BME

MŰEGYETEM 1782

# Healthcare and Medical Technology

at

# Budapest University of Technology and Economics

brief introduction

compiled by BME EMT

# BME: ~1 160 staff; ~24 000 students (2012)

- Faculty of Civil Engineering (1782-)
- Faculty of Mechanical Engineering (1871-)
- Faculty of Architecture (1873-)
- Faculty of Chemical Technology and Biotechnology (1873-)
- **Faculty of Electrical Engineering and Informatics (1949)**
- Faculty of Transportation Engineering (1951-)
- Faculty of Natural Sciences (1998-)
- Faculty of Economic and Social Sciences (1998-)

Advanced Vehicle Control Knowledge Centre

Biomechanical Cooperative Research Centre

BME–AUDI Hungaria Cooperative Research Centre

**1+1/11 knowledge centres (project-oriented units)**

Centre of Public Administration's Information Technology (1999-)
Federated Innovation and Knowledge Center (2009-)
Innovation and Knowledge Centre of Information Technology (2006-)
Mobile Innovation Centre (2004-)
Healthcare Technologies Knowledge Centre (2007-)
Student Innovation Centre (2009-)
Integrated Energetics Knowledge Centre (2009-)
Virtual Reality and Immersive Technologies Laboratory (2009-)
Morgan Stanley–BME Financial Innovation Centre (2009-)
Intelligent and Embedded Systems Knowledge Centre (2010-)
... and a few more

**10 departments (education & research units)**

Department of Automation and Applied Informatics
Dept. of Broadband Infocomm. and Electromagnetic Theory
Department of Computer Science and Information Theory
Department of Control Engineering and Information Technology
Department of Electric Power Engineering
Department of Electronics Technology
Department of Electron Devices
Department of Measurement and Information Systems
Department of Networked Systems and Services
Department of Telecommunications and Media Informatics

# *Healthcare Technologies Knowledge Center*

## *Field of activity*

Assistive information and communication systems for elderly persons, chronically ill and disabled people.

# Selected R&D&I projects of BME EMT

**CCE – Connected care for elderly persons suffering from dementia (AAL Joint Programme, 2009-2012),**
*with British, Dutch and German partners.*

- A system utilizing ICT tools and based on open-standards was developed to support the independent living of elderly persons struggling with cognitive impairments.

**CARE – Safe private homes for elderly persons (AAL Joint Programme, 2009-2012),**
*with Austrian, Finnish and German partners.*

- To support the independent living of elderly persons, a system based on visual motion sensors that automatically recognizes a fallen or immobilized person was developed.

**CVN – Connected vitality: the personal telepresence network (AAL Joint Programme, 2010-2013),**
*with Austrian, Dutch, Spanish and Swedish partners.*

- A telepresence – social presence – system, enabling people physically far from each other to participate in joint on-line activities, e.g. playing games, was developed.

**TeleNyugi (TeleCalm) activity tracking system (IVF-NSC programme, 2013-2015),**
*with Czech, Slovak and Taiwanese partners*

- Its goal is to continuously provide information – through mobile ICT devices – about the course of normal daily activities or eventual incidents of elderly family members.

**M3W - Maintaining and Measuring Mental Wellness (AAL Joint Programme, 2011-2014),**
*with Swiss, Luxembourgian and Greek partners*

- The main objective of the project is to develop a mental wellness toolset for self usage in order to help non-professionals in delaying and eventually detecting mild cognitive impairments of elders as early as possible.

***Contact: Lóránt Vajda,*** *vajda@emt.bme.hu*

# Further information

***Healthcare Technologies Knowledge Center***

- http://emt.bme.hu
- http://silvergate112.eu
- http://www.cceproject.eu
- http://care-aal.eu
- http://www.connectedvitality.eu
- http://m3w-project.eu

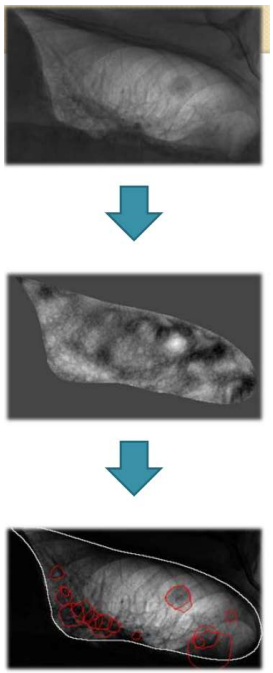

- Dr. Péter Hanák, chairman, hanak@emt.bme.hu
- Lóránt Vajda, managing director, vajda@emt.bme.hu

# *BME – MIT competences related to Healthcare and Medical technologies*

## *Fields of activities*

Embedded systems, medical laboratory technology
Image processing and analysis
Intelligent systems for assistive technologies

# CAD Systems for X-ray Chest Radiography



- CAD system for diagnosing traditional digital X-ray PA images
- CAD system for a digital chest tomosynthesis system
  - The goal is early detection of abnormalities
  - Screening for lung cancer and COPD (Chronic Obstructive Pulmonary Disease)
  - Tomosynthesis is a real alternative to Low Dose CT
- Approach applied

  *image processing and machine learning*
- Special feature

  *preprocessing: elimination of „anatomical noise”*

  *(shadows of ribs, clavicle, heart)*

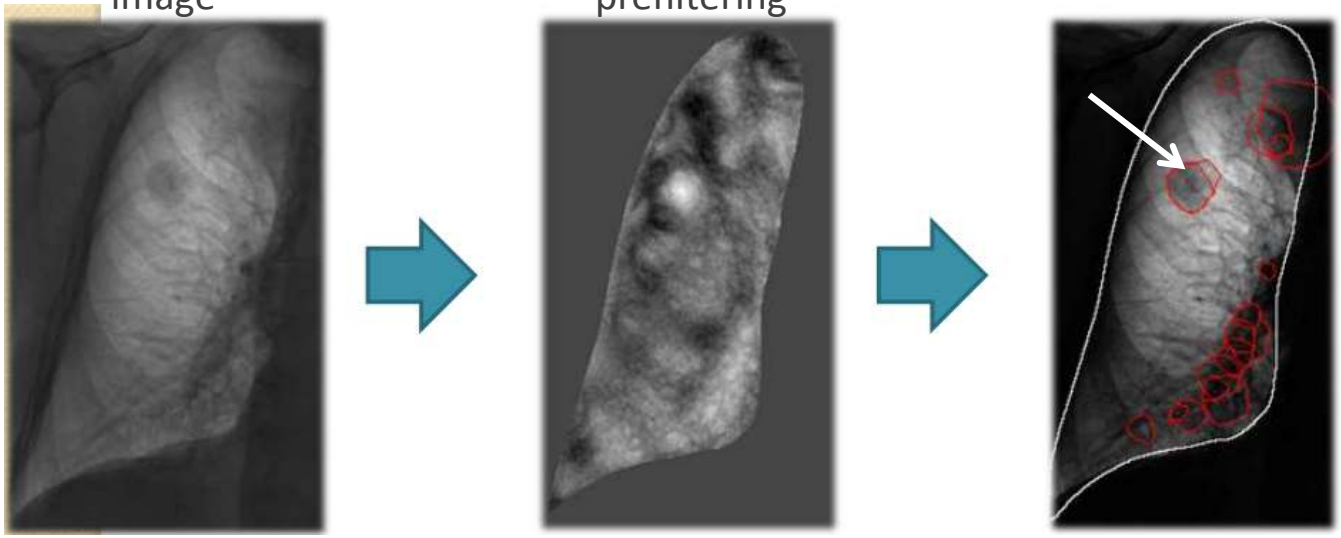
***Contact: Dr. Gábor Horváth,*** *horvath@mit.bme.hu*

# The main steps of nodule detection using X-ray PA images

Original X-ray image

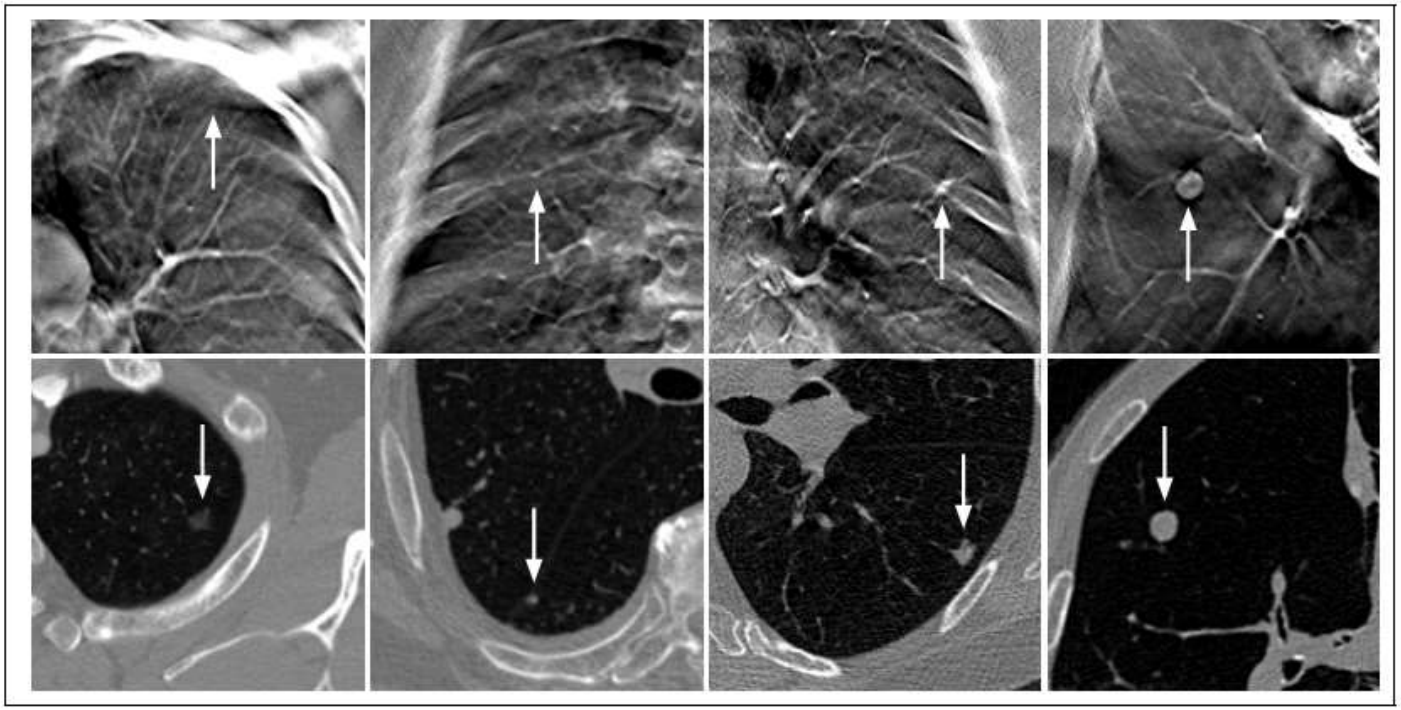
Segmentation and prefiltering

classification

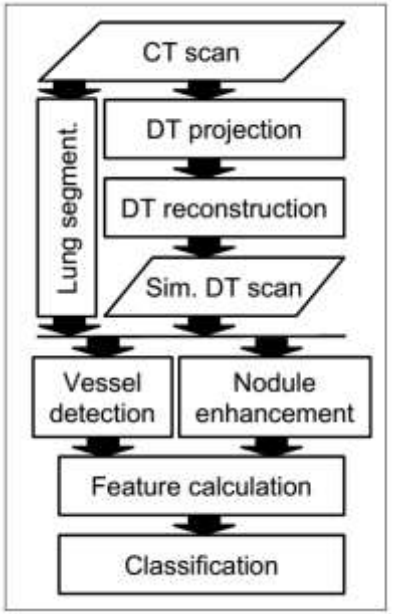


**Results**: Sensitivity of nodule detection (using joint analysis: radiologist +CAD) is increased by 18-30% comparing to that of the results of radiologists

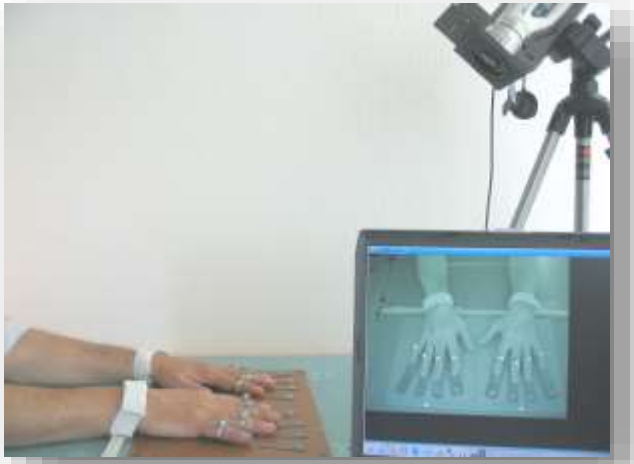
# Results on nodule detection using digital chest tomosynthesis



Invisible | Hardly visible | Visible | Clearly visible



# Medical Technologies Laboratory



**R&D&I fields**

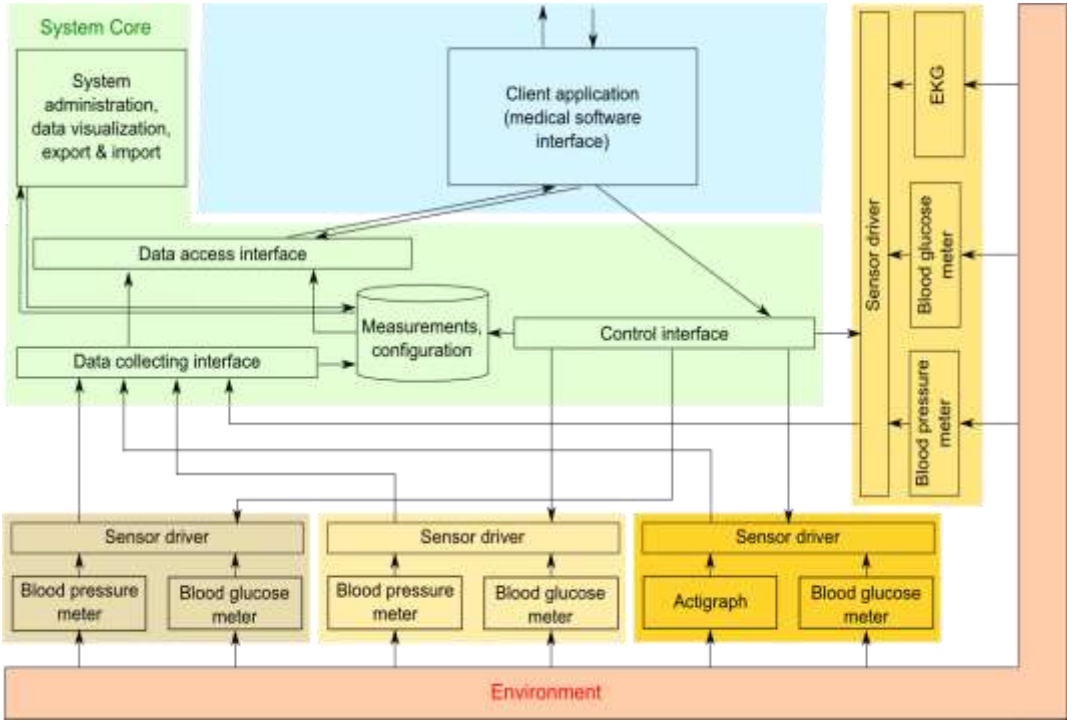
- Marker-based motion analysis/tracking
- Movement based neural disorder characterization
- New methods for blood pressure measurement
- Home Health Status Monitoring
- Drivers vigilance characterization
- Measurement and evaluation of heart rate variability (HRV)

***Contact: Dr. Ákos Jobbágy,*** jobbagy@mit.bme.hu

# TeleHealth Monitoring System

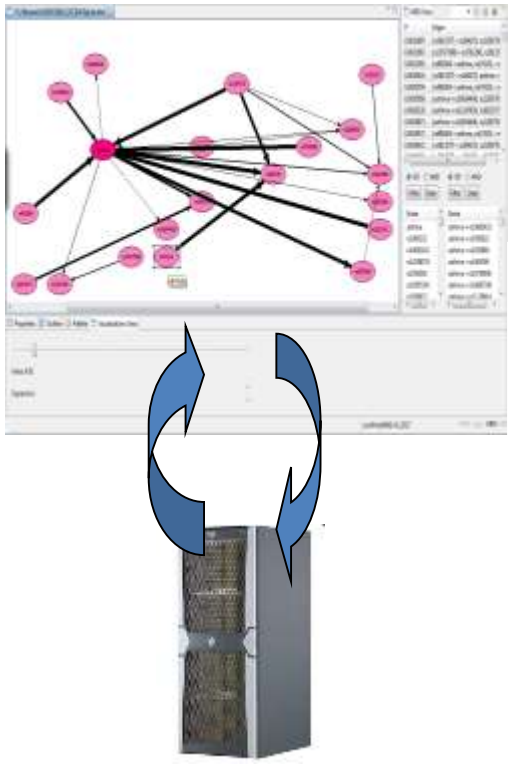
(General intelligent system for assistive technologies)

- Home health status monitoring
- Adaptable for different diseases
  - ✓ Hypertension
  - ✓ COPD
  - ✓ Sleep disorders
  - ✓ Diabetes etc.

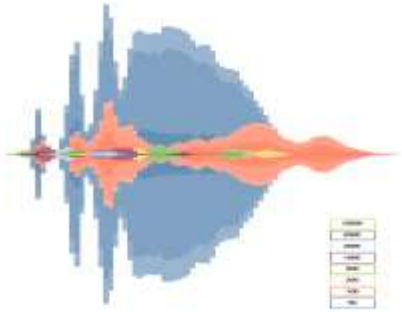


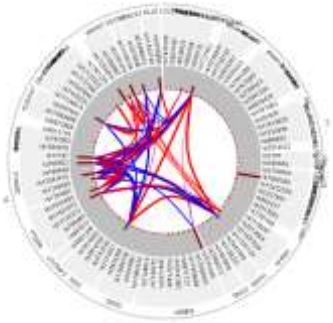

- Different medical devices are and can be integrated
- Several patients with different diseases and conditions can be monitored in parallel
- Simple configuration interface for the doctor

# Data and knowledge fusion in biomedicine



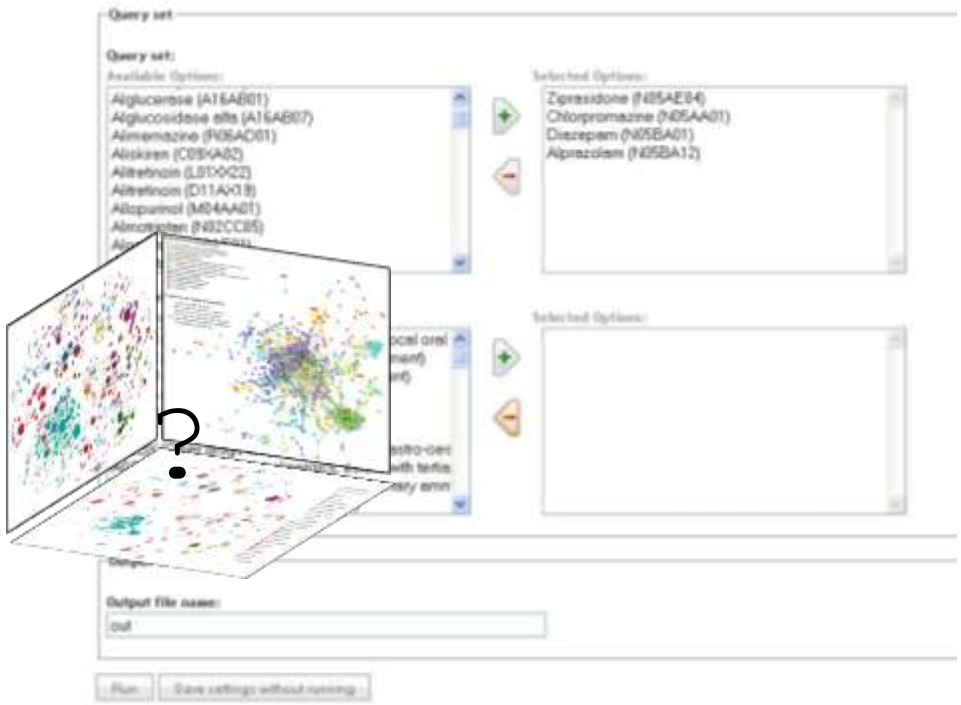
- Bayesian systems-based biomarker discovery
- Kernel-based data and knowledge fusion
- Semantic data and knowledge fusion



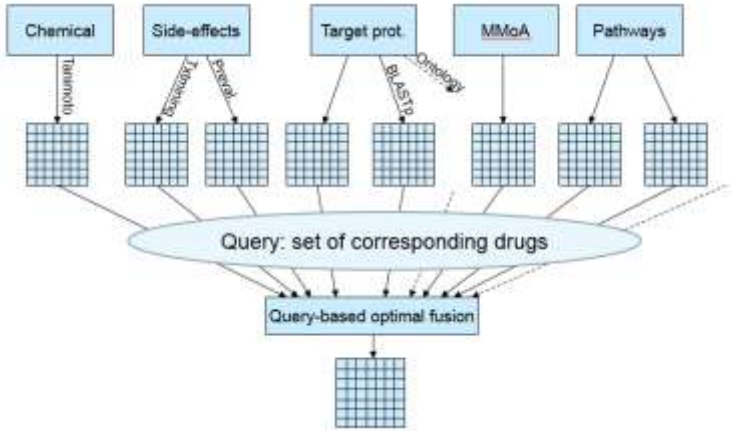


**„all models are wrong, but some are useful”**
➔**e.g.** there are stable, interesting properties

# Integration of chemo- and systems biologic information resources for drug repositioning




**Similarity-based fusion in drug repositioning**



# *BME – IIT competences related to Healthcare and Medical technologies*

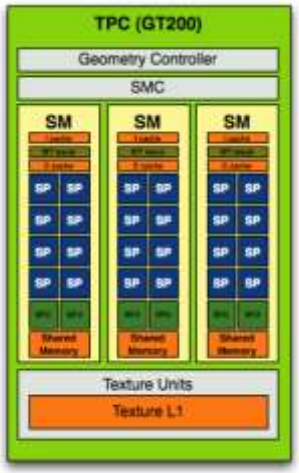
## *Fields of activities*

BME IIT - LABORATORY OF BIOMEDICAL ENGINEERING

Medical informatics, hardware accelerated 3D image reconstruction, medical image processing, 3D sensorics and robotics, motion tracking and 3D monitoring

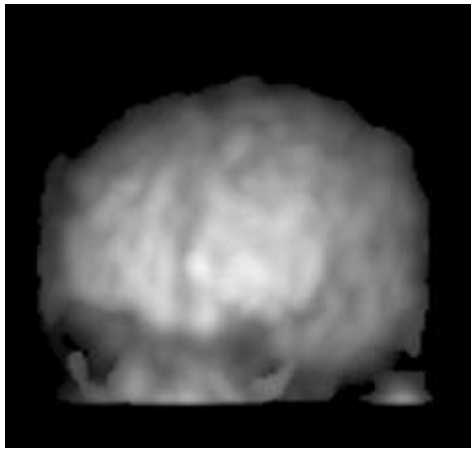
# Efficient Concurrent SPECT and PET Reconstruction Algorithms

Medical Imaging

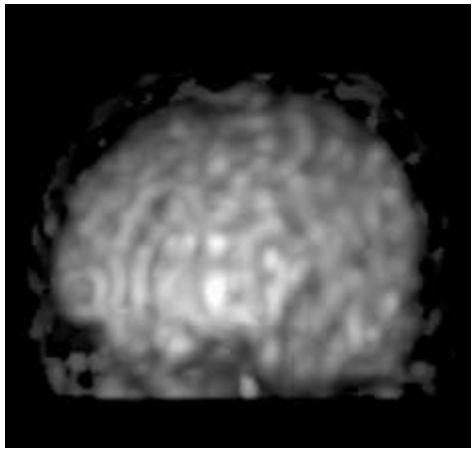



- **3D OSEMRRAC**
  3D Ordered Subset EM with Resolution Recovery and Attenuation Correction
- Efficient algorithm for GPU

BEFORE reconstruction



AFTER reconstruction

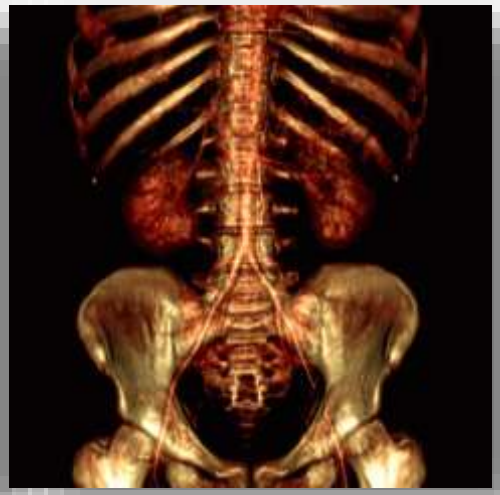


# Graphics Lab Medical Visualization

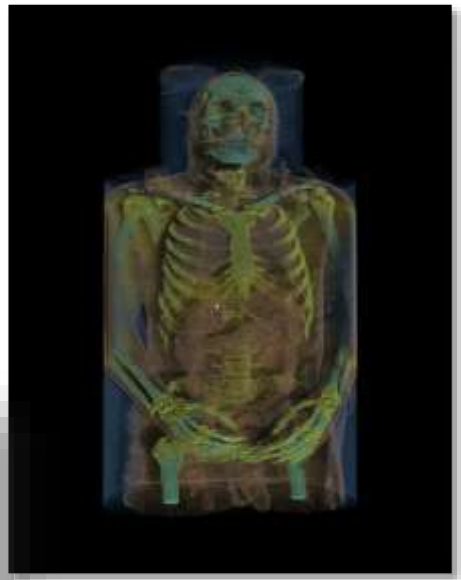
Field of activities:

- Medical visualization
- CT and PET reconstruction
- GPGPU methods

Direct volume rendering

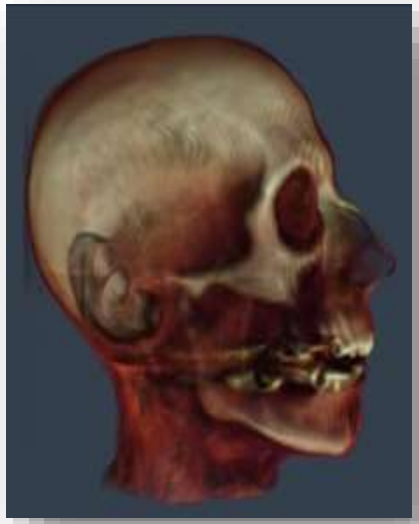


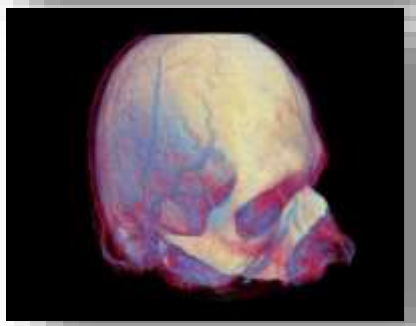
Transfer function tuning



Translucent rendering

Ambient occlusion

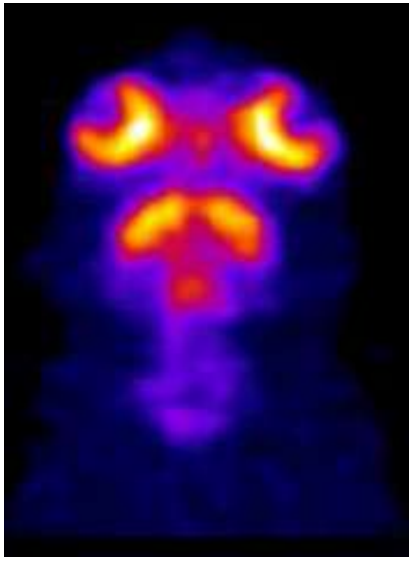


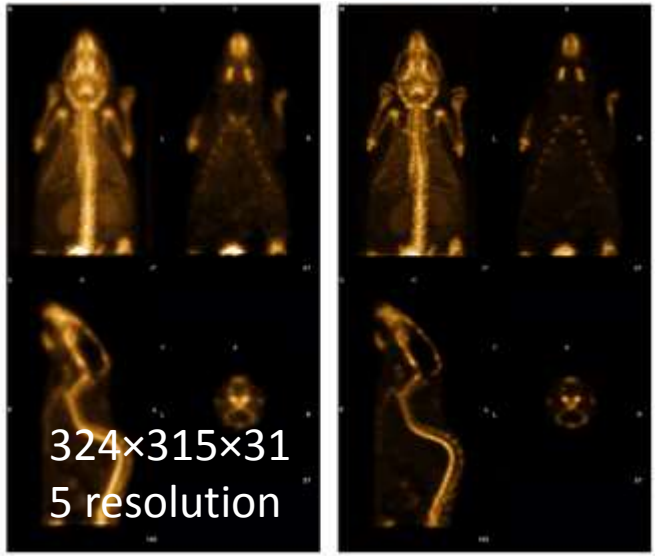


Illustrative visualization

# Positron Emission Tomography

- GPU cluster implementation
- Positron range, scattering, detector response compensation
- TV and Bregman regularization

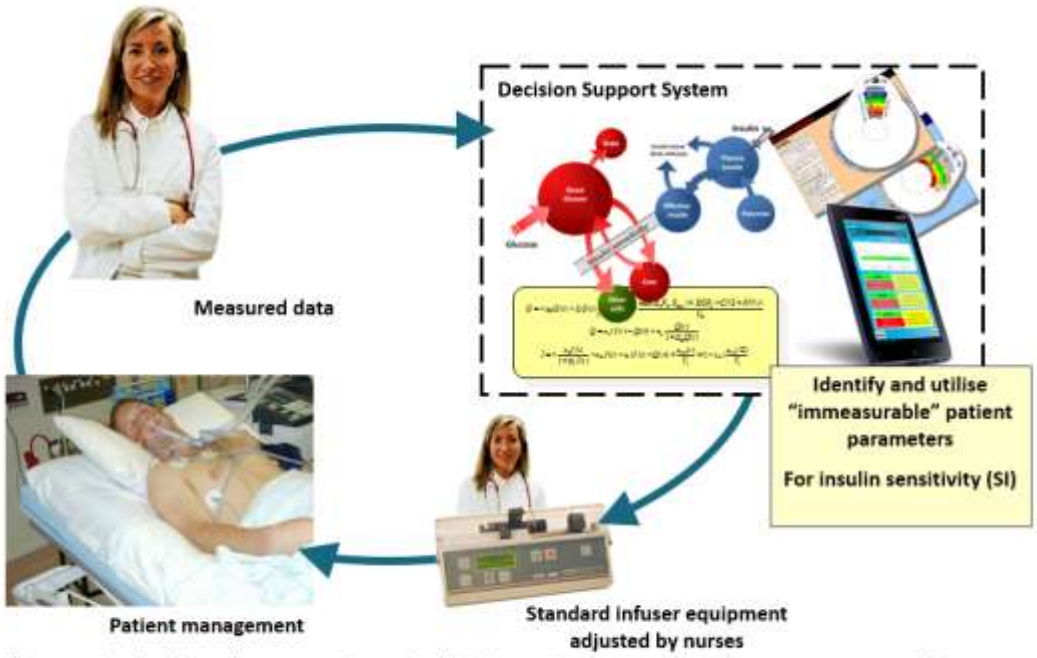





# Accurate glycemic treatment for intensive care patients

Model based diagnostics and therapeutics

AGC treatment – STAR




"Nurse-in-the-loop" system. Standard ICU equipment and/or low-cost commodity hardware.

**Current research goals:**

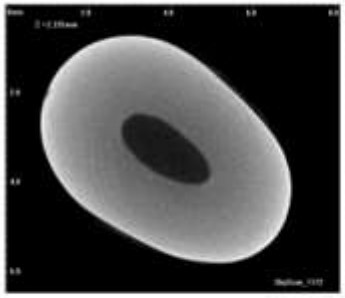
- STAR during liver transplantation
- Combination of STAR with Continuous Glucose monitoring
- STAR Advanced feeding regimes
- NICU protocol in Miskolc

Source:http://biomed.brown.edu

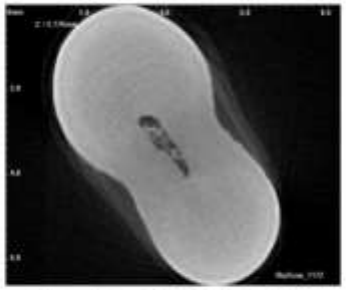
# CT image segmentation methods



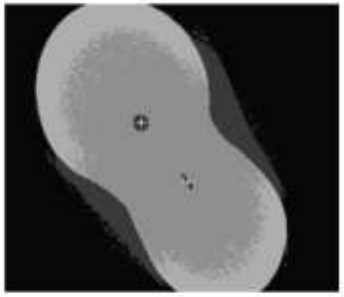
- Dental microCT
  - Parallel sections
  - Single channel intensity images
  - High resolution ~ 2500dpi
  - Pixel distance = Slice distance
- Obstacles
  - Circular artefacts
  - Granular texture
  - Inter-slice artefacts
  - Odd shape of the root canal's section



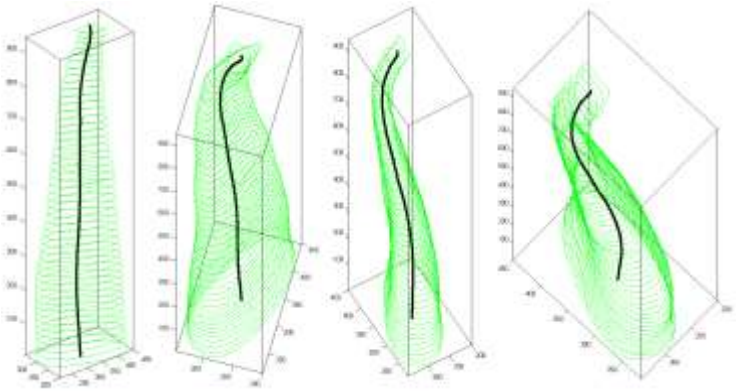
Easy case

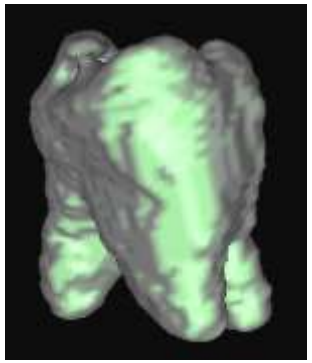


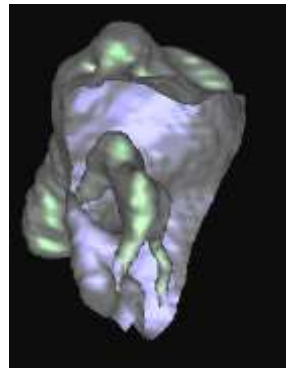
Inter-slice artefacts and odd shape in root canal



Granular texture visible in preprocessed image





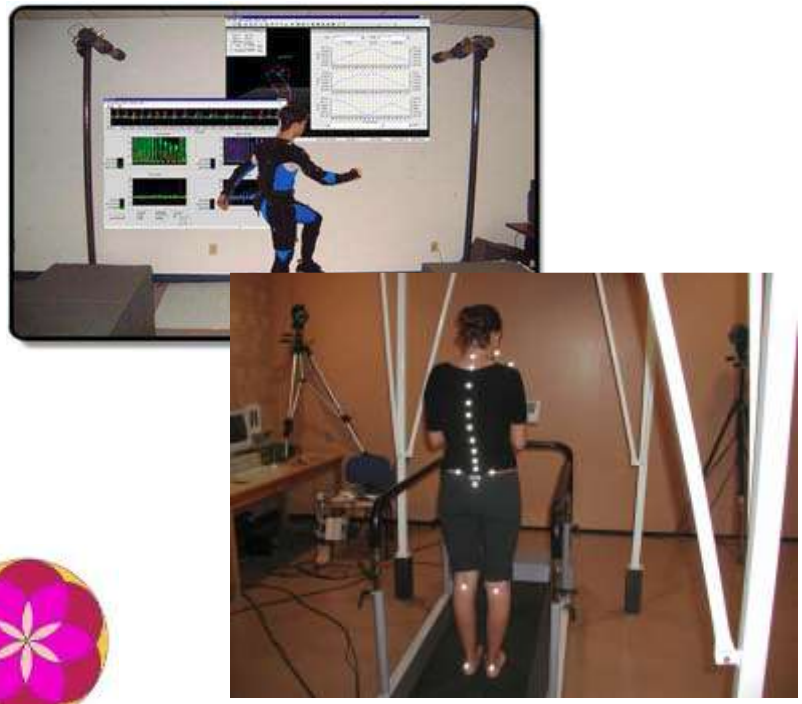


# Research Projects Summary

- Currently running projects:
  - FP7-PEOPLE-2012-IRSES: eTime—Engineering Technology-based Innovation in Medicine (Project number 318943, Funding scheme: Marie Curie Actions— International Research Staff Exchange Scheme - IRSES)
  - BAKTAT - Secure NFC Application Provisioning and Management (Hungarian National Office of Research and Technology, grant id: BAKTAT)
  - DIAD_NFC - Dynamic Distribution of Independent NFC Applications – Concept and Implementation (Hungarian National Office of Research and Technology, grant id: DIAD_NFC)
  - OTKA 80316 - Quality and safety improvements of image guided surgical procedures and nuclear medical imaging using advanced computer science (Hungarian Scientific Research Fund, grant id K80316)
  - OTKA 82066 - Novel methods for the improvement of medical diagnostics (Hungarian Scientific Research Fund, grant id K82066)
- Recently completed major projects:
  - TERATOMO - Development of a teraflop capacity image reconstruction system for various medical tomography devices used for diagnosis (Hungarian National Office of Research and Technology, grant id: Teratomo/TECH_08_A2 (2008))
  - PETCT - Development of multimodality imaging system for serial production dedicated to biomedical research and human diagnostic imaging (Hungarian National Office of Research and Technology, grant id: PETCT_06/NKFP06A1-PETCT_06)
  - StoLPaN: Store Logistics and Payment with NFC (EU FP6: Contract Number 033591)

# 3D motion tracking and therapy laboratory

Motion tracking rehabilitation



- Goethe Gait Lab
- Rehabilitation
- Motion tracking

- *Horse-riding therapy* for Down syndrome, autism and visually impaired people –> movement coordination rehabilitation

***Contact: Steiner Henriette,*** *henriette@iit.bme.hu*

# *Hand-in-Scan*

## *The visible improvement*

http://www.handinscan.com/

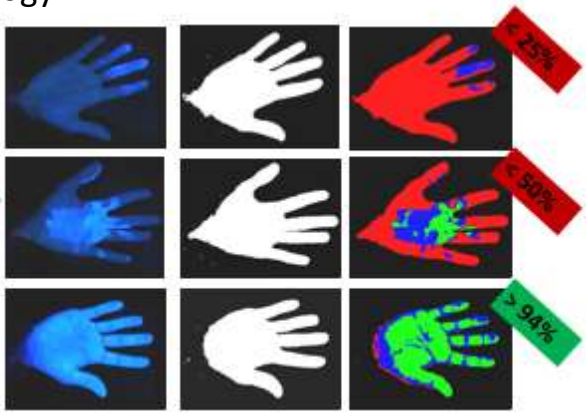
# Hand-in-Scan – objective hand hygiene control

**Primary applications of Hand-in-Scan**

- Education of medical students
- Medical institution staff training
- Public health awareness raising
- Tight control over the hospital staff's compliance
- Great potential in the food industry
- Improving clean-room technology


- objective evaluation and feedback
- reporting towards the Hospital IT System
- creating large case studies/user databases

Clinical prototype




Software-based evaluation

*Contact: Dr. Tamás Haidegger,* haidegger@handinscan.com

http://www.bme.hu

http://www.handinscan.com/

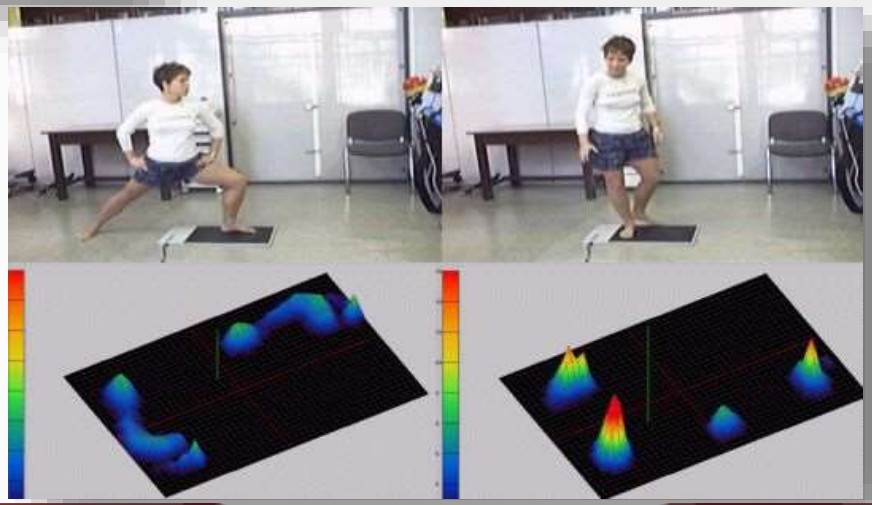
# *Research Center for Biomechanics*

## *Fields of activities*

Human and animal biological systems
Human medicine equipment
Testing and development of implants

Diff. sports activity monitoring

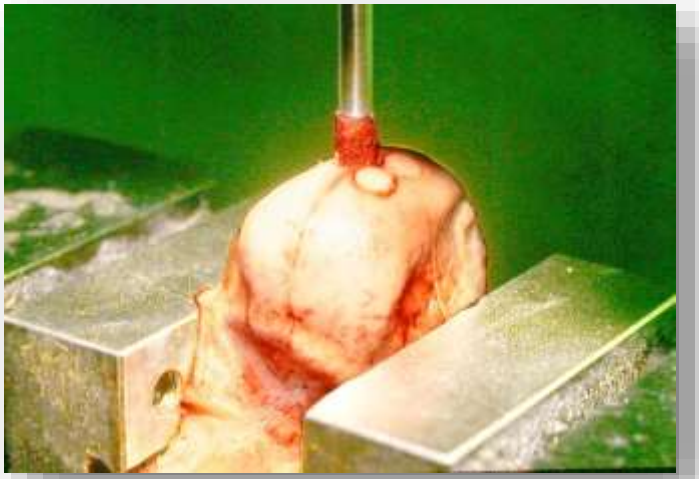
Pressure distribution

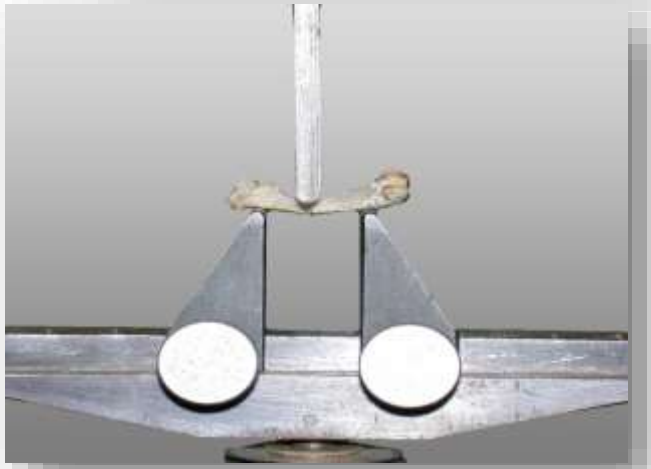


# Experimental analysis of human lumbar spine in traction hydrotherapy

***Contact: Dr. Lajos Borbás,*** borbas@kge.bme.hu

# Mechancial properties of human tissues

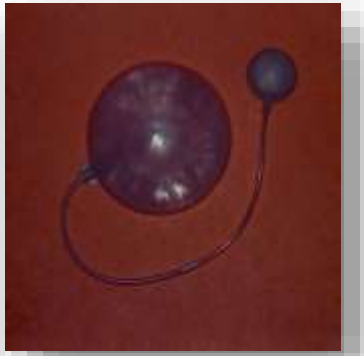




# Silicon based organ replacement

finger

elbow



surgical tool:
skin expander

# *BME – TMIT competences related to Health and Well-being*

## *Speech applications in Healthcare and Medical field*

Contact: Dr. Géza Németh
nemeth@tmit.bme.hu

# Speech, Mobile and Multimodal Interaction

- Multilingual text-to-speech experience (12 languages)
- Multilingual speech recognition experience (6 languages)
- Application of Nao robot in the treatment *of bone marrow transplanted children*
- Speech-based service automation (e.g. directory assistance, media archive search: www.mindroom.hu )

- *Industrial grade software solutions (reference users: T-Mobile Hungary, Wincor-Nixdorf, NCR, Avaya, ...)*
- Flagship publication(s): *Interspeech conferences, Books published by e.g. Kluwer and Springer*

***Contact: Dr. Géza Németh,*** *nemeth@tmit.bme.hu*

# Applications for Disabled and Elderly People





- Applications for the visually impaired (Hungarian version of the Jaws for Windows screen reader, NaviSpeech mobile navigation aid, etc.)
- Applications for speech impaired (SPECO –speech corrector- for 6 languages, VoxAid communication aid)
- GOH method for hearing screening of children
- E-mail and SMS-reading for elderly people
- MedicineLine medical information system
- Voice disorder diagnosis from speech
- Depression diagnosis from speech
- Flagship Publications: *ICCHP conferences*

# *Sensors and Microfluidics Lab*

## *Fields of activities*

Lab-on-a-Chip, blood testing,
wearable wireless sensor devices

BMEETT

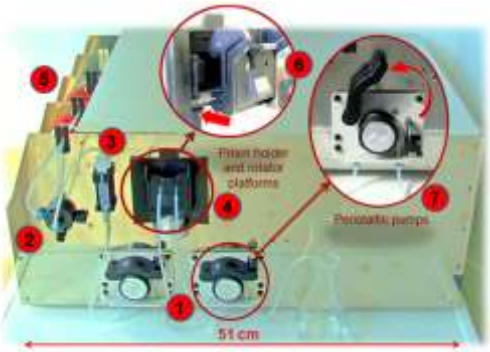
**Our main-streams:**

- **Everything a doc wants to know? … only from 1 droplet of blood? → *Lab-on-a-Chip (LoC)***
- **Comfortably wearable health monitoring devices**

Our handheld Electrochemical Impedance Spectroscopy (EIS) LoC platform →


*Blood testing for embolism in 15 minutes →*
*Bluetooth → INTERNET DATABASE*

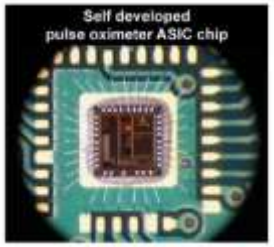
Surface Plasmon Resonance imaging (SPRi) biosensor platform (in house developed HW + SW) *with equal or better performance parameters vs. competitor products*




WE CONNECT CHIPS AND SYSTEMS

(Comfortably) wearable wireless sensor devices

← Bluetooth ECG  Wireless pulseoximeter (838 MHz) →


# Thank you for attention!