Annual scientific awards of the Division IV
Technical Sciences of the Polish Academy of Sciences in 2009

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 scientists with several Awards related to various fields of technology. The awarded candidates have to satisfy the requirements specified in suitable Regulations. In 2009 the Scientific Award Fund of the Division IV was supported by the well known international company Siemens 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 Mechanics:

**Sensitivity analysis in finite element computations of elasto-plasticity**

**Piotr Kowalczyk**
*Institute of Fundamental Technological Research, Polish Academy of Sciences*

The author received the award for his habilitation thesis which is devoted to methods of parametric sensitivity analysis in computational problems of elasto-plasticity. The thesis covers issues related to the first order sensitivity analysis in geometrically linear and nonlinear formulations of isothermal elasto-plastic and elasto-viscoplastic behaviour of metal structures. Primarily, attention is focused on formulation of analytical response gradients with respect to design parameters (contrary to their approximate determination with finite-difference formulae at small design perturbations). All the initial-boundary problems, considered in the thesis, are discussed in terms of the approximate solution techniques based on the finite-element discretization. This does not affect generality of the discussion as long as the sizing and material parameter sensitivity is considered. In the case of shape parameter sensitivity, the notion of the design-independent reference configuration is strictly related to the definition of the parent configuration of an isoparametric finite element – thus the discussion in this area is limited to discrete formulations of FEM. All formulations discussed in the thesis are presented in the form of closed-form algorithms, readily implementable in computer programs. A number of computational examples illustrate the presented computational algorithms and inspire discussion on detailed questions dealt with in the text.

In the field of Electrotechnics:

**Signal and image processing in diagnostics of electrical power equipment**

**Marek Florkowski**
*ABB Corporate Research Center – Poland*

Exploitation management strategies of electric power equipment belong to the main focus areas ensuring uninterrupted power delivery. As far as power transmission and distribution are concerned these problems are related to diagnostics. They include decision taking methodology about the actual condition of power equipment and are a subject of processes initiated during operational hazards such as overvoltages, overcurrents, mechanical or environmental stresses, influencing exploitation parameters, in particular the electric withstand.

The present problems and challenges in high voltage diagnostics of electric power equipment, applying signal and image processing pose the main aim of the monograph. This research direction aims at developing diagnostic methods in order to allow for identification of technological or operational structural changes, which are not detectable by means of conventional methods but which have critical significance for both failure rate and life time of electric power equipment. This goal has been realized on the basis of both a theoretical analysis of the phenomena initiating the degradation processes in high voltage insulation systems resulting in electric signals, being foundation of condition indicators, as well as using advanced off/on-line measurement systems and methods. The signal and image processing methods have been applied for assessing pulse diagnostic symptoms coming from stochastic signals of partial discharges in the technical structures of the insulation systems. As far as the phenomena in a strong electric field are concerned these methods refer to the phase-resolved images. There are presented both implementations and applications of these methods to power equipment, including disturbance suppression and denoising techniques. The simulations of model discharge forms and results of on-site measurements together with investigations of correlated stresses and degradation stages create a basis for image recognition and dielectric loss visualization. The introduced phase-resolved analysis of time waveforms of the pulse form of discharges extends complementary diagnostic methods. In view of these issues related to short-circuits in power equipment, the high frequency methods have been used.
for assessing the exploitation multistresses, which affect the
integrity of windings and insulation systems.

The experience gained from the application of signal and
image processing methods has been utilised for developing
diagnostic and monitoring algorithms focusing on early
detection and limitation of outages in power networks or in high
temperature equipment. The described issues have been considered
with regard to both the exploitation diagnostics in electric
power, and also in the context of selection of new electric insu-
lation materials and assessment of technological processes
in the development and design of high temperature equipment.

In the field of Chemical Technology:

Oxide hybrid systems – technologies, properties and applications

Teofil Jesionowski

Poznan University of Technology

Development of new generation of oxide hybrids has pro-
duced great interest for science, in particular chemical technol-
ogy, material engineering and environmental protection. This
area of research includes the problems related to the synthe-
sis of functionalised substances based on silicas, silicates and
oxide composites, their physico-chemical characterisation and
applications. Over the years the number of published papers
in this area has increased significantly, e.g., in Dyes and
Pigments, Journal of Power Sources, Journal of Materials Sci-
ence, Environmental Science and Technology, Journal of Ma-
terials Processing Technology, Advanced Powder Technology
and Colloid and Polymer Science concerns syntheses of spher-
ical, monodisperse silicas and oxide composites performed
in the laboratory and semi-technical scales by the method
of precipitation and evaluation of the physico-chemical and
functional properties of the products obtained. A number of
experiments were performed on oxide hybrid systems, belong-
ing to the recent materials of particles of nano- or submicron
size and well-defined shape.

An important part of the studies has resulted in synthesis
of pigment composites by adsorption of organic dyes (mod-
el solutions or waste from textile industry) by unmodified or
modified inorganic support.

The produced powder substances were tested as fillers or
pigments in modern polymer composites based on polyolefins
and thermoplastic polyesters of specific physico-chemical and
mechanical properties as well as in solid state gel electrolytes
based on PVD/HFP, developed for textile barrier materials
protecting against UV irradiation.

In the field of Informatics:

Language design for atomicity, declarative
synchronization and dynamic update
in communicating systems

Pawel T. Wojciechowski

Poznan University of Technology

The author received the award for the book, in which he
designs a novel programming language, constructs and algo-
rithms for atomicity, declarative synchronization, and dynam-
ic software updating in communicating systems. They can be
used to implement such systems from modular protocols, that
has been replaced dynamically. Communication enables useful
applications but it also makes the implementation of atomici-
ty, synchronization and dynamic update challenging. In order
to facilitate programming, and to enable a guarantee of ro-
bustness, novel programming abstractions are needed. In the
book, he designs the calculus of atomic tasks, i.e. atomic, roll-
back free transactions that may have I/O effects, and describes
novel algorithms for concurrency control in atomic tasks. The
algorithm has a type system for static verification of data re-
quired by the algorithms, which guarantees that the constructs
of the calculus are used correctly. Then, he describes two
different approaches to declarative synchronization: (1) the
calculus of concurrency combinators, with type-based verifica-
tion of combinator satisifiability (which guarantees that the
combinators are used correctly), and (2) a constraint language
for the role-based synchronization. He also describes a model
of dynamic protocol update, and gives two example switching
algorithms. Finally, he designs the class-based object calculus
of dynamic rebinding, and uses it to show the application of
atomic tasks and combinators when rebinding concurrent ob-
jects are considered. In the appendix, he has included proofs
of type soundness for the calculus of atomic tasks, including
the proof of dynamic correctness of an exemplary concurren-
cy control algorithm.

In the field of Biomedical Engineering:

Biomechanics of intervertebral disc –
assessment of overload and stabilisation effects

Celina Pezowicz

Wrocław University of Technology

The human spine is composed of highly specific tissues
and structures which together provide the extensive range of
motion and considerable load carrying capacity required for
the physical activities of daily life. Intervertebral disc pro-
vides mobility to the spine and transfers load via hydrostatic
pressurization of the hydrated nucleus pulposus. The pur-
pose of work was experimental and numerical analysis of
selected mechanical and structural properties of spine ele-
ments.

The impact of facets joint on pressure in intervertebral
disk and changes in loads bearing in functional spine unit
were assessed. Structural and mechanical responses of single
lamellae and adjacent lamellae of annulus fibrosus have been
investigated using a micromechanical technique in combina-
tion with simultaneous microscopic analysis. Additionally, in
the study there were characterized changes in biomechanical
behaviour (intradiscal pressures) at the segments mechanics
adjacent to an anterior cervical fusion with and without in-
strumentation.
In the field of Building Engineering:

The influence of selected functional and spatial parameters on the acoustical comfort of concert halls interiors  
Andrzej Kłosak  
Cracow University of Technology

The work concentrates on relations between designing of concert halls interiors and their main, acoustical function. This study includes the evaluation of existing and currently being constructed concert halls in respect of architectural and acoustical criteria, together with the answer to the question, whether the acoustical character of the concert hall depends on the choice of the architectural idea of its interior. An analysis covers architectural criteria such as form, function and construction of a concert hall, together with its acoustical character. Evaluation has been made for 44 examples of two types of concert halls, currently recognized as acoustically the best: parallel-side halls and halls with central location of stage and terraced audience. For evaluated examples main relations between architecture and acoustic has been shown. Additionally, the influence of changing of volume, dimensions and proportions of rectangular concert halls on acoustical character and acoustical comfort has been shown. Calculations have been made for 24 theoretical concert hall models with volume from 8,000 to 16,000 m$^3$. For each model 5 main acoustical parameters were calculated (reverberation time $T_{30}$, early decay time EDT, clarity $C_{80}$, strength G, early lateral fraction LF80) together with the level of acoustical comfort.

In the field of Machine Building and Operation:

Detection of early phases of damages by methods of artificial intelligence  
Jacek Dybala  
Warsaw University of Technology

The monograph presents the results of the author’s research associated with use of artificial intelligence methods in technical diagnosis. This research served the purpose of effective solving two key tasks associated with diagnosis. First of them is the assessment of usability and consequently selection of the optimum, from the point of view of the assumed state’s classification, features of registered signals (the diagnostic parameters) which are the basis for recognition of an object’s condition. Second one concerns the construction of the inference module (the classifier), which is responsible for recognition of the object’s condition on the basis of selected diagnostic parameters.

The monograph contains a brief review of basic methods and means of artificial intelligence, which aim to present the background and the roots of the solutions, which have been developed by the author. The monograph also presents selected classifiers used for pattern recognition, which the author utilized as an inspiration for his research.

The main part of the monograph is devoted to present and discusses the original feature selection and pattern classification methods, which have been developed by the author. The Subspace-oriented Geometrical Feature Selection method and the original NBV classifier (Nearest Boundary Vector classifier) are described here.

The greatest part of the monograph is devoted to present results of operation tests of the solutions, which author developed (practically realized as MATLAB environment procedures) while relying on simulation data. The selected examples of use of the new feature selection and pattern classification methods, in task of diagnosing specific technical objects, have also been presented extensively. The monograph closes summary together with outlines of further research directions.

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**Actualities**

Prof. Marian P. Kazmierkowski Doctor Honoris Causa of the Institut National Polytechnique de Toulouse – INPT

On January 2010 Professor Marian P. Kazmierkowski, from Warsaw University of Technology, the Corresponding Member of Polish Academy of Sciences (PAN), was awarded with the Doctor honoris causa degree of the Institut National Polytechnique de Toulouse (INPT), France. The INPT celebrated 100 year anniversary. The celebration was held on 11 January and on the 12 January, Prof. Kazmierkowski presented the lecture entitled: “Power Electronics for Wind and Ocean Wave Energy” (see http://honoriscausa.inp-toulouse.fr/vids/MarianPiotrKazmerkowski.pdf).

Director of the Institut National Polytechnique de Toulouse – INPT  
Prof. Gilbert Casamatta gives the Diploma of the Doctor honoris causa and congratulates Prof. Marian P. Kazmierkowski

Since 2007 Professor Kazmierkowski has been the Editor of the Bulletin of the Polish Academy of Sciences: Technical Sciences, and is responsible for Electrical Engineering area.

Professor Kazmierkowski is an author or co-author of over 350 technical papers and reports, 17 patents and also he supervised 24 PhD-theses. He co-authored (with H. Tunia) “Automatic Control of Converter-Fed Drives”, (Elsevier, 1994) and co-edited (with R. Krishnan and F. Blaabjerg), and also co-authored the compendium “Control in Power Electronics”, (Academic Press, 2002). He is IEEE Fellow and received a number of awards (Siemens Research Award, 2007, Dr Eugene Mittelmann Achievement Award, 2005 and the Anthony J. Hornfeck Service Award, 2007 both by the IEEE Industrial Electronics Society). He was Editor-in-Chief (2004–2006) and Past Editor-in-Chief (2007–2009) of the IEEE Transactions on Industrial Electronics.

During his long cooperation with the Faculty of ENSEEIHT (Ecole National Superieure d’Electrotechnique, d’Electronique, d’Informatique, d’Hydraulique et des Telecommunications) he gave lectures as Visiting Professor and supervised MSc- and PhD-Students exchange. This is the second Doctor honoris causa degree of Prof. Marian Kazmierkowski, the first he received from Aalborg University, Denmark in 2004 (see IEEE Industrial Electronics Society Newsletter, Vol. 52, No. 1, 2005, p. 6).