

Annual scientific awards of the Division IV Technical Sciences of the Polish Academy of Sciences

For many years it has been a great tradition of the Division IV of Technical Sciences of the Polish Academy of Sciences to recognize the outstanding achievements of young scientist with several Awards related to various fields of technology. The awarded candidates have to satisfy the requirements specified in suitable Regulations.

In 2005 the Scientific Award Fund of the Division IV was supported by the well known international Siemens company which significantly augmented the status of the Awards.

The list of Awarded Winners and the brief description of their achievements prepared by the authors are as follows.

In the field of Electronics:

Modelling and designing systems of a/d conversion

Michał Szremer

*Faculty of Microelectronics and Computer Sciences
Technical University of Łódź*

M. Szremer's current research area is focused on designing silicon microsystems, particularly the processing part. His main interest covers designing and modelling analogue to digital converters, which are the interface between micro-machined sensors and data processing units. During his PhD studies he was focusing on developing a sigma-delta converter. He elaborated various VHDL-AMS models of the circuit and implemented a few chosen ones in CMOS technology in CAD CADENCE environment. The designed converter is an unique one, because it is possible to reconfigure dynamically the modulator order, hence to obtain the optimal configuration of the circuit for a developed microsystem. This particular circuit was specially designed for a silicon microsystem dedicated to the water pollution monitoring which was the main aim of the 5th European Union Programme Project SEWING (System for European Water monitorING). The converter plays very important role in this system, it processes the analogue data from the CHEMFET sensors into digital form. Data are transmitted to the main computer, where the analysis of the water pollution is performed. It should be also mentioned, that the converter is to be placed near the GSM transmitter, to investigate an influence of an external electromagnetic field on the circuit, which is very important. During tests it appeared that the converter is immune on such disturbances. The problem of electric circuits immunity on electromagnetic field is also considered in Michał Szremer's research.

His work was appreciated on the International Student Contest organized on September 13, 2003 in Bratislava where he was awarded the third place and also on the 5th International Exhibition of Inventions Innovation 2003 organized on October 8–10, 2003 in Gdańsk, where he received bronze medal in the Electronics and Computer Science Category.

In the field of Acoustics:

Soft computing in acoustics, applications of neural networks, fuzzy logic and rough sets to musical acoustics

and

Perception-based data processing in acoustics. Applications to music information retrieval and psychophysiology of hearing

Bożena Kostek

*Multimedia Systems Department Faculty
of Electronics, Telecommunications and Informatics
Gdańsk University of Technology*

The Award of the Division IV of the Polish Academy of Science in the field of acoustics has been granted for two monographs, the objectives of which were to provide novel insights into perceptual mechanisms underlying the processing of sound and music in different environments. A solid understanding of these mechanisms is vital for numerous technological applications such as, for example, information retrieval from distributed musical databases. In order to investigate the cognitive mechanisms underlying music perception some soft computing methods were employed by the author. Methods based on such learning algorithms as neural networks, rough sets, fuzzy-logic, and genetic algorithms were conceived, implemented and tested on musical and acoustical data. They provided knowledge on how humans internally represent such notions as sound quality and timbre and therefore this allows for the human-like automatic processing of musical data. In addition, automatically extracted knowledge on the above processes can be compared to fundamentals of hearing psychophysiology and to principles of music perception. Also other applications of hybrid decision systems to problem solving in acoustics have been exemplified and discussed in these books based on the experimental results obtained by the author and her co-workers of the Multimedia System Department, Gdansk University of Technology.

In the field of Chemical Engineering:

**Modelling of flow in a mixer – laminar regime,
ribbon and screw impellers**

Krzysztof Szulc

*Faculty of Process and Environmental Engineering
Technical University of Łódź*

The awarded work is dedicated to experimental investigations and mathematical modelling of flow of highly viscous Newtonian liquids and the effect of various flow properties described in the study on the process of mixing and its results. The study is concerned with modern research methods, in particular with the use of a novel, on-line method of Doppler laser anemometry. In literature there is no such comprehensive study in which extensive empirical research is combined with numerical modelling. Worth noting is a 3D mathematical model proposed and solved in the thesis. The applied 3D model is non-parametric, i.e. no preliminary data, except for system geometry, are required to solve it. On the basis of the model one can obtain many useful values, starting with hydrodynamic ones: velocity components in all three directions, pressure, primary and secondary circulation, power demand and other values useful from the process point of view. The author uses the known, modern research methods to interpret the operation of mixers with screw and ribbon impellers. The model can also be used in other areas as a basis for the analysis and description of the processes of homogenisation, dispersion and mass transfer, and also to identify flow structure. A 3D modelling is possible due to advanced computer technique, and the study is one of the pioneering researches in Poland dedicated to this subject, which gives it an attribute of originality. The author proved that it is possible to construct such 3D models which can be solved on PC computers. The thesis contains original material which extends our knowledge on the hydrodynamics of mixers with laminar flow.

In the field of Material Engineering:

**Evaluation of microstructure and properties
of oxidation resistance coatings
on Ti-Al based alloys**

Grzegorz Moskal

*Faculty of Material Engineering
Technical University of Silesia*

The performed investigations were concerned with the problem of improvement of oxidation resistance of TiAl intermetallic based alloys. They present the results of detailed microstructural investigations of TiAlSi coatings deposited on TiAlCrNb alloy by Arc-PVD method. Protective layer was deposited by two steps Arc-PVD method. The thickness of the layer was ca. 40 μm . The

TiAlSi type of coating was free from cracks and characteristic for pack cementation methods imperfection. Thought after deposition process, the TiAlSi coating was built from dominated TiAl₃ phases modified by Si as well as titanium silicides Ti₅Si₃. The presence of an aluminum areas was confirmed too. The homogenization process at 950°C and diffusion treatment at the same temperature by together 10 hours permitted on formation in the coating only desirable phases such as titanium trialuminides and titanium silicides. Diffusion treatment caused a growth of transition sublayer as a result of inward diffusion of aluminum. Formation of Ti-Si phases caused a decrease of titanium's activity by Ti bonding to form of Ti₅Si₃. Results of the cyclic and isothermal oxidation tests of based alloy with and without oxidation resistance coating modified by Si was showed as well. Application of TiAlSi protective coating permitted on significant improvement of oxidation resistance of basic alloys during isothermal, as well as a long term cyclic conditions. It was possible by the suitable selection of method of coating deposition and their chemical composition with thickness sufficient to obtain long term high oxidation resistance. The presence of high aluminum activity phases such as TiAl₃ and formation of titanium silicides Ti₅Si₃ caused increasing of aluminum activity and decreasing of titanium activity. In consequence susceptibility to selective oxidation of Al and increase of heat resistance was obtained. There have been presented many interesting results of experimental studies out of which a concept of the influence of Si additions on oxidation resistance of TiAl based alloys has been created. In several publications the influence of TiAlSi coating deposition on improvement oxidation resistance and mechanism of the formation of protective layer of oxides has been explained.

In the field of Informatics:

Results of bioinformatics investigations

Marta Kasprzak

*Institute of Informatics
Poznań University of Technology*

The awarded work deals with several combinatorial aspects of reading DNA sequences. They concern lower (DNA sequencing) and higher (sequence assembly) level of genome reconstruction. The aim of the thesis was to model these processes as combinatorial problems, determine their computational complexity, and solve them, providing results of high quality.

Referring to standard DNA sequencing by hybridization, the general real-world case assuming experimental errors in input data is a strongly NP-hard computational problem. In the thesis, computational complexity of some special cases of this problem has been solved. On the other side, the collection of approaches to general DNA sequencing has been enriched by two new polynomial-time

heuristic algorithms solving the problem without restrictions on type or number of errors in the data. The algorithms are based on genetic algorithms or on tabu search with scatter search, respectively. Currently they are the best methods for the problem in the literature.

A new, promising field of the DNA sequencing, using isothermic oligonucleotide libraries, brought much more open questions to investigate. Computational complexity of several variants of the problem, on distinct assumptions on errors in the data, has been solved here. Presence of errors in the data, negative or positive ones, results in the strong NP-hardness of the problem, while for the errorless isothermic DNA sequencing an exact, polynomial-time algorithm has been constructed. Also for erroneous data an algorithm has been proposed, a heuristic based on the tabu search approach. What is important, the complexity of several variants of the isothermic sequencing is the same as the complexity of their standard counterparts. Therefore, because of a great probability that number of experimental errors will decrease thanks to the new proposition, the isothermic DNA sequencing has an advantage over the standard approach. What has been proved in the thesis, complete isothermic oligonucleotide libraries can be easily constructed.

Two methods constructed for common superstring problems and presented in the thesis appeared to be a good start point for an advanced heuristic for DNA sequence assembly. The proposed assembly algorithm passed successfully tests on real-world data coming from experiments on SARS coronavirus. In comparison with two publicly available assembly packages, Phrap and CAP3, its outcomes appeared to be the best.

In the field of Architecture and Urban Planning:

On the shaping of the museum of art – space more beautiful than object

Marek Pabich

*Institute of Architecture and Urban Planning
Technical University of Łódź*

The rewarded book presents reflections:

- on building of the Museum of Art as well as its museum space and the many limitations resulting from different ideas and the creative approaches related to this process,
- the analysis of the museum building born within the town - building structure and its natural environment,
- discussions on the spatial intervention in adopted and extended buildings focusing on the balance edge between the exhibit and the environment.

In the book author presents different opinions of artists on the shape of the museum space and realization of their aspirations by architects. The book is furthermore a reflection upon the role of light in shaping the museum interiors. The theme of space organization in the museum is running through the whole book. The space has been organized according to the accepted solutions of sightseeing routes.

In the field of Biomedical Engineering:

Selected applications of near infrared spectroscopy in medical diagnosis

Adam Liebert

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

Modern, non-invasive methods for assessment of tissue oxygenation and perfusion based on near infrared spectroscopy were presented. Proposed methods allow to perform in-vivo measurements on humans and provide new data that may significantly extend clinical information about the studied patients and may influence decisions on their treatment. Principles of measurements with the use of near infrared spectroscopy as well as methods of data analysis were presented. Advantages and limitations of these techniques were pointed out. Special attention was focused on measurements of times of flight of single photons in tissue and on metrological problems concerning emission of ultrashort laser pulses and analysis of distributions of times of flight of photons in tissue. Applications of this method in assessment of brain oxygenation and in optical mammography were discussed. Finally, the optical method based on analysis of light pulse broadening in tissue was validated in assessment of oxygenation and perfusion of the brain. The method was applied in clinical environment in stroke patients and has perspective to be routinely used for brain perfusion monitoring in acute stroke. Obtained results show also that the proposed method allows to improve significantly spatial resolution of optical mammography which has potential of application in non-invasive screening of breast tumors.

The suitable procedure aiming at the determination of the Award'2006 Winners has just started.

Actualities

Professor Piotr Wilde, the full member of the Polish Academy of Sciences, died on 12 January 2006. Piotr Wilde was an outstanding specialist in the theory of Engineering Constructions and Applied Mechanics.