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

Annual Review 2013

Institute of Electronics

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Prepared for printing by
Zdzisław Filus

Institute of Electronics, March 2014

FOREWORD

The Institute of Electronics is a part of the Faculty of Automatic Control, Electronics and Computer Science, one of the 13 faculties of the Silesian University of Technology, founded in 1945. The University is located in Gliwice and has almost 29,000 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. The total number of students is about 3,200 now. Since its creation in 1974 the Institute of Electronics has undergone a number of reorganisations. It has over 70 members of academic staff and consists of six divisions:

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

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 3.5-year courses leading to the degree of BSc in the general field of Electronics and Telecommunication and 1.5-year MSc courses in the following specialisations:

- Electronic Apparatus
- Biomedical Electronics
- Microelectronics
- Radio Engineering
- Telecommunication

Both degrees are obtained on the basis of a project and a report, presented during a final examination. In addition, the Institute participates in a joint macro-course in Automatic Control, Electronics and Computer Science, run by the Faculty, in which all teaching is in the English language. In the academic year 2013/2014 a completely new course in Information and Communication Technology was started together with the Institute of

Informatics. The courses normally consist of lectures, laboratories, seminars and projects, and are followed by examinations. 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. 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. Jacek KONOPACKI

DIVISION OF ELECTRONICS FUNDAMENTALS AND RADIO ENGINEERING

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

Research staff

Prof. Zdzisław FILUS, PhD, DSc

Prof. Andrzej KARWOWSKI, PhD, DSc
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
Maciej SURMA, PhD
Tomasz TOPA, PhD
Grzegorz WIECZOREK, PhD
Dariusz WÓJCIK, PhD

PhD Students

Krzysztof BERNACKI, MSc
Adam POPOWICZ, MSc

Research fields

- Electronic circuits synthesis
- Symbolic methods of electronic circuits analysis
- Electronic circuits for automotive applications
- 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
- Fundamentals of Measurements
- Electronic Measurement Techniques
- Switching Circuits
- Special Semiconductor Devices and Circuits
- Materials Technology and Electronic Equipment Design
- Field and Wave Electromagnetics
- Introduction to Radiocommunication
- Radio Engineering Systems
- Fields, Waves and Antennas
- Wireless Computer Networks
- Design of Radio Electronic Devices
- High-Frequency Engineering Fundamentals
- Electromagnetic Compatibility
- Optoelectronics
- Optical Fiber Techniques

DIVISION OF DIGITAL AND MICROPROCESSOR SYSTEMS

Head of Division: Prof. Dariusz Kania, PhD, DSc

Research staff

Prof. Dariusz KANIA, PhD, DSc

Prof. Edward HRYNKIEWICZ, PhD, DSc
Mirosław CHMIEL, PhD
Robert CZERWIŃSKI, PhD
Tomasz GARBOLINO, PhD
Krzysztof GUCWA, PhD
Józef KULISZ, PhD
Adam MILIK, 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
  - Pseudorandom techniques for built-in tests for VLSI circuits and design of standard P1149 compatible chips
  - Microcomputer signature analysis
- Design of systems with programmable devices and controllers
  - Design of support software
  - Logic synthesis
  - Technology mapping in CPLDs, FPGAs and PSoCs
  - Fast operating CPU structures of programmable controllers and methods of PLC programming
  - Distributed structures of PLCs
  - PLC applications
  - Embedded control system design

- 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)
  - IP-core design
  - Distributed design methodologies based on the 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
- Hardware Description Language

DIVISION OF CIRCUIT AND SIGNAL THEORY

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

Research staff

Prof. Jerzy RUTKOWSKI, PhD, DSc

Damian GRZECHCA, PhD, DSc
Jacek KONOPACKI, PhD, DSc
Andrzej PUŁKA, PhD, DSc
Tomasz GOLONEK, PhD
Jan MACHNIEWSKI, PhD
Katarzyna MOŚCIŃSKA, PhD
Łukasz CHRUSZCZYK, PhD
Piotr JANTOS, PhD
Andrzej KUKIEŁKA, PhD

Research fields

- Computer-aided electronic circuits analysis and design
  - Test and diagnosis for analogue and mixed-signal 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
- Indoor location and navigation methods

Courses

- Circuit Theory
- Systems and Signals
- Fundamentals of Electrical Engineering
- Information Theory and Coding
- Computer-Aided Design of Electronic Circuits
- Digital Signal Processing
- Neural Networks
- LabView – Graphical Programming Language
- Computer-Based Measurements with NI LabView

DIVISION OF TELECOMMUNICATION

Head of Division: Asst. Prof. Jacek Izydorczyk, PhD, DSc

Research staff

Asst. Prof. Jacek IZYDORCZYK, PhD, DSc
Leszek DZICZKOWSKI, PhD, DSc
Piotr ZAWADZKI, PhD, DSc
Adam DUSTOR, PhD
Maria DZICZKOWSKA, PhD
Grzegorz DZIWOKI, PhD
Piotr KŁOSOWSKI, PhD
Marcin KUCHARCZYK, PhD
Wojciech SUŁEK, PhD
Jerzy WOJTUSZEK, PhD

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
  - Efficient hardware implementation of decoder of LDPC code.
- 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

Marian KOTAS, PhD, DSc
Ewa STRASZECKA, PhD, DSc
Robert CZABAŃSKI, PhD
Norbert HENZEL, PhD
Jerzy IHNATOWICZ, PhD
Michał JEŻEWSKI, PhD
Michał KOZIELSKI, PhD
Tomasz PANDER, PhD
Stanisław PIETRASZEK, PhD
Tomasz PRZYBYŁA, PhD

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 systems
  - 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 eqipment
  - Design and construction of amplifiers for biological signals and data acquisition systems co-operating with computers
  - Testing of electromedical equipment
  - Design of electronic devices for data acquisition

Courses

- Electromedical Metrology
- X-ray and Nuclear Imaging
- Medical Information Systems
- Cybernetics
- Artificial Intelligence
- Electromedical Equipment
- Pattern Recognition
- Principles of Knowledge Engineering
- Diagnostic Imaging Systems
- Biocybernetics
- Computers in Medicine
- Diagnostic Cardiological Systems
- Computer Aided Medical Diagnosis
- Probability Theory and Mathematical Statistics
- Optimization Methods
- Bionics
- Principles of Digital Signal Processing
- Numerical Methods
- Biomedical Information Processing
- Digital Signal Processing
- Artificial Intelligence in Engineering Applications

DIVISION OF MICROELECTRONICS AND NANOTECHNOLOGY

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

Research staff

Prof. Jacek SZUBER, PhD, DSc

Zbigniew RYMARSKI, PhD, DSc
Wojciech FILIPOWSKI, PhD
Weronika IZYDORCZYK, PhD
Piotr KOWALIK, PhD
Monika KWOKA, PhD
Jerzy ULJANOW, PhD
Krzysztof WACZYŃSKI, PhD
Edyta WRÓBEL, PhD

PhD Students
Aleksander MIERA, MSc
Michał SITARZ, MSc

Research fields

- Design of electronic devices for data acquisition
- Technology of doped semiconductor glasses based on organosilicon compounds
- Special hybrid circuits made in thick (thin) film technology
- Solar cells and photovoltaic systems
- Passivation of semiconductor surfaces for application in microelectronics
- Nanotechnology of transparent conductive oxides and organic semiconductors for application in photovoltaics and gas sensors
- Nanotechnology of transparent conductive oxides and organic semiconductors for application in photovoltaics and gas sensors

Courses

- Design of Thick/Thin-Film Circuits
- Fundamentals of Physics
- Hybrid Circuit Technology
- Electronic Devices, Semiconductor Structures and Circuits
- Materials Science and Principles of Construction of Electronic Equipment
- Microelectronics
- Nanotechnology in Microelectronics
- Solid State Electronics
- Sensors and Actuators
- Thick-Film Technology
- Thin-Film Technology

SECRETARIAL AND TECHNICAL STAFF

Secretarial staff

Beata BIELAWNY, MBA
Edyta KAWA, MSc
Maria LANGIER
Tatiana NIEDZIELA, BBA

Technical staff

Sławomir BEDNARZ, BSc
Andrzej CZYŻ, MSc
Halina DELEWICZ, MSc
Łucja LEWANDOWSKA
Szymon PARA, MSc
Tomasz SZYMAŃSKI, BSc
Natalia WACZYŃSKA–NIEMIEC, MSc
Witold WARZECHA, BSc
Piotr ZAJĄC
Czesław ZIOBER

STATUTORY ACTIVITIES OF THE INSTITUTE OF ELECTRONICS

DSc DEGREES CONFERRED ON STAFF MEMBERS OF THE INSTITUTE OF ELECTRONICS

1. **Leszek Dziczkowski –** DSc examination on the basis of the monograph entitled "The methodology of eddy-current conductance metering" took place at the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology, on 5 November 2013.
2. **Damian Grzechca –** DSc examination on the basis of the monograph entitled "Hybrid methods to test and diagnose of analog electronic circuits – selected issues" took place at the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology on 5 March 2013.
3. **Andrzej Pułka –** DSc examination on the basis of the monograph entitled "Heuristic techniques in modeling and verification of electronic systems. Selected issues." took place at the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology, on 9 April 2013.
4. **Piotr Zawadzki –** DSc examination on the basis of the monograph entitled "Confidential communication protocol insusceptible to classic and quantum attacks" took place at the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology, on 28 May 2013.

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 and Radio Engineering:

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

Division of Digital and Microprocessor Systems:

- *Multiprocessor systems, application specific integrated circuits, 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 Nanotechnology:

- *Advanced technologies in microelectronics and nanoelectronics*

In total, forty-four individual research projects were completed in 2013.

GRANTS AWARDED BY THE COMMISSION OF EUROPEAN COMMUNITIES OR OTHER INTERNATIONAL SOURCES

1. European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability – EuNetAir within European Cooperation in the Field of Scientific and Technical Research (COST)
Grant: OC-2011-1-9706; Period: 2011-2014
Coordination: Dr. Michele Penza, ENEA, Brindisi, Italy; National Coordination: Dr. M. Kwoka
The project deals with the development of new sensing technologies including new materials and systems for air-pollution control and environmental sustainability. It has a form of an international network with the contribution of 12 European scientific centres from academia and industry.

2. Innovation Technology of Multifunctional Materials and Structures for Nanoelectronics, Photonics, Spintronics and Sensoric Techniques (InTechFun); Structural project within Operational Programme of Innovative Economy: POIG.01.03.01-00-159/08, Period: 2009-2013
Coordination: Prof. A. Piotrowska, Institute of Electron Technology, Warsaw, Contribution of the Institute of Electronics: Prof. J. Szuber - Head of group PSl-2
The project deals with the development of a new innovative technology of multifunctional materials and structures for nanoelectronics, photonics, spintronics and sensoric techniques. It has a form of a national network with the contribution of 6 Polish partners from academia and industry. The Institute of Electronics is responsible for 5 workpackages dealing with technology and characterization of novel materials, structures and prototypes. In 2013 several scientific tasks were realized within the new materials and new technological modules, together with the development of infrastructures for new materials characterization.

3. Dependable Cyber-Physical Systems. Project DAAD (Deutscher Akademischer Austausch Dienst) No. 56268155
Coordination: Dr. A. Pawlak
Collaboration with Brandenburg University of Technology in Cottbus (Prof. H.T. Vierhaus) is realised in a frame of the DCPS (Dependable Cyber Physical Systems) project. DCPS is a network project of the German DAAD-Program „Strategic Partnerships and Thematic Networks“ (2013-2016). The project supports organisation of doctoral workshops and

exchange of PhD students and professors doing research in the area of dependable cyber physical systems. Information on DCPS network activities is available on the following web pages:
http://www.iele.polsl.pl/~pawlak/DCPS/index.htm
http://www.iele.polsl.pl/~pawlak/DCPS/index-DCPS.htm
These web pages are accessible from the Institute's home page (Bookmark: *Projects*).

4. Innovative speaker recognition methodology for communications network safety. A structural project financed by the European Fund for Regional Development within the Operational Programme of Innovative Economy in a consortium formed by Silesian Technical University and Samsung: POIG.01.03.01-24-107/12, Period: 2013 – 2015
Coordination: Dr. J. Izydorczyk
The objectives of the project are: 1) Determination how certain parameters affect the process of speaker identifying. 2) Comparative studies of solutions produced in Task 1. 3) The effect of speaker model for speaker identification process. 4) Different approaches to the optimization of the system created Task 2. 5) Tests of the identification system in Matlab environment. 6) Verification and optimization of the computer code provided by the research unit within the task 3.

RESEARCH GRANTS AWARDED BY NATIONAL SOURCES

1. **Dr. D. Grzechca**, Consortium "Defence", Intelligent System for Monitoring and Access Control (Project manager: Prof. Moczulski, Silesian University of Technology, The Faculty of Mechanical Engineering) (duration: 2010-2013)
2. **Dr. P. Kowalik, Dr. Z. Pruszowski,** Influence of parameters of technology on chemical composition and structure of amorphous resistive alloys of Ni-P and Ni-Me-P types determining their electrical properties and ability for production (Coordinators: Dr. M. Cież and Dr. M. Kulawik, Institute of Electron Technology, Cracow) (duration: 18.04.2011- 17.10.2013
3. **Dr. T. Rudnicki**, Control algorithms for mechatronic systems of mechanical vehicles (duration: 18.03.2010 – 17.03.2013)

4. **Dr. W. Sułek,** Nonbinary LDPC codes over GF(q) and their effective hardware decoder implementation (duration: 18.4.2011 – 17.10.2013)
5. **Dr. Z. Rymarski, Dr. W. Oliwa, Dr. G. Wieczorek**, System controlling a group of accumulative heaters for central heating, within the project „Energy in cogeneration" cofinanced by Polish Agency for Enterprise Development (duration: 1.07.2013 – 22.10.2013)

INTERNATIONAL CO-OPERATION

1. University of Brescia, Italy (Prof. J. Szuber, Dr. M. Kwoka)
2. University of Tübingen, Germany (Dr. M. Kwoka)
3. University of L'Aquila, Italy (Prof. J. Szuber, Dr. M. Kwoka)
4. Budapest University of Technology, Budapest, Hungary (Dr. M. Kwoka, Prof. J. Szuber)
5. California University, Department of Electrical Engineering and Computer Science, Berkeley, USA (Dr. A. Pułka)
6. Technical University of Ostrava, Department of Measurements and Control, Czech Republic (Prof. E. Hrynkiewicz)
7. TIMA Laboratory, Grenoble, Francja (Dr. D. Grzechca)
8. Université Henri Poincaré, Nancy, France (Dr. N. Henzel)
9. Université Rennes I, IriSA Lannion, France (Dr. D.Pamuła, Prof. E.Hrynkiewicz)

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

The 8th International Workshop on Semiconductor Surface Passivation – SSP2013, Cracow, 8-12 September 2013 (Prof. M. Szuber, Dr. M. Kwoka)

The 5th Congress of Polish Vacuum Society, V KPTP 2013, Cracow, 12-15 September 2013 (Prof. M. Szuber, Dr. M. Kwoka)

Programmable Devices and embedded Systems (PDeS 2013), 12th IFAC/IEEE International Conference, Velke Karlovice, Czech Republic, 25-27 September 2013 (Prof. E. Hrynkiewicz) (co-organised)

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

International

1. **Dr. T. Garbolino**, Steering Committee and Program Committee, 16th IEEE Symposium on Design and Diagnostics of Electronic Circuits and Systems, DDECS 2013, 8-10 April 2013, Karlovy Vary, Czech Republic
2. **Dr. T. Garbolino**, Program Committee, 16th Euromicro Conference on Digital System Design (DSD), 4-6 September 2013, Santander, Spain
3. **Dr. K. Gucwa,** Program Committee, 16th IEEE Symposium on Design and Diagnostics of Electronic Circuits and Systems, DDECS 2013, 8 - 10 April, 2013, Karlovy Vary, Czech Republic
4. **Prof. E. Hrynkiewicz**, Steering Committee and Program Committee, 16th IEEE Symposium on Design and Diagnostics of Electronic Circuits and Systems, DDECS 2013, 8-10 April 2013, Karlovy Vary, Czech Republic
5. **Prof. E. Hrynkiewicz**, Program Committee, Programmable Devices and embedded Systems (PDeS 2013), 12th IFAC/IEEE International Conference, 25-27 September 2013, Velke Karlovice, Czech Republic
6. **Prof. E. Hrynkiewicz**, Program Committee, The International Science Conference: Computer Networks - CN`13, 17-21 June 2013, The Brunów Palace, Poland
7. **Dr. J. Izydorczyk**, Program Committee, International Symposium on Engineering Education and Educational Technologies, 2013, Orlando, Florida, USA
8. **Dr. J. Izydorczyk**, Program Committee and Organizing Committee, The International Science Conference: Computer Networks - CN`13, 17-21 June 2013, The Brunów Palace, Poland
9. **Prof. A. Karwowski**, International Steering Committee, EMC Europe 2013, 2-6 September 2013, Brugge, Belgium
10. **Prof. A. Karwowski**, Scientific Advisory Committee, Advanced Electromagnetics Symposium AES 2013, 19-22 March 2013, Sharjah - Dubai, United Arab Emirates

11. **Dr. M. Kwoka,** Chairman of Program and Organizing Committee, 8th International Workshop on Semiconductor Surface Passivation – SSP2013, Cracow, 8-12 September 2013
12. **Prof. J. Łęski**, Program Committee, 19th International Conference Medical Informatics & Technologies, 22-24 October 2013, Szczyrk, Poland
13. **Dr. A. Milik**, Program Committee, Programmable Devices and Embeded Systems (PdeS 2013), 12th IFAC/IEEE International Conference, 25-27 September 2013, Velke Karlovice, Czech Republic
14. **Dr. A. Pawlak,** Program Committee, 16th Euromicro Conference on Digital System Design DSD13, 4-6 September 2013, Santander, Spain
15. **Dr. A. Pawlak,** Program Committee, 16th IEEE Workshop on Design and Diagnostics of Electronic Circuits and Systems DDECS13, 8-10 April 2013, Karlovy Vary, Czech Republic
16. **Dr. A. Pawlak, ECYPS'2013**, Scientific Committee, EUROMICRO/ IEEE Workshop on Embedded and Cyber-Physical Systems, Budva, Montenegro, June 19, 2013
17. **Dr. A. Pawlak, CENICS 2013**, Program Committee, 6th International Conference on Advances in Circuits, Electronics and Micro-electronics, August 25 - 31, 2013 - Barcelona, Spain
18. **Prof. J. Szuber,** Director of the 8th International Workshop on Semiconductor Surface Passivation – SSP2013, 8-12 September 2013, Cracow, Poland
19. **Prof. J. Szuber**, Scientific Committee, 8th International Conference on Solid State Surfaces and Interfaces – SSSI 2013, 24-28 November 2013, Smolenice, Slovakia
20. **Dr. K. Waczyński,** Scientific Committee, 37th International Microelectronics and Packaging IMAPS-CPMT Poland Conference, 22-25 September 2013, Cracow, Poland

National

1. **Prof. Z. Filus**, member of the Scientific Committee of 12th National Electronics Conference, 10-13 June 2013, Darłówko Wschodnie
2. **Prof. E. Hrynkiewicz,** member of the Scientific Committee of 16th National Conference Reprogrammable Digital Circuits, RUC 2013, 23-24 May 2013, Szczecin

3. **Prof. E. Hrynkiewicz**, member of the Scientific Committee of 12th National Electronics Conference, 10-13 June 2013, Darłówko Wschodnie
4. **Prof. E. Hrynkiewicz**, member of the Scientific Committee of Scientific Conference „Informatics – Art. or Craft?" and Training Workshop of the Institute of Computer Science and Electronics of the Zielona Góra University, 10-13 June 2013, Łagów
5. **Prof. D. Kania,** member of the Scientific Committee of 16th National Conference Reprogrammable Digital Circuits, RUC 2013, 23-24 May 2013, Szczecin
6. **Prof. D. Kania**, member of the Scientific Committee of Scientific Conference „Informatics – Art. or Craft?" and Training Workshop of the Institute of Computer Science and Electronics of the Zielona Góra University, 10-13 June 2013, Łagów
7. **Prof. A. Karwowski**, member of the Scientific Committee of National Conference on Radiocommunications, Broadcasting and Television, 10-12 June 2013, Wrocław
8. **Dr. M. Kwoka**, Chairman of Organizing and Program Committee of 5th Congress of Polish Vacuum Society, KPTP 2013, 12-15 September 2013, Cracow
9. **Dr. A. Milik**, member of the Scientific Committee of 16th National Conference Reprogrammable Digital Circuits, RUC 2013, 23-24 May 2013, Szczecin
10. **Prof. J. Rutkowski**, member of the Scientific Committee of 12th National Electronics Conference, 10-13 June 2013, Darłówko Wschodnie
11. **Prof. J. Szuber**, Director of 5th Congress of Polish Vacuum Society, KPTP 2013, 12-15 September 2013, Cracow
12. **Prof. J. Szuber**, member of the Scientific Committee of 11th Conference on Electron Technology – ELTE2013, 16-20 April 2013, Ryn
13. **Prof. J. Szuber**, member of the Scientific Committee of 6th National Conference on Nanotechnology – NANO2013, 9-12 July 2013, Szczecin

REVIEWERS

1. **Dr. R. Czabański**, Przegląd Elektrotechniczny
2. **Dr. Ł. Chruszczyk,** Circuits, Systems and Signal Processing; Journal of Electronic Testing: Theory and Applications
3. **Dr. L Dziczkowski,** IEEE Transactions on Instrumentation and Measurement
4. **Dr. T. Garbolino**, Microelectronics Reliability, Conferences: IEEE DDECS 2013, Euromicro DSD 2013 (special sessions)
5. **Dr. W. Filipowski**, Elektronika - Konstrukcje Technologie Zastosowania
6. **Prof. Z. Filus**, International Journal of Electronics, National Electronics Conference
7. **Dr. T. Garbolino**, Microprocessors and Microsystems, Microelectronics Reliability, Microelectronics Journal, Conferences: IEEE DDECS 2012, Euromicro DSD 2012 (special sessions)
8. **Dr. D. Grzechca,** Journal of Electronic Testing: Theory and Applications, Circuits, Systems & Signal Processing, Metrology and Measurement Systems, Elektronika - Konstrukcje Technologie Zastosowania, Przegląd Elektrotechniczny, projects in the EU Operational Programme Innovative Economy 1.4
9. **Prof. E. Hrynkiewicz,** Journal of Circuits, Systems and Computers; International Journal of Electronics and Telecommunication, IEEE DDECS Symposium, IEEE-IFAC Conference on Programmable Devices and Embedded Systems, International Science Conference on Computer Networks, International Conference on Artificial Intelligence and Soft Computing, Scientific Conference „Informatics – Art or Craft?", National Electronics Conference, National Conference on Reprogrammable Digital Circuits; Pomiary, Automatyka, Kontrola; Elektronika - Konstrukcje Technologie Zastosowania, Szybkobieżne Pojazdy Gąsienicowe
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ABSTRACTS OF SELECTED RESEARCH PROJECTS

DIVISION OF ELECTRONICS FUNDAMENTALS AND RADIO ENGINEERING

A. Popowicz (MSc), Prof. Z. Filus, *Detection, classification and correction of nonlinear processes of dark current generation in CCD matrices*

Astronomical images taken with image sensors are nowadays one of the most important tools of modern astronomy. The most popular are CCD and CMOS sensors, which consist of a matrix of pixels where the light flux can be measured thanks to the photovoltaic effect. Unfortunately, not every pixel can be used effectively. It is due to the possible imperfections located within the pixel. The most commonly encountered problems are: the high dark current rate saturating the pixel's potential well, the nonlinear dark current dependencies, the transient events of the dark current due to irradiation, the pixel nonlinear light response and the CCD fabrication defects. These problems have been dealt with in the first author's PhD thesis.

In professional CCD systems there are several methods developed for investigation of the so-called bad pixels. The bad pixel masks are created to help during the image reduction. This calibration is usually repeated periodically because new bad pixels can appear. One way to reduce bad pixels' impact on the image quality is to take many images with slight shifts. Such a set of dithered pictures is shifted back and averaged, ignoring the pixels from the mask. Unfortunately, this is not possible if there is only a single image, and in such cases an interpolation over bad pixels is necessary.

One particular research aim of the PhD project was a comparison of several well-known interpolation methods of bad pixel correction in astronomical images: the linear interpolation, the cubic interpolation, the biharmonic interpolation, the nearest neighbor interpolation and the median interpolation. A thousand of images from the Sloan Digital Sky Survey were used as an examination set. The biharmonic interpolation as the most accurate method was enhanced with the idea of supporting it with a database of known astronomical image fragments. The test with a large database and a minimal database proved the effectiveness of the method as a pixel's brightness estimator and its superiority over other interpolation methods examined in our tests. Moreover, biharmonic interpolation has not been used for astronomical images interpolation yet. With the supporting idea applied, its accuracy was about 4 times higher than for the linear interpolation, which is typically used for astronomical image calibration. It should be added that the modified interpolation idea is flexible and it could be applied to any current or future interpolation method.

J. Fiołka (PhD), Z. Kidoń (PhD), *Method for stabilogram characterization using angular-segment function*

Posturography is a clinical assessment technique that is used to analyze human postural stability. In static posturography, a patient stands in an upright position on a stationary force test platform. During the trial time, which lasts from 30 to 120 seconds, the ground reaction forces, generated by the subject, are continuously registered. Then, with the aid of elementary Newtonian mechanics, these forces are used to calculate the coordinates of the center of pressure point (CoP) over the platform surface.

A number of methods based on the CoP displacement have been used in clinical contexts to examine postural stability. Due to the time-consuming nature of a visual analysis, many techniques are applied to trajectory parameterization. The classical posturographic parameters, most commonly found in the literature, describe the geometry of the trajectory (e.g. length and area of the trajectory). Another possibility is to analyze the frequency or time-frequency content of the trajectory components.

In our work, we propose a method for the characterization of stabilograms using the angular-segment function. In contrast to classical methods of analysis where postural stability is quantified in terms of geometric properties of the stabilogram, the proposed approach is based on a different technique. It has been shown that the CoP trajectory can be described in an alternative way, using a one-dimensional angular-segment function. We provide a detailed description of the two algorithms used to determine the angular-segment function. The first variant, assumes the constant distance between recalculated trajectory points, while the second - a constant path length along the trajectory.

Special attention has been paid to the development of the methods for the parameterization of the angular segment function. For this reason, we proposed three definitions of parameters. A detailed study was performed to explore the discriminative potential and reliability of the proposed parameters. Moreover, the influence of the methods used to generate the angular-segment function on the parameterization result has been examined.

In conclusion, the obtained results confirm that this function is a valuable tool in the characterization of stabilographic trajectories. It is also worth noting that the proposed method reduces dimensionality of the problem.

M. Magnuski (PhD), D. Wójcik (PhD), *Vivaldi Antenna Array for UWB Networks*

The aim of the described work was to design and fabricate an antenna array for Ultra Wide Band (UWB) applications. UWB systems are applied in radar technology or in short-range data transmission for very high-speed interchange of large amounts of information (hundreds of Mbps). UWB devices transmit sequences of very narrow

pulses of picosecond durations. As a result, the spectrum of the emission is very broad and the individual spectral components carry very little powers - which resembles spread spectrum transmission.

According to ITU, the 3 to 12 GHz frequency band is designated for UWB systems. Transmission of a single UWB signal occupies at least the 500MHz, or at least 20% of the operating frequency. Properties of UWB transmission and a very broad frequency band designated for its purpose implicate application of broadband antennas. Among a large number of broadband antennas, which are suitable for application in UWB systems, the Vivaldi antenna seems to be a reasonable choice. The Vivaldi antenna has excellent radiative and impedance properties and could be easily applied in antenna arrays.

The research concerns design of two antenna arrays operating in the 1-6 GHz frequency band, which consist of two or four Vivaldi antennas. The basic antenna system is composed of two Vivaldi radiators connected in parallel. The separate antenna of the system has 100 ohms input impedance and is connected to the other by means of a T-junction splitter built from a two-tape symmetric stripline. This kind of feeding network does not contain reactive elements and its application simplifies compensation for non-uniformity occurring at the point of connection of the radiator and the feeding line. An antenna array composed of four radiators is built from two basic antenna systems connected in parallel, fed from an impedance tapered-line transformer. This arrangement simplifies construction of arrays with a greater number of radiators.

In the designed arrays a novel method for increasing the impedance matching bandwidth is introduced. The proposed method applied a concept of deliberate capacitive coupling between radiators of the array. Good properties of the constructed models, applying new concept of coupling, resulted in two patent applications.

DIVISION OF DIGITAL AND MICROPROCESSOR SYSTEMS

Prof. E. Hrynkiewicz, A. Milik (PhD), M. Chmiel (PhD), *Tools and methods for automatic synthesis of Logic Controllers according to IEC61131-3*

This research project aims at an extended approach to the implementation of PLC CPUs. The essence of the project is to reduce a response time and increase a throughput of the entire control system. The designed systems are constructed according to the IEC61131-3 programming language reference manual. Two main threads can be distinguished in the research. One of them is a classical approach that concentrates on the implementation of a multicore and multithreaded CPU dedicated for the PLC. The dedicated CPU is designed with the use of an FPGA platform that enables evaluation of specific architectures, enabling parallel program execution and efficient handling of peripheral units. An alternative to the programmatic approach is a fully custom hardware implementation in reconfigurable FPGA devices. In order to obtain

a hardware-implemented program, an entire tool chain for compilation and synthesis has been developed. It consists of a compiler that transforms standard PLC programming languages to an intermediate form. The developed intermediate form reveals parallelism of control tasks and allows optimisation of the control algorithm. The intermediate form records only the processing dependencies and can be freely scheduled. The different scheduling and mapping strategies into logic resources of the FPGA device are evaluated. The developed intermediate form allows generation of not only hardware structures but also a highly optimised instructions stream for a PLC CPU.

R. Czerwinski (PhD), Prof. D. Kania, *Logic synthesis and technology mapping for CPLDs*

The work in the area specified above resulted in a book that presents logic synthesis and optimization methods dedicated for Complex Programmable Logic Devices (CPLDs). The methods strive to find the optimum fit for the combinational logic and finite state machines to the structure of the logic device and aim at area and speed optimization. The book summarizes many years of the authors' experience and thousands of their experiments.

CPLD macrocells can be individually configured for either sequential or combinatorial logic operation. Usually, macrocells consist of three functional blocks: AND-array, product term allocator, and programmable register. Such a macrocell can also be interpreted as a programmable AND-fixed OR structure. Some problems may appear during technology mapping. Let's say that the number of product terms in logic cells is predefined. If the number of implicants p, representing a function after minimization, is greater than the number of product terms k available in a logic cell, a greater number of logic cells has to be utilized to implement the function. The product term expansion is necessary. However, methods of product term expansion consist in utilizing feedback lines to build a multi-level cascaded structure. Such a structure is quite often area ineffective and propagation delays are increased significantly. Of course, it would be better to carry out the logic synthesis process to effectively use the limited number of product terms contained in cells. So the possibilities as well as limitations of the programmable structures should be considered in the design process as soon as possible. The state assignment and logic optimization methods that incorporate elements of technology mapping were developed and are presented in the book.

The state assignment process includes techniques of two-level minimization and the limited number of terms contained in the cell. The methods aimed at area optimization, speed maximization and the method of state assignment by means of outputs with the necessary theory are presented. Two PAL-oriented optimization methods are discussed. The essence of PAL-oriented multi-level optimization consists in selection of multi-output implicants that can be shared by several single-output functions. The possible large groups of common implicants are searched using a graph of outputs. The method

is especially attractive with respect to utilized macrocells (area optimization). The concept of optimization using product term expansion utilizing tri-state terminals is presented. The process starts with the two-level splitting minimization.

Then, partitioning of the individual minimized functions is performed. As a result of the two procedures, the set of implicants of a Boolean function is divided into subsets with cardinality less than the number of terms available in one PAL-based cell. The two-level optimization is especially attractive with respect to dynamic parameters of the implementation. The most important part of the book is presentation of complex strategies for logic synthesis and technology mapping of finite state machines.

B. Wyrwoł (PhD), *Hierarchical Fuzzy Logic Controller*

The main goal of the research is to design and implement a programmable fuzzy logic controller. A rule based fuzzy inference system in the form of the hierarchical architecture is implemented in the controller. It allows to decrease hardware and software cost of the system and computation time of the inference result. The hierarchical fuzzy inference system consists of the SISO (Single Input Single Output) subsystems, they have the same simple architecture but they differ in contents of its knowledge subbases. The knowledge subbases describe the behavior of the SISO systems and they are created using decomposition for the knowledge base of the primary fuzzy inference system. The classic decomposition method is based on linguistic projection of the knowledge base, so the inference result in the hierarchical system is more fuzzy than in the classical architecture. This is a consequence of the presence of so-called decomposition error. Based on research of the controller in the target environment (closed-loop temperature control system), influence of the decomposition error on control parameters (overshot, setting time, steady state error) is presented. The parameters of the control system are deteriorated, so decomposition error minimization methods are developed based on: modification of the consequence part of the if-then rules, partitioning the rule base or tuning the scaling factor in the denormalisation module of the controller. The programmable fuzzy logic controller was implemented in the AVR-FIS development board with ATMega128 chip and tested in a closed-loop temperature control system. In order to achieve high quality of control, the developed methods of the decomposition error minimization were used.

DIVISION OF CIRCUIT AND SIGNAL THEORY

Prof. J. Rutkowski, K. Mościńska (PhD), *Self-Directed Learning and Flip Teaching*

Today, the act of learning itself is no longer seen as simply a matter of information transfer, but rather as a process of dynamic participation in which students cultivate

new ways of thinking, migrate toward Self Directed Learning (SDL) experiences on computer and Internet. Dynamic development of ICT enables development of new instructional methods, supporting of SDL by different e-materials, such as video-recording of lectures. Such recordings create podcasts for playback on PCs and portable media players and enable introduction of a new method, based on SDL principles, called Flip Teaching (FT).

At the SUT, the Electric Circuits Theory course has been fully redeveloped into the FT model in 2012, preceded by one year preparations of:

- ✓ e-materials supporting theoretical content: video-podcasts, ppt slides, computer simulations,
- ✓ e-materials supporting assessments, based on comprehensive bank of questions:
  - quizzes, to be solved during the semester, accessible through the SUT educational platform (Moodle),
  - screencasts, in which the professor works examples in detail and explains each step along the way, with special attention paid on practical problem solving.

The podcasts and screencasts are uploaded on YouTube, slides are uploaded on Google Drive. The links are displayed on Author's personal blog, all e-materials are commonly accessible - during the first year of activity, the number of the blog-page views has exceeded 20 thousand. In the years 2012-2014, some 500 students have been surveyed. The surveys confirm students' attachment to traditional learning and resistance to innovation, unreadiness to accept SDL and FT. Some 50% percent of students confessed that they do not familiarize themselves regularly with podcasts or other e-materials, prior the next-day lecture. They use them rather as post-lecture supporting materials. It definitely proves that proper use of ICT by educators is the first step toward common acceptance of SDL principles. Use of popular Internet facilities: YouTube, Google blog and Google Drive seems to be the additional benefit of these e-materials. Improvement of students' SDL readiness is a long-term process and a big challenge for educators. The following question should be formulated: "How to convince students to give up bad habits and accept SDL principles?". This can be achieved by gradual working toward SDL, and first of all, by improving attractiveness of e-materials content, technical quality of presentation, easiness of access. If high level of SDL readiness is reached, and only then, great benefits of FT, significant improvement of students' satisfaction and performance, could be obtained. Then, at the introductory stage, monitoring of students' satisfaction and improvement of SDLR, seems more important than measuring the FT impact on exam scores.

D. Grzechca (PhD, DSc), L. Chruszczyk (PhD), *GPS-based location and identification system with custom communication protocol*

The idea of wireless personal monitoring system grows from the need of locating and identifying persons and vehicles in a wide open outdoor area, e.g. airport apron,

military traverse, game field or dock. Although security tasks for airport apron differ from outdoor patients monitoring, there are common tasks for all abovementioned cases: outdoor wide-area location and identification. The surveillance tasks of the airport security service can be divided into three main groups: intrusion prevention, detection and tracking, ground staff surveillance. The research tasks have covered the most important steps of the system design: evaluation of wireless communication environment (i.e. path loss), selection among available single-chip GPS receivers and design of a custom communication protocol with the goal of minimal transmission delay. The system structure assumes at least one base station (BS) communicating wirelessly with many mobile units (MU). BS transmits data to/from an operator PC through RS-232/22/485 or Ethernet network. Each MU contains a GPS integrated receiver, RF transceiver, power management unit, microcontroller (8-bit Atmel Xmega or 32-bit Atmel AVR32 AT32UC3B0256). Optionally it can be equipped with a keyboard, LCD display or biometric sensor (e.g. finger-print reader) in order to confirm personal authorization (on demand). A version for the patients is to be simpler and can optionally be equipped with a panic button. The structure of BS is similar, additionally it contains an RS-422/485 or Ethernet module to communicate with the operator software (PC). BS containing a GPS receiver with a constant and known position may introduce simple DGPS functionality, reducing the location error down to 1–2 m. Positioning is based on a satellite navigation. A comparison of existing available global solutions (GPS, Glonass, Galileo, Doris) resulted in selection of the GPS system: wide availability of modules, low cost and acceptable accuracy. There have been satisfied most of the initial project assumptions: low power consumption, low manufacturing cost and acceptable physical dimensions. However, there are still some problems to be solved in the future, e.g.: operation speed is still below expectations and the size could be further reduced.

DIVISION OF TELECOMMUNICATION

P. Zawadzki (PhD, DSc) *A novel method of eavesdropping detection in quantum direct communication*

Security of the contemporary and forthcoming Information and Communication Technology (ICT) systems is closely related to quantum information processing because of two reasons. First, quantum computers, if built, will introduce qualitative speed-up in solving some problems. The Shor's factorization algorithm plays here a central role because it is capable to break the presently used key distribution and authentication schemes in polynomial time. Secondly, quantum indistinguishability and nature of quantum measurement permits security paradigms to be derived from basic laws of physics. But construction of devices providing a purely quantum ICT system is not expected in a foreseeable future and design of protocols permitting functional replacement of classic key agreement protocols is possible at present.

An improved procedure for eavesdropping detection in Quantum Direct Communication (QDC) has been proposed as a result of the research undertaken. The proposed solution is an improvement of the so-called Ping-Pong protocol. It is known that this protocol is asymptotically secure in lossless channels only when a single classic bit is encoded per qubit transfer. However, principles of quantum mechanics permit superdense information coding. Unfortunately, the seminal version of Ping-Pong protocol is insecure in such a mode of operation and an eavesdropper can intercept half the message without risking of being detected. To cope with this problem, an eavesdropping detection procedure exploiting properties of mutually unbiased bases has been proposed and analyzed. It has been shown that such a procedure detects with reasonable probability attacks designed with superdense coding in mind. Also, closed form formula describing scaling of the lower bound of detection probability with the increase of the signal particle dimensionality has been derived. The proposed improvement doubles the capacity of the protocol. In lossy channels, security of communication can be improved by supplementing the protocol with a classic layer, which has been the subject of our previous research.

W. Sułek (PhD), G. Dziwoki (PhD), M. Kucharczyk (PhD), *Nonbinary LDPC codes and their effective hardware decoder implementation*

Low Density Parity Check (LDPC) codes over nonbinary Galois Fields GF(q) are a generalization of the industrial standard binary LDPC codes for forward error correction in communication and information systems. The error correcting capabilities in the case of short block length coding can be significantly improved with the employment of non-binary codes. Meanwhile the main challenge is the decoding algorithm complexity that scales exponentially with the GF field order. In consequence the decoder hardware implementation is still a challenging task.
This research project concerns the GF(q)-LDPC hardware decoder design approach targeted for the FPGA devices. Efficiency of the designed implementation is based on a balanced utilization of all types of FPGA resources: main logic elements as well as Multiplier Cores and Block RAMs. In order to achieve this, the modified decoding algorithm formulation and the modified decoder structure have been developed. Some other important aspects of efficient FPGA implementation have been also considered, e.g. pipeline processing, decoder data normalization and wordlength optimization, efficient implementation of nonlinear functions computation modules. The designed decoders are implemented making use of a Hardware Description Language VHDL.
The serial or semi parallel decoder architecture can be implemented with the latter, achieving higher throughput at the cost of higher FPGA utilization. However the semi parallel architecture is allowed only for codes with blockwise partitioned structure of the parity check matrix, which are called structured codes. Therefore the research also includes the development of a versatile algorithm for construction of codes that are both nonbinary and structured. The algorithm aims at optimizing the code graph (Tanner graph) by reducing the existence of small cycles with low external connectivity, while at the same time selecting appropriate nonzero GF(q) coefficients for the parity check

matrix. The algorithm can be used for code construction of any field order, block length and code rate. Experimental results reveal that performance of the codes constructed with the designed algorithm is generally better than performance of the codes obtained with two reference algorithms for structured and non-structured codes.
The common wireless transmission scheme that could be combined with the GF(q)-LDPC codes is the multi-carrier OFDM (Orthogonal Frequency Division Multiplexing) scheme. Therefore a simple method of the subchannel ordering for OFDM modulation with non-binary LDPC coding has been also proposed. The method exploits some special structural properties of the LDPC code parity check matrix generated based on the PEG (Progressive-Edge-Growth) algorithm. A noticeable coding gain improvement is achieved for regular codes, when the column weights of the parity check matrix is equal to 2.

DIVISION OF BIOMEDICAL ELECTRONICS

Prof. J. Łęski, *Fuzzy C-Ordered-Means Clustering*

Clustering plays an important role in many engineering fields such as pattern recognition, Web mining, image segmentation, signal processing, system modeling, communication, data mining, and so on. The clustering methods divide a set of N vector observations x_1, x_2, …, x_N into c groups denoted Ω_1, Ω_2, …, Ω_c so that the members of the same group are more similar to each other than to the members of the other groups. Generally, clustering methods can be divided into: hierarchical, graph theoretic, decomposing a density function, minimizing a criterion function. In this work fuzzy clustering by minimization of a criterion function will be considered. Fuzzy clustering helps to find natural vague boundaries in data. The fuzzy c-means method is one of the most popular clustering methods based on minimization of a criterion function. However, one of the greatest disadvantages of this method is its sensitivity to the presence of noise and outliers in data. This work introduces a new robust fuzzy clustering method named Fuzzy C-Ordered-Means (FCOM) clustering. This method uses both the Huber's M-estimators and the Yager's OWA operators to obtain its robustness. The method is introduced as the problem of a constrained minimization of the criterion function. The necessary conditions for obtaining local minimum of the criterion function are shown. The existing fuzzy c-medians method and epsilon-insensitive fuzzy clustering method can be obtained as special cases of the method developed. The described algorithm is compared with the Fuzzy C-Means (FCM) and the epsilon-insensitive Fuzzy C-Means (betaFCM) methods in the experiments performed on synthetic data with outliers and heavy-tailed and overlapping groups of points in background noise. These numerical examples show the usefulness of the method proposed when applied to clustering the data with outliers and with heavy-tailed and overlapping groups of points in background noise.

E. Straszecka (PhD, DSc), *Search for data driven diagnostic knowledge*

Nowadays, databases provide us with enormous amounts of information in the form of recorded measurements and parameter values. Yet, the information is useless, if knowledge is not obtained from the data, for instance in the form of rules. Thus, methods of an automatic rules extraction become very important. Still, in case of diagnostic data it is not sufficient to extract any rule – the rule must be understandable and acceptable for a human diagnostician. Thus, not always the classical methods of rules determination are applicable.

Diagnostic rules are usually IF-THEN rules, which should satisfy specific requirements of a diagnosis, for instance a representation of a symptom imprecision and a rule uncertainty. The Dempster-Shafer theory of inference with focal elements defined as fuzzy sets are proposed in the present research for a useful representation of medical diagnostic rules. A set of IF-THEN rules with fuzzy premises and crisp conclusions can be built in this way. Both fuzzy premises and weights of rules are data-driven, hence it is enough to provide training examples classified for appropriate diagnoses to make rules.

It is suggested to find the optimal set of rules by an elimination of superfluous rules from the maximal rule set. Rules that are obtained in this way are easy to interpret by humans and the method allows combining data-driven rules with heuristics. It is shown that the basic probability assignment determined in the Dempster-Shafer theory of evidence can be used as a measure of indicating symptoms that are the most significant for a diagnosis and should create rules. It was found for benchmark diagnostic databases that a diagnosis can be improved using this set of rules in comparison to other rule sets and other reference methods.

S. Pietraszek (PhD), D. Komorowski (PhD), *New generation universal programmable analog front- end for biopotential measurement and its application to EGG*

In this work a new application of universal programmable ECG front-end module ADS1298 is presented. To avoid amplification of the DC component of the input signal in standard biomedical amplifiers after the first stage an analog high-pass filter is used. In hardware high-pass filters it is difficult to change their corner frequency (time constant) and a step change of the DC offset voltage results in long lasting transient response. This long response saturates the next amplifier and causes a decay of the signal for a certain time. An analysis of such a case, given in our work, allows to estimate the dead time as a function of some amplifier parameters like distribution of gain into amplifying stages before and after the high-pass filter, time constant of the filter, supply voltages of the first amplifier, input signal range of the A/D converter and zoom factor p used in the visualization system.

Thanks to the 24–bit resolution of the A/D converter and the programmable gain input amplifiers, a biomedical signal can be recorded with its offset, which allows

to eliminate hardware high-pass filters. High-pass filtering is done by software that allows building more flexible systems using the same analog front-end. The proposed solution was tested on simulated signals from generators, an ECG phantom and a 12–lead ECG signal, with good results. It allows building portable, universal biomedical recording systems such as 12–lead ECG systems, Holter recorders, EEG recorders, EGG recorders, tuned only by software.

The authors decided to use the integrated system ADS1298 recently developed by TI, for noninvasive recording of gastric myoelectrical activity - EGG. The ADS 1298 contains in its internal structure a multi-channel bioelectric signals amplifier and a set of high resolution A/D converters that allow for simplification of the circuit design. The multichannel classic surface EGG signals were captured by six disposable electrodes: four signals electrodes, the reference electrode and the ground electrode placed on the anterior abdominal wall overlying the patient's stomach. The signal was divided into segments and several parameters such as dominant frequency, dominant power and index of normogastria were calculated. These parameters and their temporal distributions could be helpful in diagnosing gastric disorders. The resented work was performed in cooperation with Dr. Dariusz Komorowski from the Faculty of Biomedical Engineering, Silesian University of Technology.

DIVISION OF MICROELECTRONICS AND NANOTECHNOLOGY

P. Kowalik (PhD); *Resistors of Ni-Cu-P layer prepared by electroless metalization*

The technology of production of Ni-Cu-P layers has been commonly known since many years, but the most intensive development of this technology was observed in the 1990s. These layers are obtained from a water bath in the presence of Cu chloride as well as Ni as the basic substrates and sodium hypophosphite as a reducing agent. Due to much higher potential of red-ox ions Cu2+ (+0,337 in comparison with –0.24V) nickel reaction takes place much more slowly, despite the fact that nickel plating is autocatalytic reaction. This process occurs in an acidic or alkaline environment using citric acid or tartaric acid or their salts.

The Ni-Cu-P alloy loses its ferromagnetic properties when the concentration of cooper reaches about 10%. On the other hand, an alloy, which contains more than 1% Cu, features increased resistance against corrosion. The greatest resistance can be found in the alloy with 30% of Cu, although the alloy with 17,2% of Cu has also excellent properties.

Due to very low electrical resistivity (Ni-Cu is known as constantan) the Ni-Cu-P alloy can be useful for production of resistors below 1Ω. The initial structure is amorphous, however while heating it is becoming Ni^3P+$NiCu^3P$ in the temperature range 525-550°C.

In the first stage of research production of resistive layers Ni-Cu-P was optimised concerning the effect of the amount of additive on the final product TWR. Technological samples containing about 1000 pieces of resistors were manufactured, characterized by a power rating of 0.25W (dimensions of the ceramic rollers, on which resistive layers were applied: Φ1.67x5.5mm). Therefore the process of metallization was applied on resistors deposits of a volume not more than 50 ml. For such a deposit, which is characterized by the total surface subjected to the process of metallization equal to about 300cm2 (ratio of the volume of working solution to the volume of metallized deposit) is used. This means that the volume of the processing solution is typically equal to 500ml. The temperature of the process was set to 95ºC.

The optimisation of laboratory process parameters consists in establishing concentration of the substrate and technological process parameters, including duration of the process, and acidity of the technological solution.

In the next step of research the influence of metallization time on the resistance of the final layer was determined as well as the effect of stabilization temperature on the TWR of the layers was examined in a wide of the stabilization temperature.

Experiments concerning dispersive energy spectrometry of X-ray, that is X-ray spectra generated under the influence of an incident electron beam in a scanning electron microscope (Energy-Dispersive X-ray Spectroscopy – EDXS, EDX, EDS), were also performed. The main aim of these examinations was to determine the concentration of chemical elements, in particular phosphorus, nickel and copper in different areas of the tested samples.

Finally, exploitation tests of resistors were performed in order to determine their durability and resistance stability as a function of time and climatic exposure.

M. Kwoka (PhD), Prof. J. Szuber, M. Sitarz (MSc); *Comparative analysis of surface properties of L-CVD SnO_2 ultra thin films and VPD SnO_2 nanowires*

Tin dioxide (SnO_2) thin films have attracted great interest over the last two decades, because of their potential applications, including resistivity-type gas sensors. This results from their high electric conductivity ($\sim 10^2\ \Omega^{-1}\cdot cm^{-1}$) with tendency to variability and good response to oxidizing and reducing gases. Low power consumption of these sensors is their most significant advantage. On the other hand, they have a significant limitation - a weak extension of internal surface. It causes serious reduction in their sensitivity. However, in contrary to thin films and even nanolayers, this limitation does not concern the SnO_2 nanowires, because about 30% atoms are localized just at the surface where the sensor effect appears. Within this project we focused on the technology of selected two-dimensional (2D) and one-dimensional (1D) SnO_2 nanostructures and the characterisation of their surface properties, with a special emphasis on L-CVD SnO_2 ultrathin films and VPD SnO_2 nanowires, including their surface morphology controlled by AFM and SEM methods,

as well as on their surface chemistry, including stoichiometry and contamination controlled by the XPS method in combination with thermally programmed desorption (TPD). Our comparative XPS and TDS studies of L-CVD SnO_2 nanolayers and VPD SnO_2 nanowires deposited on an Ag-covered Si substrate showed that their surface chemistry (purity and stoichiometry) is completely different and related to their diverse morphology and crystallinity. Concerning covered L-CVD SnO_2 nanolayers, they exhibit nonstoichiometry with a relative concentration [O]/[Sn] varied between 1.3 and 1.7. Moreover, after long term exposure in dry air they are covered with undesired high carbon C contaminations that cannot be completely removed via the TPD process. This is evidently in contrary to VPD SnO_2 nanowires for which after the TPD process C contaminations are easily and fast removed and, in addition, after this process they become fully stoichiometric. From the obtained information it was clear that the evident differences in the gas response characteristics for the above mentioned two SnO_2 nanostructures in NO_2 atmosphere are related to the strong difference of their surface morphology and their surface chemistry including nonstoichiometry and C contamination. All the obtained information is crucial in the context of potential application of these nanostructures to toxic gas sensor systems.