The Technical University of Košice

Faculty of Electrical Engineering and Informatics

Annual Report 1996

Department of Electronics and Multimedial Telecommunications

THE TECHNICAL UNIVERSITY OF KOŠICE

Faculty of Electrical Engineering and Informatics
(Slovak Republic)

DEPARTMENT OF ELECTRONICS AND MULTIMEDIAL TELECOMMUNICATIONS

ANNUAL REPORT 1996

Edited by Ľuboš Ovseník

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1. INTRODUCTION

The Department of Electronics and Multimedial Telecommunication was founded in the year 1969.
The number of student studying in the Department is approximately 18O.
The basic research of the Department concentrates on multimedial communications, digital signal processing mainly digital picture and speech processing and transmission, optoelectronics systems and optical communication, implementation of neural networks in digital processing and communication, digital filtering and ADC modeling.

2. FACULTY

Head : Prof. Ing. Dušan Levický, CSc.

Assoc. Heads : Prof. RNDr. Ing. Ján Turán, DrSc.
Doc. Ing. Stanislav Marchevský, CSc.

Full professors : Prof. Ing. Dušan Levický, CSc.
Prof. Ing. Linus Michaeli, CSc.
Prof. RNDr. Ing. Ján Turán, DrSc.

Full professor Emeritus: Prof. Ing. Viktor Špány, DrSc.

Associated professors: Doc. Ing. Anton Čižmár, CSc., Dean of the Faculty of Electrical Engineering and Informatics,
Doc.Ing. Dušan Kocur, CSc.,
Doc. Ing. Stanislav Marchevský, CSc.,
Doc. Ing. Ján Mihalík, CSc.

Assistant professors: Ing.Ľubomír Doboš,CSc., Ing.Miloš Drutarovský, CSc., Ing. Pavol Galajda, CSc., Ing. Ján Gamec, CSc., Ing. Milan Chudáčik, CSc., Ing. Jozef Juhár, CSc., Ing. Ján Šaliga, CSc., Ing.Jozef Zavacký, CSc., Ing. Iveta Gladišová, CSc., Ing. Zita Klenovičová, CSc., Ing. Ľudmila Maceková, Ing. Emil Matúš

Research Staff : Dr. Ing. Ingrid Hroncová, Ing. Ľuboš Ovseník

3. COURSES GIVEN IN 1996

Subjects	Winter semester	Summer semester	Lecturer
2nd year of study			
Electronic Devices	X		Marchevský
3rd year of study			
Digital Electronics		X	Levický
Acoustics	X		Juhár
Electronics and Transmission of Information	X		Doboš, Čižmár
Linear Analog Circuits	X		Kocur
Non-Linear Analog Circuits		X	Michaeli
Signals and Systems		X	Mihalík
Design of Electronic Equipment	X		Doboš
Microwave Technology	X		Turán
Antennas and Propagation		X	Ovseník
4th year of study			
Coding and Modulation	X		Čižmár
Microprocessors in Electronic systems	X		Levický
VLSI Processors		X	Drutarovský
Communication Systems		X	Čižmár
Digital Filtering		X	Kocur
Electronic Measurements	X		Šaliga
Analog & Digital Interfaces		X	Michaeli, Šaliga Čižmár
Digital Signal Processing	X		Mihalík
TV Systems	X		Marchevský
Optoelectronics	X		Turán
Optoelectronic Communications		X	Turán
Signal Recording		X	Juhár
5th year of study			
Telematic Systems	X		Levický
Radioelectronic Systems	X		Doboš
Sensor Systems	X		Michaeli
Digital Image Communication Systems	X		Mihalík
Medical Electronics	X		Michaeli
Photonics	X		Turán
Satellite Communications	X		Marchevský

4. Research Laboratories

4.1. Laboratory of Multimedial Communications

Staff

Head: Full prof. **Prof.Ing. Dušan Levický, CSc.,** Member of the IEEE
phone: +42-95-356 92 e-mail: levickyd@ccsun.tuke.sk
Lecturer of Courses:
Microprocessor in Electronic Systems, Telematic Systems, Digital Electronics

Assoc. prof. **Doc.Ing. Anton Čižmár, CSc.,** Member of the IEEE, Member of the AES
phone: +42-95-6322483 fax:+42-95-6330115 e-mail: cizmara@tuke.sk
Lecturer of Courses:
Communication Systems, Digital Transmission Systems, Coding and Modulations

Assist. prof. **Ing. Zita Klenovičová, CSc.**
Course:
Digital Electronics

Assist. prof. **Ing. Emil Matúš** e-mail: matus@ccsun.tuke.sk
Course:
Telematic systems, Microprocessor in Electronic Systems

Research Assistant:
Dr. Ing. Ingrid Hroncová e-mail: franková@ccsun.tuke.sk

Ph.D. Students:

Ing.Peter Böhmann

Ing.Peter Chromek (distance form)

Ing.Jozef Hámorský e-mail: hamorsky@ccsun.tuke.sk

Ing.Peter Král

Ing.Milan Tkáč

Research activities:

Research project No.41141

Digital Methods for Signal Preprocessing and Transmission

Research project No. 2312/95

Intelligence Signal Processing in Telecommunication

Supervised by Prof.Ing. D.Levický, CSc.

The projects are oriented towards to digital signal processing in field digital picture processing, digital speech processing and digital filtration.

Wavelet Transform in Digital Signal Procesing

Scientific staff: D.Levický, E.Matúš, P. Král

The wavelet transform is relatively a new concept of linear transformations that generalizes properties of the Haar transform and it is very good for 1D and 2D signals analysis and synthesis. Connection with subband decomposition can be used for fast analysis and synthesis algorithms, especially in application such as image coding.

Some theoretical approaches to the wavelet transform for image decomposition and synthesis were analyzed and verified on practical experiment.

In the orthonormal case, for calculation of wavelet coefficients it is need only coefficients of LP filter that generate orthonormal scaling functions. If the regularity of wavelets is not required, perfect reconstruction state CQF filters, however QMF filters are recently very often used too.

For biorthogonal wavelets it is need coefficients of both analysis and synthesis filters, but these can be symmetric.

Fractal Image Compresion

Scientific staff: D.Levický, P.Král

Fractal image compression is based on applications of contractive transformations on image blocks. This blocks are of two different sizes (R and

D blocks) and fractal compression is based on an assumption that image redundancy can be removed through local self similarity.

One a method for fractal image compression was proposed and verified. Proposed method is in principle lossy encoding scheme with trade-off between compression ration and image quality after image reconstruction.

In experiments was image Lenna (8bpp) used and bit rate from 0.5714 to 0.0235bpp. was obtained by proposed fractal compression method.

Progressive Image Compression

Scientific staff: D.Levický, Z.Klenovičová

Progressive image compression is very important technique in image processing. In this special mode of image compression is image encoded in multiple scan and receiver built up progressively better approximation of original images.

In the field of image compression the main methods for image decomposition using image hierarchy in space domain are:

- bit planes,
- TSVQ method,
- pyramids.

Every methods were analyzed in progressive image transmission from point of view image compression and image reconstruction.

The set of Gray codes as well as arithmetic code in bit planes coding were used.

Some experimental results on set of standard image (Lenna, Cameraman, Girl) were obtained by mean bit planes decomposition and their progressive coding by arithmetic coding.

Object Movements Detection

Scientific staff: D.Levický, P.Böhmann

The goal of research work in this field is to detect the object movement in the scene with respect to the sensor (camera), or at least the projection of this motion onto the image plane. Many application use motion estimation which can always be expressed in term of matching.

A new method for compute displacement vectors from two consecutive image in image sequence was proposed. The algorithm is divided into two steps.

First, the characteristic edges are computed in both image of image sequence. The edge selection is performed by gradient operators and by filtration with 2D thresholding function.

Second, displacement vectors are determined. This computation has high computation requirements, therefore the artificial neural network (ANN) is used.

The ANN is 2D Hamming neural network and contains four layers: input layer, computation layer, computation layer and output layer.

Speech and Channel Coding and Neural Networks in Communications

Scientific staff: A.Čižmár, I.Hroncová, J.Hámorský

Applications of speech coding today have become very numerous. A few examples are listed here: mobile satellite communications, cellular mobile radio, voice/data multiplexers for public and private networks, rural telephone radio carrier systems, audio for videophones or video teleconferencing systems.

In this part of the project the stability behavior of the iterative decoding (ID) of Turbo-Codes and its influence on the overall performance are searched. Several criteria to characterize the ID are proposed and the most reliable ones

are determined. These criteria are used to partition the transmitted blocks into stable and unstable ones. For unstable blocks the decoding step is determined which most likely produces a low number of decoding errors. These operations allow to lower the bit error rate (BER) significantly and to detect the erroneous blocks with high probability. Simulation show an improvement in BER by factor 10 and more.

Author field of the usearch is oriented to the developing of a new method from the group of transform coding (TC) method. The advantage of the TC over waveform coders is its lower bit rate and over vocoders is its ability to code efficiently also non-speech signals where result of vocoders is very poor.

Proceeding from these facts, a new modified transform coder was proposed. It is based on mixed TC using constrained basis representation and voiced / unvoiced / silence detection. This coder can adaptively allocate the number of retaining dominant transform components for each transform in mixed transform coder due to the different type of speech segment. a bit rate reduction can be reached because of the possibility to transmit silence only with a small number of transform components. This way a variable bit rate can also be obtained.

International Cooperation

Continuous Speech Recognition Over the Telephone

Research project: COST 249
Supervised by Doc.Ing. A.Čižmár, CSc.
Scientific staff: S.Marchevský, D.Kocur, I.Hroncová, M.Drutarovský, J.Juhár, Ľ.Doboš

The main objective of the project is to co-ordinate research efforts in the area of multilingual continuos speech recognition for future public network services. This will be accomplished by establishing a unified language-independent speech recognition concept, and be investigating specific topics within the framework of this concept.

This research project is proposed as a 4-year action, and the work packages can be described in terms of the concepts or the kind of processing being addressed:

Working Group 1: Concept Establishment

Working Group 2: Linguistic Processing

Working Group 3: Phonetic Decoding

Working Group 4: Acoustic Signal Processing

COST 249 is common project of teams at universities and private firms from foreign countries as follows: Belgium, Czech republic, Denmark, France, Germany, Hungary, Ireland, Italy, Lithuania, The Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Turkey, Finland.

We are involved in the Working group 4 - Acoustic Signal Processing.

The quality and intelligibility of speech is often degraded by background noise, by coding noise, by noise due to transmission over a channel with non-linear intersymbol interference, and by the presence of speakers other than the desired speaker. The aim of speech enhancement, noise suppression,

and transmission-line equalization techniques is to process the degraded speech such that its intelligibility and quality are improved.

The research of the group is oriented towards the fields:

a) speech enhancement and noise suppression technique
   - time/frequency domain adaptive filtering
   - linear adaptive filtering
   - nonlinear (Volterra) adaptive filtering
   - neural networks based noise reduction
   - frequency domain adaptive postfiltering

b) transmission-line equalization techniques:
   - equalization of channels with non-linear intersymbol interference by multi-layer perception.

As fields of possible applications are defined:
   - presence of background noise in an automatic recognition systems
   - crosstalk and echo noise in telephone systems
   - co-channel noise in a cellular mobile telecommunications systems, etc.

In the COST 249 project is involved a staff of Department of Cybernetics and Artificial Intelligence.

ISMAN - Integrated Services Metropolitan Area Networks
COPERNICUS Project: COP 587
Supervisor: Doc. Ing.Anton Čižmár, CSc.
Scientific staff: D. Levický, J. Juhár, I. Hroncová, Ľ.Doboš

The main objective of ISMAN project is to define the architecture of a multiservice communication network across a metropolitan area based on advanced technologies such as ATM in order to provide data, voice, and TV services to residential, public administration, and business customers. The analysis of different scenarios for Krakow (Poland) and Košice (Slovak

Republic) will take into account the existing infrastructure, broadband and narrowband services capabilities, security, economical aspect and logistic aspects of such a network. Multimedia services and telematic applications profiles will be implemented in order to evaluate the network global performance.

During this year the two types of MAN were designed and simulated in COMNET III.

The first of them is based on FDDI technology and connects only academic institutions. It was designed to enable transmission of pictures and files over the network, and also for video - teleconferencing to enable exchange of information among researchers and for teaching purposes.

The second type of MAN is based on the new progressive ATM technology. This type of network makes it possible to include various institutions: academic, industrial or business. All types of traffic can be transmitted. The network was simulated so as to be able to transmit a large amount of information.

Partners:

LORACOM (Association Lorraine du Centre d'Igenierie des Technologies de la Communication), University of Nancy, France

University of Mining and Metallurgy, Dept. of Telecommunications, AGH Krakow, Poland

University of Catania, Italy

Technical University of Košice, Dept. of Electronics and Multimedial Communications, Slovakia

Comarch Co.Ltd., Poland

Data Processing Centre of Krakow Voivodship Office, Poland.

MOCOMTEL - Mobile Computing for Telematic Services
INCO/COPERNICUS Project: PL 961114
Supervisor: Doc. Ing.Anton Čižmár, CSc.
Scientific staff: D. Levický, J. Juhár, I. Hroncová, Ľ.Doboš

The objective of the MOCOMTEL project is to define and test in field trials with users a concept for provision of telematic services using wireless networks. The target users are from health and education sectors in Poland and Slovakia.

The objectives for the MOCOMTEL project are quantified as follows:

- Evaluation of the possibility of data and multimedia services provision in cellular and ATM radio networks,
- Evaluation of the possibility of isochromous and multimedia services provision in LANs and WANs,
- Study of management and control mechanism which are targeted to ensure provision of telematic services at highest possible QoS through simulation and analytical modeling,
- Development of telematic services for health and education.

Partners:

LORACOM (Association Lorraine du Centre d'Igenierie des Technologies de la Communication), University of Nancy, France

University of Mining and Metallurgy, Dept. of Telecommunications, AGH Krakow, Poland

University of Catania, Italy

Technical University of Košice, Dept. of Electronics and Multimedial Telecommunications, Slovakia

Foundation for Progress in Telecommunications, Krakow, Poland.

TELECOMNET - Telecommunication network and services

TEMPUS Project: JEP-09326-95
Local coordinator: Prof. Ing. Dušan Levický, CSc.

Partners of the project:

Slovak Technical University, Bratislava, Slovakia

University of Transport and Communication, Žilina, Slovakia

Technical University, Košice, Slovakia,

Universidad Politécnica de Cataluna, Barcelona, Spain

Politecnico di Torino, Torino, Italy

Slovak Telecommunication, S.T., Bratislava, Slovakia

Alcatel Business Systems, Bratislava, Slovakia

Siemens A.G., Wien, Austria

Alcatel Sel, Stuttgart, Germany

General Objective

Complex restructuring of the degree course Telecommunication Technologies at three technical universities in Slovak Republic (STU Bratislava, UTC Žilina and TU Košice) at the level of undergraduate and postgraduate study, as well as at the level of continuing education.

Goals of the Project

(i) Curriculum development of the degree course Telecommunication Technologies

- M.Sc Study
- Ph.D. Study

(ii) Curriculum development for continuing education course in the area of telecommunication technologies

- Creation a system of continuing education

(iii) Development / modernization of subjects for the degree course Telecommunication Technologies and for continuing education in the area of telecommunication technologies

- Development / modernization of subjects for M.Sc and Ph.D. study
- Development / modernization of subjects for continuing education

(iv) Establishment of training centers

Members

Doc.Ing.Čižmár Anton, CSc., Member of Technical Standardization Commission No.41 for Telecommunications in Slovakia.

Doc.Ing.Čižmár Anton, CSc., Member of AES (Audio Engineering Society), New York, I.D. 44 154.

Prof. Ing. Levický Dušan, CSc., Member of the editorial board "Radioengineering".

Other Activities

Doc.Ing.Čižmár Anton, CSc., Member of the International Conf. Org. Committee Telecommunications 96, June 5-6, 1996, in Bratislava, Slovakia.

Doc.Ing.Čižmár Anton, CSc., Member of the 1st International Conf. Org. Committee RSEE 96 , May-June 30-1, 1996, in Oradea, Romania.

Doc.Ing.Čižmár Anton, CSc., Chairman of the International Conf.: Neural Networks and their Application Possibilities, November 1996, Košice, Slovakia.

Prof. Ing. Levický Dušan, CSc., Member of the International Conf. Program Committee „Biosignal 96“, June 25-27, 1996, Brno, Czech Republic.

Prof. Ing. Levický Dušan, CSc., Member of the Scientific International Conf. on Communication, Signal and Systems. CSS 96, Program Committee Sep. 10-.12, 1996, Brno, Czech Republic.

Prof. Ing. Levický Dušan, CSc., Member of the Scientific Conf. with International Participation Radioelektronika 96, Program Committee April 23-24, 1996, Brno, Czech Republic.

Prof. Ing. Levický Dušan, CSc., Member of the Scientific Conf. with International Participation „Nové smery v spracovaní signálov III.“ Program Committee May 29-31, 1996, Lipt. Mikuláš, Slovak Republic.

PUBLICATIONS

Journal Papers

Klenovičová,Z.: Gray Codes for Image Compression. Journal of Elec. and Engineering. Vol.47, No. , 1996, (in press).

Levický,D.-Drutarovský,M.-Galajda,P.-Kocur,D.-Marchevský,S.: Adaptive Goertzel's Algorithm for DFT Compution with Higher Accuracy. Radioengineering. Vol. 5, No. 1, April 1996, 1-6.

Levický,D.-Matúš,E.-Král,P.: Wavelet Transforms Analysis - Synthesis Algorithm. Journal of Elec. and Engineering. Vol.47, No. , 1996, (in press).

Conference Papers

Čižmár,A.: Some Possibilities of Using Neural Networks in Speech Processing and Telecommunications. Proc. of the 1st Int. Conf. on ANN and their Applications Possibilities, Košice, Nov.18-19, 1996, 15-21.

Čižmár,A.: Contribution to MAN Standards and Technologies. Proc. of the 1st Int. Conf. Renewable Sources and Environmental Electro-Technologies, May 30 - June 1, 1996, Felix Spa, Bihor, Oradea, Romania, 182-188.

Čižmár,A.-Hroncová,I.: MAN Standards and Technologies with Simulations. Proc. of the 2nd Int. Conf. on Telecommunication Technology, June 5-6, 1996, Bratislava, 83-88.

Čižmár,A.-etal.: Science and .Technology Development from the view of FEI TU Košice. Proc.: Rozvoj vedy a technológií v stratégii rozvoja revitalizácie priemyslu. Stará Lesná, 1996, 50-54. (in Slovak)

Čižmár,A.: Ako ďalej v definovaní strategických smerov rozvoja národného hospodárstva. (Defining the Strategic Fields of Economy Development in Slovakia.) Proc. of the Conf.: Stratégia a podpora rozvoja potenciálu vedy a techniky v SR. NOVTECH 96, Žilina, Nov. 26-28, 1996. (in Slovak)

Hroncová,I.: ISDN služby poskytované sieťovou vrstvou. (Network Layer Supported ISDN Services.), Proc. 1st Int. Workshop TEMPUS - TELECOMNET, Žilina, Sep. 11-12, 1996, 81-83. (in Slovak)

Král,P.: Aktívtext - aktívny teletextový systém. (The Interactive Teletext System - Activtext.), Proc. 1st Int. Workshop TEMPUS - TELECOMNET, Žilina, Sep. 11-12, 1996, 73-76. (in Slovak)

Král,P.-Levický,D.: A Method for Fractal Image Compression. Proc. of Sci. Conference „New Trends in Signal Processing III“, Lipt. Mikuláš, May 1996, 70-73.

Levický,D.-Böhmann,P.-Kostelník,J.: Artificial Neural Networks for Displacement Vectors. Proc. of the Int. Conf. "Artifical Neural Networks and their Application Possibilities", Košice, November 18-19, 1996, 28-32.

Levický,D.: Reštrukturalizácia študijného odboru Rádioelektronika do oblasti telekomunikačného inžinierstva v rámci projektu TEMPUS - TELECOMNET. (Restructuring of Degree Courses of Radioengineering into the area of Telecommunication Engineering within the TEMPUS Project TELECOMNET.), Žilina, Sep. 11-12, 1996, 66-68. (in Slovak)

Matúš,E.: Koncové zariadenia pre ISDN siete. (Terminals for ISDN Networks.), Proc. 1st Int. Workshop TEMPUS - TELECOMNET, Žilina, Sep. 11-12, 1996, 77-80. (in Slovak)

Thesis

Hroncová,I.: Transformačný kóder s detekciou znelosti, neznelosti a pauzy. (Transform coder with voiced / unvoiced / silence detection.) Ph.D. Thesis, FEI TU Košice, Slovakia, April 1996.

Other Publications

Čižmár,A.-Levický,D.-Hroncová,I.-Doboš,Ľ.: Integrated.Services Metropolitan Area Networks - ISMAN. Technical Copernicus 587 Report, Sept. 1996.

Čižmár,A.: MAN - A New Technology in Telecommunications. Internal Report for Slovak Telecom. August 1996, 15-29.

Čižmár,A.-etall.: Annual Project Report, COPERNICUS 587 - ISMAN. LORACOM - Nancy, France, April 18, 1996.

Čižmár,A.-Levický,D.-Marchevský,S.: New Technologies and Services in Telecommunications. Prognostic Study for Slovak Telecom, Košice, August 1996. (in Slovak)

Čižmár,A.: Improvements of MLP in Channel Equalization. Minutes of 6th MCM of COST 249 in Stockholm, Sweden, Working Group 4, June 17-19, 1996.

4.2. Laboratory of Digital Signal Processing and Satellite Communications

Staff

Head: Assoc. prof. **Doc.Ing. Stanislav Marchevský, CSc.**
phone: +42-95-6333458 e-mail: Stanislav.Marchevský@tuke.sk
Lecturer of Courses:
Electronic Devices, TV Systems, Satellite Communications

Assist. prof. **Ing. Ľuboš Doboš, CSc.**
phone: +42-95-399 071 line 698
Lecturer of Courses:
Electronics and Transmission of Information, Design of Electronic Equipment, Radioelectronic Systems

Assist. prof. **Ing. Jozef Juhár, CSc.**
phone: +42-95-399 071 line 698 e-mail: juharj@ccsun.tuke.sk
Lecturer of Courses:
Acoustics, Signal Recording

Assoc. prof. **Doc. Ing. Dušan Kocur, CSc.**
phone: +42-95-63 386 59 line 6 e-mail: Dusan.Kocur@tuke.sk
Lecturer of Courses:
Linear Analog Circuits, Digital Filtering

Assist. prof. **Ing.Miloš Drutarovský, CSc.**
phone: +42-95-63 38659 line 6 e-mail: Milos.Drutarovsky@tuke.sk
Lecturer of Courses:
VLSI Processors
Courses:
Electronic Devices,Satellite Communications

Assist. prof. **Ing.Ľudmila Maceková**
phone: +42-95-63 38659 line 6 e-mail: Macekova@hron.ef.tuke.sk
Courses:
Electronic Devices, Design of Electronic Equipment, Linear Analog Circuits, TV Systems

Ph.D. Students:

Ing.Imrich Hendel	e-mail: hendel@ccsun.tuke.sk
Ing.Ľudmila Maceková (distance form)	e-mail: Macekova@hron.ef.tuke.sk
Ing.Ladislav Mihalčík (distance form)	
Ing.Abdulah Poian	
Ing.Jozef Raček	e-mail: racek@ccsun.tuke.sk
Ing.Viliam Segeďa	e-mail: Viliam.Segeda@tuke.sk
Ing.Radoslav Stanko	e-mail: stanko@ccsun.tuke.sk

Research activities:

Research project No. 41141
Digital Methods for Signal Preprocessing and Transmission

Research project No. 2312/95
Intelligence Signal Processing in Telecommunications
Supervised by Prof. Ing. Dušan Levický, CSc.

Design and Implementation of Neural Filters for Image Processing

Scientific staff: S. Marchevský, M. Drutarovský, Ľ. Doboš, Ľ. Maceková, J. Raček, V. Segeďa, A. Poian

The purpose of the project is to develop efficient algorithms for the design and implementation of nonlinear adaptive filters based on neural networks.

A new fast generalized design algorithm for neural weighted order statistic filters (NWOSF) based on minimization of k-th power error criterion is derived. This algorithm is almost the same as the back propagation algorithm used in neural networks that the positivity of the weights of NWOSF is imposed.

A new method of iterative filtration by using a classifier based on local image statistic is introduced. Iterative filtration allows significant improvement noise suppression.

Experimental results from monochrome and color image enhancement were provided to illustrate the performance of NWOSF.

Hybrid realization of SF (HRSF) was proposed. In HRSF, the signal processing is performed on the border between the analog and the digital worlds, where a set of analog signals is used as inputs, and digital data are obtained as the output. The problem of large array of A/D converters can be avoided. The realization is very effective when the input signals come from a sensor array (e.g. CCD image sensor), and which be integrated on the same chip as the hybrid SF. Another interesting application of HRSF is that the combination of sensor array and proposed hybrid realization of SF can be used as the A/D converter with high noise immunity to impulsive noise, and complete filtration is performed by analog hardware.

The architecture of neural stack filters for vector valued signals was proposed. They use additional information about the signals in different components of vector valued signals. Experimental color television signal RGB results from image enhancement of corresponded by impulsive noise and comparison with vector median filters and with component wise filtering by weighted order statistics filters were presented.

Pitch Detection Algorithms for Speech and Audio.

Scientific staff: J.Juhár

Speech and audio signals consists of alternating periodic and aperiodic intervals. Periodic of voiced intervals are characterized by waveform patterns called pitch periods, associated with the activity of the vocal cords. A pitch period is the waveform interval between successive glottal pulses in voiced portions of speech. The location of a sequence of pitch periods in the waveform is called pitch tracking and represents an important part of many speech processing systems. The pitch contour of an utterance is useful

for recognizing speakers, for speech instruction to the hearing impaired and is required in almost all speech analysis-synthesis systems.

Because of the importance of pitch detection, a wide variety of algorithms for pitch detection and tracking have been proposed. Our research in this field has been devoted to comparative performance study of various pitch detection algorithms. Our goal in the following period is studying new detection algorithms based on some modern signal analysis methods such as wavelet transform, time-frequency distributions (e.g. Wigner-Ville) and neural networks as well as their real-time implementation with DSP's.

Nonlinear Digital Filters

Scientific staff: D.Kocur

Digital filtering belongs to basic methods of digital signal processing. It has found a number of applications in the various fields of human activities. It may be supposed that in the future the spectrum of digital filtering applications will be remarkably extended.

One of the actual trends of the research in the field of digital filtering methods is represented by nonlinear digital filtering studying. The interest in nonlinear filtering results from knowledge that under condition of non-Gaussian signal processing or in the case of nonlinear system modeling a filter which is optimum for the solution of these tasks, is some nonlinear filter. It means that the applications of nonlinear filters can provide the higher quality of signal processing than corresponding linear filter applications. This property of the nonlinear filters has presented the reach source of a motivation for the research in the field of nonlinear filters.

Our research in the field of nonlinear filtering has been intent on nonlinear Volterra filters (VF), nonlinear microstatistic Volterra filters (MVF), nonlinear filters with canonical piecewise-linear structure (PWLF) as well as on tree-structured piecewise-linear adaptive filters (TPWLF).

The VFs belong to a group of nonlinear estimators and they are based on the approximation of nonlinear functionals by a truncated Volterra series. Within our research in the field of Volterra filtering we have focused on the problems of adaptive algorithms of adaptive VFs. Here, a new adaptive algorithm of adaptive VFs based on conjugate gradient method was developed. This algorithm belongs to the group of block algorithms of adaption. It is characterized by high rate of convergence at computational complexity of O(LP) wher L and P are block size and number of coeficients of VF, respectively.

In the field of a design of new categories of unconventional nonlinear filters we have proposed a new class of nonlinear filters so-called time-invariant MVF. This class of nonlinear filters is based on the idea of the conventional microstatistic filters (CMF) generalization by substituting Wiener filters (WF) applied in the CMF structure by the VFs. The results obtained by computer experiments have shown that in the case of non-Gaussian signal processing the MVF can outperform WF, VF and CMF. The task of MVF or CMF design can be formulated as a solution of nonlinear optimization problem. In order to solve this problem we have proposed to apply a genetic algorithm approach.

In the field of unconventional nonlinear adaptive filters we have focused our effort on the PWLFs and TPWLFs. We found that very unpleasant shortcoming of the PWLFs is beeing local minima of mean-square error corresponding to the PWLFs. It means that a special initial conditions have to be used for acceptable performance of this kind of filters. These conditions could be very restrictive for many applications. The TPWLFs are more complex than that of the PWLFs. In spite of that fact we found that their performance do not require a special inital conditions like e.g. the PWLFs performance. In the next period of our research in the field of TPWLFs we will try to find some interisting applications of this kind of filters.

International Cooperation

Innovative Methods of Noise and Vibration Analysis on Reciprocating Machinery for the Purpose of Quality Control and Diagnostics.

Supervisor: Doc. Ing. Dušan Kocur, CSc.
Scientific staff: M.Drutarovský, P.Galajda, S.Marchevský, E.Matúš, R.Stanko

Partners: MEDAV Digitale Signalverarbeitung GmbH, Germany
Technical University Ilmenau, Germany
Technical University Liberec, Czech Republic
LIAZ a.s. Jablonec n. Nisou, Czech Republic
ŠKODA a.s., Czech Republic
Technical Testing Institute Piešťany, Slovak Republic
Technical University Budapest, Hungary

This project represents an applied research in the field of noise and vibration analysis on reciprocating machinery. The intended measurement methods should improve the conditions for the development of new low noise and vibration products in the area of machine tools, machinery, and automobile industry. The methods should also contribute to improvement of safety, reliability, and maintainability of the new products.

The theoretical base of the project are modern methods of digital signal processing (DSP), statistic signal analysis, system identification and signal classification using neural nets. The implementation of the algorithms is founded on a modular DSP-based systems called miniSYS systems.

The effort of our research and development (R&D) group has been focused on activities in the field of miniSYS system programming, psychoacoustic and studying non-conventional methods of signal analysis including higher-order spectra (HOS) and wavelet transformation.

The miniSYS system is a DSP system based on signal processor DSP 56001/2 developed by MEDAV GmbH. This DSP system is especially suitable to industrial applications. The operational system (DSP OS) as well as a

considerable part of DSP library of the miniSYS system were developed by our R&D group. The DSP OS application is necessary for any miniSYS applications. At the present time, the DSP library developed in co-operation with other partners includes a number of routines for implementations of FFT algorithms, neural networks, order analysis, etc. It is expected that routines for conventional FIR and IIR digital filters and higher-order spectrum estimations will be available at the beginning of the next year.

The second field of our activities within CIPA-CT94-0220 project is represented by studying non-conventional methods of signal analysis with stress on the vibration and noise analysis and diagnostics. So far the conventional methods (e.g. a windowed Fourier transform, the Wigner distribution, etc.) were used for machine condition monitoring. These methods are effective in processing vibration signals but each possesses its own shortcomings. For the purpose of the solution of these problems non-conventional methods of signal analysis could be used. Here, the our R&D group has focused on signal analysis methods based on the applications of wavelet transformations and higher order spectra (HOS). In the field of wavelet and HOS analysis MATLAB software for signal analysis was developed.

Psychoacoustics represents the basic science which studies the correlations between physically well defined stimuli and the hearing sensations elicited by these stimuli. Therefore, the science of psychoacoustics provides the background for practical applications in noise evaluation and control, environmental protection, fault-finding in mechanical equipment and machines, early diagnosis of engine damage, musical acoustics, hearing aids, broadcasting and communication systems, speech recognition, room acoustics, etc. the basic psychoacoustic quantities or so-called auditory sensations are loudness, roughness, sharpness and tonality. Within COPERNICUS project CIPA-CT94-0220 a MATLAB Toolbox

PSYCHOACOUSTIC has been developed by our R&D group. MATLAB m-files for evaluation of above given basic auditory sensations, for evaluation of some acoustical quantities (e.g. acoustic pressure level, etc.) as well as for design of octave and one-third-octave digital filters are included in this toolbox.

It is expected that the MATLAB software developed for the wavelet analysis, HOS estimation as well as Toolbox PSYCHOACOUSTIC will be used for date analysis obtained by measurement on gearboxes at Škoda Mladá Boleslav a.s. within the next period of our project.

Members

Ing. Juhár Jozef, CSc., Member of the Audio Engineering Society, New York, I.D. 44164

Ing. Juhár Jozef, CSc., Member of Technical Standardization Commission No.55 for Electroacoustics and ultrasound in Slovakia.

Doc. Ing. Marchevský Stanislav, CSc., Member of the Scientific Board Military Academy, Lipt. Mikuláš, Slovakia.

Doc. Ing. Marchevský Stanislav, CSc., Member of Technical Standardization Commission No. 60, Sound, Image and Audiovideo Equipment and Systems in Slovakia.

Other Activities

Doc. Ing. Marchevský Stanislav, CSc., Member of the Scientific Conf. Program Committee „New Trends in Signal Processing III.“ Conf. with International Participation, May 29-31, 1996, Lipt. Mikuláš, Slovakia.

Doc. Ing. Marchevský Stanislav, CSc., Member of the International Conf. Program Committee „Neural Networks and their Application Possibilities.“, Nov. 1996, Košice, Slovakia.

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4.3. Laboratory of Digital Image Processing and Videocommunication

Staff

Head: Assoc. prof. **Doc.Ing.Ján Mihalík, CSc.**
phone: +42-95-63 334 58 e-mail: mihalik@ccsun.tuke.sk
Lecturer of Courses:
Signals and Systems, Digital Signal Processing, Digital Image Communication Systems

Assist. prof. **Ing. Jozef Zavacký, CSc.**
phone: +42-95-63 224 60 line 231 line 24 e-mail: zavacky@ccsun.tuke.sk
Lecturer of Course:
Electronic Systems
Courses:
Signals and Systems, Electronic Systems

Assist. prof. **Ing. Iveta Gladišová, CSc.**
phone: +42-95-63 224 60 line 231 line 23 e-mail: gladis@ccsun.tuke.sk
Courses:
Signals and Systems, Digital Signal Processing, Electronic Systems

Ph.D. Students:

Ing.Jozef Dzivý e-mail: dzivyj@ccsun.tuke.sk

Ing.Martin Dulina e-mail: dulina@ccsun.tuke.sk

Ing.Ján Fedor e-mail: J.Fedor@ccsun.tuke.sk

Ing.Igor Kuba (distance form)

Ing.Rastislav Labovský (distance form)

Ing.Le Hoang Lien Son (distance form)

Research activities:

Digital Coding and Transmission of Images in Videotelephone and Videoconference Systems

Grant research project No.1707/94
Supervised by Doc.Ing. Ján Mihalík, CSc.
Scientific staff: J. Zavacký, I. Gladišová, J. Dzivý, M. Dulina, J. Fedor, R. Labovský, I. Kuba, L. M. Lien Son

Efficient image coding reduces a bit rate at the same quality of coded images and so there may be a decrease in channel capacity for transmission or storage for record of digital images. The high data compression, complexity of hardware and noise immunity are important characteristics for a choice of efficient coding methods. At present, the well - known ones are prediction, transform and hybrid methods of image coding. The hybrid image coding is a combination of the transform and prediction ones. Its different modifications are divided from the modifications of the transform and prediction ones. Our research in regard to CCITT International standardization of image codecs for their application into videotelephone and videoconference systems is orientated above all to hybrid codecs with two dimensional DCT, vector quantization and interframe prediction by using motion compensation.

In the area of vector quantization we make research towards suboptimal vector quantizers, because the optimal (full search) one has a large computational complexity, which grows exponentially with dimension. The suboptimal vector quantizers with a structural code-book achieve lower performance compared to the full search on of the same dimension and bit rate. They can achieve higher performance one that of the full search for the same computational complexity, because they may have bigger dimensions at the same bit rate. The suboptimal ones are: the tree search, geometrical, contour - gain, multistage and hierarchical vector quantizers, which can be realized as fixed or adaptive ones.

The interframe prediction of videotelephone or videoconference images with high performance is carried out by using motion compensation. Our research of the motion estimation is orientated to words the difference methods by using the recursive or nonrecursive algorithms next to the correlation methods from which are known iterative, logarithmic and hierarchical ones.

The image spectrum is anizotropic therefore the efficient discrete representation of an image may be obtained by multidimensional sampling in general by nonorthogonal lattice. The spline interpolators can carry out interpolation of the decoded images with high accuracy at low sampling frequency. In this area we concentrate towards searching for the optimal spline functions from the point of view precision as the advantageous technical realization and to the developing of hardware of spline interpolators on the basis of VLSI technology.

Digital Image Processing in Videocodecs

Institutional research project No.42143
Supervised by Doc.Ing. Ján Mihalík, CSc.
Scientific staff: J. Zavacký, I. Gladišová, J. Dzivý, M. Dulina, J. Fedor, R. Labovský, I. Kuba, L. M. Lien Son

The specific methods of digital image processing in videocodecs increase the performance of coding and data compression. Our research in the area involves the statistical and structural analysis in the image space and transform domain. Multiresolution decomposition of images by using the bank of mirror filters and the wavelet transform. Next, the block matching and recursive methods of motion estimation and compensation in images on the basis of the hierarchical or Kalman algorithms. Finally, nonlinear interpolation and prediction of images by the spline functions and the neural networks. The results of the research are applied at the vector quantization, prediction, transform, hybrid and subband coding of images.

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Dzivý,J.: Metódy analýzy a syntézy pre subpásmové kódovanie obrazu. (Methods of Analysis and Synthesis for Subband Image Coding.), Rigorous Work, FEI TU Košice, Slovakia, June 1996.

4.4.Laboratory of Optoelectronic Communications

Staff

Head: Full prof. **Prof. RNDr. Ing. Ján Turán, DrSc.,** Senior Member of the IEEE
phone: +42-95-399 071 line 231 line 26 e-mail: jturan@ccsun.tuke.sk
Lecturer of Courses:
Microwave Technology, Optoelectronics, Optoelectronic Communications, Photonics

Assist. prof. **Ing. Ján Gamec, CSc.**
phone: +42-95-386 59 line 7 e-mail: gamec@ccsun.tuke.sk
Courses:
Optoelectronics, Optoelectronic Communications, Microwave Technology

Research Assist. **Ing. Ľuboš Ovseník**
phone: +42-95-386 59 line 7 e-mail: ovsenikl@ccsun.tuke.sk
phone: +42-95-63 224 60 line 231 line 23
Course:
Photonics, Optoelectronic Communications, Microwave Technology, Antennas and Propagation

Ph.D. Students:

Ing.Juraj Futo

Ing.Miroslav Jacko (distance form) e-mail: mijac@ccsun.tuke.sk

Ing.Ladislav Kövesi e-mail: kovesil@ccsun.tuke.sk

Ing.Mikuláš Kövesi e-mail:kovesim@ccsun.tuke.sk

Ing.Marián Mihok (distance form) e-mail: mihokm@ccsun.tuke.sk

Ing.Ľuboš Ovseník (distance form) e-mail: ovsenikl@ccsun.tuke.sk

Ing.Róbert Probstner

Ing.Oleg Tkáč (distance form) e-mail: tkacoleg@upjs.sk

Ing.Július Tomčík (distance form)

Research activities:

Multidimensional digital signal processing and transmission

Fiber Optics

Simulation of Fibre Optic Communication and Sensory Systems

Financial support: Institutional grant project No.42144, FEI TU Košice

COST 254 Intelligent Processing and Facilities for Communication Terminal

COPERNICUS 1529 Development of Teleworking and Multimedia Services over High Speed Digital Networks

Supervised by Prof.RNDr.Ing. J. Turán, DrSc.

Scientific staff: Ľ.Ovseník, M.Mihok, O.Tkáč, J.Tomčík, R.Probstner

Wavelength division multiplexing in optical fiber sensor and communication systems

Combining the sensing and signal transmitting (i.e. telemetry) capability of optical fibers provide the strongest driving force for fiber optic sensor network development in the coming years. This capability becomes increasingly attractive as fiber optical local area networks (LANs) are likely to be implemented in factories, buildings, offshore platforms and mobile systems.

In a sensor network, at least two sensors, which may be discretely or continuously distributed in space according to a suitable topological pattern (linear array, star, ladder, ring), are operated and controlled by a single central optoelectronic terminal or transceiver unit. This requires a scheme to provide unambiguous sensor addressing (or multiplexing) and interrogation (or demodulation). We will deal only with networks of sensors having spatial distribution that is discrete or quantized, i.e. point sensors. The intrinsic or extrinsic sources of optical information regarding the non-optical measured, and this information may be carried by the amplitude (intensity), phase, polarization, or spectral distribution of the optical carrier. In addition, the sensor information may be encoded in the frequency or time

domain by means of the phase of an envelope modulation of the light. The topology of a fiber optic sensor network is strongly determined by the desired method of sensor modulation and interrogation. The interrogation may be performed in the time (TDM), frequency (FDM), or wavelength domain (WDM). The WDM technique is feature unique to optical sensors, whereas the others are used for addressing conventional electrical sensors.

Wavelength division multiplexing offers a potentially powerful technique for use with in optical fibre sensor and communication systems. The work deals with short review of this technique with reference to systems of discrete optical fibre sensors. Potential network topologies for wavelength division multiplexing multiple sensor networks are analyzed, with description of their major features and implementation constraints. The program code for CAD system for WDM fiber optic sensor system projecting will be developed.

Optically powered sensor telemetry system

Optically powered sensor telemetry systems include advantages of electrical as well as fiber - optic sensors. The applications of the system include aerospace, aircraft, automobile instrumentation, process control, industry and medical test instruments, etc. The system is created by optical and electrical parts. The optical part is used for the transmission of energy to electrical sensor itself, i.e. for electrical sensor powering, as well as for transmission of the information from the sensor to the processing unit. The electrical part is composed of the coding circuit and the optical pulse transmitter. The main part of the coding circuit is the resistance-dependent generator. Signal from the generator is converted to series of pulses. The time distance between two pulses corresponds to the sensed quantity. The restrictions for the electrical parts are the minimum possible current consumption and very small supply voltage: A very important role plays the opto-electrical converter and the laser source used for feeding

the system. A single optically powered sensor telemetry system can by simply extended to the optically powered sensor network.

Modeling high speed optical communication systems

Many commercial, scientific and educational environments face the communications bottleneck resulting from the limited transmission speed of to days interconnect technologies. Medical centers and hospitals would be able to transmit images form magnetic resonance scans to hundreds of work stations simultaneously. Universities, research centers and large corporations all need to link their mainframes, minicomputers, work stations and PC, to highs speed networks over campuses. In other areas, users do not need to share computing power, but they do need access to central mass storage in the form of large, redundant disk arrays. Potential network architectures are analyzed and modelled with the applications in multimedia communications electrical power industry and digital image transmission.

Hough and rapid transform

Transform Methods for Digital Multidimensional Signal Processing

Financial support :Grant project No. GAV 1680/94-9431 Ministry of Education and Science Slovak Republic, Bratislava

COST 254 Intelligent Processing and Facilities for Communication Terminals

COPERNICUS 1529 Development of Teleworking and Multimedia Services over High Speed Digital Networks

Supervised by Prof.RNDr.Ing.J. Turán, DrSc.

Scientific staff: Ľ.Ovseník, J.Gamec, J.Futő, L.Kövesi, M.Kövesi, M.Jacko

Hough transform

Hough transform (HT) is an universal method of detecting parametric curves, non-parametric curves of other objects in noisy pictures. It is used in picture information processing in robotics, scene analysis, medical science, industry, military technology, etc. Through the detection properties

of HT have been analyzed from different points of view, it is necessary to study the HT representation properties in connection with methodology of using HT spectral region, based on the new results of digital or analog signal processing theory. The major problem with practical application of HT in industry is the need of fast, reliable and economic HT processor (HTP). The current HTP perform the computation of HT spectrum in the electrical or optical area. A disadvantage of electronic digital HTP is that it is necessary to implement a great number of multiplications and additions which usually results in the low speed of computation and increasing the complexity of device. Though the current optical HTP make it possible to speed up the HT spectrum computation, they require spatial, very exacting, and thus also very expensive optical components. They are also very sensitive to the surrounding effects due to the volume optics components used. Diversification in HT applications shows its remarkable adaptability in solving new picture processing problems.

Based on the our new inventions this will be a development and implementation of new electronic fast HTP, working in real time in on-line with previous development our original Digital Image Preprocessing System (CSPO-III). We also continue further evaluation of use of HT for feature extraction in pattern recognition with study of new methods of HT spectral domain processing.

Rapid transform and its inversion

Rapid transform (RT) and others fast translation invariant transforms (CT) are very attractive for many digital image classifications 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 realization. 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-l, 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 -l 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-l 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 analyzed in the time - invariant RT transform domain and compared wit reference patterns stored in memory. The application of fast shift - invariant RT in signal classification increase the capability of the system to distinguish and identify different objects.

International cooperation

Project: **"Crowd Evaluation by Digital Image Processing"**
King's College, University of London, UK (Prof. A.C.Davies)

Project: **" COPERNICUS 1529 Development of Teleworking and Multimedia Services over High Speed Digital Networks"**
Supervised by Prof.RNDr.Ing.J. Turán, DrSc.
Scientific staff: M.Kövesi, Ľ.Ovseník, L.Kövesi
Partners:
TU Budapest, Dept. of Microwave telecommunication, Hungary
University of Ljubljana, Dept. of Electrical and Computer Eng., Slovenia
University of Delft, Dept. of Electrical Eng., Laboratory for Telecommunications and Image Processing, Netherlands
Technical University of Cluj-Napoca, Dept. of Electrical Eng., Romania
University of Firenze, Dept. of Electrical Eng., Italy
University of Gent, Dept. of Telecommunications and Information Technologies, Belgium

Recent advances in compression technology for video and audio on overhand, and the availability of global digital communication networks, as for example the Internet, on the other hand, server as a starting framework which will make those new methods of international cooperation possible. The technology is available now. What is needed, is a highlevel application which combines existing standards (MPEG, audio and video, TCP/IP protocols, ATM, Telephony, …) into a single application. The project strives after the integration of the following services into a personal desktop communications package: -computer data and image exchange, -multimedia e-mail, -interactive video/speech, -videotelephony, -teleconferencing.

Project: **"COST 254 Intelligent Processing and Facilities for Communication Terminals"**
Project coordinator: Prof. A.R.Figueiras-Vidal, EPS - Universidad Carlos III, Madrid, Spain.
Supervised by Prof.RNDr.Ing.J. Turán, DrSc.
Scientific staff: J,Gamec, M.Kövesi, Ľ.Ovseník, L.Kövesi, M.Jacko
Partners:France, Italy, Norway, Hungary, Spain, Slovenia, Poland, Portugal, Ireland, Greece, Belgium, Switzerland.

The project represents a theoretical base for the emergent new telecommunication terminals. The work is done in Working Groups:

WG.1G: Emerging Techniques for Terminal Hardware and Software.

WG.2G: Distributing Intelligence (Terminal to Terminal, Terminal versus Network).

WG.3A: Integrating Transmission, Computing, Processing, and User Needs at Terminals For Specific Applications.

Our research group will focus on special applications, such as teleworking and teleeducation terminals.

Member

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, Member of New York Academy of Sciences.

Turán Ján, Member of Slovak Optical Committee of the Slovak Academy of Science.

Turán Ján, Member of Scientific Commission for Electronics and Informatics, Slovak Academy of Sciences.

Turán Ján, Senior Member of the IEEE.

Turán Ján, Member of Czech and Slovak Radioelectronics Society.

Turán Ján, Member of Czech and Slovak Photonics Society.

Turán Ján, Member of Editorial Board of the journal Radioengineering.

Turán Ján, Member of Editorial Board of the journal Sensor.

Turán Ján, Member of Stearing Committee of International Conference on Multimedia Technology and Digital Telecommunication Services and Co-Chairman of the section: „Signal Processing in Multimedia“, Budapest, Hungary, 28-30.10.1996.

Turán Ján, Member of Stearing Committee of International Conference Signal/Image Processing and Co-Chairman of the section: „Pattern/Object Recognition“, Manchester, Great Britain, 4-7.11.1996.

Turán Ján, Vice-president of SAPTU, TU Košice.

PUBLICATIONS

Journal Papers

Gamec,J.-Turán,J.: Use of Invertible Rapid Transform in Motion Analysis. Radioengineering, Vol.4, 1996. (in press)

Turán,J.-Probstner,R.: Principles of WDM Optical Sensor Systems and its Projecting. Journal of El. En., Vol.28, No.10, 1996, 1-5.

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Conference Papers

Chudáčik,M.: Hough Transform in the Harmonic Signal Detection. In.: SIAD, Košice, Slovakia, September 1996, 29-34.

Fazekas,K.-Turán,J.-Erényi,I.: Video Coding Standard Conversion in Distributed Multimedia System. Int. conf. on Multimedia Technology and Digital Telecommunication Services, Budapest, Hungary, October 28-30, 1996, 83-87.

Fazekas,K.-Turán,J.-Erényi,I.: Development of Multimedia Courseware for Signal Procesing Teaching. Int. conf. on Multimedia Technology and Digital Telecommunication Services, Budapest, Hungary, October 28-30, 1996, 157-163.

Fazekas,K.-Turán,J.-Erenyi,I.: Transcoding in Distributed Multimedia System. Intelligent Methods in Signal Processing and Communications, COST 254, Bayona-Vigo, Spain, 24-26 June, 1996

Turán,J.-Ovseník,Ľ.-Kövesi,M.: Systematic Methods for Multimedial Communication Graphical User Interface Design. Radioelectronika 96, Brno, Czech Republic, 23-24 April, 1996, 320-323.

Turán,J.-Kövesi,M.-Kövesi,L.: Recognition of Meteorological Symbols Using Modified Rapid Transform. Radioelectronika 96, Brno, Czech Republic, 23-24 April, 1996, 180-183.

Turán,J.-Kövesi,M.-Kövesi,L.: Image Coding with Invertible Rapid Transform. New Directions in DSP III, Liptovský Mikuláš, Slovakia, 29-31 May, 1996, 60-64.

Turán,J.-Kövesi,M.-Kövesi,L.: Recognition of Airport Passenger Orientation Symbols Using Modified Rapid Transform. New Directions in DSP III, Liptovský Mikuláš, Slovakia, 29-31 May, 1996, 65-69.

Turán,J.-Ovseník,Ľ.-Kövesi,M.: Graphical User Interface for Multimedial Engineering Teleeducation. New Directions in DSP III, Liptovský Mikuláš, Slovakia, 29-31 May, 1996, 55-59.

Turán,J.-Fazekas,K.-Gamec,J.-Kövesi,L.: Crowd Motion Estimation Using Invertible Rapid Transform. Intelligent Methods in Signal Processing and Communications, COST 254, Bayona-Vigo, Spain, 24-26 June, 1996

Turán,J.-Fazekas,K.-Kövesi,L.-Kövesi,M.: Recognition of Information Symbols Using Modified Rapid Transform. Intelligent Methods in Signal Processing and Communications, COST 254, Bayona-Vigo, Spain, 24-26 June, 1996

Turán,J.-Fazekas,K.-Kövesi,L.-Kövesi,M.: Modified Rapid Transform Features in Information Symbols Recognition System. 3rd International Workshop in Signal/Image Processing - Advances in Computational Intelligence, Manchester, United Kingdom, 4-7 November, 1996, 173-176.

Turán,J.-Fazekas,K.-Ovseník,Ľ.-Kövesi,M.: Multimedial Communication Graphical User Interface Design Principles for the Teleeducation. 3rd International Workshop in Signal/Image Processing - Advances in Computational Intelligence, Manchester, United Kingdom, 4-7 November, 1996, 545-548.

Turán,J.-Ovseník,Ľ.-Kövesi,M.: Graphical User Interface Design for Multimedia Communication. TELEKOMUNIKÁCIE ’96, Bratislava, Slovakia, June 5-6, 1996

Turán,J.-Gamec,J.-Kövesi,L.: Invertible Rapid Transform and Motion Estimation. In.: SIAD, Košice, Slovakia, September 1996, 21-28.

Turán,J.-Ovseník,Ľ.-Kövesi,M.: Graphical User Interface Design for Multimedia Communication and Multimedia Rapid Transform Course Description. Int. conf. on Multimedia Technology and Digital Telecommunication Services, Budapest, Hungary, October 28-30, 1996, 75-82.

Turán,J.-Fazekas,K.-Gamec,J.-Kövesi,L.: Railway Station Crowd Motion Estimation Using Invertible Rapid Transform. Int. conf. on Multimedia Technology and Digital Telecommunication Services, Budapest, Hungary, October 28-30, 1996,

Other Publications

Kövesi,L.: Inteligentné metódy spracovania signálov s využitím rapid transformácie. (Intlligent Methods of Signal Processing Using Rapid Transform.) Rigorous Work, FEI TU Košice, Slovakia, September, 1996.

Probstner,R.: Projektovanie optických vláknových senzorových systémov s využitím spektrálneho multiplexu. (Projecting of Optical Fiber Sensor Systems with Using of Wavelength Division Multiplexing.) Rigorous Work, FEI TU Košice, Slovakia, September, 1996.

Turán,J.-Ovseník,Ľ.-Kövesi,L.-Kövesi,M.: Motion Analysis with IRT. COP1529_KOSI_DEL_01, Jan. 15, 1996, 13 pp.

Turán,J.-Ovseník,Ľ.-Kövesi,L.-Kövesi,M.: Design of Graphical User Interface. COP1529_KOSI_ DEL_02, Jan. 15, 1996, 22 pp.

Turán,J.-Ovseník,Ľ.-Kövesi,L.-Kövesi,M.: Document of a Practical Implementation of Example in the S1 and S2 Plane. COP1529_KOSI_DEL_03, July 3, 1996, 23 pp.

Turán,J.-Ovseník,Ľ.-Kövesi,L.-Kövesi,M.: Multimedia Rapid Transform Teleeducation Course Design Principles. COP1529_KOSI_DEL_04, July 23, 1996, 36 pp.

4.5.Laboratory of Electronic Circuits & Measurement

Staff

Head: Full prof. **Prof.Ing. Linus Michaeli, CSc.**
phone: +42-95-33458 e-mail: Linus.Michaeli@ccsun.tuke.sk
Lecturer of Courses:
Non-Linear Analog Circuits, Radioelectronic Measurement, Analog & Digital Interfaces, Sensor Systems, Medical Electronics

Full prof. **Prof.Ing. Viktor Špány, DrSc.**
phone: +42-95-33458
Lectures of Courses:
Statistical sensors, Integrated function blocks

Assist. prof. **Ing. Ján Šaliga, CSc.** e-mail: Saliga@ccsun.tuke.sk
phone: +42-95-399 071 line 231 line 28
Course:
Analog & Digital Interfaces, Radioelectronic Measurement

Assist. prof. **Ing. Pavol Galajda, CSc.**
phone: +42-95-38659 line 6 e-mail: Pavol.Galajda@tuke.sk
Courses:
Medical Electronics, Non-Linear Analog Circuits

Ph.D. Students:

Ing.Ján Baláž

Ing.Tomáš Frič e-mail: tomifric@ccsun.tuke.sk

Ing.Milan Guzan e-mail: guzan@ccsun.tuke.sk

Ing.Gabriel Hanko

Ing.Peter Kalakaj e-mail: kalakaj@ccsun.tuke.sk

Ing.Pavol Mikulík

Ing.Andrej Šak e-mail: sakan@ccsun.tuke.sk

Research activities:

Neural networks and fuzzy logical structures for intelligent instrumentation.

Scientific staff:
L.Michaeli,V.Špány,J.Šaliga,P.Galajda,M.Guzan,P.Kalakaj,A.Šak
Co-laborating part time scientific staff:
V.Pirč, Dept. of Mathematics, FEI TU Košice, Slovakia,
J.Pivka, University of California, Berkeley, USA,
T.Frič, TU Delft, Netherlands.

Artificial neural networks in instrumentation

The neural circuits represent a contemporary system of the parallel working processors with the ability to solve complex constrained optimization problems. The programming of neural networks is based on the training procedure in which the structure and the connection parameters are modified through experience represented by training set. Hardware implemented neural networks are perspective components for fast pattern recognition tasks in the instrumentation (analog-to-digital conversion, quantization of the measured analogue, time limited output signals into final number of the discrete classes) and the signal processing in the conditioning circuit of a measuring chain. The network output are the binary values determining the presence or absence of single base components. The orthogonality of the base function is not necessary. Various neural network structure for fast one dimensional signal classification leas been studied (Hopfield, back propagation, counter propagation).

A new neural circuits design approach was developed in framework of scientific co-operation with the research partners abroad. This approach utilizes a transformation of functional block scheme into a structure of sub-sets containing connection of the neurons. The nextgoing circuit optimization allows to create final perception with minimal number of neurons.

The theoretical conclusions are being experimental verified on the commercialized component ETANN (Electrically Trainable Analog Neural Network) i 18070 NX by Intel at the partner's University of Calabria in Rende (CS), Italy. This circuit contains 64 neurons and it suit well for signal decision tasks in measurement.

The deeper study of the neural network mathematical model is focused on the main aim to suppress a presence of the "spurious states" created by local minima. Software simulation of designed neural structure is a sophisticated tool for the estimation of parameters expected. Both models allow to predict metrological parameters of the processing procedure in statical and dynamical mode.

Intelligent measurement

The digital methods of systematic error correction in the processing circuits of intelligent measuring systems is another research objective of this scientific group. The main topic in this objective is focused on the application of standard and nonstandard interfaces, plug-in boards and analog-to-digital converters. In the framework of this tasks the methods of A/D converters testing with using the FFT of the harmonic test signal are being studied. The obtained outcomes are utilized for the software driver design in the LabWindows environment.

Statistical sensors

The statistical sensor has been the next component which measured information is represented by the probability of the one binary state occurrence in the output signal. Its advantage is small dimension, sensitivity on the wide scale of the physical quantities and possibility to create the field from these sensors. The simple principle of an information conversion and transmission designate this sensors for the application in the intelligent sen-

sors. There is possible to realize diagnostic and autocalibration very simple. That is a necessary condition for the special applications in the sensing of the nonelectrical quantities with high grade of the reliability (nuclear energetic and traffic systems).

Multilevel memory elements

The multilevel memory cell has been another component of the fuzzy logic structure. The goal of the study of its dynamic behavior is to find out the influence of the control pulse parameters on the memory cell ability to rewrite or damage the written information. The response of the multilevel memory cell on the control pulse has been advantageous to study using a computer simulation. The present state of the computer technology enables us to suppose the computer simulation to be equivalent of the physical verification. This is especially advantageous in the cases when the studied cell is a part of the integrated circuits structure with tiny geometrically dimensions.

International cooperation

TEMPUS Project: **Information Systems in Industry**
Project No. S_JEP-09484-95
Supervisor: Prof. Ing. Karol Florian, DrSc.
Scientific staff: L. Michaeli, J. Šaliga, and members of various departments from all faculties of TU.

Partners: University of Salerno, Faculty of Engineering, Italy
University of Calabria, Faculty of Engineering, Italy
The Nottingham Trent University, Dept. of Electrical and Electronic Engineering, UK
Fachhochschule Ulm, Fachbereich Automatisierungtechnik, Germany
University of Transport and Communication, Institute of Industrial Engineering, Žilina, Slovakia
VSŽ Košice, Research and Testing Institute, Slovakia
Electronic Control Systems, Ltd., Bratislava, Slovakia
Transtech Parallel Systems, Ltd., High Wycombe, UK.

The project complies with objective - I of TEMPUS priorities for Slovak Republic: Development of integrated and interdisciplinary studies with emphasis upon compatibility and equivalence with EU universities in a priority subject area of information and telecommunication technology.

The project will develop a curriculum for a new major speciality area - in industrial engineering - based upon the theory and practice of information technologies. The curriculum affords essential education to those who have an aptitude for engineering and a potentional capacity for management. The program is planed to prepare students for careers in industrial production operations in which automatization and current programming methods are being applied completely or in a part.

Research area:**Hardware implementation of neural-based A/D converters**

Prof. Linus Michaeli, Invitation as a visiting professor, Dept. of Electronics, Informatics and Computer Science, Univ. of Calabria, Rende(CS), Italy, 12 weeks.

Ing. Ján Šaliga, CSc., Individual Mobility Grant Tempus S-JEP-09484-95, Preparation of course „Technological Data Acquisition Systems“, University of Salerno, Italy, 4 weeks.

Ing. Pavol Galajda, CSc., Short term stay, University of Csenstochova, Faculty of Electrical Engineering, Poland, 1 week.

Ph.D. students exchange:

T.Frič, Ph.D.Study at the TU Delft, Netherlands.

The scientific co-operation is supported by means of common prepared project in the framework "TEMPUS" project JEP .

Courses given for technicians:

Ing. P. Galajda, CSc. - responsible person

The methods of Digital Signal Processing in Telecommunication for students from Technical University of Csenstochova, Faculty of Electrical Engineering, Poland, Sept. 1996, 5 days.

Lectures: Čižmár,A., Gladišová,I., Juhár,J., Kocur,D., Levický,D., Mihalík,J., Marchevský,S., Ovseník,Ľ.

Research area: **Chaos in Nonlinear Circuits**

Long-term study stay: **L. Pivka**, Cal Tech, Berkeley, California, USA, Dept. of Electronics and Computer Science.

Member

Michaeli Linus, Head of Slovak IMEKO Technical Committee TC-4 "Measurement of Electrical Quantities".

Michaeli Linus, Member of Technical Standardization Commission No. 55 for Electroacoustics and Ultrasound in Slovakia.

Michaeli Linus, Slovak Metrological Institute, Member of the Scientific Board.

Michaeli Linus, Member of the editorial board „Electrical Engineering Research Report“, Issued at University of Naples, Italy.

Michaeli Linus, Member of the IPC IMEKO TC-4 Conference, Budapest Sept. 1996, Hungary.

Michaeli Linus, Member of the International Review Board, MELECOM’96, Bari 1996, Italy.

Michaeli Linus, Member of the Scientific Board University of Transport and Communication, Žilina, Slovakia.

Šaliga Ján , Member of Slovak IMEKO Technical Committee TC-4 "Measurement of Electrical Quantities".

PUBLICATIONS

Journal Papers

Daponte,P.-Grimaldi,D.-Michaeli,L.: A Full Neural Gray-Code-Based ADC. IEEE Transaction on Instrumentation and Measurement, Vol.45, No.2, April 1996, 634-639.

Michaeli,L.-Somora,M.-Kalakaj,P.-Šak,P.: Korrektursystem für Temperature-inflüsse. Chapter 23. in „Multisensorikpraxis", Editor Dr.Ing.habil.H.Ahlers, Springer Verlag Berlin, 1996, 384-390.

Špány,V.-Pivka,L.: Dynamic Properties of Flip-Flop Semsors. Journal of Electrical Engineering, Vol.47, No.7-8, 1996, 169-178.

Conference Papers

Daponte,P.-Grimaldi,D.-Michaeli,L.: A Design Method for Signal Processing in Measurement Instrumentation by Neural Networks. Proc. of IEEE Instr. And Meas. IMTC'96, Brussels, Belgium, Jun 4-6, 1996, 340-347.

Drutarovský,M.-Galajda,P.-Galajdová,A.: Applications of sigma-delta Converters in Minimechanism Control Systems. Zb. Mini-microTech'96, Jun 1996, Košice, Slovakia, 73-77.

Galajda,P.-Drutarovský,M.: Aplikácia sigma-delta prevodníkov v riadiacich systémoch. (Applications of sigma-delta Converters in Control Systems.) Zb. ELMAT´96, May 1996, Košice, Slovakia.

Galajda,P.: Basic Auditory Sensation-Calculation of Tonality. COPERNICUS-6th Workshop, November 1996, Starý Smokovec, Slovakia.

Grimaldi, D.-Maiorca,F.-Molinaro,A.-Mollica,F.-Michaeli,L.: Improvement of the Neural ADC Accuracy by Successive Weight Optimisation. Proceedings „ADC Modelling" Workshop IMEKO TC-4 Publ. CUES Fisciano, Italy, 1996, 87-93.

Kalakaj,P.-Špány,V.-Šoltys,R.: Flip-Flop Semsors with Feedback. Tesla. III Milenium V International Conf., Oct. 1996, Belgrade, Yugoslavia.

Kocúr,D.-Mihalčík,L.-Galajda,P.-Marchevský,S.: The Basic Methods and Problems of Loudness Measurement Evaluation. COPERNICUS-5th Workshop, June 1996, Budapest, Hungary.

Michaeli,L.- Šaliga,J.: Neural Based 2-D.imensional Signal Quantisers in Instrumentation. 1th Slovak Neural Network Symposium, Nov. 1996, Herľany, Slovakia.

Michaeli,L.-Pirč,V.: Some Analytical Methods Suitable for Studying of the Hopfield. Neural Networks for Signal Processing. ANN Symposium, Nov. 1996, Košice, Slovakia.

Špány,V.-Galajda,P.-Guzan,M.: Boundary Surfaces of One-Port Memoris. Proc. Tesla. III Milenium V International Conf., Oct. 1996, Belgrade, Yugoslavia.

Other Publications

Šak,A.: Wienov oscilátor v senzorike. (Wien Oscilator in Sensors.).Rigorous Work, FEI TU Košice, October 1996.

5. FACULTY ESSAYS

Chudáčik Milan

Assistant professor

His research interests are in digital signal and image processing, Hough transform and Hough transform processors.

Čižmár Anton

Associated professor

His research interests include speech processing, neural networks, data compression and digital communications.

Doboš Ľubomír

Assistant professor

His current interests are in the linear adaptive digital filters, least Mean Square algorithms and QR decomposition.

Drutarovský Miloš

Assistant professor

His research interests include neural networks, nonlinear digital filters for image processing, digital signal processors and microcontrollers.

Galajda Pavol

Assistant professor

His present fields of interest are multiple - valued logic systems and its application, VLSI multiple - valued memory design and smart sensors, dynamic properties of a multiple-valued sequential circuit.

Gamec Ján

Assistant professor

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

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
Assistant professor
His research interests are in the application of various signal processing methods in pitch detection and tracking algorithms for speech and audio.

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, especially in linear and nonlinear time-invariant and adaptive digital filters, higher-order spectra and psychoacoustics.

Levický Dušan
Full professor
His main interests and activities are in the digital signal processing, microprocessors and picture processing and transmission.

Maceková Ľudmila
Assistant professor
Her general research interest includes design and implementation algorithms for two and three dimensional median filters for image processing.

Marchevský Stanislav
Associated professor
His main research interests are multidimensional digital filters, linear and non-linear digital filters for image processing.

Matúš Emil
Assistant professor
His research interest include digital picture processing.

Michaeli Linus
Full professor
His research interests are the preprocessing systems in the instrumentation, modeling of AD converters and hardware implementation of the neural networks for measuring systems.

Mihalík Ján
Associated 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
Research assistant
His general research interests include fiber optics, fiber optical sensors and the fiber optical application in the microwave domain.

Šaliga Ján
Assistant professor
His general research interests include neural networks in charge of an amplitude shape pulse detector, measurement instruments, systems and methods.

Špány Viktor
Full professor
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.

6. Ph.D. Programme

Name	Supervisor	Field
First year of study		
Ing.Fedor Ján	doc.Mihalík	digital signal processing
Ing.Hendel Imrich	doc.Kocur	adaptive nonlinear filters
Ing.Le Hoang Lien Son	doc.Mihalík	digital image processing
Ing.Mihalčík Ladislav (d. f.)	doc.Marchevský	digital filters
Ing.Mikulík Pavol (d. f.)	prof.Michaeli	decimation - interpolation
Ing.Poian Abdulah	doc.Marchevský	digital filters image processing
Ing.Stanko Radoslav	doc.Kocur	bispectrum signal analysis
Ing.Tkáč Milan (d. f.)	prof.Levický	digital picture coding
Second year of study		
Ing.Dulina Martin	doc. Mihalík	digital picture coding
Ing.Hanko Gabriel (d. f.)	prof. Michaeli	ADC converter
Ing.Frič Tomáš (d. f.)	prof.Michaeli	neural networks
Ing.Futó Juraj (d. f.)	prof. Turán	optical communication
Ing.Ovseník Ľuboš (d. f.)	prof.Turán	optical fiber sensors
Third year of study		
Ing.Baláž Ján (d. f.)	prof.Michaeli	
Ing.Jacko Miroslav (d. f.)	prof.Turán	Hough transform, DIP
Ing.Kövesi Mikuláš	prof.Turán	Rapid transform, DIP
Ing. Maceková Ľudmila (d. f.)	doc.Marchevský	Weighted median filters for DIP
Ing.Raček Jozef	doc.Marchevský	Kalman's filters for DIP
Ing.Segeďa Viliam	doc.Marchevský	Stack filters,genetics algorithms
Fourth year of study		
Ing.Böhmann Peter	prof.Levický	picture sequence processing
Ing.Dzivý Jozef	doc.Mihalík	digital signal processing
Ing.Hámorský Jozef	doc.Čižmár	digital speech processing
Ing.Kövesi Ladislav	prof.Turán	rapid transform, DIP
Ing.Král Peter	prof.Levický	digital picture coding
Ing.Probstner Róbert	prof.Turán	fibre optical sensors
Ing.Šak Andrej	prof.Špány	small signal quantities measur.
Ing.Tkáč Oleg (d. f.)	prof. Turán	optical communications

Name	Supervisor	Field

Fifth year of study		
Ing.Chromek Peter (d.f.)	prof.Levický	mathematic morphology
Ing.Guzan Milan (d. f.)	prof.Špány	smart sensors
Ing.Kalakaj Peter (d. f.)	prof.Špány	oscillator sensors
Ing.Kuba Igor (d. f.)	doc.Mihalík	digital image processing
Ing.Labovský R. (d. f.)	doc.Mihalík	digital signal processing
Ing.Matúš Emil (d. f.)	prof. Levický	Wavelet transform
Ing.Mihok Marián (d. f.)	prof.Turán	optically powered sensors

7. OTHER ACTIVITIES

7.l. Conferences, Seminars and Meetings

Organization of the 5th Management Committee Meeting og COST 249 in Košice, Slovakia, Febtuary 29 - March 1, 1996. (Čižmár)

Organization of the COPERNICUS 587 - ISMAN - Meeting in Košice, Slovakia, July 9-10, 1996. (Čižmár)

Organization of one week course for foreign students: **„MAN - A New Technology in Telecommunications“**, Košice, Slovakia, September 1996. (Čižmár, Hroncová)

Organization of Seminar **„Measurement Systems Based on PC“**, Košice, Slovakia, June 1996, (Šaliga, Michaeli)

Presentation of COPERNICUS 587 Project Results **„MAN Simulation in Košice“** at Int. Exhibition T.I.S. 96, Žilina, September 1996. (Čižmár, Levický, Hroncová)

7.2. Study tours

Ing. Jozef Hámorský
University Erlangen-Nürmberk, FRG

7.3. Visitors and visits

Prof. Comerlatti, Prof. Gnaedinger, University of Nancy, France. Visit of FEI TU Košice, July 9-10, 1996.

Prof. Ing. Dušan Levický, CSc., Participation on the COPERNICUS 587 meeting at AGH Krakow, Poland, December 10-12, 1996.

Prof. Ing. Dušan Levický, CSc., Politechnico di Torino, TEMPUS Project: JEP-09326-95, Italy, April 15-28, 1996.

Prof. Ing. Linus Michaeli, CSc., Workshop TEMPUS S - JEP 09484-95, at University of Salerno, Italy, June 3-17, 1996.

Prof. Ing. Linus Michaeli, CSc., Working stay, TEMPUS S - JEP 09484-95, at University of Calabria, Cosenza, Italy, June 25 - July 17, 1996.

Prof. Ing. Linus Michaeli, CSc., Lecture and research stays at University of Calabria, Cosenza, Italy, April, October, 1996.

Prof. Pach, Dr. Derkacz, Dr. Hulicki, Department of Telecommunications, AGH Krakow, Poland. Visit of FEI TU Košice, July 9-10, 1996.

Prof. RNDr. Ing. Ján Turán, DrSc., TU Vigo, Spain, International Conference on Intelligeny Methods for Signal Processing and Communications, 24-26.6.1996.

Prof. RNDr. Ing. Ján Turán, DrSc., TU Ljubljana, Slovenia, COP 1529 meeting, 18-21.7.1996.

Prof. RNDr. Ing. Ján Turán, DrSc., TU Budapest Hungary, COP 1529 meeting, 13-14.8.1996.

Prof. RNDr. Ing. Ján Turán, DrSc., TU Budapest Hungary, International Conference on Multimedia Technology and Digital Telecommunication Services, 28-30.10.1996.

Prof. RNDr. Ing. Ján Turán, DrSc., UMIST Manchester, Great Britain, International Conference Signal/Image Processing, 4-7.11.1996.

Doc. Ing. Anton Čižmár, CSc., Participation on the COPERNICUS 587 meeting at AGH Krakow, Poland, December 10-12, 1996.

Doc. Ing. Anton Čižmár, CSc., Participation on the 6th MCM of COST 249 in Stockholm, Sweden, June 15-18, 1996.

Doc. Ing. Anton Čižmár, CSc., Participation on the 7th MCM of COST 249 at ETH Zůrich, Switzerland, October 16-19, 1996.

Doc. Ing. Dušan Kocur, CSc., Technical University of Liberc, Czech republic, Feb. 12-24, 1996.

Doc. Ing. Dušan Kocur, CSc., Technical University of Budapest, Hungary, Jun 27-30, 1996.

Doc. Ing. Stanislav Marchevský, CSc., Politechnico di Torino, TEMPUS Project: JEP - 09326-95, Torino, Italy, April 15-28, 1996.

Doc. Ing. Stanislav Marchevský, CSc., Technical University of Budapest, 5th Copernicus CIPA-CT94-0220 Workshop, Budapest, Hungary, June 27-29, 1996.

Ing. Ľuboš Doboš, CSc., Participation on the COPERNICUS 587 meeting at AGH Krakow, Poland, December 10-12, 1996.

Ing. Miloš Drutarovský, CSc., Technical University of Liberec, Czech Republic, Feb. 4th-14th, 1996, working stay supported by Copernicus project CIPA-CT94-2002.

Ing. Miloš Drutarovský, CSc., MEDAV Digitale Signalverarbeitung GmbH, Germany, May 5th-11th, 1996, working stay supported by Copernicus project CIPA-CT94-2002.

Ing. Miloš Drutarovský, CSc., Technical University of Budapest, Hungary, June 27th-29th,1996, 5th Copernicus project CIPA-CT94-2002 workshop.

Ing. Miloš Drutarovský, CSc., MEDAV Digitale Signalverarbeitung GmbH, Germany, Sept. 17th-28th, 1996, working stay supported by project VHČ1 10/0414/96.

Ing. Ladislav Kövesi, TU Ljubljana, Slovenia, COP 1529 meeting, 18-21.7.1996.

Ing. Ján Šaliga, CSc., Working stay, TEMPUS S - JEP 09484-95, at University of Salerno, Italy, May 14 - June 7, 1996.

Frederic Rota, ISTASTE Saint Etienne, France, Engineer Training period, professor in charge M. Drutarovský, March-July 1996.

Isabella Serre, Engineer training period, Saint Etienne, France, professor in change S.Marchevský, March-July 1996.

The group of 12 students, Politechnika Csenstochova, Csenstochovska, Poland, September 1996.

7.4. External lectures

Courses given for technicians :

1. AmiPro 3.1
2. Analogue and digital interfaces
3. Application of microprocessors systems (5 days)
4. C language, advanced course (5 days)
5. Computer and MS DOS (5 days)
6. EXCEL 4.0 (5 days)
7. Introduction to microprocessors systems (5 days)
8. Introduction to digital circuits (6 days)
9. Introduction to C language (5 days)
10. Introduction to now-a-days analogue circuits (10 days)
11. Introduction to switch. power circuits
12. Measurement instruments and methods
13. Operational amplifiers (3 days)
14. Programming of microprocessors systems (5 days)

Courses given for engineers with technical education.

1. Fiber Distributed Data Interface (3 days)

8. PUBLICATION ACTIVITY OF THE DEPARTMENT

Journal Papers

Daponte,P.-Grimaldi,D.-Michaeli,L.: A Full Neural Gray-Code-Based ADC. IEEE Transaction on Instrumentation and Measurement, Vol.45, No.2, April 1996, 634-639.

Gamec,J.-Turán,J.: Use of Invertible Rapid Transform in Motion Analysis. Radioengineering, Vol.4, 1996. (in press)

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For further information :

Department of Electronics and Multimedial Communication
Prof.Ing. Dušan Levický, CSc
Faculty of Electrical Engineering and Informatics
The Technical University of Košice
Letná 9
O41 2O Košice
Slovak republic
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phone: +42-95-356 92
e-mail: levickyd@ccsun.tuke.sk