

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 over-voltages, 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 voltage 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 insulation materials and assessment of technological processes in the development and design of high voltage 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 profound importance for science, in particular chemical technology, material engineering and environmental protection. This area of research includes the problems related to the synthesis of functionalised substances based on silicas, silicates and oxide composites, their physico-chemical characterisation and applications. The cycle of papers published e.g. in *Dyes and Pigments*, *Journal of Power Sources*, *Journal of Materials Science*, *Environmental Science and Technology*, *Journal of Materials Processing Technology*, *Advanced Powder Technology* and *Colloid and Polymer Science* concerns syntheses of spherical, 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, belonging 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 (model 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 PVdP/HFP, developed for textile barrier materials protecting against UV irradiation.

In the field of Biomedical Engineering:

Biomechanics of intervertebral disc – assessment of overload and stabilisation effects

Celina Pezowicz

Wroclaw 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 provides mobility to the spine and transfers load via hydrostatic pressurization of the hydrated nucleus pulposus. The purpose of work was experimental and numerical analysis of selected mechanical and structural properties of spine elements.

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 combination 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 instrumentation.

In the field of Informatics:

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

Paweł T. Wojciechowski

Poznań University of Technology

The author received the award for the book, in which he designs a novel programming language, constructs and algorithms for atomicity, declarative synchronization, and dynamic software updating in communicating systems. They can be used to implement such systems from modular protocols, that can be replaced dynamically. Communication enables useful applications but it also makes the implementation of atomicity, synchronization and dynamic update challenging. In order to facilitate programming, and to enable a guarantee of robustness, 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 calculus has a type system for static verification of data required 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 verification of combinator satisfiability (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 objects 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 concurrency control algorithm.

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 m³. 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.

* * *

The suitable procedure aiming at the determination of the Award 2010 Winners has just started.

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/MarianPiotrKazmierkowski.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.

He organized two Special Issues: “Control in Power Electronics and Drives”, Volume 54, Issue 3, September 2006 and “Power Electronics in Renewable Energy Systems”, Volume 57, Issue 4, December 2009.

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 EN-SEEIHT (Ecole Nationale Supérieure 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).