Name of the Institution:
University of Zagreb Faculty of Electrical Engineering and Computing

Web: www.fer.hr, www.unizg.hr

Name of the TEMPUS CRH-BME representative (for your Institution):
Prof. dr. sc. Ratko Magjarević

BME GROUP/LABORATORY PRESENTATION

Research in the field of Biomedical Engineering at University of Zagreb Faculty of Electrical Engineering and Computing is devoted to biosignal measurement and processing methods, in particular of heart and brain activity; bioimpedance measurement methods and instrumentation including characterization of bioelectrodes; computational modelling of electric and thermal effects in tissue during electroporation- based treatments, minimally invasive medical electronic instrumentation; electrical tissue stimulation in heart therapy; intelligent sensor networks for medical applications like development of new non-invasive diagnostic methods, instrumentation and networked sensor systems for physiological parameters monitoring and processing of extracted information in order to build up personalised intelligent mobile health systems for health care support. One of projects aims to develop devices for minimally invasive therapeutic procedures in cancer treatment and muscle stimulation, including pacing.
Research is also conducted in theory and applications of image processing, pattern recognition and computer vision methods in various areas including biometric security, biomedical imaging, and automotive applications. The main research problems include image feature extraction, image segmentation, image registration, and motion analysis in the area of biomedical image processing and analysis. Methods for real-time intravascular catheter tracking from X-ray image sequences and 3-D reconstruction of catheter tip, atlas-based image analysis of cardiac ultrasound Doppler images, nuclear medicine image analysis, CT and MR brain image analysis have have been investigated. In biometric security applications were developed for personal ID image analysis for quality control of passport photographs.
Mathematical models for extracting 3-D content from the images and devise methods, algorithms, and software packages that best implement these models are investigated. Research objectives are camera (self) calibration algorithms and methods, 3D structured light scanning, image feature extraction, marker tracking, surface registration. In this respect we research computer vision theory and methods applicable in variety of applications, and in particular for human motion analysis.

Measurement equipment used for research and development is shared with other research laboratories, e.g. the Precision Impedance Analyser Agilent 4294A, Precision RLC Meter HP 4284A, Philips IntelliVue MP50 monitor, International Safety Analyzer Biotec ISA 601 ProXL, GigEVision and Firewire digital video cameras and network IPcameras for multi-view scene analysis and state-of-the-art simulation tools, design and development tools for digital system design and embedded design (Actel, Microchip, Atmel). A high-performance computing cluster is used for research ofcomplex information processing algorithms.

BME EDUCATION

Elective courses at Master and Postgraduate level:

Title	Semester	Program
Biomedical Informatics	3	University graduate
Biomedical Instrumentation	3	University graduate
Biomedical Signals and Systems	3	University graduate
Biomonitoring systems	1	Post-graduation study
Computer Modeling of Physiological Systems	3	University graduate
Digital Image Analysis	2	Post-graduation study
Digital Image Processing and Analysis	2	University graduate
Digital Signal Processing	1, 3	University graduate
Digital Speech Processing	1, 3	University graduate
Electrical Instrumentation in Environmental Protection	1	Post-graduation study
Medical Instrumentation for 2-D Imaging	2	Post-graduation study
Networked Sensor Systems	3	University graduate
Neural Networks	1, 3	University graduate
Selected Topics in Digital Image Processing	1	Post-graduation study

Smart sensor networks	2	Post-graduation study
Transducers in Measurement Systems	1, 3	University graduate
Use of Computers in Medicine	2	Post-graduation study

COURSES AVAILABLE IN ENGLISH? (IF YES, ON WHICH LEVEL?)

- BSc:
- MSc: Yes
- PhD: Yes

ECTS: Total number

- BSc:
- MSc: 45
- PhD: 42

BILATERAL AGREEMENTS WITH OTHER UNIVERSITIES? (LIST THOSE UNIVERSITIES)

- Polytechnic University of Milano

MAIN BME INTERESTS

- BME instrumentation and measurement, sensors, signal and image processing, pattern recognition, safety of equipment, bioinformatics, medical informatics

ACTIVE PROJECTS

- **National (at Uni Zg, FEEC, Dept. for Electronic Systems and Information Processing, selected)**
- *Noninvasive Measurements and Procedures in Biomedicine, Ministry of Science, Education and Sport, project leader prof. S. Tonković, 2007-*
- *panoVRama: System for tiled vizualization using multiple projectors, Ministry of Science, Education and Sports, project leader prof. S. Lončarić, 2009-2010*
- *Intelligent multidimensional image processing and analysis, Ministry of Science, Education and Sports, project leader prof. S. Lončarić, 2005-2007*
- *Methods for real-time geometric correction, perspective correction and video stiching using multiple cameras, project leader prof. S. Lončarić, Xylon, Croatia, 2008-2010*
- *Enabling Technologies for Ambient Assisted Living, project leader prof. R. Magjarević, SD Informatika, 2007-2008*
- *Non-invasive Measurement and Technologies in Biomedicine, project of the Ministry of science and technology, project leader prof.dr.sc. Stanko Tonković, 2002-2006.*
- *Measurement Systems and Instrumentation for Biological Quantities Processing, project of the Ministry of science and technology, project leader prof.dr.sc. Ante Šantić, 1997-2002*

International (at Uni Zg, FEEC, Dept. for Electronic Systems and Information Processing, selected)

- *Virtual Physiological Human NoE, EU FP7 Network of Excellence, 2009-*
- *Advanced Methods for the Estimation of Human Brain Activity and Connectivity (NEUROMATH), COST Project, 2008-2011*
- *Numerical Modelling of Electric Field Distribution in Electrochemotherapy of Esophagus Malignant Tumors, Croatian – Slovenian Project, 2009-2010*
- *Medical imaging and image processing, CEEPUS, 1998-2010*
- *Numerical Modelling of Electrical and Thermal Effects during Electrochemotherapy and Electrogene Therapy, Croatian – Slovenian Project, 2007-2008*
- *Electrophysiology of Expectatory and Learning process: Processing of Cognitive EXG potentials, Croatian – Macedonian Project, 2005-2006*
- *Intelligent Instrumentation for Home Health Monitoring, Croatian – Hungarian Project, 2007-2009*
- *Real-time tracking of objects in biomedical Xray image sequences, Philips Medical Systems, Netherlands, 2005-2010*
- *Determination of Parameters for Prediction of Atrial Fibrillation in Postsurgery Patients from Esophageal and Surface ECG, bilateral project with the Institute for Biomedical Engineering, Stuttgart, 2004-2006.*
- *Physiological Modelling of MR Image Formation, COST B21, 2003-2008*
- *Chartography of Medical and Biological Engineering in Europe, FP-5, SSA, 2002-2004*
- *Evaluation of use of information technologies for the benefit of disabled and patients during rehabilitation, bilateral Croatian – British project, 2001-2003.*
- *Psychosocial Rehabilitation of Heavily Disabled, project of the World Association for Psychosocial Rehabilitation, Chair for Education and Informationt Technology Implementation in Rehabilitation, 2000*

- *Other*
- *Patents*

- …

RECENT PUBLICATIONS (LAST 2 YEARS)

Selected publications:

- Magjarević, Ratko. Encyclpedia of medical physics – 23 pojma iz znanstvenog područja // www.emitel2.eu, Emitel Network, S Tabakov, P. Smith, F. Milano, S-E. Strand, C. Lewis, eds., London 2010.
- Magjarević, Ratko; Tonković, Stanko. Biomedical Engineering Worldwide - Celebrating 50th Anniversary of the IFMBE // Annual 2009 of the Croatian Academy of Engineering / Tonković, Stanko (ur.). Zagreb : Croatian Academy of Engineering, 2009. Str. 35-50. ISSN 1332-3482
- Magjarevic, R; Ferek-Petric, B. Implantable Cardiac Pacemakers-50 Years from the First Implantation ZDRAVNISKI VESTNIK-SLOVENIAN MEDICAL JOURNAL 79 (1):55-67 2010.
- Sovilj, S; Van Oosterom, A; Rajsman, G; Magjarevic, R. ECG-based prediction of atrial fibrillation development following coronary artery bypass grafting PHYSIOLOGICAL MEASUREMENT 31 (5):663-677 2010.
- Lackovic, I; Magjarevic, R; Miklavcic, D. Three-dimensional Finite-element Analysis of Joule Heating in Electrochemotherapy and in vivo Gene Electrotransfer. I IEEE Transactions on Dielectrics & Electrical Insulation. 16 (5):1338-1347 2009
- Katrina Wendel, Outi Vaisanen, Jaakko Malmivuo, Nevzat G. Gencer, Bart Vanrumste, Piotr J. Durka, Ratko Magjarević, Selma Supek, Mihail Lucian Pascu, Hugues Fontenelle, and Rolando Grave de Peralta. EEG-MEG Source Imaging: Methods, Challenges, and Open Issues. // Computational Intelligence and Neuroscience. 2009 (2009) ; 1-12 (članak, znanstveni).
- Luka Celić, Darko Trogrlić, Ivan Paladin, Ratko Magjarević. Tehnologijska podrška osobama oboljelim od dijabetesa // Liječničke novine 95, prosinac 2010: 66-71
- Magjarević, Ratko; Lacković, Igor; Zhivko Bliznakov; Nicolas Pallikarakis. Challenges of the Biomedical Engineering Education in Europe // 32nd Annual Conference of the IEEE EMBS Buenos Aires, Argentina, August 31-September 4, 2010., 12959-62 (predavanje, međunarodna recenzija, objavljeni rad, znanstveni)
- Lacković, Igor; Magjarević, Ratko; Miklavčič, Damijan. Incorporating Electroporation-related Conductivity Changes into Models for the Calculation of the Electric Field Distribution in Tissue // IFMBE Proceedings vol. 29 / P.D. Bamidis, N. Pallikarakis (ur.). Berlin : Springer, 2010. 695-698
- Lacković, Igor; Magjarević, Ratko; Miklavčič, Damijan. Influence of anisotropic tissue electrical conductivity on electric field and temperature distribution during electroporation-based therapy // IFMBE Proceeding vol. 25/XIII / Dössel, Olaf ; Schlegel, WolfgangC. (ur.). Berlin : Springer, 2009. 210-213

COLLABORATION WITH OTHER INSTITUTIONS (OPTIONAL)

Universities:

- Uni#1: University of Ljubljana
- Uni#2: University of Budapest
- Uni#3: University of Trieste
- Uni#4: University of Patras
- Uni#5: University of Loughborough
- Uni#6: Jesuit University of Bogota
- Uni#7:University of Dubrovnik

- Uni#8: University of Rijeka

Research Centers:

- RC#1 : Institute for Medical Research and Occupational Health

Medical Institutions:

- MI#1: Clinical Hospital Centre Zagreb
- MI#2…University Hospital for Tumors

Other: Technical Museum Zagreb