support and substitution of the lost functions of the organism.
  - 2.1. Technical support and substitution of lost functions of the organism (e.g. artificial kidney, hollow fiber membranes for blood purification and cell's immunoisolation, technical support of the diabetes therapy, support of the therapy of respiratory and circulatory system disorders, speech synthesis and navigation system for blind people, bioreactors for hepatic support, immunoisolated pancreatic islets xenotransplantation).
  - 2.2. Mathematical models and computer simulations of the organ functions (e.g. fluid and solute transport in hemodialysis and peritoneal dialysis, computer modeling of blood circulation and respiratory system, modeling of muscle structure).

At the Institute National Centre of Excellence in the field of artificial and hybrid organs supporting metabolism, ARTOG, was established in 2004.

The detailed description of Institute's activities can be found at the web side: [www.ibib.waw.pl](http://www.ibib.waw.pl)