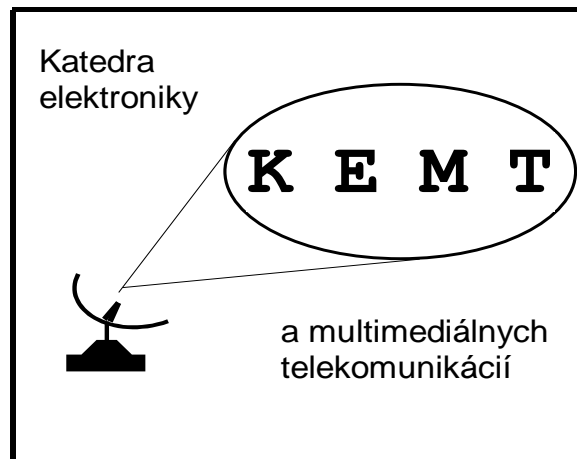

DEPARTMENT OF ELECTRONICS AND MULTIMEDIA TELECOMMUNICATIONS



Annual Report

2002

Technical University of Košice
Faculty of Electrical Engineering and Informatics

TECHNICAL UNIVERSITY OF KOŠICE
Faculty of Electrical Engineering and Informatics
(Slovak Republic)

DEPARTMENT OF ELECTRONICS AND
MULTIMEDIA TELECOMMUNICATIONS

ANNUAL REPORT 2002

Edited by Ľuboš Ovseník

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1. BRIEF OVERVIEW

The Department of Electronics and Multimedia Communications is responsible for degree course Electronics and Telecommunication Engineering at MSc. level as well as for degree courses Electronics, Telecommunications and Measurement Techniques at PhD. level.

The subjects in degree course Electronics and Telecommunications Engineering are orientated to the linear and non-linear analogue circuits, digital electronics, microwave technology, optoelectronics, signal and systems, acoustics, digital signal processing, digital filtering, VLSI processors and microcontrollers, radioelectronic measurements, television systems, signal recording, digital communication and digital transmission systems, optoelectronic communication systems, photonics, sensor systems, multimedia communication systems, mobile and satellite communication systems, digital image communication systems and medical electronics.

The basic research activities of Department are concentrated on digital image and speech processing, multimedia communications, digital filtering, optoelectronics and optical communication, implementation on neural network in digital signal processing and A/D converters modelling.

The history of the Department. The Department of Electronics and Multimedia Communications was founded in 1969. The original name of department was Department of Electronics and first head of department was Prof. Špány. In the first 5 years Department was responsible for some subjects in the field of electronics.

The name of Department has been change to Department of Electronic Circuits and System in 1974. It was responsible for the new degree course Electronics Systems. First students have been finished his study in this degree course at 1976. The new degree course Radioelectronics at the Department has been started in 1979, which was orientated in the field of microwave technology, analog and digital electronics, digital signal processing and radioelectronic systems. The name of Department has been change to Department of Radioelectronics. Since 1986 the head of Department is Prof. Levický. The process of degree course Radioelectronics transformation to the new degree course Electronics and Telecommunication engineering at the department has been finished in 1997. The recent name of department since 1997 is Department of Electronics and Multimedia Communications.

2. DEPARTMENT STAFF AND STRUCTURE

Total number of staff members is 26.

- ◆ Professors: Čižmár Anton, Levický Dušan, Marchevský Stanislav, Mihalík Ján, Michaeli Linus, Turán Ján

- ◆ Associated Professors: Doboš Ľubomír, Drutarovský Miloš, Galajda Pavol, Juhár Jozef, Kocur Dušan, Šaliga Ján

- ◆ Assistant Professors: Gamec Ján, Gamcová Mária, Gladišová Iveta, Klenovičová Zita, Matúš Emil, Ovseník Ľuboš, Zavacký Jozef

- ◆ Research Assistant: Hroncová Ingrid, Maceková Ľudmila

- ◆ Support staff: Botta František, Chocholová Pavlína, Marchevská Božena, Lenárt Jozef, Šumáková Viera

- ◆ Ph.D. students:
Internal form: Bača Martin, Čížová Jana, Filo Peter, Floriš Peter, Grega Marián, Hovančák Rastislav, Kollár Martin, Lihan Slavomír, Longauer Leoš, Michalčín Viktor, Michalko Peter, Pleva Matúš, Šimka Martin, Šiškovičová Dana, Štefanišin Radoslav, Šurin Stanislav
External form: Abdulghafoor Jalal Mahmood, Benčo Stanislav, Florek Vladimír, Gamcová Mária, Gebeová Gyongyike, Goriľ Jozef, Hintoš Ľudovít, Homolya Viktor, Horniak Ľubomír, Chochol Peter, Kováč Miloš, Kravecová Daniela, Krivda Marián, Mohamoud Ali Omer, Novikmec Jozef, Papaj Ján, Pavlík Marcel, Pavlíková Anastázia, Pillár Slavomír, Siman Roman, Švač Pavol, Vlasatý Anton

3. DIVISIONS OF THE DEPARTMENT

◆ Laboratory of Multimedia Communications

Head: prof. Prof. Ing. Dušan Levický, CSc., Member of the IEEE

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e-mail: Lubomir.Dobos@tuke.sk

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e-mail: Emil.Matus@tuke.sk

Research Assistant:

Dr. Ing. Ingrid Hroncová

e-mail: Ingrid.Hroncova@tuke.sk

◆ Laboratory of Digital Signal Processing and Satellite Communications

Head: prof. Prof. Ing. Stanislav Marchevský, CSc.

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e-mail: Stanislav.Marchevsky@tuke.sk

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◆ **Laboratory of Optoelectronic Communications**

Head: prof. Prof. RNDr. Ing. Ján Turán, DrSc., Senior Member of the IEEE

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e-mail: Jan.Turan@tuke.sk

Assist. prof. Ing. Ján Gamec, CSc.

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Assist. prof. Ing. Ľuboš Ovseník, PhD.

phone: +421-55-6024277

e-mail: Lubos.Ovsenik@tuke.sk

◆ **Laboratory of Electronic Circuits & Measurement**

Head: prof. Prof. Ing. Linus Michaeli, CSc.

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e-mail: Linus.Michaeli@tuke.sk

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Assoc. prof. doc. Ing. Pavol Galajda, CSc.

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4. COURSES

Bachelor Degree Course (title BcC.) – Telecommunications Engineering

The Bachelor degree course is orientated into the field Telecommunication mainly into the basic telecommunication systems and networks. The students achieve good skills in telecommunication services, management of telecommunication networks and economics in telecommunications.

Master Degree Course (title Ing.) – Electronics and Telecommunication Engineering

The Master degree course is orientated into the field of Electronics and Telecommunications. In the field of Electronics the students have been achieve good skills in mathematics, physics, electromagnetic field, electrical measurement, electronics components, linear and non-linear circuits, digital electronics, microprocessors and signal processors, optoelectronics and digital signal processing.

In the field Telecommunications the students have been achieve good skills in digital communication and transmission systems, mobile and satellite communications, optoelectronics communication systems and multimedia communication.

Master Degree Course (title Ing.) – Measurement Techniques

The Master degree course is orientated into the field of Measurement techniques. The degree course is the specialisation of the general programme Electronics. In the field of Measurement techniques the students have been achieve good skills in electrical measurement, metrology, electronics components, linear and non-linear circuits, digital electronics, microprocessors and signal processors, digital signal processing targeted on enhancement of the metrological properties, virtual instrumentation using ICT, measurement in the biomedicine, measurement in the telecommunications, industrial measurement for process control and TQM.

Ph.D. Degree Courses (title Ph.D.) – Electronics

The Ph.D. degree course is orientated into the field of digital image and speech encoding and transmission, optoelectronics systems and digital filtering as well as design of electronic and optoelectronics systems, sensor systems and digital circuit's simulation.

Ph.D. Degree Courses (title Ph.D.) – Telecommunications

The Ph.D. degree course is orientated into the field of multimedia communications, mobile and satellite communications as well as modern telecommunication technologies and networks and digital signal processing in telecommunications.

Ph.D. Degree Courses (title Ph.D.) – Measurement Techniques

The Ph.D. degree course is focused into the methodology of instrumentation in industry, scientific research and monitoring of physical parameters. The related scientific areas are metrology, sensors of different physical qualities, digital signal processing and pre-processing, calibration and self-diagnostic as well as virtual instrumentation.

5. LIST OF SUBJECTS TAUGHT

Master Degree Course (Ing.) *Electronics and Telecommunications*

| <i>Subjects</i> | <i>Hours/Week</i> <i>Lecture/Seminar</i> | <i>Lectures</i> |
|--|---|----------------------|
| 2nd year of study: | | |
| 3rd year of study: | | |
| Transmission of Information in Electroenergetics | 2/2 | Čižmár |
| Analog Electronic Systems | 2/2 | Galajda |
| Electronic Systems | 3/2 | Galajda |
| Linear Analog Circuits | 4/3 | Kocur |
| Microwave Technology | 3/2 | Gamec |
| Digital Electronics | 3/2 | Levický |
| Electronic Devices | 3/3 | Gamec |
| Digital Communication Systems | 3/3 | Levický |
| Non-Linear Analog Circuits | 4/3 | Michaeli |
| Signals and Systems | 3/3 | Mihalík, Zavacký |
| Design of Electronic Equipment | 3/2 | Doboš |
| Acoustics | 3/2 | Juhár |
| 4th year of study: | | |
| Radioelectronic Measurement | 3/3 | Šaliga |
| Electronic Systems with Microprocessors | 3/2 | Matúš/Drutarovský |
| Digital Signal Processing | 3/3 | Mihalík |
| Optoelectronics | 3/2 | Turán |
| Switching Systems | 3/2 | Marchevský |
| Coding and Modulation | 2/2 | Čižmár |
| Semestral Projects | 0/2 | Marchevský |
| Digital Transmission Systems | 3/2 | Čižmár |
| Signal Processors in Telecommunication | 3/2 | Drutarovský |
| TV Systems | 3/2 | Marchevský |
| Analog & Digital Interfaces | 3/2 | Michaeli, Šaliga |
| Optoelectronic Communications Systems | 3/2 | Turán |
| Digital Filtering | 3/2 | Kocur, Drutarovský |
| Applied Cryptography | 2/2 | Levický |
| Digital Proc. and Transmission of Speech and Audio | 3/2 | Juhár |
| Programmable Integrated Circuits | 2/2 | Galajda, Drutarovský |
| 5th year of study: | | |
| Photonics | 3/2 | Turán |
| Medical Electronics | 3/2 | Michaeli |
| Sensor Systems | 3/2 | Michaeli |
| Radioelectronic Systems | 3/2 | Doboš |
| Multimedia Communications | 3/2 | Levický |
| Satellite Communications | 3/2 | Marchevský |
| Digital Image Communication Systems | 3/3 | Mihalík |
| Mobile Communications Systems | 3/2 | Doboš |
| Spread Spectrum Communication Systems | 3/2 | Kocur |

Master Degree Course (Ing.) Measurement Techniques

| Subjects | Hours/Week Lecture/Seminar | Lectures |
|--|---------------------------------------|--------------------|
| 4th year of study: | | |
| Radioelectronic Measurement | 3/3 | Šaliga |
| Electronics Systems with Microprocessors | 3/2 | Matúš/Drutarovský |
| Digital Signal Processing | 3/3 | Mihalík |
| Electromagnetic Compatibility | 3/2 | Marton |
| Sensor Systems | 2/2 | Mojžiš |
| Semestral Projects | 0/2 | Michaeli |
| Digital Transmission Systems | 3/2 | Čižmár |
| Signal Processors in Telecommunication | 3/2 | Drutarovský |
| Technical Diagnostic | 3/2 | Smrczek |
| Virtual instrumentation | 3/2 | Šaliga |
| Modelling and Measurement | 3/2 | Kováč |
| Measurement in High Voltage Technology | 2/2 | Kolcunova |
| Measurement in Electroenergetic | 2/2 | Leščinský |
| Digital Filtering | 3/2 | Kocur, |
| Applied Cryptography | 2/2 | Levický |
| Measurement in Experimental Physics | 2/2 | Kudela/Drutarovský |
| 5th year of study: | | |
| Signal Processing in Measurement | 3/2 | Michaeli |
| Medical Electronics | 3/2 | Michaeli |
| Measurement in Telecommunication | 3/2 | Šaliga |
| Diagnostic of Electrical Systems | 2/2 | Kolcunova |
| Technology of Sensors | 2/3 | Banský |

Undergraduate Study (Bc.) Telecommunications

| Subjects | Hours/Week Lecture/Seminar | Lectures |
|---------------------------------------|---------------------------------------|------------------|
| 1st year of study: | | |
| Electronic Devices | 3/3 | Gamec |
| 2nd year of study: | | |
| Linear Analog Circuits | 4/3 | Kocur |
| Microwave Technology | 3/2 | Gamec |
| Signals and Systems | 3/2 | Mihalík, Zavacký |
| Digital Electronics | 3/2 | Levický |
| Data Acquisition Systems | 3/3 | Michaeli, Šaliga |
| Optoelectronics | 3/2 | Turán |
| Digital Signal Processing | 3/2 | Mihalík |
| Basics of Telecommunication Systems | 3/2 | Levický |
| Circuits for Communications Systems | 4/3 | Michaeli |
| 3rd year of study: | | |
| Telecommunications Networks | 3/2 | Čižmár |
| Transmissions Systems | 3/2 | Čižmár |
| Switching Systems | 3/2 | Marchevský |
| Semestral Projects | 0/2 | Marchevský |
| Measurement in Telecommunications | 3/2 | Šaliga |
| Optoelectronic Communications Systems | 3/2 | Turán |
| Videocommunications | 3/2 | Mihalík |
| Telecommunications Services | 3/2 | Čižmár |
| Management of Telecom. Networks | 3/2 | Čižmár |
| Security of Communications Networks | 3/2 | Levický |
| Multimedia Communications | 3/2 | Levický |
| Satellite Communications | 3/2 | Marchevský |
| Mobile Communications Systems | 3/2 | Doboš |

Undergraduate and Graduate Study for Foreign Students (in English Language)
Study plan for MSC degree in *Telecommunication technology*

| Subjects | Hours/Week Lecture/Seminar | Lectures |
|--|---------------------------------------|-----------------|
| 1st year of study: | | |
| Digital Signal Processing | 3/3 | Mihalík |
| Coding in Communication Systems | 3/2 | Levický |
| Optoelectronics | 3/2 | Turán |
| Digital Filtration in Communications | 3/2 | Marchevský |
| Microwave Technology | 3/2 | Turán |
| Telematic Systems | 3/2 | Levický |
| Digital Speech in Communication Systems | 3/2 | Marchevský |
| Optoelectronic Communications Systems | 3/2 | Turán |
| Image Coding | 3/2 | Mihalík |
| VLSI Processors in Telecommunications | 3/2 | Drutarovský |
| Digital Transmission Systems | 3/2 | Čižmár |
| Digital Filtering | 3/2 | Kocur |
| 2nd year of study: | | |
| Multimedial Communications | 3/2 | Levický |
| Satellite Communications | 3/2 | Marchevský |
| Mobile Communications | 3/2 | Doboš |
| Digital Image Communication Systems | 3/3 | Mihalík |
| Digital Proc. and Transmission of Speech and Audio | 3/2 | Juhár |
| Distributed Virtual Instrumentation | 3/2 | Michaeli |
| Photonics | 3/2 | Turán |
| Semestral Projects | 0/5 | Marchevský |

6. RESEARCH AND PROJECTS

Title of the Project: *Multimedia processing, transmission and watermarking* Funding:

Institutional grant

Duration: 2000-2002

Co-ordinator: Prof. Ing. Dušan Levický, CSc.

Group members: A. Čižmár, E. Matúš, S. Marchevský, D. Kocur, M. Drutarovský, J. Juhár,
L. Doboš, Z. Klenovičová, M. Gamcová, Ľ. Maceková, R. Hovančák, R.
Lukáč, P. Radoczi, S. Šurin

Scientific goals/research targets:

- ◆ Design of new methods for digital watermarks implementation in multimedia.
- ◆ Innovation of speech data base for Slovak language for speech recognition.
- ◆ Applications of spread spectrum principle for wireless and mobile systems.
- ◆ Analysis of methods for digital image filtering based on neural networks.

Results Achieved:

- ◆ Implementation of digital watermarking by using CDMA.
- ◆ Design of the new method for block matching motion estimation in digital image sequence coding.
- ◆ Analysis of method for mobile internet access over UMTS.
- ◆ Simulation of Frame Relay Networks.
- ◆ Design of adaptive order-statistic LMS filters and Volterra filters for CDMA systems.

Title of the Project: *Digital Signal Processing and Watermarking in Multimedia Communications*

Funding: VEGA 1/8130/01

Duration: 2001-2003

Co-ordinator: Prof. Ing. Dušan Levický, CSc.

Group members: A. Čižmár, E. Matúš, S. Marchevský, D. Kocur, M. Drutarovský, J. Juhár,
Ľ. Doboš, Z. Klenovičová, M. Gamcová, Ľ. Maceková, R. Hovančák, P.
Radoczi, M. Marcinek, R. Lukáč, S. Šurin

Scientific goals/research targets:

- ◆ Design of the new methods for image coding and digital image watermarking in information technologies for multimedia communications.

- ◆ Design of the new method for speech coding, speech recognition and audio watermarking.
- ◆ Design of the new methods for digital image filtration from point of view digital image processing and watermarking.

Results Achieved:

- ◆ Design and verification of digital watermarking in wavelet transform domain.
- ◆ Analysis of influence of noise corruption to image watermarking in DCT domain and wavelet domain.
- ◆ Design of method for digital watermarks in colour images.
- ◆ Analysis of several types of attacks on selected digital watermark techniques.
- ◆ Analysis of Slovak Speech database SpeechDat and design of automatic system for speech recognition.
- ◆ Analysis of Voice XML language and its application in speech interactive services.
- ◆ Analysis of non-linear stack filters for colour image processing by using LUM filters.
- ◆ Design and verification of new algorithms by using impulse detectors and adaptive LMS filters for colour image filtration.
- ◆ Verification of Volterra filters in mobile communication system based on DS-SS.

Title of the Project: *Spoken Language Interaction in Telecommunication*

Funding: COST 278

Collaboration with: 29 academic and commercial research institutions from 18 European countries

Duration: 2001-2005

Co-ordinator: Prof. Ing. Anton Čižmár, CSc.

Group members: L. Doboš, J. Juhár, S. Lihan, D. Levický, M. Marcinek, M. Pleva, S. Matis

Scientific goals/research targets:

- ◆ To improve the knowledge of the issues and problems involved in general in spoken language interaction in telecommunication.
- ◆ To achieve knowledge of issues related to robustness and multi-linguality within spoken language processing.
- ◆ To achieve knowledge of spoken language interaction in the context of multi-modal communication.

- ◆ To achieve knowledge of human-computer dialogue theories, models and systems and associated tools for the establishment of such systems.
- ◆ To achieve knowledge of and evaluate telecommunication applications that apply spoken language as one out of more input or output modalities.

Results Achieved:

- ◆ Initiation of Slovak language analysis for the purpose of automatic spoken language interaction in telecommunication services.
- ◆ Developing a reference automatic speech recognition system based on hidden Markov modelling and SpeechDat-Slovak database.
- ◆ Creation an experimental automatic voice service "Departmental telephone numbers directory" based on VoiceXML and through IP/H323 network.

Title of the Project: Automated Voice Driven Services in Telecommunications

Funding: SLOVAK TELECOM project: No. 13/0414/2002

Duration: 2002

Co-ordinator: Prof. Ing. Anton Čižmár, CSc.

Group members: J. Juhár, S. Lihan, M. Pleva, L. Doboš, D. Levický

Title of the Project: Power Line Communications

Funding: VSE project: No. 17/TUKE/2002

Duration: 2002

Co-ordinator: Prof. Ing. Anton Čižmár, CSc.

Group members: J. Gamec, J. Juhár, S. Lihan, M. Pleva, L. Doboš, D. Levický

Title of the Project: *Towards Mobile Broadband Multimedia Networks*

Funding: COST 273

Collaboration with: academic and commercial research institutions and groups from 18 European countries

Duration: 2001-2005

Co-ordinator: doc. Ing. Ľubomír Doboš, CSc.

Group members: J. Juhár, A. Čižmár, M. Pleva, J. Goril', J. Novikmec

Scientific goals/research targets:

The main objective of the Action is to increase the knowledge on the radio aspects of mobile broadband multimedia networks, by exploring and developing new methods,

models, techniques, strategies and tools towards the implementation of 4th generation mobile communication systems. It will consider frequencies ranging from the upper UHF up to millimetre waves, and data rates higher than 2 Mb/s (probably up to 155 Mb/s).

It is also expected that the Action will contribute to the deployment of systems that are very close to completion of their standardisation phase, in particular UMTS and HIPERLAN 2.

Results Achieved:

- ◆ Analysis Medium Access Control protocol for wireless ATM
- ◆ Design and simulation of new Call Admission Control algorithm for wireless ATM networks
- ◆ Analysis and simulation OFDM technique for high speed mobile communications

Title of the Project: *Non-linear Speech Processing*

Funding: COST 277

Collaboration with: academic and commercial research institutions and groups from 15 European countries

Duration: 2001-2005

Co-ordinator: doc. Ing. Jozef Juhár, CSc.

Group members: D. Kocur, L. Doboš, A. Čížmár, S. Lihan, M. Marcinek, M. Pleva, A. Vlasatý

Scientific goals/research targets:

The ultimate objective of this Action is to improve the voice services in telecommunication systems through the development of new nonlinear speech processing techniques.

The new technologies developed within the Action are to provide:

- ◆ higher quality speech synthesis,
- ◆ more efficient speech coding,
- ◆ improved speech recognition, and
- ◆ improved speaker identification and verification.

The methods are expected:

- ◆ to contribute significantly to the acceptance of voice interfaces for information systems such as the mobile Internet (by improved synthesis and recognition) and
- ◆ to improve efficiency in future generations of speech coders used in wireless networks, including packet-based wireless networks.

The Action intends to accomplish the stated goals by developing techniques based on nonlinear speech processing.

Results Achieved:

Robust non-linear methods for speech recognition in adverse environment has been studied with concentration on:

- ◆ noise robust features extraction techniques,
- ◆ noise immune auditory features and
- ◆ noise-removal preprocessing techniques.

Title of the Project: *Biometrics-Based Recognition of People over the Internet*

Funding: COST 275

Collaboration with: academic and commercial research institutions and groups from 13 European countries

Duration: 2001-2005

Co-ordinator: doc. Ing. Jozef Juhár, CSc.

Group members: L. Doboš, A. Čížmár, S. Lihan, M. Pleva, M. Kováč

Scientific goals/research targets:

The main objective of the Action is to investigate effective methods for the recognition of people over the Internet based on voice and facial characteristics in order to facilitate, protect, and promote various financial and other services over this growing telecommunication medium.

The main objectives can be specified as follows.

- ◆ To improve knowledge of the issues and problems involved.
- ◆ To study the current techniques for voice and face recognition and to evaluate their performance in the medium considered.
- ◆ To investigate methods for the fusion of the considered biometric data and the interpretation of the results.
- ◆ To analyse the implementation problems including user-interface issues and investigate effective solutions.
- ◆ To identify the potential applications and analyse the requirements of these.
- ◆ To develop standard methods and tools for the assessment of biometrics-based identification methods.

Results Achieved:

Preparation of a review of biometrics-based recognition of people over the Internet is being in progress with stress on:

- ◆ speaker recognition, verification and identification algorithms,
- ◆ development tools and toolkits, that can be used and
- ◆ Voice over IP transmission techniques and protocols.

Title of the Project: *Spread-Spectrum Systems and Techniques in Wireless and Wired Communications*

Funding: COST 262

Collaboration with: 18 research and industrial institutions from European countries

Duration: 1999-2002

Co-ordinator: doc. Ing. Dušan Kocur, CSc.

Group members: D. Kocur, M. Drutarovský, P. Galajda, S. Marchevský, S. Benčo, J. Čížová, R. Zetík

Scientific goals/research targets:

- ◆ General Goal:
 - ◆ to increase the knowledge of spread-spectrum techniques and applications for any wireless and wired system and to propose common products and methods for a variety of possible applications.
- ◆ Partial Goals:
 - ◆ investigation of any spread-spectrum application, a classification and registration of common features and differences. A tutorial on existing techniques and standards will be given as a result of this activity,
 - ◆ direct-sequence spread-spectrum systems architectures and modulation concepts,
 - ◆ receiver implementation for spread-spectrum communication systems,
 - ◆ equalisation and interference rejection in spread-spectrum communication systems.

Results Achieved:

- ◆ development of wideband interference suppression method in direct-sequence spread-spectrum communication systems based on Volterra filter application,
- ◆ development of narrowband interference suppression method in direct-sequence spread-spectrum communication systems based on Volterra filter application,

- ◆ development of joined wideband and narrowband interference suppression method in direct-sequence spread-spectrum communication systems based on Volterra filter application,
- ◆ analysis of chaos application in spread spectrum communication systems,
- ◆ analysis of spread spectrum method applications in steganography.

Title of the Project: Packet-Oriented Service Delivery via Satellite

Funding: COST 272

Collaboration with: 16 research and industrial institutions from European countries

Duration: 2001-2005

Co-ordinator: prof.Ing.Stanislav Marchevský,CSc.

Group members: D. Kocur, M. Drutarovský, P. Galajda, M.Gamcová, L. Maceková, S. Benčo, L. Longauer, M. Grega,

Scientific goals/research targets:

- ◆ General Goal:
- ◆ To contribute to the identification of key requirements, analysis, performance comparison, architectural design and protocol specification of future packet-oriented satellite communication systems, with a clear focus on Internet-type system concepts, applications and protocols/techniques on the various layers.
- ◆ Partial Goals:
- ◆ the design of efficient receivers with low consumption for mobile terminals,
- ◆ the design of low cost reconfigurable terminals
- ◆ design and implementation multi-user detection receiver for CDMA signals from satellites,
- ◆ to identify suitable models integrating Internet services and worldwide communication
- ◆ to identify the tradeoffs between complexity and effectiveness for supporting QoS in multi-network environments using different media or networking technologies

Results Achieved:

- ◆ development of multi-user detection receivers for CDMA signals using FIR filters
- ◆ development of multi-user detection receivers for CDMA signals using blind adaptive filtering,
- ◆ the study of IP telephony architecture for satellite networks application.

Title of the Project: Embedded Architectures for Applied Cryptography

Funding: French national research program ACI Cryptologie - the project CryptArchi

Collaboration with: academic institutions from France and USA

Duration: 2002-2003

Co-ordinator: doc. Ing. Miloš Drutarovský, CSc.

Group members: M. Drutarovský, D. Kravecová, M. Šimka

Scientific goals/research targets:

- ◆ General Goal:
 - ◆ Development of architectures of embedded cryptographic systems.
- ◆ Partial Goals:
 - ◆ Evaluation of the possibilities of hardware/software co-design within different families of configurable logic devices - CPLDs, FPGAs.
 - ◆ Estimation of the possibilities of parallelism in hardware (pipeline structures) and in software (multiprocessors structures).
 - ◆ Development of the parameterised cryptographic functions adapted to implementation in reconfigurable devices (RSA, ECC, AES-Rijndael, SHA, TRNG, ...).
 - ◆ Adaptation of the existing algorithms for implementation in reconfigurable devices in order to obtain the best performance.
 - ◆ Measurement of the security and performance of the proposed systems.
 - ◆ Evaluation of the possibilities of side-channel attacks and finding a way how to increase the resistance of reconfigurable devices against this kind of attacks.

Results Achieved:

- ◆ Design of new true random number generator (TRNG).
- ◆ Implemented parameterised TRNG IP block embedded in Altera CPLDs.
- ◆ Implemented scalable Montgomery multiplication coprocessor.

Title of the Project: *The Methods of Digital Image Processing for Videocodecs with Very Low Bit Rate.*

Funding: VEGA, 1/7387/20

Duration: 2000-2002

Co-ordinator: Prof. Ing Ján Mihalík, Ph.D.

Group members: J. Zavacký, I. Gladišová, M. Dulina, R. Labovský, I. Kuba, M. Kapinos,
P. Drább. V. Michalčín

Scientific goals/research targets:

- ◆ New methods of digital image processing for applications in videocodecs with very low bit rate.

Results Achieved:

- ◆ Neural network architectures for vector prediction and vector quantization of images.
- ◆ A new efficient method of resampling of image by block-base interpolation or decimation with compensation.
- ◆ Decreasing of bit rate of lattice vector quantizers by using entropy coding.
- ◆ Design of QMF filter banks in time domain satisfying perfect reconstruction property.
- ◆ Interframe prediction of video by using motion compensation.

Title of the Project: *EuroWorkshops on "ADC Modelling and Testing"*

Funding: 5th Framework Programme (EUR 34000)

Collaboration with: Italy, Hungary, Portugal, Czech Republic, Finland, Germany

Duration: 2000-2003

Project coordinator: Prof. Ing Linus Michaeli, PhD.

Group members: J. Šaliga , R. Holcer

Scientific goals/research targets:

To develop models of A/D converting systems convenient for simulating correction algorithms and optimisation of testing procedures.

Results Achieved:

- ◆ Estimation of the uncertainties of fast testing procedures.
- ◆ Comments to ADC testing standards with respect to the needs of the prospective customers.
- ◆ Coherency between definitions of ADC parameters in European Standards and US, Japan standards.
- ◆ New digital processing methods for dynamic error reduction.
- ◆ Proposals for suppression EMC disturbance on ADCs.

Title of the Project: *Summer school on "Data Acquisition systems"*

Funding: SOCRATES (EUR 15000)

Collaboration with: Italy, Hungary, Czech Republic.

Duration: 2002-2004

Project coordinator: Prof. Ing Linus Michaeli, PhD.

Group members: J. Šaliga, R. Holcer

Scientific goals/research targets:

The IP course is aimed on the preparation graduates in the hardware and software design of the Data Acquisition Systems integrated with the computerized information environment. It allows to achieve the requirements of industrial partners for graduates skilled in the relevant field for the organisation according to TQM. The project meets needs of highly qualified graduates, able to work in multinational teams.

Results Achieved:

- ◆ Student's skills how to design Data Acquisition Systems using modern approaches from the area of information and communication technologies.
- ◆ Knowledge about metrological parameters of DAQ according to actual International standards and inform them about ambiguity of the interpretation among various producers.
- ◆ Student's skills in the simple testing methods for metrological parameter assessment coherent with ISO standards
- ◆ Production teaching materials for students and teacher related with Data Acquisition Systems.

Title of the Project: AGORA 2000

Funding: LEONARDO DA VINCI (EUR 27000)

Collaboration with: Italy, Belgium, Slovak Republic.

Duration: 2000-2003

Project coordinator: Prof. Dr. Nicola DeNardi,

Project sub-coordinator: Prof. Ing Linus Michaeli, PhD.

Group members: J. Šaliga, R. Holcer

Scientific goals/research targets:

The Pilot project Agorà2000 aims at predicting and satisfying the training needs of the SME's, authorities, training organisations in the telematic and multimedia sector in relation to the ICT. The project develops training path for: web design, electronic commerce, telework, telecontrol, increasing the potentialities of the ICT in the extension of the sale market of businesses manufacturing goods and services, through a mix of software products, provided in the project, to implement for the direct sale in the Internet.

Results expected:

- ◆ multimedia training package on CD-ROM in eight didactic modules; abridged version on the Internet,
- ◆ software for the direct sale on the Internet;
- ◆ software for case application of the telecontrol via Internet,
- ◆ the implementation of web sites of each partner, in order to simulate the situations of e-commerce.

Title of the Project : *Hardware implementation of unconventional analogue-to-digital interfaces and their error corrections***Funding:** VEGA, 1/3207/96**Duration:** 1999 – 2001**Co-ordinator:** Prof. Ing Linus Michaeli, CSc.**Group members:** V. Pirč, V. Špány, J. Šaliga, P. Galajda, V. Sedlák, P. Mikulík, A. Galajdová, R. Holzer**Research activity of the group is concentrated on:**

The effort of the research performed is focused on the following representatives :

- ◆ ADC and DAC as a quantisator of one analogue input parameter.
- ◆ Classifier of measuring signals carrying more parameters based upon hardware implemented neural networks.
- ◆ Flip-flop switching sensor as the direct converters of physical quantity to digit.
- ◆ Application of neural networks in instrumentation.

Scientific goals/research targets:

The common objective is the study of methods how to increase accuracy and reliability AD and DA converting systems. The proposed methods is oriented on the digital signal processing for error correction under different working condition. The single tasks are:

- ◆ The research in the field of neural networks is oriented on its utilisation for signal processing with help of its high grade of parallelism and for multiparametrical quantisation in the measurement applications.
- ◆ The area of the statistical sensor research. is the study of the impact of the measured physical quantity on the equivalent voltage. The importance is given on the statistical sensor with feedback where the sensor's behaviours are studied by the developed algorithm and the waving separatrix.

- ◆ The common error criteria and the mathematical description are established in order to settle a converter error model giving possibility to utilise results from the testing in the reduced number of significant points. The error values from mentioned points together with known model allow to approximate the error function over the whole working range.
- ◆ Another task is the research of different testing methods, preferably those, which reduce the performing time. The outcome of this stage is preparation of new standards for assessment of all kinds of neural and classical converters.

Results Achieved:

- ◆ Enhancement of dynamic range by oversampling and successive low pass filtering causes arising of the parasitic effects generated by systematic errors of the range below few LSB of integral nonlinearity INL(k). The outcomes of the research allows to achieve systematic error reduction by changes in the oversampling flux according to known probabilistic model of the corrected SAR ADC.
- ◆ Study of histogram testing method using small amplitude exponential or triangular waves superimposed with variable DC level. Those signals are easy to generate with high precision and low EMC interference.
- ◆ The stochastic sensors are based on the probability evaluation of chosen stable state for flip-flop circuit occurrence under repetitive connection to the supply source. The improvement of this idea by autocompensative and noise shaping structure allows to linearise the transfer characteristic with higher dynamic resolution and suppression of the parasitic electromagnetic interference.

Title of the Project: *Fibre Optic Communication and Sensory Systems*

Funding: Institutional grant, G - 4119

Duration: 2000-2002

Co-ordinator: Prof. RNDr. Ing Ján Turán, DrSc.

Group members: Ľ. Ovseník, P. Marenčák, M. Benča, P. Farkaš, D. Šišková

Collaboration with:

- ◆ Prof. E.F. Carome, John Carrol University, Cleveland, USA
- ◆ Prof. F. Mohr, University Pforzheim, Germany

Scientific goals/research targets:

- ◆ Modelling digital optical fibre communication systems.
- ◆ Modelling optical fibre sensor systems.

Results Achieved:

- ◆ Potential fiber optic networks architectures are analyzed and modeled with the applications in multimedia communications, electrical power industry and digital image transmission in private networks.
- ◆ A software package for fiber optics communication networks design was developed.
- ◆ Multimedia courseware: Optical Communications, Optoelectronics and Photonics were developed.
- ◆ Designed and extensively tested an innovative fiber optic index of refraction sensory system based on fiber optic technology was developed. Two variants: portable device and laboratory PC controlled device were developed.
- ◆ Optically powered fiber optic sensory system with very low power consumption was developed.

Title of the Project: *Invariant Transformational Systems for Visual Signal Processing.***Funding:** VEGA 1/74444/20**Duration:** 2000-2002**Co-ordinator:** Prof. RNDr. Ing Ján Turán, DrSc.**Group members:** Ľ. Ovseník, P. Marenčák, M. Benča, P. Farkaš, D. Šiškovičová**Collaboration with:**

- ◆ Prof. K. Fazekas, TUB, Budapest, Hungary
- ◆ Prof. A. Figueras, University Carlos III, Madrid, Spain
- ◆ Prof. J. Tasic, TU Ljubljana, Slovenia
- ◆ Prof. P. P. L. Regtien, University of Twente, Netherlands
- ◆ Prof. M. Nojima, University Bordeaux, France
- ◆ Prof. K. Skala, University Zagreb, Croatia
- ◆ Prof. M. Ansorge, University Neuchâtel, Switzerland

Scientific goals/research targets:

- ◆ New systematic approach to multimedia communication graphical user interface (GUI) design and its application to teleeducation.
- ◆ New methods for image processing based on non-linear DSP, fast translation invariant transform (CT – Certain Transforms) and neural networks (NNs).
- ◆ Development, implementation and experimental verification of new invariant systems for image recognition based on the hybridisation CT with Radon and Mellin transform.

Results Achieved:

- ◆ Rapid transform (RT) and others fast translation invariant transforms (CT) are very attractive for many digital image classification problems. They belong to a special class of non-linear transforms with a fast computing graph. As a consequence the transforms have a very simple and fast hardware realisation. Although the RT is a non-linear and thus non-invertible, adding to the RT transform process a binary coding process (i.e. computing so called coding matrix (CM)) one may obtain the original signal (one, or two-dimensional) from its RT spectrum coefficients.
- ◆ Our research group has a long time, more than 10 years, history of research into RT or CT. We discovered RT-I, new fast translation invariant transform NT and new methods for they evaluation, computation and theoretical analysis. We have one patent on a very fast RT processor (RTP). It is intended that the result of this study will be new methods of effective signal (picture) coding and the use of RT and RT -I in image sequence coding.
- ◆ In TV picture sequence there is a high degree of correlation between successive frames, and interframe coding makes use of the redundancy to reduce the information to be transmitted. The motion compensation can be used to overcome the difficulty of significant movement. For motion estimation will be studied the application of RT-I and other transform methods.
- ◆ New 3D-object recognition system studied in this project is based on the analysis of acoustic waves reflected by the objects. The reflected signals are analysed in the time - invariant RT transform domain and compared wit reference patterns stored in memory. The applications of fast shift - invariant RT in signal classification increase the capability of the system to distinguish and identify different objects.

Title of the Project: *Information and Knowledge Management for Integrated Media Communication.*

Funding: COST 276

Collaboration with: France, Italy, Norway, Hungary, Spain, Slovenia (Project coordinator: Prof. J. Tasic, University Ljubljana), Greece, Switzerland, Croatia, Czech republic, Portugal.

Duration: 2000-2003

Co-ordinator: Prof. RNDr. Ing Ján Turán, DrSc.

Group members: J. Gamec, Ľ. Ovseník, P. Marenčák, M. Benča, P. Farkaš, D. Šiškovičová

Scientific goals/research targets:

- ◆ The project represents a theoretical base for the emergent new method for *Information and Knowledge Management for Integrated Media Communication*.

Results Achieved:

- ◆ The work is ongoing in Working Groups:
 - ◆ *WG.1*: Multimedia, Data, Information and Knowledge Management.
 - ◆ *WG.2*: Communications Intelligent Agents.
 - ◆ *WG.3*: Personalisation of Information and Interfaces for Telecommunications.
 - ◆ *WG.4*: Advanced Signal, Audio and Video Processing.
- ◆ Our research group will focus advanced methods for image processing based on the use of fast, linear and non-linear selected transforms (CT, RT, NT, Hough, Radon, Trace Transform) and interface design for teleworking and teleeducation terminals.

7. EQUIPMENT

Teaching and Research Laboratories and Special Measuring Instruments and Equipment.

| <i>Laboratory</i> | <i>Equipment</i> |
|--|--|
| ATM Laboratory | ATM Laboratory Network, ATM Switch |
| DSP Laboratory | Development tools for Analog Devices digital signal processors ADSP218x, ADSP219x, ADSP21535 – Blackfin and ADSP21161 SIMD SHARC. Laboratory is supported by Analog Devices University program (www.kemt.fei.tuke.sk/adsp). |
| Laboratory of Measurement | Special precise measurement system for ADC testing |
| Laboratory of Microcontrollers and VLSI Processors | Development tools for single chip microcontrollers 8051, PIC and embedded Altera RISC soft processor NIOS |
| Laboratory of Optoelectronics | Development tools for optical fibre communications training systems and optical desk with He-Ne laser |
| Laboratory of TV System | Special TV system for teaching |
| Laboratory of Microwave Technology | Development tools for microwave training systems |
| Laboratory of Speech Technology for Telecommunications | Development tools for automatic speech recognition systems and automatic voice services in telecommunications and Internet |

8.CO-OPERATION

Co-operation in Slovakia

| <i>Institution</i> | <i>Type of activity</i> |
|------------------------------------|-------------------------|
| Slovak Telecom Bratislava | Research, TEMPUS |
| Alcatel SEL Liptovský Hrádok | TEMPUS |
| Siemens Software House Bratislava | TEMPUS |
| Ericsson Slovakia | TEMPUS |
| Telenor Slovakia | TEMPUS |
| Acatel Bussiness System Bratislava | TEMPUS |
| VSE, Košice | Research |

International Co-operation

| <i>Institution</i> | <i>Type of activity</i> |
|---|-------------------------|
| Alcatel SEL Stuttgart | TEMPUS |
| Siemens Viena | TEMPUS |
| UPC Barcelona | TEMPUS |
| Politechnico di Torino | TEMPUS |
| Loracom France Nancy | INCO/COPERNICUS |
| University of Catania Italy | INCO/COPERNICUS |
| University of Mining and Mettalogy Krakow | INCO/COPERNICUS, JOINT |
| MEDAV GmbH Germany | Bilateral Contract |
| Technical University Ilmenau Germany | SOCRATES |
| Technical University Budapest | COST |
| Technical University of Ljubljana | COST |
| Technical University of Delft | COST |
| Technical University of Clju-Napoca | COST |
| University of Firenze Italy | COST |
| University of Gent | COST |
| University of Sannio Italy | TEMPUS / SOCRATES |
| University of Calabria Italy | TEMPUS / SOCRATES |
| University of Mediteranea Italy | SOCRATES |
| Universite Jean Monnet-Saint-Etienne France | SOCRATES |
| Universite Jean Monnet-Saint-Etienne France | CryptArchi |

9. FACULTY ESSAYS

Čižmár Anton

Full professor

His research interests include speech processing, data compression, digital communications, project management, telecommunication technologies and services.

Doboš Ľubomír

Associated professor

His current interests are in the linear adaptive digital filters, least Mean Square algorithms, QR decomposition and wireless communication systems (GSM, UMTS), wireless ATM and wireless LAN.

Drutarovský Miloš

Associated professor

His research interests include applied cryptography, digital signal processing (digital filters and spectral analysis), algorithms and architectures for embedded cryptographic architectures, digital signal processors, field programmable devices and soft microcontrollers embedded into field programmable devices.

Galajda Pavol

Associated professor

His research interest is in nonlinear circuit's theory, CHAOS in spread spectrum communication systems and programmable logic devices- ALTERA.

Gamec Ján

Assistant professor

His general research interests include digital signal processing, block - matching algorithm and motion estimation.

Gamcová Mária

Assistant professor

Her general research interests includes one and two dimensional processing based on the method of digital filtering.

Gladišová Iveta

Assistant professor

Her research interests are in the digital signal processing, geometric source coding and vector quantization, an algorithm for lattice and pyramid quantizers and codes.

Hroncová Ingrid

Research assistant

Her professional area of interests is digital signal processing, digital speech processing, transform coding and metropolitan area networks.

Juhár Jozef*Associated professor*

His research interests are in digital speech/audio processing and transmission, automatic speech/speaker recognition, speech synthesis and application of speech technologies in developing and deploying automatic voice services in telecommunications and Internet.

Klenovičová Zita*Assistant professor*

Her research interests include digital circuits and digital picture processing.

Kocur Dušan*Associated professor*

His research interest is in digital signal processing, spread spectrum communication systems, CDMA systems, adaptive linear and non-linear filters, polyspectral signal analysis.

Levický Dušan*Full professor*

His main interests and activities are in the multimedia communications, cryptography and watermarking.

Maceková Ľudmila*Research assistant*

Her general research interest includes design and implementation algorithms for two and three dimensional filters for image processing.

Marchevský Stanislav*Full professor*

His main research interests are multidimensional digital filters, linear and non-linear digital filters for image processing, and design of multi-user detectors for CDMA signals from satellites.

Matúš Emil*Assistant professor*

His research interest include digital picture processing.

Michaeli Linus*Full professor*

His research interests are the pre-processing systems in the instrumentation, modelling of AD converters and methods for correction of their uncertainties.

Mihalík Ján*Full professor*

His current research interest includes signal and information theory, digital image processing (including effective coding, restoration, enhancement and statistical filtering), digital image communication.

Ovseník Ľuboš*Assistant professor*

His general research interests include fiber optics, fiber optical sensors and the fiber optical application in the microwave domain.

Šaliga Ján*Associated professor*

His general research interests include ADC testing, distributed measurement systems, measurement instruments, systems and methods.

Špány Viktor*Professor Emeritus*

His main interests and activities are in the non-linear circuits theory, smart sensors, flip-flop sensors, integrated functional blocks and statistical sensors.

Turán Ján*Full professor*

His main interests and activities are in the digital signal processing, Hough transform, rapid transform, fiber optics and its applications in communications, sensing and signal processing.

Zavacký Jozef*Assistant professor*

His current interest includes signal and information theory, sampling of the one-dimensional and multidimensional signals.

10. Ph.D. STUDENTS

| Name | Supervisor | Degree Course |
|----------------------------------|-------------------|-----------------------|
| First year of study | | |
| Filo Peter | Turán | Electronics |
| Floriš Peter | Levický | Telecommunications |
| Grega Marián | Marchevský | Telecommunications |
| Michalko Peter | Michaeli | Measurement technique |
| Šimka Martin | Drutarovský | Electronics |
| Florek Vladimír (df.) | Michaeli | Measurement technique |
| Homolya Viktor (df.) | Juhár | Telecommunications |
| Kravecová Daniela (df.) | Drutarovský | Telecommunications |
| Siman Roman (df.) | Doboš | Telecommunications |
| Second year of study | | |
| Čížová Jana | Kocur | Electronics |
| Longauer Leoš | Marchevský | Telecommunications |
| Pleva Matúš | Čižmár | Telecommunications |
| Štefanišin Radoslav | Mihalík | Telecommunications |
| Šurin Stanislav | Levický | Telecommunications |
| Gamcová Mária (df.) | Marchevský | Telecommunications |
| Gebeová Gyongyike (df.) | Čižmár | Telecommunications |
| Kováč Miloš (df.) | Juhár | Telecommunications |
| Krivda Marián (df.) | Levický | Electronics |
| Mohamoud Ali Omer (df.) | Doboš | Telecommunications |
| Novikmec Jozef (df.) | Doboš | Telecommunications |
| Papaj Ján (df.) | Čižmár | Telecommunications |
| Pavlíková Anastázia (df.) | Kocur | Electronics |
| Pillár Slavomír (df.) | Marchevský | Telecommunications |
| Švač Pavol (df.) | Kocur | Electronics |
| Vlasatý Anton (df.) | Juhár | Telecommunications |
| Third year of study | | |
| Bača Martin | Drutarovský | Electronics |
| Hovančák Rastislav | Levický | Telecommunications |
| Kollár Martin | Michaeli | Measurement technique |
| Lihan Slavomír | Juhár | Telecommunications |
| Michalčin Viktor | Mihalík | Telecommunications |
| Šiškovičová Dana | Turán | Electronics |
| Goriľ Jozef (df.) | Doboš | Telecommunications |
| Chochol Peter (df.) | Marchevský | Telecommunications |
| Pavlík Marcel (df.) | Kocur | Electronics |
| Fourth year of study | | |
| Abdulghafoor Jalal Mahmood (df.) | Levický | Telecommunications |
| Benčo Stanislav (df.) | Marchevský | Telecommunications |
| Horniak Ľubomír (df.) | Michaeli | Measurement technique |
| Fifth year of study | | |
| Hintoš Ľudovít (df.) | Čižmár | Telecommunications |

11. MEMBERS

- Čižmár Anton**, Member of Technical Standardization Commission No.41 for Telecommunications in Slovakia.
- Čižmár Anton**, Member IEEE Affiliate Computer Society, No. 41237162
- Čižmár Anton**, Member of AES (Audio Engineering Society), New York, I.D. 44 154.
- Doboš Ľubomír**, Member of Technical Standardization Commission No.80 for Radiocommunications in Slovakia.
- Galajda Pavol**, Member of the Editorial Board of the Journal Radioengineering.
- Juhár Jozef**, Member of the Audio Engineering Society, New York, I.D. 44164
- Juhár Jozef**, Member of Technical Standardization Commission No.55 for Electroacoustics and ultrasound in Slovakia.
- Levický Dušan**, Member of the editorial board "Radioengineering".
- Levický Dušan**, Member of the IEEE.
- Levický Dušan**, Member of Czech and Slovak Radioelectronics Society.
- Levický Dušan**, Slovak Government Commission for Accreditation.
- Levický Dušan**, Scientific Grant Agency of Slovak Republic.
- Marchevský Stanislav**, Member of the Scientific Board Military Academy, Lipt. Mikuláš.
- Marchevský Stanislav**, Member of Technical Standardization Commission No. 60, Sound, Image and Audiovideo Equipment and Systems in Slovakia.
- Michaeli Linus**, Head of Slovak IMEKO Technical Committee TC-4 "Measurement of Electrical Quantities".
- Michaeli Linus**, Slovak Metrological Institute, Member of the Scientific Board.
- Michaeli Linus**, Member of the editorial board „Computer Standard & Interfaces“, Issued by Elsevier, Amsterdam, New York.
- Michaeli Linus**, Member of the reviewer board “Measurement”. Journal IMEKO, Issued by Elsevier, Amsterdam, New York.
- Michaeli Linus**, Member of the Scientific Board University of Transport and Communication, Žilina, Slovakia.
- Michaeli Linus**, Co-ordinator of IMEKO Working Group “AD and DA metrology”.
- Michaeli Linus**, Member of the IEEE, Instrumentation & Measurement Society.
- Šaliga Ján**, Member of Slovak IMEKO Technical Committee TC-4 "Measurement of Electrical Quantities".
- Turán Ján**, Member of the Slovak Technical Standardization Committee No.53 for Cables, Conductors and Isolating Materials.
- Turán Ján**, Member of the Slovak Technical Standardization Committee No.43 for Terminology.
- Turán Ján**, Senior Member of the IEEE.
- Turán Ján**, Member of Czech and Slovak Radioelectronics Society.
- Turán Ján**, Member of Editorial Board of the journal Radioengineering.

12. PUBLICATION ACTIVITY OF THE DEPARTMENT

Books:

- [1] Delina,R.-Grohol,M.-Horovčák,P.-Lavrín,A.-Levický,D.-Mihók,P.-Ševců,S.-Vodzinský,V.: Elektronický obchod (E-Business)-kap.7 – Informačná bezpečnosť v prostredí E-biznisu (problémy, princípy, systémy a prostriedky), STU Bratislava, 1.vydanie, ISBN 80-227-1710-X, 197-213. (in Slovak)
- [2] Doboš,L.-Dúha,J.-Marchevský,S.-Wieser,V.: Mobilné komunikácie. (Mobile communications). EDIS, Žilinská univerzita v Žiline, December 2002. (in Slovak)
- [3] Galajda,P.-Lukáč,R.: Elektronické obvody. Mercury-Smékal Publishing House, Košice 2002, ISBN 80-89061-59-1, 1-176. (in Slovak)
- [4] Levický,D.: Multimediálne telekomunikácie. Multimédiá, technológie a vodoznaky. Elfa, Košice, Slovakia, 2002, ISBN 80-89066-58-5, 0-240. (in Slovak)
- [5] Mikuš,L.-Benčo,S.-Díc,M.-Gamec,J.-Galajda,P.-Stupák,Cs.-Matúš,E.-Čandík,M.-Doboš,L.-Hronec,R.-Žilka,Z.-Hudec,R.: Office 2000, Internet, Intranet, Databázové systémy. STU Bratislava, 2002, ISBN 80-227-1676-6, 0-222. (in Slovak)
- [6] Turán,J.-Ovseník,L.: Optoelectronics (examples, tests). Harlequin, s.r.o. Košice, Slovakia, 2002, ISBN 80-89082-02-5, 0-251. (in Slovak)
- [7] Turán,J.: Optoelectronics. Harlequin, s.r.o. Košice, Slovakia, ISBN 80-89082-01-7, 2002, 0-309. (in Slovak)

Journal Papers:

- [1] Arpaia,P.-Pasquale,D.-Grimaldi,D.-Michaeli,L.: ANN-Based Error Reduction for Experimentally Modelled Sensors. IEEE Transactions on Instrumentation and Measurement, Vol.51, No.1, February 2002, ISSN 0018-9456/02, 23-30.
- [2] Čižmár,A.: Mobilný záchranný systém. Acta Electrotechnica et Informatica, Vol.2, No.2, 2002, FEI TU Košice, Slovakia, ISSN 1335-8243, 25-28. (in Slovak)
- [3] Galajda,P.-Kocur,D.: Chua's Circuit in Spread Spectrum Communication. Radioengineering, Vol.11, No.2, 2002, ISSN 1210-2512, 6-10.
- [4] Hansen,K.-Reinecke,M.-Klär,H.-Benča,M.: High-Speed High-Resolution Signal Processing for Multicell Silicon Drift Detectors. IEEE Transactions on Nuclear Science, Vol.49, časť 2, April 2002, New York, USA, ISSN 0018-9499, 541-547.
- [5] Kocur,D.-Zetík,R.: Volterra Filter Application in DS-SS Receiver for Narrowband Interference Suppression. Acta Electrotechnica et Informatica, Vol.2, No.2, 2002, FEI TU Košice, Slovakia, ISSN 1335-8243, 56-59.
- [6] Kocur,D.-Zetík,R.-Galajda,P.: Volterra Filter Application in DS-SS receiver for Broadband and Narrowband Interference Suppression. Journal of Electrical Engineering, Vol.52, No.5-6, 2002, FEI STU Bratislava, Slovakia, ISSN 1335-3632, 132-137.
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