Silesian University of Technology
Faculty of Automatic Control, Electronics and Computer Science

Annual Review 2007

Institute of Electronics

Akademicka 16, 44-100 Gliwice, Poland
phone: (+48) 32 2371495, (+48) 32 2371529
fax: (+48) 32 2372225, e-mail: instytut.elektroniki@polsl.pl
http://iele.polsl.pl

Compiled by
Zdzisław Filus and Edward Hrynkiewicz

Edited by
Maria Drelichowska

Institute of Electronics, March 2008

FOREWORD

The Institute of Electronics is a part of the Faculty of Automatic Control, Electronics and Computer Science, one of the 12 faculties of the Silesian University of Technology, founded in 1945. The University is located in Gliwice and has about 32,000 students at present. The Faculty of Automatic Control was founded in 1964, and after a few reorganisations it changed its name to the Faculty of Automatic Control, Electronics and Computer Science. Since its creation in 1974 the Institute of Electronics has been involved in various research and teaching activities. The Institute has about 100 members of academic staff and consists of six divisions:

- ***Division of Electronics Fundamentals***
- ***Division of Digital and Microprocessor Systems***
- ***Division of Circuit and Signal Theory***
- ***Division of Telecommunication***
- ***Division of Biomedical Electronics***
- ***Division of Microelectronics and Biotechnology***

The Institute specialises in such advanced fields of engineering as analogue and digital electronic systems, including biomedical systems, production of telecommunication and electronic systems etc. Research in these areas ranges from component to system level, encompassing practical and theoretical investigations with the application of both hardware and software techniques. Research groups are supported by a wide range of test and instrumentation equipment together with computer facilities, which can run with programming languages of all levels and offer various application software. Many of the Institute's research programmes are carried out in close co-operation with industry in order to satisfy the needs of the region, which is the main industrial centre of Poland.

The Institute offers two-stage five-year courses leading to the degree of MSc, which is obtained on the basis of a project and a report, presented during a final examination. After the first stage of study, lasting three and a half years, students can complete their education and leave the university with the BSc degree. The Institute participates also in a five-year MSc course in Automatic Control, Electronics and Computer Science, run by the Faculty, in which all teaching is in the English language. The courses normally consist of lectures, laboratories, seminars and projects, and are followed by examinations. Apart from this, the Institute offers five-year courses at evening studies, leading to the degree of BSc. The curricula of the courses run by the Institute are designed for people who want to achieve both theoretical knowledge and practical skills in electronics. At present, the total amount of students is about 1,000. Other didactic activities include postgraduate and PhD studies.

The following pages provide detailed information regarding the research carried out as well as the subjects taught in each division.

CONTENTS

DIRECTORS OF THE INSTITUTE

Director of the Institute:

Prof. Edward HRYNKIEWICZ

Vice Director of the Institute for Research:

Prof. Zdzisław FILUS

Vice Director of the Institute for Teaching:

Asst. Prof. Adam BŁASZKOWSKI

DIVISION OF ELECTRONICS FUNDAMENTALS

Head of Division: Prof. Zdzisław Filus, PhD, DSc

Research staff

Prof. Zdzisław FILUS, PhD, DSc

Prof. Andrzej KARWOWSKI, PhD, DSc
Prof. Leon LASEK, PhD, DSc
Asst. Prof. Adam BŁASZKOWSKI, PhD
Asst. Prof. Władysław CIĄŻYŃSKI, PhD
Andrzej BŁONAROWICZ, PhD
Jacek CHĘCIŃSKI, PhD
Jerzy FIOŁKA, PhD
Zenon KIDOŃ, PhD
Adam KRISTOF, PhD
Sławomir LASOTA, PhD
Mirosław MAGNUSKI, PhD
Andrzej MALCHER, PhD
Artur NOGA, PhD
Wojciech OLIWA, PhD
Zbigniew RYMARSKI, PhD
Maciej SURMA, PhD
Włodzimierz SZMELCER, PhD
Tomasz TOPA, PhD
Grzegorz WIECZOREK, PhD
Dariusz WÓJCIK, PhD
Piotr ZASTAWNIK, MSc

Research fields

- Electronic circuits synthesis
- Symbolic methods of electronic circuits analysis
- Electronic circuits for automotive applications
- Measurement of selected physical quantities based on eddy current methods
- Power electronic circuits
- Microprocessor-based measurement systems
- Computational electromagnetics
- Numerical modelling of radiating and scattering wire objects
- Linear antenna theory
- Electromagnetic compatibility
- Optoelectronics, Fiberoptics

Courses

- Semiconductor Devices
- Analogue Electronic Circuits
- Analogue Circuits Design
- Electronic Measurement Techniques
- Switching Circuits
- Special Semiconductor Devices and Circuits
- Materials Technology and Electronic Equipment Design
- Field and Wave Electromagnetics
- Introduction to Radio Communication
- Radio Engineering Systems
- Fields, Waves and Antennas
- Wireless Computer Networks
- Design of Radio Electronic Devices
- High-Frequency Engineering Fundamentals
- Electromagnetic Compatibility

DIVISION OF DIGITAL AND MICROPROCESSOR SYSTEMS

Head of Division: Prof. Edward HRYNKIEWICZ, PhD, DSc

Research staff

Prof. Edward HRYNKIEWICZ, PhD, DSc

Prof. Andrzej HŁAWICZKA, PhD, DSc
Asst. Prof. Zdzisław POGODA, PhD
Mirosław CHMIEL, PhD
Robert CZERWIŃSKI, PhD
Tomasz GARBOLINO, PhD
Krzysztof GUCWA, PhD
Eugeniusz KOSEK, PhD
Józef KULISZ, PhD
Adam MILIK, PhD
Maciej NOWIŃSKI, PhD
Adam PAWLAK, PhD
Krzysztof PUCHER, PhD
Tomasz RUDNICKI, PhD
Wojciech SAKOWSKI, PhD
Dariusz STACHAŃCZYK, PhD
Krzysztof TABOREK, PhD
Bernard WYRWOŁ, PhD
Dariusz POLOK, MSc

PhD Students
Jan MOCHA, MSc

Research fields

- Testing and testability of digital systems
  - Generation of test patterns
  - I_{DDQ} testing
  - Design for testability
  - Built-in self-tests and concurrent testing
  - Pseudorandom techniques for built-in tests for VLSI circuits and design of standard P1149 compatible chips
  - Microcomputer signature analysis
- Design of systems with PLDs, FPGAs and programmable controllers
  - Design of support software
  - Logic synthesis
  - Implementation of logic structures in CPLDs, FPGAs and PSoCs
  - Fast operating CPU structures of programmable controllers and methods of PLC programming
  - Distributed structures of PLCs
  - PLC applications

- Frequency multipliers based on digital techniques
- Laboratory and industrial data acquisition and control systems
  - Signal conditioning
  - Analogue-to-digital and digital-to-analogue converters with optical isolation and fibre optic transmission systems
- Multiprocessor systems
  - Pipelining and parallel processing
  - Systems with global memory and arbitration
  - Statistical analysis of performance for pipelining processing
- ASIC design
  - High level design methodologies
  - System modelling and simulation (using VHDL and Verilog)
  - Distributed design methodologies based on Internet

Courses

- Digital Systems Fundamentals
- Design of Digital Devices
- Microprocessors Fundamentals
- Microprocessor Systems
- Reliability and Testing of Electronic Devices
- Computer Aided Design of Integrated Circuits
- Programmable Logic Devices
- Programmable Controllers

DIVISION OF CIRCUIT AND SIGNAL THEORY

Head of Division: Prof. Jerzy RUTKOWSKI, PhD, DSc

Research staff

Prof. Jerzy RUTKOWSKI, PhD, DSc

Tomasz GOLONEK, PhD
Tadeusz GRABOWIECKI, PhD
Damian GRZECHCA, PhD
Lucjan KARWAN, PhD
Jacek KONOPACKI, PhD
Jan MACHNIEWSKI, PhD
Katarzyna MOŚCIŃSKA, PhD
Andrzej PUŁKA, PhD

PhD Students
Łukasz CHRUSZCZYK, MSc
Piotr JANTOS, MSc
Piotr KYZIOŁ, MSc

Research fields

- Computer-aided electronic circuits analysis and design
  - Failure diagnostics in analogue electronic circuits
  - Application of sensitivity methods to the analysis and synthesis of electronic circuits
  - Modelling and simulation of digital and mixed analog-digital circuits in VHDL language
  - System level design in SystemC
  - Application of artificial intelligence methods and genetic algorithms to circuit theory and electronics
  - Common-sense reasoning modelling and application of AI techniques to circuits models generation and verification
- Digital signal processing focused on digital filters design and application
- Signal processing and basic research into neural networks (analysis, synthesis and optimisation) and their application to engineering practice
  - Application of neural networks to image processing and recognition, including texture images
  - Application of wavelet techniques to signal processing
- Web – based education

Courses

- Circuit Theory
- Signal Theory
- Fundamentals of Electrical Engineering
- Information Theory and Coding
- Computer-Aided Design of Electronic Circuits
- Digital Signal Processing
- Neural Networks

DIVISION OF TELECOMMUNICATION

Head of Division: Dr. Jacek IZYDORCZYK

Research staff

Jacek IZYDORCZYK, PhD
Prof. Dariusz KANIA, PhD, DSc
Adam DUSTOR, PhD
Maria DZICZKOWSKA, PhD
Leszek DZICZKOWSKI, PhD
Grzegorz DZIWOKI, PhD
Piotr KŁOSOWSKI, PhD
Marcin KUCHARCZYK, PhD
Andrzej KUKIEŁKA, PhD
Jerzy WOJTUSZEK, PhD
Piotr ZAWADZKI, PhD

PhD Students
Mariusz BĄK, MSc
Wojciech SUŁEK, MSc

Research fields

- Digital commutation in modern telecommunication systems
  - Construction of telephone exchanges
  - Supervisory software for telephone exchanges
  - Special services (e.g. teleconferences)
  - Implementation of digital networks with integrated services (ISDN, B-ISDN, ATM)
- Application of digital signal processing to telecommunication
  - Compression of speech signal with the application of DSPs
  - Speech synthesis
  - Speech and speaker recognition
  - Application of artificial neural networks to signal processing
  - Design, testing and implementation of error correcting and modulating codes
  - Design of modern local area networks
  - Implementation and testing of new services in the Internet
  - xDSL technology

- Electromagnetic field engineering
  - Radiation and scattering of electromagnetic waves
  - Lightning protection
- Modems

Courses

- Fundamentals of Analogue and Digital Communication
- Fundamentals of Commutation
- Switching Nodes and Exchanges
- Principles of Transmission
- Communication Systems
- Signal Theory
- Information Theory and Coding
- Digital Signal Processing
- Computer-Aided Analysis of Electronic Circuits
- Digital Signal Processors (DSP)
- Neural Networks
- Computer Networks
- Internet
- Modems
- Introduction to Cryptography

DIVISION OF BIOMEDICAL ELECTRONICS

Head of Division: Prof. Jacek ŁĘSKI, PhD, DSc

Research staff

Prof. Jacek ŁĘSKI, PhD, DSc

Prof. Ewa PIĘTKA, PhD, DSc
Paweł BADURA, PhD
Robert CZABAŃSKI, PhD
Arkadiusz GERTYCH, PhD
Norbert HENZEL, PhD
Jerzy IHNATOWICZ, PhD
Jacek KAWA, PhD
Marian KOTAS, PhD
Tomasz PANDER, PhD
Stanisław PIETRASZEK, PhD
Sylwia POŚPIECH-KURKOWSKA, PhD
Tomasz PRZYBYŁA, PhD
Dominik SPINCZYK, PhD
Ewa STRASZECKA, PhD
Wojciech WIĘCŁAWEK, PhD
Piotr ZARYCHTA, PhD

PhD Students

Michał JEŻEWSKI, MSc
Joanna MUSIOŁ, MSc
Marcin RUDZKI, MSc

Research fields

- Biocybernetics and biomedical engineering - processing of information in medicine
  - Processing of biomedical signals
  - Image processing and analysis
  - Fuzzy sets and systems, neuro-fuzzy systems
  - Pattern recognition
  - Cybernetics
  - Computer assisted medical diagnosis
  - Hospital information system
  - Picture archiving and communications systems
  - Medical information systems integration
  - Expert systems in medicine
  - Time-frequency analysis of biomedical signals
  - Multirate signal processing

- Evolutionary computations
- Artificial neural networks
- Data mining
- Artificial intelligence

- Design, construction and testing of electronic medical apparatus
  - Design and construction of amplifiers for biological signals and data acquisition systems co-operating with computers
  - Testing of electromedical apparatus
  - Design of electronic devices for data acquisition

Courses

- Electromedical Metrology
- X-ray and Nuclear Imaging
- Medical Information Systems
- Cybernetics
- Electromedical Equipment
- Pattern Recognition
- Principles of Knowledge Engineering
- Diagnostic Imaging Systems
- Biocybernetics
- Computers in Medicine
- Diagnostic Cardiological Systems
- Computer Aided Medical Diagnosis
- Materials Science and Principles of Construction of Electronic Equipment
- Probability Theory and Mathematical Statistics
- Numerical Methods
- Biomedical Information Processing

DIVISION OF MICROELECTRONICS AND BIOTECHNOLOGY

Head of Division: Prof. Ewaryst TKACZ, PhD, DSc

Research staff

Prof. Ewaryst TKACZ, PhD, DSc

Prof. Sławomir KOŃCZAK, PhD, DSc
Dariusz KOMOROWSKI, PhD
Paweł KOSTKA, PhD
Piotr KOWALIK, PhD
Zbigniew PRUSZOWSKI, PhD
Jerzy ULJANOW, PhD
Krzysztof WACZYŃSKI, PhD
Edyta WRÓBEL, PhD
Weronika IZYDORCZYK, MSc

PhD Students

Wojciech FILIPOWSKI, MSc
Artur GINTROWSKI, MSc

Research fields

- Biotechnology and bioinformatics
  - Analysis of gene expressions
  - Computer assisted medical diagnosis
  - Time-frequency analysis of biomedical signals
  - Multirate signal processing
  - Evolutionary computations
- Design of electronic devices for data acquisition
- Application of organosilicon compounds to the production of doped glasses for semiconductor technology
- Special hybrid circuits made in thick (thin) film technology
  - Hermetic sealing of hybrid circuits based on epoxy plastics
  - Manufacture and stability testing of resistance ladders based on pastes of Polish production
  - Vapour deposition of metallic layers applied to hybrid circuits
- Chemical compounds for thick- and thin-film sensors
- Solar cells and photovoltaic systems

Courses

- Materials Science and Principles of Construction of Electronic Equipment
- Electromedical Metrology
- Bionics
- Computers in Medicine
- Biotechnology in Medicine
- Computer Assisted Diagnostics in Medical Care
- Artificial Organs
- Microelectronics
- Physics of Microfabrication
- Electronic Devices, Semiconductor Structures and Circuits
- Sensors
- Principles of Electron Technology
- Semiconductor Devices
- Special Semiconductor Devices
- Thin-Film Technology
- Thick-Film Technology
- Design of Thick/Thin-Film Circuits
- Hybrid Circuit Technology
- Hermetic Sealing
- Solid-State Physics
- Physics
- Physics in Medicine

STATUTORY ACTIVITES OF THE INSTITUTE OF ELECTRONICS

TITLE OF PROFESSOR

1. The President of Poland conferred the title of professor on **Ewaryst Tkacz**, PhD, DSc, on 22 October 2007.

PhD DEGREES CONFERRED ON STAFF MEMBERS AND PhD STUDENTS OF THE INSTITUTE OF ELECTRONICS

1. **Jacek Kawa**, Fuzzy processing in segmentation of demyelination plaques in brain magnetic resonance images, PhD advisor: Prof. E. Piętka, 17 July 2007
2. **Artur Noga**, Improvement of efficiency of the hybrid MM-PO method for wide-band analysis of the radiating structures, PhD advisor: Prof. A. Karwowski, 30 October 2007 (with honours)
3. **Tomasz Topa**, Fast MM-FDTD hybrid method in computational electromagnetics, PhD advisor: Prof. A. Karwowski, 30 October 2007
4. **Dominik Spinczyk**, Active Contour in CT lung segmentation, PhD advisor: Prof. E. Piętka, 30 October 2007
5. **Paweł Badura**, Three-Dimensional Segmentation of Lung Nodules with Elements of Artificial Intelligence, PhD advisor: Prof. E. Piętka, 18 December 2007

RESEARCH GRANTS

Research activities of the Institute of Electronics are mainly financed by the Ministry of Science and Higher Education within the frames of a general research programme:

- ***Development of new research areas in electronics, telecommunication and signal processing***

Apart from this, each division of the Institute carries out its own research in the following general areas, which are further subdivided into individual research projects:

Division of Electronics Fundamentals:

- *Electronic components, circuits and systems - development of measurement methods, analysis and synthesis*

Division of Digital and Microprocessor Systems:

- *Multiprocessor systems, application specific integrated circuits and programmable logic devices and systems - analysis, design and testing*

Division of Circuit and Signal Theory:

- *Computer-aided methods of analysis, synthesis and testing of electronic systems and their selected applications*

Division of Telecommunication:

- *Development of methods and applications of digital channel commutation and transmission of digital signals, theoretical and experimental methods of examination of bodies radiating and dissipating electromagnetic waves*

Division of Biomedical Electronics:

- *Acquisition and processing of biomedical information*

Division of Microelectronics and Biotechnology:

- *Application methods of microelectronic technologies and biotechnologies*

In total, forty nine individual research projects were completed in 2007.

GRANTS AWARDED BY THE COMMISSION OF EUROPEAN COMMUNITIES

1. Project IST- World - Knowledge Base for RTD competencies in IST Contract No 015823, duration: April 2005 - October 2007 (Dr. T. Grabowiecki)

The objective of the project was to set up and populate an information portal with automatic services that help to promote RTD competencies in specific fields of IST in the NMS and ACC and facilitate and foster the involvement of RTD actors in joint research activities. The portal contains information about RTD actors on the local, national and international (European) level, such as persons, research groups, organisations and projects, and their experience and expertise. Such a unified portal makes information accessible that is currently spread over a variety of national and European databases. It adds value compared to existing databases by providing a single point of access to information about RTD expertise in the IST field in the NMS/ACC, and by providing innovative data analysis and social networking functionalities.

The portal stimulates *active involvement* of researchers, research groups and organizations by building active professional virtual communities, using existing models for community building and maintenance upgrading them by community identification and community monitoring services.

The target user groups are organisations from all countries looking for specific RTD competencies, organisations from NMS/ACC wishing to promote their own competencies, and service providers (such as consultancies or other support actions requiring a knowledge base for their work).

The portal overcomes the shortcomings of the existing on-line services by offering advanced analytical and prediction services and by joining knowledge mapping with social networks building. It supports partner search for IST proposals and commercial projects by providing the following functionalities:

1. **Information Repository:** information about partners, their resources, active projects and their expertise.
2. **Partner Finding Tool:** predicting the optimum consortia of partners based on their competences, experiences and trust.

3. **Social Network Identification:** analysis of the present research activities, actors, social networks and results visualized by different techniques.
4. **Forecasting/Prediction:** forecasting of RTD trends based on monitoring of current research initiatives, projects and achievements, and predicting possible future research themes based on automatically detected trends.
5. **Expertise Identification:** summarising and presenting different aspects of a person's complex expertise profile based on extraction of information from a potentially huge number of web search results.

The information portal and promotion activities focus on two out of four major thematic priorities within IST:

1. Knowledge and interface technologies

2. Applied IST research addressing major societal and economic challenges

The best coverage for the NMS/ACC has been assured by importing or harvesting already existing data, and by promoting self-registration in the portal through multipliers in different countries, with special emphasis on SMEs. Organisations of all countries from NMS/ACC were represented in the consortium. Of course, the portal is not restricted to organisations from NMS/ACC, but it is open to experts and organisations from all of Europe.

2. MAPPER Project (Model-based Adaptive Product and Process Engineering), 6th Framework Programme of European Union) - FP6-2004-IST-NMP-2, Project 016527 (Dr. A. Pawlak)

During the second year of the MAPPER project we continued close cooperation with Evatronix SA (Dr. W. Sakowski) in the frame of R&D tasks that constituted verification of utility of the MAPPER technology in the selected design tasks of the Evatronix SA design flow. These were:

- **Virtual meeting used for refinement of design specification**: use of the CURE workspace environment[1] (from Fern Univ. Hagen, Germany) to support asynchronous discussion on the specification of the IP component that was designed in a distributed way by Evatronix SA and advICo GmbH (Germany);

[1] http://cure.sourceforge.net/

- **Intra-organisation distributed design and verification** of an IP component between two branches of Evatronix SA (Gliwice and Bielsko-Biała). This experiment used the TRMS environment[2] from Silesian University of Technology for integration of remote design tools that were running at both Evatronix sites;
- **Inter-organisation distributed design and verification** conducted between two different international companies, namely Evatronix SA and advICo GmbH (Germany). This experiment among others needed to verify use of TRMS in an inter-organisational and international collaboration.

The TRMS environment has been further investigated and developed with a services-based architecture (SOA) as an underlying concept. The justification for SOA for TRMS2 is a need for closer integration with other collaborative tools of the MAPPER project that all together form a MAPPER collaborative framework, and assurance of interoperability of TRMS2 with a new generation of collaborative working environments.

The additional thread of our activities has constituted experimentation with active knowledge models supported by the modelling tool METIS from Troux Technologies and AKM[3] – a Norwegian company that had been formed recently as a spin-off from the Troux Technologies. Here, our aim is to demonstrate that this technology is useful for combined design and business processes modelling which is an innovative approach that is not provided by current typical electronic design automation tools.

Continuing a tradition of international workshops on **Challenges in Collaborative Engineering**, the group organised the 5th event as an accompanying event to the IEEE DDECS workshop (Kraków 11-13 April 2007, cce.ecolleg.org/2007/). Public reports of the MAPPER project, as well as prototype versions of tools are available through the MAPPER Industrial User group portal at: http://mapper.eu.org/miug/.

More information on MAPPER is available on: mapper.eu.org

[2] http://mapper.eu.org/miug/trms/
[3] http://www.akmodeling.com/

INDIVIDUAL RESEARCH GRANTS AWARDED BY THE MINISTRY OF SCIENCE AND HIGHER EDUCATION TO STAFF MEMBERS OF THE INSTITUTE

1. **Prof. E. Tkacz**, Elaboration of the New Methodology for Electrogastrographic Signals Examination Concerning Identification of Human Multi-channel EGG Characteristic Parameters Repeatability
2. **W. Izydorczyk (MSc)** (PhD grant, advisor: Prof. B. Adamowicz), Studies of an influence of surface states on the electronic properties of SnO_2 sensor layers
3. **D. Grzechca (PhD),** Hardware Implementation of the Hybrid Methods to Analog Fault Circuits Diagnosis
4. **A. Noga (MSc)** (PhD grant, advisor: Prof. A. Karwowski), Improvement of efficiency of the hybrid MM-PO method for wide-band analysis of radiating structures
5. **T. Topa MSc)** (PhD grant, advisor: Prof. A. Karwowski), An effective hybrid method MoM-FDTD for wide-band analysis of radiating and scattering objects

INTERNATIONAL CO-OPERATION

1. Technical University of Ostrava, Department of Measurements and Control, Czech Republic (Prof. E. Hrynkiewicz)
2. University of Southern California (Prof. E. Piętka)
3. SECTRA – Sweden (Prof. E. Piętka)
4. Technical University of Prague, Institute of Bioengineering, Czech Republic (Prof. E. Tkacz)
5. Technical University of Stuttgart, Institute of Bioengineering, Germany (Prof. E. Tkacz)
6. California University, Department of Electrical Engineering and Computer Science, Berkeley, USA (Dr. A. Pułka)
7. Université Henri Poincaré, Nancy, France (Dr. N. Henzel)

SCIENTIFIC CONFERENCES ORGANISED AND CO-ORGANISED BY THE INSTITUTE OF ELECTRONICS

1. IEEE Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS'07), 11 – 13 April 2007, Cracow, Poland (Dr. A. Pawlak, Dr. T. Garbolino)
2. Workshop on Challenges in Collaborative Engineering, (CCE'07) 11 – 13 April 2007, Cracow, Poland (general co-chair: Dr. A. Pawlak)
3. The Sixth International PhD Students' Workshop Control and Information Technology IWCIT 2007, 6-7 September 2007, Ostrava, Czech Republic (Prof. E. Hrynkiewicz)

STAFF MEMBERS PARTICIPATING IN SCIENTIFIC AND ORGANISING COMMITTEES OF CONFERENCES AND SYMPOSIA

International

1. **Prof. Z. Filus**, International PhD Students' Workshop Control and Information Technology IWCIT 2007, 6-7 September 2007, Ostrava, Czech Republic
2. **Dr. T. Garbolino,** Chairman, IEEE Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS), 11 – 13 April 2007, Cracow, Poland
3. **Prof. A. Hławiczka,** General Chairman, IEEE Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS), 11 – 13 April 2007, Cracow, Poland
4. **Prof. E. Hrynkiewicz**, IEEE Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS), 11 – 13 April 2007, Cracow, Poland
5. **Prof. E. Hrynkiewicz**, Vice-Chairman, International Workshop Control & Information Technology IWCIT 2007, 6-7 September 2007, Ostrava, Czech Republic
6. **Prof. J.Łęski,** The 5th International Conference on Computer Recognition Systems CORES, 22-25 October 2007, Wroclaw, Poland
7. **Dr. A. Pawlak**, Co-Chair and PC member, Workshop on Challenges in Collaborative Engineering, 11 – 13 April 2007, Cracow, Poland

8. **Dr. A. Pawlak**, General Vice-Chair, IEEE Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS), 11 – 13 April 2007, Cracow, Poland
9. **Dr. A. Pawlak**, 6th Electronic Circuits and Systems Conference ECE'07, 6 – 7 September 2007, Bratislava, Slovakia
10. **Dr. A. Pawlak**, 8th IFIP Working Conference on Virtual Enterprises PRO-VE07, 10-12 September 2007, Guimaraes, Portugal
11. **Dr. A.Pawlak**, Program co-chair, keynote, Collaborative Architectural and Building Design 2007 - CollABD'07, 1st Workshop on Integrated Practices for the 21 st Century: Collaborative Working Environments, 13-15.12.2007, Sapienza Univ., Rome
12. **Prof. E. Piętka**, Chair of the International Conference on Information Technologies in Biomedicine
13. **Prof. E. Piętka**, The 5th International Conference on Computer Recognition Systems CORES, 22-25 October 2007, Wroclaw, Poland
14. **Prof. J. Rutkowski**, International Workshop Control & Information Technology IWCIT 2007, 6 - 7 September 2007, Ostrava, Czech Republic
15. **Prof. E. Tkacz**, The 5th International Conference on Computer Recognition Systems CORES, 22-25 October 2007, Wroclaw, Poland

National

1. **Prof. Z. Filus**, National Electronics Conference, 11-13 June 2007, Koszalin- Darłówko Wschodnie
2. **Prof. E. Hrynkiewicz**, National Conference Reprogrammable Digital Circuits RUC 2006, 17-18 May 2007, Szczecin
3. **Prof. E. Hrynkiewicz**, National Electronics Conference, 11-13 June 2007, Koszalin- Darłówko Wschodnie
4. **Prof. E. Hrynkiewicz**, IX Electron Technology Conference ELTE 2007, 4-7 September 2007
5. **Prof. E. Hrynkiewicz**, Scientific Conference „Computer ScienceArt or Craft" KNWS'07, Szklarska Poręba, 22-25 May 2007
6. **Prof. D. Kania,** National Conference Reprogrammable Digital Circuits RUC 2006, 17-18 May 2007, Szczecin
7. **Prof. L. Lasek**, National Electronics Conference, 11-13 June 2007, Koszalin- Darłówko Wschodnie

16. **Prof. J. Łęski**, National Conference Biocybernetics and Biomedical Engineering, 12-15 September 2007, Wrocław
17. **Prof. E. Piętka**, National Conference Biocybernetics and Biomedical Engineering, 12-15 September 2007, Wrocław
8. **Prof. J. Rutkowski**, National Electronics Conference, 11-13 June 2007, Koszalin- Darłówko Wschodnie
9. **Prof. J. Rutkowski**, Conference Computer Networks, 18-21 June 2007, Zakopane
10. **Prof. J. Rutkowski**, Databases: Applications and Systems, Ustroń 30 May – 2 June 2006
11. **Prof. E. Tkacz**, IX Electron Technology Conference ELTE 2007, 4-7 September 2007

REVIEWERS

1. **Dr. R. Czabański**, Fuzzy Sets and Systems; IET Control Theory & Applications; Hindawi Publishing Corporation; Applied Mathematics and Computer Science
2. **Dr. T. Garbolino,** reviewer of EU project proposals
3. **Dr. T. Golonek**, IEEE Transactions on Circuits and Systems-Part II; International Journal of Modelling and Simulation; International Journal of Circuit Theory and Applications
4. **Prof. A. Hławiczka**, grant proposals for the Czech Grant Agency (since 2000)
5. **Prof. E. Hrynkiewicz,** grant proposals for the Czech Grant Agency (since 2000); International Journal on Applied Mathematics and Computer Science; Sensors, Annales UMCS – Informatica; IEEE – ICSES, VLSI Design (Hindavi Publishing Corporation)
6. **Dr. J. Izydorczyk:** reviewer of conference papers: 15th European Signal Processing Conference EUSPICO2007 (April 2007); 6th International Conference on Education and Information Systems, Technologies and Applications: EISTA 2008, 29 June – 2 July 2008, Orlando, Florida, USA, and journal contributions: Physica Status Solidi („Switching thresholds in MTJ using SPICE model – Effects of spin and Ampere torques"), IEEE Transactions on Magnetics („High-Frequency Measurements on Three-Phase 50 Hz Power Transformers")

7. **Prof. A. Karwowski,** IET Proceedings Microwaves, Antennas & Propagation (London); Electronic Letters; IEEE Transactions on Antennas and Propagation; IEEE Transactions on Microwave Theory and Techniques; International Symposium and Exhibition on Electromagnetic Compatibility (EMC)
8. **Dr. J. Konopacki,** IEEE Signal Processing Letters; IEEE Transactions on Circuits and Systems-Part II; IEEE Transactions on Signal Processing; IEEE Transactions on Circuits and Systems I
9. **Dr. M. Kotas**, IEEE Transactions on Biomedical Engineering; Computer Methods and Programs in Biomedicine; Biomedical Signal Processing and Control
10. **Prof. J. Łęski**, Medical Technology in Medical Science Monitor; IEEE Trans. Neural Networks; International Journal Applied Mathematics and Computer Sciences; IEEE Trans. Systems, Man & Cybernetics; Fuzzy Sets and Systems; Pattern Recognition Letters; IEEE Trans. Biomedical Engineering; IEEE Trans. Fuzzy Systems; IEEE Trans. Signal Processing; Computational Statistics and Data Analysis; Bulletin of the Polish Academy of Sciences; BioMedical Engineering OnLine
11. **Prof. E. Piętka,** CARS – Computer Assisted Radiology and Surgery; EuroPACS (European PACS Society); CORES, IEEE Transactions on Medical Imaging; Computerised Medical Imaging and Graphics; Medical Science Monitor; European Journal of Operational Research; Modelling and Simulation in Engineering VLSI Design
12. **Dr. A. Pawlak**, reviewer of EU projects and project proposals
13. **Dr. A. Pułka**, reviewer of EU projects and project proposals
14. **Prof. J. Rutkowski**, IEEE Transactions on Computer Aided Design (CAD)
15. **Dr. E. Straszecka**, Information Sciences, International Journal Elsevier
16. **Prof. E. Tkacz,** grant proposals for the Czech Grant Agency, IEEE Transactions on Biomedical Engineering; Elsevier Signal Processing

OTHER IMPORTANT AFFILIATIONS

1. **Prof. Z. Filus**, member of the section Electronics at the Katowice Branch of the Polish Academy of Sciences
2. **Prof. Z. Filus**, member of the Electronics and Telecommunication Committee, Polish Academy of Sciences
3. **Prof. A. Hławiczka**, member of the Steering Committee of the European Dependable Computing Conference (EDCC) and the European Workshop (EWDC)
4. **Prof. A. Hławiczka**, member of the Steering Committee of the European Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS)
5. **Prof. E. Hrynkiewicz**, member of the Steering Committee of the European Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS)
6. **Prof. E. Hrynkiewicz**, member of the Electronics and Telecommunication Committee, Polish Academy of Sciences
7. **Prof. E. Hrynkiewicz**, member of the section Electronics at the Ministry of Science and Higher Education
8. **Prof. E. Hrynkiewicz**, Chairman of the section Electronics at the Katowice Branch of the Polish Academy of Sciences
9. **Prof. E. Hrynkiewicz**, Section on Signals, Circuits and Systems of the Electronics and Telecommunication Committee, Polish Academy of Science
10. **Prof. E. Hrynkiewicz**, Microelectronics Section of the Electronics and Telecommunication Committee, Polish Academy of Science
11. **Prof. E. Hrynkiewicz**, Member of IFAC Technical Committee TC 4.1 on Components and Technologies for Control
12. **Dr. J. Izydorczyk**, Chairman of Computer Society Chapter, Poland Section IEEE
13. **Dr. J. Izydorczyk**, member of the section Electronics at the Katowice Branch of the Polish Academy of Sciences
14. **Prof. D. Kania**, member of the section Electronics at the Katowice Branch of the Polish Academy of Sciences
15. **Prof. D. Kania**, member of the Electronics and Telecommunication Committee, Polish Academy of Sciences

16. **Prof. A. Karwowski**, founder and Chairman of the Polish Chapter of the IEEE Electromagnetic Compatibility Society
17. **Prof. A. Karwowski**, Vice-Chairman of the Antennas and Propagation Society, AP/AES/MTT Joint Chapter of the IEEE Poland Section
18. **Prof. A. Karwowski**, member of the 4th Workgroup (WG 4) "Characterization of high frequency electromagnetic fields and SAR produced by specific sources", Technical Committee 106 "Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure" of the International Electrotechnical Commission (IEC)
19. **Prof. A. Karwowski,** member of the Project Team (PT) 62209 "Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices - Human models, Instrumentation, and Procedures", Technical Committee 106, IEC
20. **Prof. A. Karwowski,** member of the Project Team (PT) 62232 "EM fields from base stations for mobile telephone", Technical Committee 106, IEC
21. **Prof. A. Karwowski,** member of the Technical Committee 104 for Electromagnetic Compatibility of the Polish Standardisation Committee
22. **Prof. A. Karwowski**, member of the Electromagnetic Compatibility Section, Electronics and Telecommunication Committee, Polish Academy of Sciences
23. **Prof. A. Karwowski**, member of the Microwave Section, Electronics and Telecommunication Committee, Polish Academy of Sciences
24. **Dr. J. Konopacki,** Secretary of the section Electronics at the Katowice Branch of the Polish Academy of Sciences
25. **Prof. J. Łęski**, member of the section Electronics at the Katowice Branch of the Polish Academy of Sciences
26. **Prof. J. Łęski**, member of the division Fuzzy Logic and Neural Networks at the section Automatics and Robotics of the Polish Academy of Sciences, Polish Biomedical Engineering Society
27. **Prof. J. Łęski**, member of the Scientific Committee of the Institute of Medical Technology and Equipment

28. **Prof. J. Łęski**, member of the Steering Committee at the Gliwice-Opole Branch of the Polish Society of Theoretical and Applied Electrotechnics
29. **Prof. J. Łęski**, member of the Scientific Committee of the Biomedical Engineering Centre
30. **Dr. A. Pawlak**, member of IFIP (International Federation for Information Processing) W.G. 10.5 "Electronic Systems Description and Design Tools"
31. **Dr. A. Pawlak**, correspondent of EUROMICRO Association, IFIP (International Federation for Information Processing) W.G. 10.5 "Electronic Systems Description and Design Tools"
32. **Dr. A. Pawlak**, member of the Telecommunication Board at the Office of Electronic Communications
33. **Dr. A. Pawlak**, ECSI (European CAD Standardization Initiative) supported by the Institute of Electron Technology, Warsaw
34. **Dr. A. Pawlak**, member of the Steering Committee of the European Workshop on Design and Diagnostics of Electronic Circuits and Systems (DDECS)
35. **Prof. E. Piętka**, IEEE Poland Section - Engineering in Medicine and Biology - chair of the EMS Chapter
36. **Prof. E. Piętka**, member of the Board of European PACS Society /EuroPACS/
37. **Prof. E. Piętka**, member of the Programme Committee of Computer Assisted Radiology and Surgery
38. **Prof. E. Piętka**, member of the Programme Committee of European Congress of Radiology
39. **Prof. E. Piętka,** member of the Section Electronics at the Katowice Branch of the Polish Academy of Sciences
40. **Dr. A. Pułka**, member of Chess (Center for Hybrid and Embedded Software Systems) at the University of California, headed by Prof. Edward Lee
41. **Prof. J. Rutkowski**, member of IEEE CAS (Circuits and Systems) Society, since 1997
42. **Prof. J. Rutkowski**, member of IEEE IAM (Instrumentation and Measurements) Society, since 2005

43. **Prof. J. Rutkowski**, member of the Polish Association of Theoretical and Applied Electrotechnics (PTETIS), since 1995
44. **Prof. J. Rutkowski**, member of the Committee of Electronics and Telecommunication of the Polish Academy of Sciences – Electronic Signals, Circuits and Systems Section, since 2000
45. **Prof. J. Rutkowski**, member of the Committee of Electronics and Telecommunication of the Polish Academy of Sciences - Microelectronics Section, since 2004
46. **Prof. J. Rutkowski**, member of the Accreditation Commission of Technical Universities in Poland - Electronics and Telecommunication Section, since 2002
47. **Prof. J. Rutkowski**, Steering Committee member of the Electronics and Telecommunication Panel of the Polish Academy of Sciences, since 2007
48. **Prof. E. Tkacz,** member of the International Advisory Board of the Annual Journal of Medical Informatics and Technology published by the University of Silesia
49. **Prof. E. Tkacz,** member of the Section Electronics at the Katowice Branch of the Polish Academy of Sciences
50. **Prof. E. Tkacz,** IEEE/EMBS (Engineering in Medicine and Biology Society)
51. **Prof. E. Tkacz,** EUROSIM – BIOSIGNAL, TTK (Polish Cardiac Society)
52. **Prof. E. Tkacz,** ECS (European Cardiac Society)

PATENTS AND PATENT APPLICATIONS

1. **Prof. Dariusz Kania**, Patent No. 194827, 26 January 2007, „The method of state coding for programmable devices with constant (H, L) or programmable output active level"
2. **Michał Salecki (MSc),** Patent No. 197977, 12 November 2007, „A method of rainfall measurement with a float pluviometer"
3. **Dr. Robert Czerwiński**, Patent application No. P-381884 of 2 March 2007, „The method of the state assignment of finite state machines for programmable logic devices"

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OTHER IMPORTANT INFORMATION

In cooperation with Mentor Graphics Corporation, a course of Printed Circuit Board Design, started in 2006, was continued in 2007. The course, based on Mentor software tools, was focused on the design and putting into production sophisticated PCBs for modern digital and mixed AD electronic devices. Sixty seven 5th-year students from Electronics& Telecommunications, Computer Science and Macrofaculty at the Faculty of Automatic Control, Electronics and Computer Science have successfully completed the course.

LIBRARY RESOURCES OF THE INSTITUTE OF ELECTRONICS

Total number of book titles	7030
Number of subscribed national journals	8
Number of subscribed foreign journals	16

LIST OF PUBLICATIONS - 2007

The Institute publishes its own publication, Zeszyty Naukowe Pol. Śl. ELEKTRONIKA, edited by Asst. Prof. Zdzisław Pogoda. Fourteen issues have been published up to now.

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ABSTRACTS OF SELECTED RESEARCH PROJECTS

DIVISION OF ELECTRONICS FUNDAMENTALS

J. Fiołka (PhD), *Some aspects of using signal processing techniques in automotive electronics*

Digital signal processing techniques are used in various areas of automotive electronics, including e.g. engine control, audio video systems, navigation, safety and security systems. One of the key factors contributing to the successful application of a signal-processing algorithm is a low computational complexity of the proposed method. This comes from the fact that the cost, which depends on computational power of the processor, is probably the most important issue in the design of high-volume production. Only low-cost production can lead to broad acceptance of the solution.

The research work briefly described here concerns the knock detection problem. Knock in spark ignition engines is an undesirable mode of combustion, producing sharp pressure pulses associated with vibration of the engine block. This phenomenon limits performance, durability and fuel economy. Moreover, knock can destroy engine parts and considerably increase rates of pollution. For these reasons, early detection of knocking combustion is necessary. One of the difficulties encountered in detection is that the signals measured by a pressure sensor (or knock sensor) include the background noise coming from ignition, valve closing etc. Therefore, a method that rejects the background noise away from the measured signal is desirable.

The proposed method utilizes wavelet-based signal processing to the detection of knocking combustion. The wavelet transform belongs to a class of linear time-frequency representations. The transform has proven to be very effective in analyzing a wide class of signals that appear in practical applications but are not well matched by the Fourier basis. Moreover, there exists a simple and efficient algorithm - called Mallat's scheme - to compute the wavelet expansion coefficients.

In the method two techniques have been applied to remove the background noise: time-frequency filtering and noise suppression (thresholding in the wavelet coefficient domain). Thanks to that we are able to obtain a very precise measure of knock intensity. To reduce the computational complexity a few methods have been used, such as the lifting scheme, which reduces the computational complexity of the Mallat's scheme by a factor of two (asymptotically). Additionally, the lifting scheme allows for an in-place calculation.

In order to verify the method, a knock database of about 37,000 cycles was used. The experimental results, obtained with the application of the database mentioned, confirmed that the proposed method is better in background noise removal and sensitivity than the other methods.

Prof. A. Karwowski, A. Noga (PhD), T. Topa (PhD), *Fast Hybrid Computational Electromagnetics Techniques*

The intention of this research is to improve computational efficiency of two hybrid Computational Electromagnetic Techniques (CEM), namely, MoM–PO (Method-of-Moments–Physical Optics) and MoM–FDTD (Method-of-Moments–Finite Difference Time Domain). MoM-PO performances have been investigated in the context of wide-band analysis of antennas radiating in the presence of electrically large non-penetrable conducting bodies, and two methods of improving efficiency have been thoroughly examined: (1) use of the impedance matrix interpolation technique in the frequency domain, and (2) employing a dynamic adaptive frequency sampling of the desired observable. Both these partial concepts are not basically new but combined together yield an extremely efficient technique which seems to have a bit of novelty and offers spectacular saving in terms of both CPU time and memory storage relative to the conventional MoM and MoM-PO approaches.

In turn, MoM-FDTD hybrid approach requires the information to be exchanged forth and back between the MoM-regions and the FDTD-regions coupled through the Huygens surfaces. For electrically large structures, evaluation of the electric and magnetic field components and related equivalence-principle sources on the Huygens surfaces can represent a significant (even dominant) fraction of the total solution time required for the problem. Within this research, we have carefully examined a possibility of increasing computational efficiency of MoM-FDTD hybrid method by employing spatial interpolation combined with adaptive sampling in calculating the electric and magnetic field components and the effective sources on the Huygens surfaces. Numerical examples show that the proposed approach offers a considerable CPU time saving.

Z. Rymarski (PhD), D*esign hints for single phase voltage inverters dedicated for UPS systems*

The resarch concerned the generalized design methodology of the single-phase voltage source inverters. The design of an inverter dedicated for a UPS system begins with the analysis of the PWM-AC voltage signal spectrum. Output filter parameters should be calculated to meet the requirements of the IEEE-519 standards for the steady-state inverter mode. The discussion of the inverter output impedance in comparison to the type of controller was based on the simplified continuous model of the inverter. Then a discrete model of the inverter power stage was created for the different PWM types. Finally, the parameters of the digital controller for the discrete inverter model were computed using the Coefficient Diagram Method – the pole placement (a polynomial approach) method. The influence of the load impedance on the dynamic properties of the inverter (stability) was calculated. The time constant of the inverter closed loop system was selected to ensure sufficient system robustness. Finally, the step load

change response of the inverter closed loop system was simulated and verified in the laboratory model.

DIVISION OF DIGITAL AND MICROPROCESSOR SYSTEMS

Prof. D. Kania, J. Kulisz (PhD), *Logic synthesis for PAL-based CPLD-s based on two-stage decomposition*

A PAL-based (PAL – Programmable Array Logic) logic block is the core of great majority of contemporary CPLD (Complex Programmable Logic Device) circuits. The purpose of the work, described in a paper, is to present a novel method of two-stage decomposition dedicated for PAL-based CPLD-s. The key point of the algorithm lies in sequential search for a decomposition providing feasibility of implementation of the free block in one PAL-based logic block, containing a limited number of product terms. The proposed method is an alternative to the classical approach based on two-level minimisation of separate single-output functions. An original method of determining the row multiplicity of the partition matrix is presented. For this purpose a new concept of graph is proposed – the Row Incompatibility and Complement Graph. An appropriate algorithm of the Row Incompatibility and Complement Graph colouring is presented. On the basis of row multiplicity evaluated for individual partitionings, the partitioning which provides minimisation of the bound block is chosen. Results of experiments, which are also presented, prove that the proposed method leads to significant reduction of chip area in relation to the classical approach, especially for CPLD structures that consist of PAL-based blocks containing 2i product terms. The proposed method was also compared with decomposition algorithms presented in other works. The results lead to a conclusion, that the proposed two-stage PAL decomposition is especially attractive with respect to the number of logic levels obtained.

M. Chmiel, (PhD), Prof. E. Hrynkiewicz, A. Milik (PhD), *Programmable logic controllers – Architecture, Programming and Implementation*

The investigations are concentrated on two subjects. The first is hardware solutions for the PLC dual processor bit-byte CPUs, which are oriented for optimized data exchange between the CPU processors. The aim of optimisation is maximum utilization of the capabilities of two-processor architecture of the CPU. The key point is preserving high speed of instruction processing by the bit-processor and high functionality of the byte-processor. The structure should enable the processors to work in concurrent mode as far as possible, and minimize the situations, when one processor has to wait for the other.

The second issue resulted in introduction of a modified idea of program execution in PLCs. Instead of serial cyclic execution event sensitive cyclic execution is proposed. Such an approach to control program execution allows selective execution of program blocks. Only these blocks from the entire program are executed whose variables have

changed since the last calculation. The proposed method can be implemented as software modification or as hardware accelerated solution. The most important part of the idea is task or subprogram triggering condition computation. Different methods of program optimisation were discussed. Finally, hardware implementation of an event triggered system was presented. In order to determine program blocks that require recalculation in a current program loop execution specific hardware support is used. A unit used for detection of memory content change allows to determine changes in memory content since the last program block execution. Variables that are used by the program block can be located in different locations of process image memory. In order to precisely determine a condition change of the control program execution, the detector should observe desired regions of memory while other parts should not be considered. This approach requires to equip the change detector with a map of watched regions. Finally, an implementation of the change detector unit together with process image memory in an FPGA was carried out. The work on efficient PLCs are in progress and the presented detector is a part of the larger design of an event driven PLC CPU.

Prof. A. Hławiczka, T. Garbolino (PhD), K. Gucwa (PhD), *Testing dynamic faults in interconnects*

Two methods for reliable measurement of interconnect delays were proposed. One of them enables distinguishing between the inherent delay of a net and the delay induced in the net by crosstalk. It is also insensitive to crosstalk-induced glitches. The proposed solution is scalable and independent from interconnection network structure. It does not require generation of deterministic test patterns for interconnect faults, either. The hardware architecture implementing the proposed solution was designed as well.

Another approach for reliable measurement of interconnect delays involves a specific test pattern sequence that never induces crosstalks. Minimization of ground bounce noise and reduction of power consumption during a test is its additional advantage. The presented method allows to localize and identify static faults of both stuck-at (SaX) and short types too. Structures of a specific test pattern generator and a test response analyser that are necessary for implementing the method are proposed as well. Furthermore, techniques for test data compression that allow substantial reduction of data volume transferred between SoC and ATE are also proposed.

Another activity was devoted to designing ring registers that have short feedback connections and contain cells functioning as D or T flip-flops. The proposed approach enables obtaining a ring register operating with a maximum frequency for a wide range of polynomials for which existing methods are unable to provide optimal results. Such registers can be especially useful as high speed test pattern generators and test response compactors for interconnect testing. Their high operating frequency is particularly important when dynamic faults in interconnects are taken into consideration.

DIVISION OF CIRCUIT AND SIGNAL THEORY

Prof. J. Rutkowski, D. Grzechca (PhD), T. Golonek (PhD), Ł. Chruszczyk (MSc), A. Pułka (PhD), P. Jantos (MSc), *An artificial intelligence method for diagnosis and design of analog electronic circuits*

Current research work has been focused on the diagnosis, testing and design of analog electronic circuits. The application of the artificial intelligence methods was the main goal. During the research project the following new algorithms have been developed:

1. Evolutionary based method for analog filter design. The phenotype is coded by the transfer function with the use of the tree binary structure and a basic two port matrix. The optimization process takes into account: the configuration between basic two ports (internal tree nodes) and circuit (filter) parameters (tree terminals). The proposed algorithm offers both standard and non-trivial amplitude response filter design with cost reduction of the practical circuit.
2. Methods for optimal multi-tone excitation with use of:
    a) Gene Expression Programming, which allows for minimization of the tones (frequencies of the input stimuli) and takes into consideration tolerance margin and ambiguity set of the system.
    b) Simulated Annealing, which takes into account priority of testing and diagnosis (the testing process has greater priority than the diagnosis stage). This method considers hard faults only.
3. Two common-sense reasoning algorithms (SALTO and COSMO). The advantage of these methods is practical implementation in the artificial intelligence language – Prolog. The obtained practical results are much less time and resources consuming.
4. Wavelet – Genetic based method for fault detection and localisation with the use of small signal sensitivity in the time and frequency domains. The chosen algorithms have been tested in the DSP Analog Devices board and reconfigurable analog arrays (FPAA). Results in this field are very promising and tend to prove that highly mixed algorithms give good diagnosis rate. The hardware implementation of the most time consuming procedures leads to a short testing time.
5. Production yield optimization of the analog electronic circuits based on the evolutionary method. The simple genetic algorithm and evolution strategy have been utilized for finding the center region of an analog electronic circuit with elements tolerance deviation. The project has been verified with a few examples. Moreover, the analysis between computational time and complexity of the circuit has been evaluated.

K. Mościńska (PhD), A *Web-based assessment and examination system – from experiment to practice*

Over the last few years the Circuit Theory course at the Faculty of Automatic Control, Electronics and Computer Science has been gradually converted into a blended e-course. The guidelines for computer-assisted multi-choice test development and evaluation were practically verified on the Circuit Theory exam. The idea of information channel has been applied for elaboration of the new model. Maximization of the relative mutual information is the criterion for the exam parameters tuning. The genetic algorithm method is utilized for the optimisation purpose. There are numerous advantages of computer-assisted exams, including reduction of workload, objectivity of marking and elimination of cheating. Permanent verification, modification and expansion of repository should be carried out, mostly with respect to data randomization.

Recently the Web-based assessment (WBA) has been introduced based on the Moodle Distant Education Platform. The application of WBA enables to decrease costs and, first of all, enhance quality of learning. The authors applied the Internet technologies for summative as well as formative assessment. The summative assessment proved to be very successful, even though some modifications should be introduced. A statistical analysis of the obtained results has been performed. The authors analysed the applied forms of assessments, enlightened the main difficulties and provided some tips for teachers introducing WBA, especially in the case of technical university courses. Various forms of Web-based summative and formative assessment, including the modification and randomisation of repository will be permanently developed at the Silesian University of Technology during the next academic years.

DIVISION OF TELECOMMUNICATION

P. Kłosowski (PhD), *The Distance Learning Platform at the Silesian University of Technology*

This research concerns the Distance Learning Platform used by the Silesian University of Technology. The Distance Learning Platform is based on modular object-oriented dynamic learning environment and represents LMS (Learning Management Systems) technology, a software package designed to help educators create quality online courses. Currently on the Distance Learning Platform at the Silesian University of Technology over 600 online courses are available created for students of twelve University's faculties. The total number of Distance Learning Platform users exceeds 17,000. The Distance Learning Platform works as typically asynchronous e-learning service, but in the future more synchronous e-learning services will be added. The Distance Learning Platform has a great potential to create a successful e-learning experience by providing a plethora of excellent tools that can be used to enhance

conventional classroom instruction, in hybrid courses, or any distance learning arrangements.

Development research on creating an integrated distance learning system for the Silesian University of Technology was started in 2001, but the Internet was practically used in education since the 1990s. Technical possibilities of using the Internet in education are in existence since 1991, the year of connecting Polish academic networks to the worldwide Internet. The Silesian University of Technology was among the very first Polish universities connected to the Internet in 1991.

Over the following years the Internet application in education has been more and more popular, especially at the Faculty of Automatic Control, Electronics and Computer Science and other faculties, where using personal computers in education is necessary. Standardization and regularization of all activities in distance learning at the University as a whole has become necessary for years. It is the main purpose of the Distance Learning Platform.

The platform is constantly developed. New interesting features are added as new modules to the source code. The new platform modules implement the most modern technologies that appear in Web-based e-learning and Internet services. An example of these is the Web 2.0 technology.

Web 2.0 refers to a perceived second-generation of web-based communities and hosted services, such as social networking sites, that facilitate collaboration and sharing between users. While interested parties continue to debate the definition of a Web 2.0 application, a Web 2.0 web site may exhibit some basic characteristics. These might include:

- "Network as a platform" — delivering (and allowing users to use) applications entirely through a browser (web operating system).
- Users owning the data on the site and exercising control over that data.
- An architecture of participation and democracy that encourages users to add value to the application as they use it. This stands in sharp contrast to hierarchical access control in applications in which systems categorize users into roles with varying levels of functionality.
- A rich, interactive, user-friendly interface based on Ajax (Asynchronous JavaScript and XML) or similar frameworks.
- Some social-networking aspects.

Most of elements of the Web 2.0 technology listed above are currently implemented to the Distance Learning Platform, thus significantly contributing to increasing efficiency of students' education at the Silesian University of Technology.

M. Kucharczyk (PhD), *Assessment of Teachers and Classes – Measurement of Teaching Quality by the Internet*

The research project, whose results are described in a paper under the same title, deals with an Internet survey system for classes and teaching stuff assessment used by students at the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology. The survey should be available for all students and for them only, so the control of voting is necessary but, on the other hand, the voting should be anonymous. Problems connected with the creation of anonymous but controlled electronic survey, using the Internet, are presented in the paper.

Some technical details of the created survey system solution are also included in the paper. The e-voting system includes two main modules: a student module for filling the survey and an administration module available for authorized users only.

The student needs a token number to login into the system and fill a survey form. Identification of the student on the basis of his token number is almost impossible. The main information contained in a token is the identifier of the survey to which access is allowed by the token. After login he or she must choose from the lists: teacher's name, subject and type of the classes, and next fill the survey according to the pattern issued under the direction of the university's Rector.

The administration module is available only to some persons appointed by the Rector. Administrators can edit lists of teachers and subjects, create surveys and tokens and view statistics. The administrator's rights are limited to the part of the system made accessible to them.

The system is easy to use and has a high level of anonymity. Students prefer it to paper survey forms used before.

P. Zawadzki (PhD), *The security subsystem of the WiMAX networks*

The WiMAX standard provides a wireless solution for the Metropolitan Area Networks (MAN). The correct design of the security subsystem addressing a threat model found in the given environment is the crucial part of the successful network implementation. A synthetic overview of the authentication and key agreement protocols and cryptographic algorithms used on different stages of the WiMAX network standardisation process are presented in the paper devoted to the results of this work.

The first generation of the WiMAX networks is based on Line Of Sight (LOS) links providing point-to-point connections. The threat model of the LOS network is very similar to the one observed in wired networks. The security subsystem of the first WiMAX incarnation imitates the DOCSIS BPI+ standard used by the cable TV providers. The provision of mobility and Non Line Of Sight (NLOS) communication changed the threat model and resulted in the irrelevance of the security subsystem. Some deficiencies of the first version of the Privacy and Key Management (PKM) protocol are named as well as modifications required to take into account multipath propagation and mobility incorporated in the last generation of the WiMAX network

are proposed. The architecture of the proposed security subsystem is very similar to the one applied for Wireless Local Area Networks (WLAN) protection.

Authentication and Key Agreement (AKA) protocols are executed by the Authentication, Authorisation, Accounting (AAA) server. The cryptographic protection of the radio path is provided by the network access points. The presented discussion advertises the WiMAX standard as a secure wireless solution.

DIVISION OF BIOMEDICAL ELECTRONICS

N. Henzel (PhD), *Noise reduction in biological and biochemical signals processing*

Biological and biochemical measurement signals, beside useful information, often contain disturbances, which affect the quality of interpretation. This implies that noise reduction methods have decisive influence on performance of all biomedical and biochemical signal processing systems. Disturbances present in the measurement signal come from different sources and their characteristics and level determines the best way for reducing their influence. This work deals with this problem of noise reduction in the case of reographic and NMR signals.

In the case of Nuclear Magnetic Resonance (NMR) signals the noise reduction is performed in two basic stages. The first stage consists in averaging several acquisitions of the signal in the time domain. The second stage of noise reduction, leading to qualitative and quantitative information, is performed in the frequency domain, where the parameters values, describing in the best way the spectral lines, are determined. The interactions among the spectral lines, their presence or absence, their amplitude and other parameters values define the constraints for this optimization process.

In the case of reographic signals, interpretation requires that several characteristic points on the recorded signal are determined. The first key stage in this process is, once again, noise reduction. In this case, this is performed by detection, synchronization and averaging of reographic cycles. Due to heterogeneous form of this signal this detection is not an easy task. However, it is possible to exploit the localization of characteristic points from the recorded simultaneously ECG signal. These points can be used to estimate the signal cycles localization. On the other side, the ECG characteristic points are also useful for centring and averaging of the impedance signal waves. The determination of these characteristic points is based on digital filtering and requires that flexible digital filter design techniques are developed that accept more sophisticated specifications than the classical methods. Typical specifications include the passband and stopband edges, desired stopband attenuation, maximum passband deviation, maximum filter length, etc. Part of this research work was aimed on developing a new digital filter design method that uses not only the constraints on the designed filter's frequency response but takes also into account the constraints on the output, time domain, signal. The application of weighted filtering is also interesting, where the weights, proper for each reographic cycle, are determined with respect to the actual noise level.

M. Kotas (PhD), *Projective filtering for ventricular repolarization analysis*

The time between depolarization and repolarization of the ventricles is covered by the QT interval. It is an important electrocardiographic parameter, often used to quantify the duration of the ventricular repolarization. The range of the QT intervals measured in different leads is called QT dispersion. A number of publications claimed that a high value of this index is a good marker of the patient's risk for sudden cardiac death. Other papers denied these findings. They saw the reason of the higher QT dispersion mainly in the measurement errors. Moreover, it was shown that QT dispersion significantly changes from beat-to-beat. Thus a static QT dispersion index does not seem to be a good measure allowing identification of the patients at risk. Dynamical, beat-to-beat measurements of the QT interval and the QT dispersion, and evaluation of their variability, are one of the promising approaches to clinical risk stratification.

Unfortunately, the problem, which has not been satisfactorily solved yet, is the problem of the measurement errors. An important source of the errors is the presence of different types of noise in the electrocardiographic signals. Among them electromyographic and motion artifacts are the most difficult to be suppressed because their frequency spectrum overlaps the spectrum of the desired ECG signal. Nonlinear projective filtering, the method which allows ECG noise suppression with limited reduction of the desired signal morphological variability, appeared very useful. It was applied to ECG enhancement prior to the measurements of the QT interval. Compared to the classical linear filtering, the projective filtering was much more effective. It helped to obtain the repeatable measurements in a wide range of the signal-to-noise ratio. The achieved precision of measurements allowed accomplishing successfully one of the most demanding problems of evaluating the beat-to-beat variability of the QT interval. Thus application of the nonlinear projective filtering leads to a reliable analysis of the ventricular repolarization.

E. Straszecka (PhD), *Medical diagnosis support by means of the Dempster-Shafer theory and fuzzy sets*

Medical diagnosis is based on uncertain and imprecise information. Hence, algorithms that support medical inference comply with specific requirements. Medical parameters of different nature: measurable (like laboratory tests), precisely formulated (pregnancy), described in an imprecise way (putting on weight) or defined in an assumed scale (pain) should be included in a model of the diagnosis. Expert's knowledge as well as information from databases have to be used to formulate diagnostic rules. In many references the Dempster-Shafer theory is implemented in the models of the diagnosis, since it neglects dependence of symptoms. Yet, the theory does not solve the problem of unified symptom representation. During the research an extension of the theory for fuzzy focal elements has been proposed. Methods of defining membership functions and an estimation of rule weights in diagnosis are suggested. An algorithm of the diagnosis determination is provided, which makes it possible to indicate diagnostic

rules. Theoretical basics are verified for simulated data, for benchmark databases from the Internet as well as for individually gathered data. Results of the research are presented in scientific papers. They show that the suggested methods can significantly improve automatic inference in medical diagnosis support.

DIVISION OF MICROELECTRONICS AND BIOTECHNOLOGY

E. Wróbel (PhD), K. Waczyński (PhD), W. Filipowski (MSc), *A study on the application of boron doped spin-on glasses in the technology of silicon solar cells*

The study was aimed at examining the possibility of forming a diffusion layer in a solar cell acting as BSF (Back Surface Field), using boron-doped SOG solutions. In this research practical properties of boron-doped solutions (emulsions) were assessed. The emulsions with low concentrations of chemical and mechanical impurities which enabled required parameters of diffusion layers were tested: solution A contained 250 ml of anhydrous ethyl alcohol, 20 ml of deionised water, 89 ml of tetraethyl orthosilicate, 6.8 g of boric acid (equivalent to 2.22% concentration of the acid in the emulsion), solution B had a similar composition and differed only in the concentration of boric acid (4.1 g – concentration of 1.44%). The main factors that determine the practical properties of a dopant solution and hence its suitability are the basic parameters of dopant layers formed from a given source during diffusion i.e. surface resistance R_S and the junction depth x_j. Dopant solutions containing boron were spun in the monitored and dust-free atmosphere of a tank: relative humidity below 60%, temperature of (293÷295) K. The spin-on technique was employed: (2,000÷6,000) rpm for 15 s. The solution spun was dried and hardened to form dopant glass in the air atmosphere at 523 K for (15÷20) min. The silicon wafers thus prepared were diffused at (1,300÷1,400) K for (0.5÷4)h. The surface resistance R_S of (10÷200) Ω/□ and the junction depth x_j of (3-6) μm were observed, depending on the time and temperature of diffusion and the type of dopant emulsion used. They are typical values for boron. Satisfactory scatter of R_S values on the wafers was obtained. Surface resistance was measured employing the ResTest TM 2208 analytic four-point probe station and ResTest TM 2101 (measurement system). The measurements of surface resistance helped determine the uniformity of diffusion layers formed. The results are presented using a computer program. The program is compatible with the ResTest TM analytic four-point probe station. It enabled us to collect and archive data, but first of all draw detailed maps of the distribution of surface resistance of the semiconductor samples. The depth of the junction was determined using the standard technique of spherical grinding and n and p regions were revealed by selectively etching the ground region in a solution of $CuSO_4+H_2O+5\%HF$. The measurement were made geometrically. While generating electric field at the back surface of a silicon wafer, the time of diffusion annealing at high temperatures should be limited so as not to reduce the lifetime of minority carriers. Therefore, the diffusion doping process (time, temperature and dopant concentration) should be designed so as to produce diffusion layers of suitable

parameters. The results of surface resistance and junction depth refer to the doping process carried out at (1,300÷1,400) K. If a lower temperature is required (below 1,200 K), the concentration of a dopant in the source i.e. glass should be increased in order to obtain similar parameters. The problems mentioned herein form a basis for further research into boron-doped SOG emulsions.

P. Kostka (PhD), Prof. E. Tkacz, *Feature extraction and selection algorithms in biomedical data classifiers based on time-frequency and principle component analysis*

As a result of this research project some methods for feature extraction and selection stages of a biomedical pattern recognition system have been proposed. Time-Frequency signal analysis based on the adaptive wavelet transform and the Principle Component Algorithm (PCA) algorithm are used for extracting and selecting from original data the input features that are most predictive for a given outcome. From the discrete fast wavelet transform coefficients an optimal feature set based on energy and entropy of wavelet components is created. Then PCA is used to shrink this feature group by creating the most representative parameter subset for a given problem, which is the input for the last neural classifier stage. The system was positively verified on the set of clinically classified ECG signals for control and atrial fibrillation (AF) disease patients taken from MITBIH data base. The measures of specificity and sensitivity computed for the set of 20 AF and 20 patients from the control group divided into learning and verifying subsets were used to evaluate the presented pattern recognition structure. Different types of wavelet basic function for the feature extraction stage as well as supervised (Multilayer Perceptron) and unsupervised (Self Organizing Maps) neural network classification units were tested to find the best system structure.