Curriculum Vitae

Prof. Gábor Székely

Professor of Medical Image Analysis and Visualization
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Degrees/Higher Education

1986	Dr.-Univ. in Analytical Chemistry Technical University of Budapest, Hungary
1981	MSc in Applied Mathematics, Eötvös Lorand University, Budapest, Hungary
1974	MSc in Chemical Engineering, Technical University of Budapest, Hungary

Professional Career

2008-present	Full Professor of Medical Image Analysis and Visualization, Department of Information Technology and Electrical Engineering, D-ITET, ETH Zurich
2007-present	Co-founder and member of the Board of the spin-off company Virtamed
2002–2008	Associate Professor of Medical Image Analysis and Visualization, Department of Information Technology and Electrical Engineering, D-ITET, ETH Zurich
2001–present	Director, Swiss National Center of Competence In Research on Computer Aided and Image Guided Medical Interventions
1991–2002	Senior Research Fellow, Computer Vision Laboratory, ETH Zurich
1986–1990	Software Development, Spectrospin AG, Fällanden, Switzerland
1974–1986	Member, later Head, Computer Department, Institute of Isotopes of the Hungarian Academy of Sciences, Budapest, Hungary

Professional Activities

- Editorial Board, Medical Image Analysis
- Editorial Board, Computer Aided Surgary
- Editorial Board, Computer Aided Radiology and Surgery
- Editorial Board, Current Medical Imaging Review
- Special Session Chair, 9th IEEE Int. Symp. for Biomedical Imaging (2012)
- General Chair, 22nd International Conference on Information Processing in Medical Imaging (2011)
- Organizer and Chairman, 3rd International Symposium on Biomedical Simulation (2006)
- Program Co-Chair (2002,2008) and Tutorial Chair (2003), International Conference on Medical Image Computing and Computer Aided Interventions

Honors and Awards

- 2006 Best Workshop Paper Award, Int. Conf. on Scientific Computing
- 1981/82 SNSF Swiss/Hungarian exchange scholarship

Publications

- 68 Refereed Journal Publications
- 125 Refereed Conference Publications
- 21 Books and book chapters
- 74 Non-refereed papers and abstracts

Achievements

- Skeleton based characterization of biological shapes
- Statistical shape model generation and application for segmentation and shape prediction
- Real-time non-linear Finite Element simulation of soft tissue deformations
- 3D Implant localization on clinical X-Ray images with submillimeter precision
- Highly realistic virtual reality based surgical training simulation
- Multi-modal, immersive virtual and augmented reality environments
- Simulation-based predictive surgical planning
- Assessment and characterization of organ motion
- Computational model of tumour growth and angiogenesis

Committees

- Member of the Swiss Commission for Technology and Innovation
- Chairman of the Scientific Advisory Board of the ArtOrg Center, University of Bern
- Member of the Fraunhofer Gesellschaft, Vice Chairman of the Kuratorium of the Fraunhofer MeVis, Institute for Medical Image Computing, Bremen
- Speaker of the Zurich Center of Imaging Science and Technology
- Member of the Hirslanden Research Foundation Committee

Teaching

- Image Analysis and Computer Vision
- Human Vision in Product Development and Innovation
- CIMST Interdisciplinary Summer School on Bio-medical Imaging

Personnel

Scientific coworkers	24
Non-scientific coworkers	7
Diploma/BA/MA projects	10
Doctoral students	19

Facilities and Major Equipment

- Vicon motion capture system
- Several haptic displays
- Tracking devices, cameras, HMDs
- Computational clusters

For more information visit www.vision.ee.ethz.ch

Prof. Gábor Székely- Research Highlights

Biomedical Image Analysis, Visualization, Simulation

Keywords
- Medical image analysis
- 3D shape description and analysis
- Virtual and augmented reality in medicine
- Biomedical simulation techniques

New priority areas
- Modeling and simulation of biological systems and processes (tissue development, tumour growth, angiogenesis, aging)
- Multi-physics, multi-scale simulation techniques
- Organ motion compensation for radiation therapy and focused ultrasound based interventions
- Navigation support for minimally invasive soft tissue surgery
- Scalable, massively parallel numerical solvers for partial differential equations

Focus

As the coordinator of the National Center of Competence in Research on Computer Aided and Image Guided Medical Interventions (NCCR Co-Me), the group of Prof. Gabor Szekely focuses on biomedical image analysis (including segmentation, registration and organ motion analysis), visualization, virtual and augmented reality techniques, and biomedical simulation for surgical planning and training.

Image Segmentation

Segmentation is in many cases the bottleneck when trying to use radiological image data in many clinically important applications as radiological diagnosis, monitoring, radiotherapy and surgical planning. While manual image segmentation is often regarded as a gold standard, its usage is not acceptable in many clinical situations, not only because of the amount of work involved, but also due to the poor reproducibility of the results.

Automatic segmentation is therefore a very important problem to be solved in medical image analysis. We have been investigating for several years different possibilities to code and utilize such prior information for image segmentation. Statistical shape models offer an elegant way to incorporate the (large, but still strongly limited) variability of organ shape into the data interpretation process. The idea is to code the variations of selected shape parameters in an observed population (the training set), and characterize this in a possible compact way. Finding decorrelated or even independent components of the shape parameters' covariance matrix results in a very compact representation and has been successfully applied for example for the automatic segmentation of deep gray matter structures of the human brain in volumetric magnetic resonance image (MRI) data. In addition, we are recently investigating, how such statistical models can be used for reliable prediction of organ shape from highly incomplete information.

While first results demonstrated the power of these techniques, generic segmentation systems capable to automatically analyze a broad range of radiological data cannot be expected in the near future. The discussed methods allow to work only within very narrow, specialized problem domains and fundamental difficulties have to be expected if trying to establish more generic platforms. Accordingly, we are working on interactive 3-dimensional segmentation approaches allowing optimal cooperation between computerized image analysis algorithms and human operators. We demonstrated that multi-modal virtual reality environments can very effectively support the user during the complex interaction with volumetric radiological datasets. Especially the integration of visual and haptic feedback technology proved to be very successful in solving difficult segmentation problems, like the identification of the digestive system in CT and MRI images (see Fig. 1).

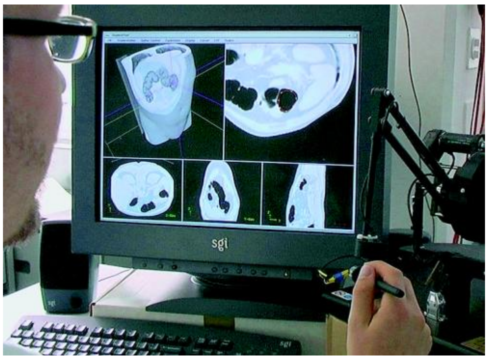

Figure 1: A desktop visuo-haptic environment for the interactive segmentation of the small intestine from volumetric CT and MRI data

Biomedical simulation

With the fast growth of available computational power and the development of complex, coupled, multi-scale, multi-physics models of biomedically relevant processes, the predictive, patient-specific simulation of normal physiological processes and of the development of pathologies are becoming increasingly feasible. Our current research concentrates on modelling tumour growth and angiogenesis, also covering the interconnection of these processes. First results already demonstrate the feasibility of the applied methods for describing the growth and neovascularisation of solid tumours (see Fig. 2) and for the quantitative description of intussusceptive angiogenesis. We are currently setting up the frames of a generic modelling, simulation and validation environment, allowing the incorporation of further biological observations into the models applied, the systematic estimation of hidden biological and imaging parameters and the thorough quantitative evaluation of the simulation results based on comparisons with imaging data on small animals.

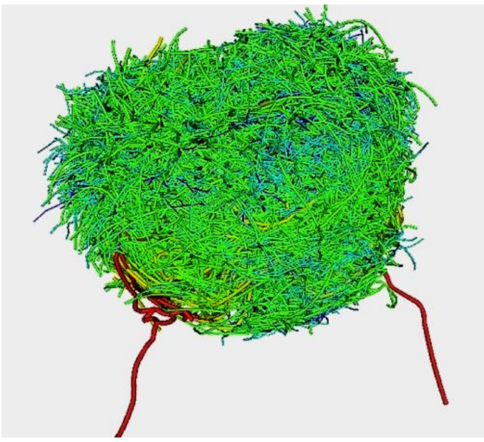

Figure 2: Simulated solid tumor, embedded into a layer of newly formed vessels generated according to the response to angiogenic stimuli of hypoxic tumor cells

For more information on our research group and our projects:
www.vision.ee.ethz.ch
http://co-me.ch