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INSTITUTE FOR MEDICAL IMAGE COMPUTING

ANNUAL SUMMARY 2012

FRAUNHOFER MEVIS

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Cover: Under the microscope, fat retention in the tissue becomes visible as thousands of roundish vacuoles, which are unevenly distributed across the tissue section. Manual determination of the number and size of these fat vacuoles is often difficult to reproduce, because the values can only be estimated at random. With new image analysis technology developed by Fraunhofer MEVIS, fatty changes can be measured automatically in entire tissue sections (marked in yellow). The measurement of fatty liver is an important factor in evaluating the risk of surgical interventions. In a fatty liver, organ function is impaired, which can lead to complications after tumor surgery or transplantations.

Photo: Prof. Dr. Uta Dahmen and PD Dr. Olaf Dirsch, Jena University Hospital and Fraunhofer MEVIS.

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MEDICAL IMAGE COMPUTING

KEY TECHNOLOGIES IN MEDICAL TECHNIQUES

Medical imaging forms one of the central technological pillars of health care and serves as a driving force in medical progress. Since the discovery of X-ray radiation in 1895, medical imaging has developed quickly and produced highly complex image acquisition technologies such as computer and magnetic resonance tomography. The development of higher resolutions, new functional contrasts, and lower runtime has not yet finished.

The consistent digitalization of radiological imaging in the mid 1990s caused a fundamental change in medicine: Highly developed scanner technology with a steadily growing flood of medical images has faced a glaring deficit of equally capable and problem-specific software methods, such that a majority of the available information remains unused.

A new discipline – medical image computing – has emerged with the aim of making the contained information accessible in a highly efficient manner, reliably quantifying and combining new procedures in computer supported imaging, and leading to substantial improvements as well as a lower complexity in clinical diagnosis and therapy.

Situation in Germany

The enormous potential of medical image computing is gaining increasing recognition in both industry and research in Germany. Although German industry continues to rank at the top position of imaging equipment technology, it lags behind international competitors in medical image computing.

Medical image computing is on the right track towards become a strategic key technology by creating the prerequisites for evidence-based medicine, which considerably relies on quantification, reproducibility, and comparability – "measuring generates knowledge."

A closer investigation reveals that objective medical imaging based on scientific models can only be enabled through medical image computing. This serves as a foundation for:

- Image-based assistance systems, such as computer-aided diagnosis (CAD) and image-guided therapy (IGT)
- information extraction that augments the human eye and far exceeds its capabilities in terms of in quality and reliability
- the development of urgently needed failure management in medical imaging
- intelligent imaging with reduced dosage and measurement time
- increased accuracy and extent of the quality of medical caretaking

The Fraunhofer-Gesellschaft can contribute significantly with its broad, interdisciplinary expertise in the field of medical technology. A large section of the Fraunhofer Institute is thematically closely concerned with the development of hardware and software for medical technology as well as with related problems in life sciences. One proven skill of the institute is the prompt implementation of research results into products – one of the most important aspects of competitiveness in German medical technology.

One must note with criticism that the strategical process in German for 'innovation in medical technology,' the topic of information and communication technology (ICT), particularly the discipline of medical image computing, has been seen as separate technological compartments instead of being considered one cohesive unit. In international comparison, this reveals structural deficits. Many other industrialized nations, such as the United States, Japanw, the Netherlands, and France, have established a far better integration of image-based medical research and natural science research.

Germany lacks a research community in the field of image-based medicine that is strong, clinically oriented, and based upon natural sciences.

Whereas the aforementioned fields concerning medical image computing are hardly sufficiently represented in the majority of national funding programs, industry and funding bodies are beginning to recognize that medical image computing has already yielded a considerable amount of innovation in the broader field of medical imaging. The differentiating characteristics of medical products are no longer the hardware,

but in a manifold of cases the additional benefit brought about by software. Considering image-based medicine, including epidemiologically and economically significant diseases such as cancer, age-related diseases and diseases of the cardiovascular system, the effects of employing and further developing medical image computing become obvious.

Modeling in the Natural Sciences and Quantitative Imaging

Compared to the natural sciences, medical imaging, and in particular radiology, have remained 'imaging sciences,' which since their emergence have placed visual appraisal with empirical validation in the foreground. Due to the ongoing digitalization of radiological methods, measuring image evaluation has emerged alongside interpretative viewing. This is based on the analytical understanding of the underlying complex physical measuring processes and forms the foundation for a novel, quantitative medical imaging.

By acknowledging this quantitative discipline as a valuable addition, a tight web of knowledge and methodology of modern natural and information sciences could be available to image-based medicine given appropriately long-term funding ('quantitative imaging'). This allows for an entirely new interdisciplinary quality of knowledge transfer, as well as for scientific modeling to pave the way for truly quantitative assessment of pathophysiological changes of morphology, function, and metabolism.

Reduction of Complexity and Information Management

In the medical environment, the demand to merge data and information for extracting knowledge is given in a special manner. Technologically advanced systems of modern medicine diagnosis produce large numbers of images within a short time, upon which the status of a patient's disease can be gathered. This data can then be condensed into clinically relevant information exclusively through methods of medical image computing, which fully utilizes the potential for clinical diagnosis and therapy. It is easy to recognize the burden and risk of making mistakes that interpreting doctors face due to progressive technological developments which produce floods of information in related clinical processes.

The desperately needed reduction of complexity can only be attained by reliably and consistently merging and concentrating diverse information as well as new forms of information presentation (such as human-computer interaction) in an intelligent manner.

Decentralization and Knowledge-Based Solutions

Additionally, data storage, information processing and visualization increasingly produce divided structures. 'Cloud computing,' which is popular in other contexts, and related technologies will revolutionize medicine, particularly the handling of image-based information. This allows for the systematic extraction of knowledge to augment individual patient data, which is consistently monitored outside of the clinic's boundaries. Medical procedures are no longer limited to the location of the clinic, and they encompass human and automated performances, even including full-fledged support of portable devices, which offer various interaction possibilities at the hospital bed, the patient's home, or on the go. This consequently generates an entirely new quality of computer supported diagnosis with great health economics potential, which is accompanied by related legal implications, including consistent quality assurance and risk analysis.

Intelligent Imaging

Medical imaging traditionally works exclusively with a clear separation of both data collection and data evaluation. This separation results in temporarily saving image data in a central archive from which evaluations are conducted in the clinic scenario. This results in two effects in practically all fields of application. First, pre-set protocols generate a scope of images, which usually deliver only partial diagnostic result and vice versa. Second, the need for further image data for steadily high

diagnostic quality in individual cases or the need for new scans due to patient movement (resulting in suboptimal delivery of contrast agent or image artifacts) is often only identified afterwards.

To attain the best results with minimal effort, imaging and image analysis should be more closely integrated and optimized ('co-optimization'). These fields have been largely separated, not only in clinical application, but also in research and development. Overcoming this separation in the long run and laying the foundation for common optimization of data gathering and evaluation will require significant technological and organizational effort. Fraunhofer MEVIS and its partners could lead the way on a global scale.

The field of application includes requirements of subsequent visual diagnosis as well as automated and quantitative analysis during measurement. This leads to a reassessing and fundamentally new analyses of the process of transforming measured data into image information. In many common imaging processes, information from the primary measuring data is lost which could be of great value to both quantitative analysis as well as subsequent evaluation.

The research field of intelligent imaging, which aims for an advanced, tighter integration of imaging and image analysis, carries immense potential thanks to more reliable, more efficient, higher quality, and medically conservative imaging processes. The complexity of these issues demands the integration of complementary research and development institutions, each of which excel in their subfields, to carry out this process consistently.

Prognosis and Risk Modeling

In addition to serving as a foundation for quantification and computer-supported diagnosis, medical image computing and the natural science modeling which it enables serve as the foundation for scientifically based extrapolation of the image data for risk assessment and prognosis of therapeutic intervention and courses of action. This allows access to clinically valuable information based on imaging, which are otherwise inaccessible to the human eye ('imaging beyond the eye'). In other words, data from imaging modalities provides an incomplete representation for diagnosis . Especially for therapy, this is merely a snapshot of the relevant morphologic, functional, and metabolic processes.

Biophysical modeling and simulation grant access to information which cannot be gathered through imaging alone. This results in entirely new diagnoses, such as blood flow simulations and cardiac function diagnosis, as well as optimized therapeutic options, such as simulation of thermoablation for tumors and quantitative analysis of surgical risks. Many innovative and clinically relevant therapy procedures, including radiotherapy, focused ultrasound, and 'targeted drug delivery,' can only develop their true potential through such detailed, forward-looking calculations.

New Approaches for Transdisciplinary Research and Development

Contrasting development of medical hardware technology, it will be of crucial importance in the field of medical image computing to ensure close transdisciplinary integration of all relevant aspects of diagnosis and therapy. To achieve optimum software results in a minimum amount of time, more intense efforts to advance cooperation of medics and scientists are required. The virtual institute VICORA, which was supported by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) as an isolated case, is an exemplary pilot scheme.

An equally great challenge is faced in technology. To be able to transfer the developed software assistants into medical devices as smoothly as possible, standardized and efficiently expandable interfaces need to be continually updated and developed in close cooperation with industry. Considering the perspective of the aforementioned distributed processes, it is possible to develop modular applications which are flexibly and versatilely applicable as well as platforms and networks which strengthen both vertical and horizontal cooperation between medicine, research, and industry.

In conclusion, novel options for designing product-oriented development emerge, which are more application oriented and faster than present solutions. This development must not neglect the need to ensure a consistent software quality beginning in the application-oriented research phase, which is fundamental for the following clinical testing, validating, and licensing as medical device.

Horst K. Hahn

Prof. Dr.-Ing. Horst K. Hahn is physicist, Acting Institute Director of Fraunhofer MEVIS and Professor for Medical Imaging at Jacobs University Bremen.

FRAUNHOFER MEVIS AT A GLANCE

BRIEF PROFILE

The Fraunhofer Institute for Medical Image Computing MEVIS (short: Fraunhofer MEVIS) adheres to a clear philosophy: To achieve significant improvements in medical diagnosis and therapy in relevant fields of disease using image-based computer support. At the heart of all research and projects at Fraunhofer MEVIS lie relevant clinical questions, which are addressed by developing and using the technological equipment in the field of medical image computing.

Research at Fraunhofer MEVIS does not merely focus on answering questions that appear interesting on a scientific level; it aims to achieve solutions that reach industrial partners and directly benefit patients involved in clinical routines. The objective of Fraunhofer MEVIS is to attain long-term, substantial improvements in medical treatment.

Clinical Commitment

Research and development at Fraunhofer MEVIS pursue a clinical direction instead of technological or methodological orientations. Work focuses on developing innovative solutions for image-based medical processes and their industrial implementation for clinical use. Identifying and analyzing clinical issues demands a deep understanding of medical research and calls for close cooperation with clinical partners. Fraunhofer MEVIS maintains an international network of over 100 clinical partners. This clinical network is an essential source of user feedback for evaluating the clinical relevance and feasibility of developed solutions. Partners for cooperation and clients for industrial research and development include large firms and small- or medium-sized ventures in medical technology or related fields such as pharmaceutics.

Industrial Collaboration

True innovation, the successful launch of solutions onto the market, is only possible through close collaboration with industrial partners with the necessary resources and market know-how to fuel the development of new technologies. Fraunhofer MEVIS functions as the link between clinicians and industry, aiming to establish solutions for clinical use. Transferring applied research to the industry is a pillar of the institute and a requirement for future research. Industrial research and development partners and clients include large medical technology firms, such as Siemens AG, as well as medium-sized enterprises, such as spin-off MeVis Medical Solutions AG.

An era comes to an end for Fraunhofer MEVIS

Prof. Dr. Heinz-Otto Peitgen, founder and director of the Fraunhofer Institute for Medical Image Computing MEVIS in Bremen, left the institute on the October 1, 2012 and assumed the presidency of Jacobs University Bremen in January 2013.

From the outset, Peitgen and the research at MeVis aimed to develop image-based software solutions for clinical routines. Under his direction, MeVis participated in multiple modeling projects for breast cancer diagnosis and mammography screening on national and European levels as a central and leading research partner. Several successful new companies have emerged from research projects, leading to the first digital diagnosis system for screening mammography worldwide, developed by researchers in Bremen. In addition, an integrated system for the diagnosis of magnetic resonance mammography was developed and released onto the market. It supports image-guided tissue sampling and sets new standards for breast cancer treatment. Research by Peitgen and MeVis on patient-specific planning and risk analysis of complex liver surgeries represent the state of the art. Over 6,000 clinical liver resections and transplantations have been supported by this internet-based service.

With his personality and visionary power, Heinz-Otto Peitgen has significantly shaped Fraunhofer MEVIS and created a unique working environment. Fraunhofer MEVIS's personnel thanks him wholeheartedly and wishes him all the best for the future.

Certification

Successful introduction of innovative approaches onto the market requires adherence to specific regulations, such as the German Act on Medical Devices (MPG) or the approval guidelines of the United States Food and Drug Administration (FDA). Fraunhofer MEVIS is one of only a select group of research facilities that, since 2005, has been certified according to the EN ISO 9001 and EN ISO 13485 quality standards for medical products. This certification lays out well-defined steps for industrial cooperation. In addition, Fraunhofer MEVIS also has experience with CE and FDA approval for clinical environments.

A Complete Innovation Cycle

Together with industrial partners, Fraunhofer MEVIS has established a quality-controlled innovation cycle that spans across applied research and development, clinical prototypes, and certified medical products, which were awarded the German Business Founder Award (Deutscher Gründerpreis) in 2006. A network of clinical partners and numerous research alliances fuels this innovation cycle. Industry partners market the software solutions developed by Fraunhofer MEVIS, whose contribution can range from the delivery of single components to the development of a complete application. This process has generated a number of medical products that are market leaders. Prime examples of this leadership include products for digital screening mammography evaluation, MR mammography, liver operation planning, and tumor progress control.

The MeVisLab Software Platform

The need for an integrated research and development platform for clinical software solutions was recognized at an early stage. The MeVisLab development platform by Fraunhofer MEVIS and MeVis Medical Solutions AG is a tool equally suited for highly flexible development of clinical software solutions and developing products and methods for fields such as image analysis, visualization, and biophysical modeling. The joint use of MeVisLab at Fraunhofer MEVIS and partners in research, medicine, and industry promotes synergy and accelerates development, ensuring engagement between the links of the chain of innovation. This supports the tight technological integration of clinics, research, and industry.

Field of Activity

Work at Fraunhofer MEVIS deals with epidemiologically significant diseases, such as tumors (especially in the breast, liver, prostate, and brain), cardiovascular diseases, neurological diseases, and lung disease. Clinical partnerships have led to numerous patient-specific image-based software solutions to support early detection, diagnosis, and therapy. Many of these software solutions have entered clinical use as research prototypes or medical products. Major focuses of research at Fraunhofer MEVIS include developing algorithms (for quantitative analysis of image data, tumor size measurement, or evaluation of the form and function of an organ, for instance), as well as comprehensive clinical software for applications such as preoperative planning and intraoperative support for therapeutic interventions. Further important fields of activity include visualization, human-computer interaction (HCI), multimodal support, and workflow optimization.

Fraunhofer MEVIS - guests of the German Chancellery

Two Fraunhofer MEVIS staff members exhibited current research projects about neurological imaging and computer-supported surgery planning as part of the Girls' Day 2012 to Chancellor Angela Merkel and 24 female students. The students were given the opportunity to use iPads to plan a neurosurgical intervention and reconstruct essential nerve fiber bundles close to a brain tumor. Eight companies and research institutions presented at the science and technology exhibit in the Chancellery organized by Initiative D21. In cooperation with the Fraunhofer FOKUS institute, Fraunhofer MEVIS hosted the stand of the Fraunhofer Group for ICT (IuK-Verbund).

Core Expertise

The future development of medical image computing must address how to bridge the gap between information extracted from medical images beyond the naked eye and the individual clinical reality for each patient. The emerging trends from this investigation are reflected in the core expertise of Fraunhofer MEVIS. The tight integration of classical medical image processing, imaging physics, and biophysical modeling and simulation is unique on the global stage and gives Fraunhofer MEVIS a clear advantage over competitors. This is further enhanced by close clinical partnerships taking place internationally.

Chancellor Angela Merkel explores the neuro exhibit of Fraunhofer MEVIS during the opening event at Girls' Day 2012 in the Chancellery.


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Imaging physics: Fraunhofer MEVIS's expertise in imaging physics facilitates analysis and optimization of the complete process, ranging from image acquisition to therapy support. Fraunhofer MEVIS boasts unique expertise and intensive partnerships with industrial partners in developing and optimizing magnetic resonance imaging (MRI) protocols, in particular for perfusion measurement without using contrast agents.

Ten years of increasing safety for living-donor transplantations

On October 28, 2002, a small group from MeVis Research visited the University Clinic in Kyoto, Japan to introduce liver surgeon Professor Koichi Tanaka to surgery planning software developed in Bremen.

At the time, Professor Tanaka was one of the leading global experts in the field of living-donor liver transplantations, a medically demanding transplantation of part of the liver of a healthy donor into the body of a diseased recipient. Approximately one third of the 3,000 live transplants carried out at that time, which for ethical and religious reasons serve as a widespread alternative to cadaver transplants in Asia, were conducted by Professor Tanaka. The partnership between Bremen and Tokyo resulting from the visit in 2002 was a vital milestone on the path to clinically relevant and practical computer support for living-donor liver transplantations. The consequences for all regions drained by liver veins were considered in addition to the impact of the planned sections on the region of the liver supplied with blood via the portal vein. Only through the combination and consideration of the regional supply and drainage patterns, which are unique for each patient, can a reliable estimate of the surgery risk for both donor and recipient be formulated and an optimized proposal for splitting of the donor liver be designed. Professor Tanaka is »firmly convinced that the MeVis software has made liver surgery, including the transplantation of living-donor liver donations worldwide safer and easier.«

In addition to the University Clinic in Kyoto, many other transplantation centers have partnered to use the living donor liver transplantation planning software from Bremen, including the Lahey Clinic in Boston and the Asian Center for Liver Diseases and Transplantation in Singapore. The clinical and practical uses of the procedure have been published by internationally renowned liver surgeons in various journals.

Algorithms and applications: Critical for the development of clinically applicable solutions is the exploration of problem-specific algorithms that meet the demands of daily clinical routines. Fraunhofer MEVIS has gained great international recognition and developed many commercial algorithms for segmentation and image registration. Such algorithms have been applied in various clinical software systems.

Modeling and simulation: Modeling and simulating biophysical processes form a central pillar of medical image computing. To support diagnosis and therapy planning, the information visible in acquired image data can be complemented with patient physiology models. Fraunhofer MEVIS has a globally unique, recognized expertise in modeling and simulating thermal ablation processes.

Visualization, interaction, and user experience engineering: A fundamental advantage that Fraunhofer MEVIS holds over competitors is the tight clinical integration and expertise in visualization, interaction, and user experience engineering (UXE). When developing demonstrators and prototypes, special attention is paid to integration into the clinical workflow, so that any generated application smoothly integrates into the clinical workflow and can be recognized and appreciated by clinicians as helpful.

Computing and software technology: The MeVisLab rapid-prototyping platform is Fraunhofer MEVIS's central tool for developing algorithms, modules, application prototypes, and complete software assistants for clinical applications. The platform, which has been developed by Fraunhofer MEVIS and MeVis Medical Solutions AG for over 15 years, is the key to efficient software development at Fraunhofer MEVIS and is globally recognized and employed. MeVisLab contains modern image-processing and visualization algorithms and is ready for most modern technologies, such as thin clients and cloud computing.

Intraoperative and intrainterventional support: To implement computer-supported planning data for surgeries and interventions, Fraunhofer MEVIS researches efficient, innovative navigation and interaction processes for the operating room. Augmented reality methods, gesture-based control, and audiovisual communication are being investigated with the aim of minimizing the cognitive demands of the surgeons with the computer.

Image registration: A fundamental shortcoming of current multimodal imaging is the registration of image data on a shared-reference coordinate system. An equally challenging

task is registering unimodal image data of an organ during different states of deformation. Fraunhofer MEVIS's Project Group in Lübeck is a global leader in the field of registration. The group has greatly shaped the field over many years and has established remarkable expertise.

Computer-aided detection and diagnosis: Computer-aided detection and diagnosis (CAD) provides software for early diagnosis and decision-making for diagnosis and therapy to support radiologists in interpreting multimodal, multidimensional, and dynamic data. At Fraunhofer MEVIS, intensive work on CAD systems for lung and breast tumor diagnosis has been undertaken in recent years. Object-based image analysis (OBIA), used in CAD, ranks among the primary techniques of Fraunhofer MEVIS's core expertise.

Connections with Universities

Since its founding as an institute associated with the University of Bremen, Fraunhofer MEVIS has maintained close ties with the university. After the departure of Prof. Peitgen in October 2012, Fraunhofer MEVIS has been connected with the University of Bremen, Jacobs University Bremen, and the University of Lübeck through a total of five professorships. Since December 10, 2012, two further professorships have linked the institute to Radboud University in Nijmegen, the Netherlands. Ties with the Bremen universities exist through the following three connections:

University of Bremen: The support of the Stiftung Bremer Wertpapierbörse helped create an endowed professorship in Department 1 (physics/electrotechnology) in imaging physics to focus on magnetic resonance tomography imaging and spectroscopy. In November 2012, this position was filled by MEVIS physicist Prof. Dr. Matthias Günther. Since April 2011, Fraunhofer MEVIS has operated its own 3-tesla MRI scanner at the Technology Park Bremen with Fraunhofer ITWM and the University of Bremen.

Jacobs University Bremen: Former deputy and current institute director Prof. Dr. Horst K. Hahn is a full professor at the School of Engineering and Science in the field of medical imaging. With the support of a private donation by honorary Bremen citizens Conrad and Lotti Naber, another endowed professorship was created in the School of Engineering and Science in mathematical modeling of medical processes. Since the beginning of 2009, this position has been held by MEVIS mathematician Prof. Dr. Tobias Preußer.

Promoting young researchers at Fraunhofer MEVIS

In 2012, Fraunhofer MEVIS offered a variety of programs for promoting talented youth in science. The youngest, aged 8 to 12, were invited to take part in the Children's University over Easter, where Fraunhofer held lectures in mathematics. Another initiative that received positive feedback was Mathematics Research Days, which has been held since 2011 at the University of Bremen for students in grades 4 and 5. From grade 10, students were able to pursue individual internships at Fraunhofer MEVIS or take part in the Fraunhofer MEVIS workshops at the five-day Summer Academy held at the University of Bremen. Additionally, pupils could complete a two-week autumn internship at the Technology Park Bremen in which Fraunhofer MEVIS participates. Fraunhofer MEVIS and MeVis Medical Solutions AG collaborated to offer a joint program for female students at Girls' Day.

A highlight in promoting young talents in 2012 was a pilot workshop at the Fraunhofer Talent School. In addition to training other personnel, a budding, qualified IT specialist and a prospective office clerk are currently being trained at Fraunhofer MEVIS.

Activities to foster talented youth through internships and thesis supervision were also expanded. Four bachelor theses and 14 master and PhD theses were completed at the institute in the reporting period.

In March, a three-day workshop for the German Section of the ISMRM e.V. (Deutsche Sektion der ISMRM e.V.) was organized and held as an education program for around 40 graduates in the fields of magnetic resonance imagining and spectroscopy by Fraunhofer MEVIS. Seven dissertations were completed at the institute in 2012.

A three-day workshop was offered to women interested in computer science. This was part of the Informatica Feminale hosted by the University of Bremen.

Project Group for Image Registration

Through the financial support of the State of Schleswig-Holstein and the European Union, the Fraunhofer MEVIS Project Group for Image Registration was established at the University of Lübeck in April 2010. Under the direction of mathematician Prof. Dr. Bernd Fischer (with deputy directors Dr. Stefan

Heldmann, Prof. Dr. Jan Modersitzki, and Dr. Nils Papenberg), the internationally renowned project group addresses medical image registration, a key skill in medical image computing, in close cooperation with the Institute of Mathematics and Image Computing at the university. The goal of registration is to harmonize medical imagery gathered from different processes (modalities), capture times, or patients, so that this information may be evaluated together.

International Conference on Information Processing in Medical Imaging - IPMI 2011

The 22nd International Conference on Information Processing in Medical Imaging (IPMI 2011), an outstanding scientific event in the field of medical image processing, was organized by Fraunhofer MEVIS and ETH Zurich at the Irsee abbey in Bavaria from July 3 to 8, 2011. Organization of the internationally renowned IPMI 2011 was led by the deputy chairman of the MEVIS Advisory Board Prof. Dr. Gábor Székely of ETH Zurich and then-deputy and current acting director of Fraunhofer MEVIS Prof. Dr. Horst K. Hahn.

Topics included image and signal processing, image recording and fusion, functional and molecular imaging, static and mathematical modeling, computer-supported detection, objective image quality assessment, visualization, and new imaging and image reconstruction techniques.

The active participation was reflected in the large number of submission of scientific contributions. With 224 submissions, the IPMI 2011 reached a new record. Around one tenth (24 contributions) were presented as lectures and another 39 as posters. The total acceptance quota of 28 percent for the submissions in the full proceedings indicates the high scientific quality of the event.

The event has been held every two years since 1969 and is the oldest international conference on medical image analysis.

Development of the Institute

The current Fraunhofer MEVIS institute was founded in August 1995 as MeVis – Center for Medical Diagnostic Systems and Visualization, a non-profit limited liability company (gGmbH). For much of this time, MeVis' sole partner was the Verein zur Förderung der wissenschaftlichen Forschung in der Freien Hansestadt Bremen e.V., a publicly funded organization that promotes scientific research in Bremen. To expand the institute, MeVis received yearly funding from the State of Bremen. Prof. Dr. Heinz-Otto Peitgen was appointed executive director, and an international scientific advisory board oversaw research. In 2006, the institute was renamed MeVis Research GmbH, Center for Medical Image Computing.

Since 1997, MeVis Research has produced several legally and financially independent spin-offs that were consolidated in 2007 into MeVis Medical Solutions AG, a publicly traded company that employs about 150 people. Aside from a few temporary declines in staff due to changes in personnel caused by the founding of a new company, the number of employees steadily increased between the founding in August 1995 and integration into the Fraunhofer-Gesellschaft in January 2009. During this time, the number of employees has increased from 10 to 51 full-time positions.

Affiliation with the Fraunhofer-Gesellschaft

On January 1, 2009, MeVis Research was incorporated into the Fraunhofer-Gesellschaft and renamed Fraunhofer MEVIS, Institute for Medical Image Computing (Institut für Bildgestützte Medizin). Prof. Dr. Heinz-Otto Peitgen was appointed Institute Director. The Advisory Board (Kuratorium) of Fraunhofer MEVIS convened on June 4, 2009, headed by Prof. Dr.-Ing. Erich. R. Reinhardt, at the time, the head of medical technology on the board of Siemens AG and current chairman of Medical Valley EMN e.V. in Erlangen. Since early 2009, Fraunhofer MEVIS has been a member of the Fraunhofer Group for Information and Communication Technology (Fraunhofer-Verbund IuK), for which Prof. Peitgen was elected Deputy Chairman in 2010.

During the transition phase of five years, the parent institute in Bremen and the project group in Lübeck have received funding from the States of Bremen and Schleswig-Holstein and have been co-financed by the European Regional Development Fund. In the first four years after affiliation with the Fraunhofer-Gesellschaft in January 2009, the number of employees at Fraunhofer MEVIS rose from 51 to 70 full-time positions in Bremen by the end of 2012. The project group in Lübeck has increased its staff from 3 to 15 full-time positions between its founding in spring 2010 to the end of 2012.

On October 1, Prof. Peitgen left Fraunhofer MEVIS institute and resigned his position as Deputy Chairman of the Fraunhofer-Verbund IuK. The appeal procedure for his successor as Institute Director of Fraunhofer MEVIS and the corresponding professorship at the University of Bremen is ongoing and has progressed significantly. Until the completion of the process, the Board of the Fraunhofer-Gesellschaft has appointed former Deputy Institute Director Prof. Dr. Horst K. Hahn as interim Institute Director.

OPERATING AND ORGANIZATIONAL STRUCTURES

Fraunhofer MEVIS's interdisciplinary focus incorporates medicine, science, and industry, reflecting the institute's operating principles and organizational structure. Researchers are not bound to strict, hierarchically organized work groups; they function in a flexible work environment that consists of medically defined domains and technologically oriented focuses which together dynamically adapt to the demands of research and development.

This matrix of domains and focuses is the basis for the creation of project teams. According to the demands and affiliation of each project, Fraunhofer MEVIS researchers may belong to multiple domains, focuses, or project teams.

This form of collaboration promotes cooperation between researchers for current projects and facilitates putting synergies into practice. This fosters the exchange of application-specific expertise and allows researchers to introduce their own multidisciplinary expertise for the benefit of the institute as a whole.

The domains are grouped according to medically relevant topics such as organ systems, disease patterns, or diagnosis and therapy procedures. Current domains include tumor diseases as well as organ systems of the breast, liver, lung, brain, heart, and blood vessels. The technologically oriented focuses are organized according to fundamental cross-application issues. Current focuses address intersectional themes such as the emerging fields of modeling and simulation, magnetic resonance imaging, and image registration, as well as the traditional fields of image analysis and visualization. Members of domains and focuses elect coaches who coordinate work and meetings. Domains and focuses are important vehicles for exchanging expertise and developing new project ideas.

The networked organizational structure of Fraunhofer MEVIS, composed of domains, focuses, and project teams is illustrated in the adjacent figure.

The Heads of the Institute are:

- Prof. Dr. Heinz-Otto Peitgen (Institute Director until 10/2012)
- Prof. Dr.-Ing. Horst K. Hahn (Deputy Institute Director, Acting Institute Director from 10/2012 onwards)
- Dipl.-Betrw. Thomas Forstmann (Head of Administration)

The directors are assisted in operational tasks by the extended institutional management. The small committee (Kleines Gremium) includes (in addition to the directors):

- Prof. Dr. Bernd Fischer, Dr. Stefan Heldmann, Prof. Dr. Jan Modersitzki, Dr. Nils Papenberg (Project Group for Image Registration)
- Prof. Dr. Matthias Günther (MR Imaging)
- Prof. Dr. Tobias Preußer (Modeling & Simulation)
- Dr. Stefan Kraß (Clinical Partners, Industry)
- Dr. Markus Lang (Personnel, Law, Industry)
- Dr. Guido Prause (Publicly Funded Research Projects, PR)

Additionally, the large committee (Großes Gremium) includes an employee representative (see below) as well as:

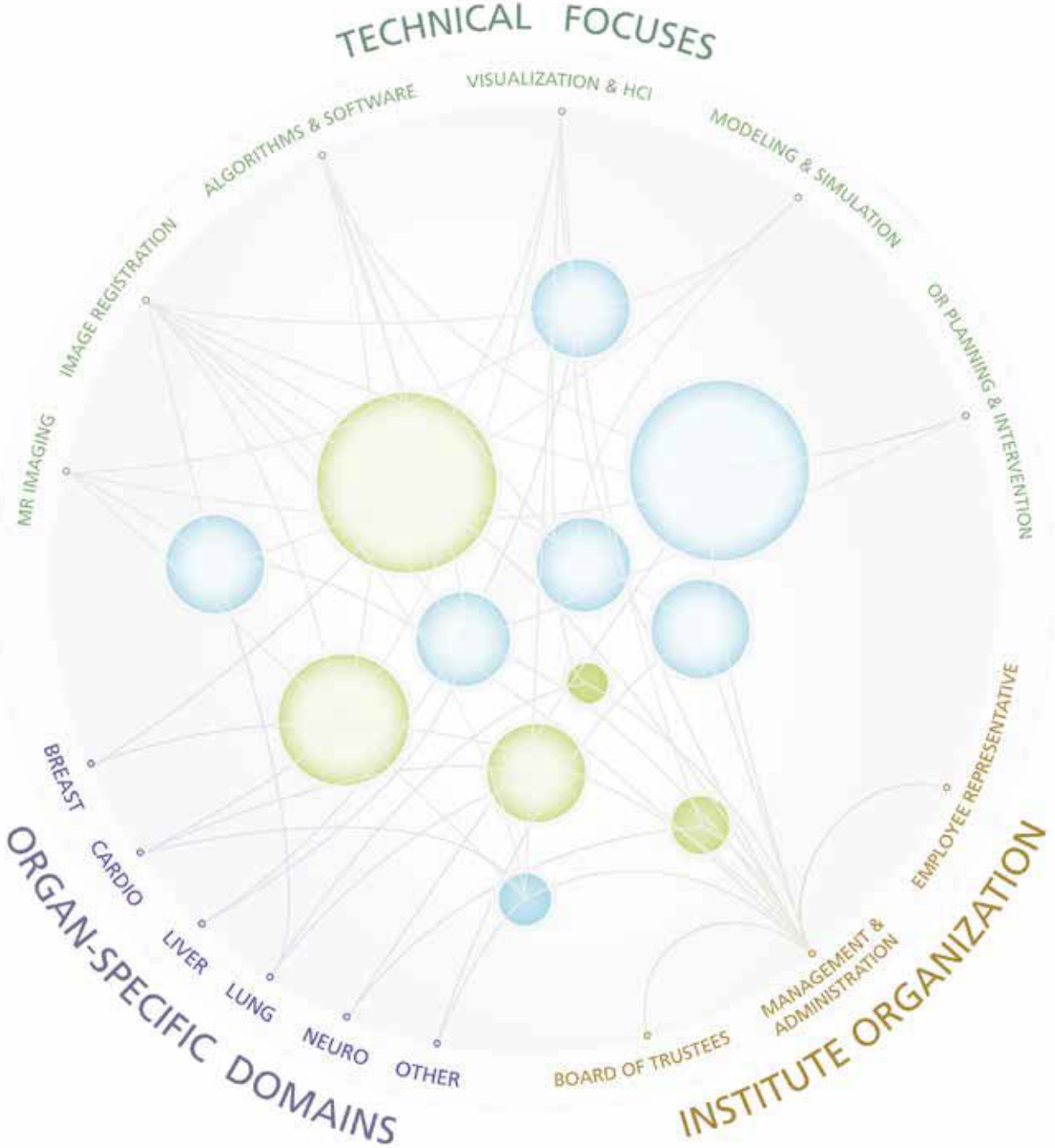
- Dr. Jan-Martin Kuhnigk (Software, IT)
- Dr. Christina Stöcker (Equal Opportunity)
- Dr. Stephan Zidowitz (Certification, QM)

Office management tasks (IT, personnel, accounting, etc.) are undertaken by the administration, which also make up the secretary's office:

- Roswitha Hornung, Karin Entelmann (Bremen)
- Anja Pawlowski (Lübeck)

Each year, four employee representatives are elected from the staff, excluding management. These employee representatives function as liaisons and mediators when needed.

The Advisory Board of Fraunhofer MEVIS is composed of nineteen members with backgrounds in research funding, business, science, and medicine and advises the management in issues of scientific focus and industrial application.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MODELING & SIMULATION
IMAGE REGISTRATION
OR PLANNING & INTERVENTION
MR IMAGING
EMPLOYEE REPRESENTATIVE
BREAST
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BOARD OF TRUSTEES
ORGAN-SPECIFIC DOMAINS
INSTITUTE ORGANIZATION

ADVISORY BOARD

On June 14, 2012, the Advisory Board of Fraunhofer MEVIS assembled for the fourth time under the direction of Chairman Prof. Dr.-Ing. Erich R. Reinhardt. The report on the current situation of the Fraunhofer-Gesellschaft was given by the head of research department, Dr. Hans-Otto Feldhütter from Fraunhofer headquarters in Munich. Institute Director Prof. Dr. Heinz-Otto Peitgen presented the intermediate-term planning and perspectives of Fraunhofer MEVIS as well as current developments in structure and content of the institute in Bremen and the project group in Lübeck. With regards to his departure from the institute on October 1, 2012, Prof. Peitgen wholeheartedly thanked all present Advisory Board members for their valuable cooperation and support in developing the institute.

During the reporting period, the Fraunhofer MEVIS Advisory Board consisted of nineteen individuals.

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Medical Valley
Erlangen

Vice Chairman

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ETH Zürich

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Prof. Dr. Jens Falta
Institute of Solid State Physics,
University of Bremen

Dr. Alexander Ziegler-Jöns
Vice President of University Development,
Jacobs University Bremen

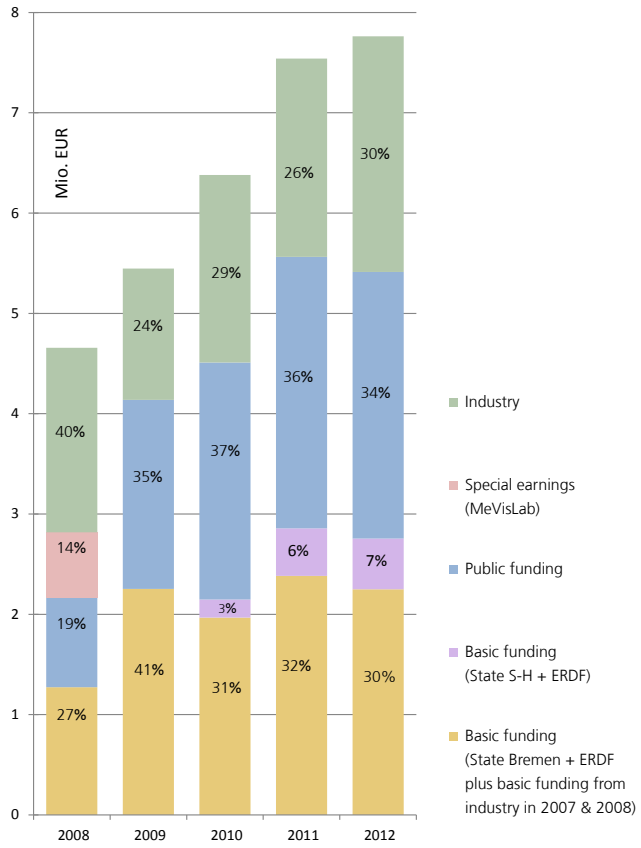
Image Caption:
Attendees of the fourth assembly of the Fraunhofer MEVIS Advisory Board in Bremen on June 14, 2012 on the campus of Jacobs University in Bremen.

THE INSTITUTE IN FIGURES

Budget and Earning Trends

2012 was marked by further growth. Compared to the previous fiscal year (PFY), earnings of the entire institute rose by +3% (PFY +18%, including +4% from the Lübeck PG) to 7,761 thousand euro (T€) (PFY 7,540 T€). Industrial and other earnings rose strongly by +19% compared to the previous fiscal year (+6%). This was due to the immediate success of the new acquisition strategy. In addition, industrial projects of significant size were realized in Lübeck (183 T€). In comparison to the previous fiscal year, basic financing experienced a decline of -4% (PFY +33%). The development of the two locations is trending in opposite directions. Whereas basic financing in Bremen decreased by -6% (PFY +21%), the share of basic financing rose by +7% (PFY +163%). Returns from publicly funded projects decreased by -2% from the previous fiscal year (PFY +15%). The expiration of the BMBF DOT-MOBI project is noteworthy, but has been partially compensated by projects with other Fraunhofer institutes.

The operating budget (OB) in Bremen grew marginally in 2012. In comparison to the previous fiscal year, the Bremen operating budget declined overall by around 120 T€ (-2%). This can primarily be explained by the purchase of the MRI scanner in the previous fiscal year, which particularly affected the investment budget (IB). In Lübeck, the operating budget rose strongly as expected (+86%), whereas the investment budget decreased by half from the previous fiscal year. In sum, the budget development has experienced positive growth.



Total earnings for the period from 2008 to 2012 (since 2010: Bremen & Lübeck).

Development of Budget Lübeck in TEUR:

	2008	2009	2010	2011	2012
OB:	0	0	160	446	828
IB:	0	0	23	91	49
Total	**0**	**0**	**182**	**537**	**877**

Overall Budget in TEUR:

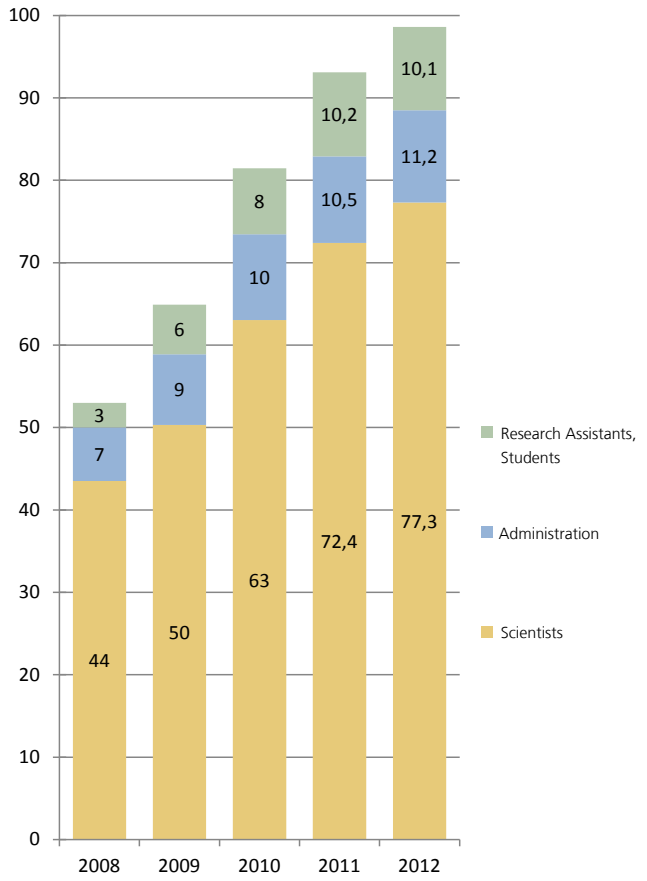
	2008	2009	2010	2011	2012
OB:	4 103	5 121	6 162	6 981	7 401
IB:	281	326	218	559	360
Total	**4 383**	**5 446**	**6 380**	**7 540**	**7 761**

Development of Budget Bremen in TEUR:

	2008	2009	2010	2011	2012
OB:	4 103	5 121	6 002	6 535	6 574
IB:	281	326	195	468	311
Total	**4 383**	**5 446**	**6 197**	**7 003**	**6 884**

Human Resources

2012 experienced a further increase in personnel. The number of researchers rose by approximately five positions, or +7% (PFY + 15%). The number of staff in the administration increased by approximately one additional position by +7% (PFY +1%). The number of research assistants experienced a minor decrease of -1% (PFY+28%). In total, Fraunhofer MEVIS generated approximately five new full-time positions in 2012 (+2 in Bremen; +3 in Lübeck).



Human resources development (full-time equivalent positions at year's end) in the period 2008 to 2012 (since 2010: Bremen & Lübeck).

THE FRAUNHOFER-GESELLSCHAFT

Applied research lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector, and public administration.

At present, the Fraunhofer-Gesellschaft maintains 66 institutes and independent research units in Germany. The majority of the more than 22,000 staff are qualified scientists and engineers, who work with an annual research budget of €1.9 billion. Of this sum, more than €1.6 billion is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and state governments in the form of basic financing, enabling the institutes to work in advance on solutions to problems that will not become acutely relevant to industry and society for five or ten years from now.

Affiliated international research centers and representative offices provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance for the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation processes. Applied research has a domino effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry, and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor, and entrepreneur.

PUBLICATIONS 2012

ACADEMIC PUBLICATIONS

Journal Articles

Altrogge, I., Preusser, T., Kröger, T., Haase, S., Pätz, T., & Kirby, R. M. (2012). Sensitivity Analysis for the Optimization of Radiofrequency Ablation in the Presence of Material Parameter Uncertainty. International Journal for Uncertainty Quantification, 2(3), 295–321.

Amann, M., Achtnichts, L., Hirsch, J., Naegelin, Y., Gregori, J., Weier, K., et al. (2012). 3D GRASE arterial spin labelling reveals an inverse correlation of cortical perfusion with the white matter lesion volume in MS. Multiple Sclerosis Journal, 18(11), 1570.

Barbieri, S., Klein, J., Bauer, M. H. A., Nimsky, C., & Hahn, H. K. (2012). Atlas-based fiber reconstruction from diffusion tensor MRI data. Int J Comput Assist Radiol Surg, 7(6), 959–967.

Barbieri, S., Bauer, M. H. A., Klein, J., Moltz, J., Nimsky, C., & Hahn, H. K. (2012). DTI Segmentation via the Combined Analysis of Connectivity Maps and Tensor Distances. Neuroimage, 60(2), 1025–1035.

Barendt, S., & Modersitzki, J. (2012). A Variational Model for SPECT Reconstruction with a Nonlinearly Transformed Attenuation Prototype. International Journal of Computer Mathematics, 90(1), 82–91.

Boehler, T., Zoehrer, F., Harz, M., & Hahn, H. K. (2012). Breast image registration and deformation modeling. Crit Rev Biomed Eng 40(3):235-58, Review.

Braunewell, S., Günther, M., & Preusser, T. (2012). Towards Focused Ultrasound Liver Surgery under Free Breathing. Critical Reviews in Biomedical Engineering, 40(3), 221–234.

Brunenberg, E. J. L., Moeskops, P., Backes, W. H., Pollo, C., Cammoun, L., Vilanova, A., et al. (2012). Structural and resting state functional connectivity of the subthalamic nucleus: identification of motor STN parts and the hyperdirect pathway. PLoS One, 7(6), e39061.

Burger, M., Modersitzki, J., & Ruthotto, L. (2012). A hyperelastic regularization energy for image registration. SIAM Journal on Scientific Computing. SIAM Journal on Scientific Computing, 31, B132–B148.

Dettmer, S., Entrup, J., Schmidt, M., de Wall, C., Wacker, F., & Shin, H. (2012). Bronchial wall thickness measurement in computed tomography: effect of intravenous contrast agent and reconstruction kernel. Eur J Radiol, 81(11), 3606–3613.

Fabel, M., Wulff, A., Heckel, F., Bornemann, L., Freitag-Wolf, S., Heller, M., et al. (2012). Clinical lymph node staging--influence of slice thickness and reconstruction kernel on volumetry and RECIST measurements. Eur J Radiol, 81(11), 3124–3130.

Georgii, J., & Dick, C. (2012). Efficient Finite Element Methods for Deformable Bodies in Medical Applications. Critical Reviews in Biomedical Engineering, 40(2), 155–172.

Giesel, F. L., Kratochwil, C., Mehndiratta, A., Wulfert, S., Moltz, J. H., Zechmann, C. M., et al. (2012). Comparison of neuroendocrine tumor detection and characterization using DOTATOC-PET in correlation with contrast enhanced CT and delayed contrast enhanced MRI. Eur J Radiol, 81(10), 2820–2825.

Gigengack, F., Ruthotto, L., Burger, M., Jiang, X., Wolters, C. H., & Schäfers, K. P. (2012). Motion Correction in Dual Gated Cardiac PET using Mass-Preserving Image Registration. IEEE Transactions on Medical Imaging, 31, 698–712.

Golay, X., & Günther, M. (2012). Arterial spin labelling: final steps to make it a clinical reality. MAGMA, 25(2), 79–82.

Gregori, J., Kramme, J., & Günther, M. (2012). T2-based Arterial Spin Labeling measurements of blood to tissue water transfer in human brain. J Magn Reson Imag, 37(2), 332–342.

Haase, S., Süss, P., Schwientek, J., Teichert, K., & Preusser, T. (2012). Radiofrequency ablation planning: An application of semi-infinite modelling techniques. European Journal of Operational Research, 218(3), 856–864.

Hansen, C., Zidowitz, S., Ritter, F., Lange, C., Oldhafer, K. J., & Hahn, H. K. (2012). Risk maps for liver surgery. Int J Comput Assist Radiol Surg, 2012 Sep 30 (Epub ahead of print).

Henze, R., Brunner, R., Thiemann, U., Parzer, P., Klein, J., Resch, F., et al. (2012). The Optic Radiation and the Cerebellar Peduncles in Adolescents with First-Admission Schizophrenia – A Diffusion Tensor Imaging Study. Journal of Neuroimaging, (in press).

Henze, R., Brunner, R., Thiemann, U., Parzer, P., Klein, J., Resch, F., et al. (2012). White matter alterations in the corpus callosum of adolescents with first-admission schizophrenia. Journal of Neuroscience Letters, 513(2), 178–182.

Jenne, J. W., Preusser, T., & Günther, M. (2012). High-intensity focused ultrasound: Principles, therapy guidance, simulations and applications. Z Med Phys, 22(4), 311–322.

Komori, M., Matsuyama, Y., Nirasawa, T., Thiele, H., Becker, M., Alexandrov, T., et al. (2012). Proteomic Pattern Analysis Discriminates Among Multiple Sclerosis – Related Disorders. Ann Neurol, 71(5), 614–23.

Lagarrigue, M., Alexandrov, T., Dieuset, G., Perrin, A., Lavigne, R., Baulac, S., et al. (2012). A new analysis workflow for MALDI imaging mass spectrometry: application to the discovery and identification of potential markers of Childhood Absence Epilepsy. J Proteome Res, 11(11), 5453–63.

Mets, O. M., van Hulst, R. A., Jacobs, C., van Ginneken, B., & de Jong, P. A. (2012). Normal range of emphysema and air trapping on CT in young men. AJR Am J Roentgenol, 199(2), 336–340.

Moltz, J. H., D'Anastasi, M., Kiessling, A., Pinto dos Santos, D., Schulke, C., & Peitgen, H.-O. (2012). Workflow-centred evaluation of an automatic lesion tracking software for chemotherapy monitoring by CT. Eur Radiol, 22(12), 2759–2767.

Oldhafer, K. J., Donati, M., Lipp, M., Keller, B., Ojdanic, D., & Stavrou, G. A. (2012). Anterior approach liver resection with the liver hanging maneuver: Technique and indications. Chirurg, 83(1), 65–70.

Oldhafer, K. J., Donati, M., Maghsoudi, T., Ojdanic, D., & Stavrou, G. A. (2012). Integration of 3D Volumetry, Portal Transection and In Situ Split procedure: a new Surgical Strategy for inoperable Liver Metastasis. J Gastrointestin Surg, 16(2), 415–416.

Pätz, T., & Preusser, T. (2012). Composite Finite Elements for a Phase-Change Model. SIAM Journal on Scientific Computing, 34(5), B672–B691.

Pätz, T., & Preusser, T. (2012). Segmentation of Stochastic Images with a Stochastic Random Walker Method. IEEE Trans. Image Processing, 21(5), 2424–2433.

Pätz, T., Kirby, R. M., & Preusser, T. (2012). Ambrosio-Tortorelli Segmentation of Stochastic Images: Model Extensions, Theoretical Investigations and Numerical Methods. International Journal of Computer Vision, (e-pub).

Ruthotto, L., Kugel, H., Olesch, J., Fischer, B., Modersitzki, J., Burger, M., et al. (2012). Diffeomorphic Susceptibility Artifact Correction of Diffusion-Weighted Magnetic Resonance Images. Phys Med Biol, 57(18), 5715–5731.

Schumann, C., Bieberstein, J., Braunewell, S., Niethammer, M., & Peitgen, H.-O. (2012). Visualization support for the planning of hepatic needle placement. In International Journal of Computer Assisted Radiology and Surgery (Vol. 7, pp. 191–197). Springer.

Schwen, L. O., & Preusser, T. (2012). Analysis and Algorithmic Generation of Hepatic Vascular Systems. International Journal of Hepatology, (Article ID 357687).

Schwenke, M., Hennemuth, A., Fischer, B., & Friman, O. (2012). A Novel Anisotropic Fast Marching Method and its Application to Blood Flow Computation in Phase-contrast MRI. Methods Inf Med, 51(5), 423–428.

Simon, D., Fritzsche, K. H., Thieke, C., Klein, J., Parzer, P., Weber, M. A., et al. (2012). Diffusion weighted imaging based probabilistic segmentation of high- and low-proliferative areas in high grade gliomas. Cancer Imaging, 12(1), 89–99.

Srikantha, A., Harz, M., Wang, L., Platel, B., Mann R. M., Hahn H. K., et al. (2012). Symmetry-based detection of ductal carcinoma in situ in breast MRI. European Journal of Radiology, 81, 158–159.

Sverzellati, N., Cademartiri, F., Bravi, F., Martini, C., Gira, F. A., Maffei, E., et al. (2012). Relationship and Prognostic Value of Modified Coronary Artery Calcium Score, FEV1, and Emphysema in Lung Cancer Screening Population: The MILD Trial. Radiol, 262(2), 460–467.

Tan, T., Platel, B., Huisman, H., Sanchez, C. I., Mus, R., & Karssemeijer, N. (2012). Computer-aided lesion diagnosis in automated 3-D breast ultrasound using coronal spiculation. IEEE Trans Med Imaging, 31(5), 1034–1042.

Tan, T., Platel, B., Mann, R. M., Huisman, H., & Karssemeijer, N. (2012). Chest wall segmentation in automated 3D breast ultrasound scans. Med Image Anal, 2012 Dec 5 (Epub ahead of print).

Tiesler, H., Kirby, R. M., Xiu, D., & Preusser, T. (2012). Stochastic Collocation for Optimal Control Problems with Stochastic PDE Constraints. SIAM J. Control Optim., 50(5), 2659–2682.

Trede, D., Kobarg, J. H., Oetjen, J., Thiele, H., Maass, P., & Alexandrov, T. (2012). On the Importance of Mathematical Methods for Analysis of MALDI-Imaging Mass Spectrometry Data. In J Integr Bioinform (Vol. 9, 189).

Trede, D., Schiffler, S., Becker, M., Wirtz, S., Steinhorst, K., Strehlow, J., et al. (2012). Exploring Three-Dimensional Matrix-Assisted Laser Desorption/Ionization Imaging Mass Spectrometry Data: Three-Dimensional Spatial Segmentation of Mouse Kidney. Anal Chem, 84(14), 6079–87.

Wang, Y., Zhang, Y., Peitgen, H.-O., Schenk, A., Yuan, L., Wei, G., et al. (2012). Precise Local Resection for Hepatocellular Carcinoma Based on Tumor-Surrounding Vascular Anatomy Revealed by 3D Analysis. Dig Surg, 29(2), 99–106.

Welter, S., Stöcker, C., Dicken, V., Kühl, H., Krass, S., & Stamatis, G. (2012). Lung Segment Geometry Study: Simulation of Largest Possible Tumours That Fit into Bronchopulmonary Segments. Thorac Cardiovasc Surg, 60(2), 93–100.

Articles in Conference Proceedings

Barendt, S., & Modersitzki, J. (2012). SPECT Reconstruction with a Transformed Attenuation Prototype at Multiple Levels. In Bildverarbeitung für die Medizin (pp. 352–357).

Dresky, C. v., Georgii, J., Jakobsson, S., Scherrer, A., Demedts, D., Schumann, C., et al. (2012). Efficient Computation of Optimal Treatment Plans for High Intensity Focused Ultrasound Therapy of Liver Tumors. In: Focused Ultrasound 2012, 3rd International Symposium (171).

Georgii, J., v. Dresky, C., Schumann, C., Meier, S., Demedts, D., & Preusser, T. (2012). Efficient Numerical Simulation of High Intensity Focused Ultrasound Therapy respecting Reflections and Deformations. In 12th International Symposium on Therapeutic Ultrasound.

Georgii, J., Dresky, C. v., Meier, S., Schumann, C., Demedts, D., & Preusser, T. (2012). Efficient GPU Simulation of High Intensity Focused Ultrasound Therapy. In Focused Ultrasound 2012, 3rd International Symposium (172).

Haase, S., Pätz, T., Tiesler, H., Altrogge, I., & Preusser, T. (2012). Radiofrequency ablation planning beyond simulation. In Engineering in Medicine and Biology Society (EMBC), 2012 Annual International Conference of the IEEE (pp. 191–194).

Hansen, C., Zidowitz, S., Preim, P., Oldhafer, K. J., & Hahn, H. K. (2012). Impact of Model-based Risk Analyses for Liver Surgery Planning. In Proceedings of the Annual Meeting of the German Society of Computer- and Robot-Assisted Surgery (in print).

Harz, M., Georgii, J., Wang, L., Schilling, K., & Peitgen, H.-O. (2012). Efficient Breast Deformation Simulation. In Proc. of 9th Workshop on Virtual Reality Interactions and Physical Simulations (pp. 117–126).

Harz, M. T., Ritter, F., Benten, S., Schilling, K., & Peitgen, H.-O. (2012). A Novel Workflow-Centric Breast MRI Reading Prototype Utilizing Multitouch Gestures. In IWDM ´12: Proceedings of the 11th international workshop on breast imaging (pp. 276-283).

Heckel, F., Braunewell, S., Soza, G., Tietjen, C., & Hahn, H. K. (2012). Sketch-based Image-independent Editing of 3D Tumor Segmentations using Variational Interpolation. In Eurographics Workshop on Visual Computing for Biomedicine (pp. 73–80).

Hennemuth, A., Friman, O., Huellebrand, M., & Peitgen, H.-O. (2012). Mixture-model-based segmentation of myocardial delayed enhancement in MR image data. In Proceedings of Statistical Atlases and Computational Models of the Heart, LNCS (Vol. 7746, pp. 87-96).

Hennemuth, A., Friman, O., Huellebrand, M., Peitgen, H.-O., & Mahnken, A. (2012). Semi-Automatic Quantification of Late Enhancement in CT and MRI Images. In International Society for Magnetic Resonance in Medicine (1251).

Hennemuth, A., Knowles, B., Huellebrand, M., Tautz, L., & Peitgen, H.-O. (2012). Automatic Detection of Left Atrial Scar Tissue in DE-MRI using a Mixture Model and Location Constraints. In cDEMRI Challenge, ISBI 2012 (pp. 1–2).

Honroth, T., von Samson-Himmelstjerna, F., Sobesky, J., & Günther, M. (2012). Combining low-resolution and high-resolution ASL images. In Magnetic Resonance Materials in Physics, Biology and Medicine (Vol. 25, pp. 129–130).

Jacobs, C., Kuhnigk, J. M., van Rikxoort, E. M., Twellmann, T., de Jong, P., Gietema, H., et al. (2012). Optimized workflow for low dose thoracic CT lung cancer screening: automated detection, measurement, temporal matching and volumetry and mass analysis, individualized prediction of cancer risk, structured reporting with follow-up recommendation. In Annual Meeting of the Radiological Society of North America.

Jacobs, C., Scholten, E. T., Saur, S. C., Twellmann, T., de Jong, P. A., & van Ginneken, B. (2012). Computer-Aided Detection of Ground Glass Nodules in Lung Cancer Screening: Retrospective Evaluation of Potential Benefit. In European Congress of Radiology.

Jacobs, C., van Rikxoort, E. M., Twellmann, T., de Jong, P., Schaefer-Prokop, C., Prokop, M., et al. (2012). Improved computer-aided detection of pulmonary nodules by combining a solid and subsolid nodule CAD system. In Annual Meeting of the Radiological Society of North America.

Klein, J., Diehl, V., Geisler, B., Matthias, G., Hildebrandt, H., & Kastrup, A. (2012). Entwicklung einer klinisch anwendbaren quantitativen MRT-Verlaufskontrolle zum Monitoring der Effektivität immunmodulatorischer Medikamente bei Multipler Sklerose. In Research Day MS 2012, Nuremberg, Germany (74).

Klein, J., Köhler, B., & Hahn, H. K. (2012). Efficient global fiber tracking on multidimensional diffusion direction maps. In Proceedings of SPIE Medical Imaging 2012: Image Processing, (Vol. 8314, pp. 83140M:1–8).

Klein, J., Weiler, F., Barbieri, S., Hirsch, J. G., Geisler, B., & Hahn, H. K. (2012). Novel Features of NeuroQLab – A Software Assistant for Evaluating Neuroimaging Data. Lecture Notes in Informatics, (in press).

Kramme, J., Gregori, J., & Günther, M. (2012). Comparison of multi echo approaches in ASL T2 imaging. MAGMA, 25(Suppl 1), in press.

Lassen, B., E. M. van Rikxoort, E. M., Kuhnigk, J. M., van Ginneken, B. (2012). Fast and Intuitive Interactive Lung Lobe Segmentation in Thoracic Computed Tomography Scans. In Annual Meeting of the Radiological Society of North America.

Lassen, B. C., Schmidt, E. M., van Rikxoort, E. M., van Ginneken, B., Jacobs, C., Kuhnigk, J., et al. (2012). Automated and interactive image analysis workstation for the extraction of imaging biomarkers related to chronic obstructive pulmonary disease from thoracic computed tomography scans. In Annual Meeting of the Radiological Society of North America.

Lesniak, J. M., van Schie, G., Tanner, C., Platel, B., Huisman, H., Karssemeijer, N., et al. (2012). Multimodal Classification of Breast Masses in Mammography and MRI using Unimodal Feature Selection and Decision Fusion. In IWDM ´12: Proceedings of the 11th international workshop on breast imaging (pp. 88-95).

Mann, R., Mus, R., Geppert, C., Frentz, C., Karssemeijer, N., Huisman, H., et al. (2012). Dynamic analysis of breast lesions: Can we use the wash-in phase instead of the wash-out phase? In International Society for Magnetic Resonance in Medicine.

Mann, R., Mus, R., Geppert, C., Frentz, C., Karssemeijer, N., Huisman, H., et al. (2012). Initial maximum slope of the contrast enhancement versus time curve for dynamic evaluation of breast lesions on ultrafast breast MRIs. In European Congress of Radiology.

Meier, S., Hennemuth, A., Drexl, J., Bock, J., Jung, B., & Preusser, T. (2012). A fast and noise-robust method for computation of intravascular pressure difference maps from 4D PC-MRI data. In Proceedings of Statistical Atlases and Computational Models of the Heart, LNCS (Vol. 7746, pp. 215-224).

Ojdanic, D., Chen, L., & Peitgen, H.-O. (2012). Improving interaction in navigated surgery by combining pan-tilt mounted laser and a pointer with triggering. In Proceedings of SPIE Medical Imaging (Vol. 8316, 83160Z).

Pätz, T., & Preusser, T. (2012). Fast Parameter Sensitivity Analysis of PDE-Based Image Processing Methods. In ECCV 2012, Part VII, LNCS (Vol. 7578, pp. 140–153).

Platel, B., Welte, T., Mus, R., Mann, R., Sanchez, C., Hahn, H., et al. (2012). Automated Evaluation of an Ultrafast MR Imaging Protocol for the Characterization of Breast Lesions. In Annual Meeting of the Radiological Society of North America.

Rieder, C., Poch, F., Tiesler, H., Lehmann, K., & Preusser, T. (2012). Software Tool for the Analysis of the Coagulation Zone from Multipolar Radiofrequency Ablation. In Proceeding of CURAC (in press).

Rieder, C., Wirtz, S., Zidowitz, S., Bruners, P., Isfort, P., Mahnken, A. H., et al. (2012). Automatic Alignment of Pre- and Post-Interventional CT Images for Assessment of Radiofrequency Ablation Therapy. In Proceedings of SPIE Medical Imaging (Vol. 8316, pp. 83163E:1-8).

Riesenkampff, E., Meier, S., Schubert, S., Al-Wakeel, N., Ewert, P., Hennemuth, A., et al. (2012). Non-invasive three-dimensional pressure maps by flow-sensitive MRI: comparison of measurement accuracy compared to invasive catheterization in patients with aortic coarctation. In 46th Annual Meeting of the Association for European Paediatric and Congenital Cardiology (pp. S51-52).

Ritter, F., Harz, M. T., Al Issawi, J., Benten, S., Schilling, K. J. (2012) Combining Mobile Devices and Workstations for the Reading of Medical Images. In Mensch & Computer Workshop-Band 2012 (pp. 231-240).

Ruthotto, L., Gigengack, F., Burger, M., Wolters, C., Jiang, X., Schäfers, K., et al. (2012). A Simplified Pipeline for Motion Correction in Dual Gated Cardiac PET. In Bildverarbeitung für die Medizin (pp. 51–56).

Ruthotto, L., Hodneland, E., & Modersitzki, J. (2012). Registration of Dynamic Contrast Enhanced MRI with Local Rigidity Constraint. Biomedical Image Registration, 190–198.

Schneider, R., Bellenberg, B., Kleiter, I., Gold, R., Köster, O., Klein, J., et al. (2012). Regional volumetry of the central nervous system to detect differences between Neuromyelitis Optica and Multiple Sclerosis. In Proceedings of the 29th Annual Meeting of the European Society for Magnetic Resonance in Medicine and Biology (in press).

Schwen, L. O., & Wolfram, U. (2012). Validation of Composite Finite Elements Efficiently Simulating Elasticity of Trabecular Bone. Computer Methods in Biomechanics and Biomedical Engineering, (in press).

Schwen, L. O., Pätz, T., & Preusser, T. (2012). Composite Finite Element Simulation of Radio Frequency Ablation and Bone Elasticity. In Proceedings of the 6th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS2012).

Schwier, M., Boehler, T., Hahn, H. K., Dahmen, U., & Dirsch, O. (2012). Registration of histological whole slide images guided by vessel structures. In MICCAI Workshop on Histopathology Image Analysis: Image Computing in Digital Pathology (pp. 147–158).

Strehlow, J., Rühaak, J., Kluck, C., & Fischer, B. (2012). Effiziente Verpunktung pulmonaler MR-Bilder zur Evaluierung von Registrierungsergebnissen. In Bildverarbeitung für die Medizin (pp. 219–224).

Tan, T., Platel, B., Mus, R., & Karssemeijer, N. (2012). Detection of Breast Cancer in Automated 3D Breast Ultrasound. In Proceedings of SPIE Medical Imaging, (Vol. 3815, pp. 381505:1-8).

Tautz, L., Hennemuth, A., & Peitgen, H.-O. (2012). Quadrature Filter Based Analysis of Myocardial Deformation Based on 3D Ultrasound. In Proceedings of Statistical Atlases and Computational Models of the Heart, LNCS, (Vol. 7746, pp. 169-177)..

Thiele, H., Heldmann, S., & Fischer, B. (2012). 3D Visualisierung von Organismen. In Proceedings der INFORMATIK 2012 (pp. 1535–1545). GI-Editon Lecture Notes in Informatics, (Vol. 208, pp. 1535-1545).

Wang, L., Moltz, J. H., Bornemann, L., & Hahn, H. K. (2012). A Minimally-interactive Method to Segment Enlarged Lymph Nodes in 3D Thoracic CT Images Using a Rotatable Spiral-Scanning Technique. In Proceedings of SPIE Medical Imaging (Vol. 8315, 83150D).

Wang, L., Platel, B., Ivanovskayay, T., Harz, M., & Hahn, H. K. (2012). Fully automatic breast segmentation in 3D breast MRI. In Proceedings of ISBI 2012, Image Segmentation I, (pp. 1024-1027).

Weiler, F., Rieder, C., David, C. A., Wald, C., & Hahn, H. K. (2012). On the Value of Multi-Volume Visualization for Preoperative Planning of Cerebral AVM Surgery. In Eurographics Workshop on Visual Computing for Biomedicine (pp. 49–56).

Zöhrer, F., Georgii, J., & Hahn, H. K. (2012). Towards spatial correlation of multimodal breast images. In Biomedizinische Technik/Biomedical Engineering (Vol. 57, 4467).

Conference Proceedings

Preusser P., Günther M., & Hahn H. K. (2012). Critical Reviews in Biomedical Engineering, Special Issue on Detection, Modeling and Compensation of Organ Motion and Deformation, Begell House, New York.

Book Chapters

Altrogge, I., Büskens, C., Kröger, T., Peitgen, H.-O., Preusser, T., & Tiesler, H. (2012). Modeling, Simulation and Optimization of Radio Frequency Ablation. Constrained Optimization and Optimal Control for Partial Differential Equations. In: G. Leugering, S. Engell, A. Griewank, M. Hinze, R. Rannacher, V. Schulz, M. Ulbrich, & S. Ulbrich (Eds.), International Series of Numerical Mathematics, Vol. 160. Birkhäuser, Basel (pp. 487–499).

Dissertations

Barbieri, Sebastiano (2012). On the Accuracy of Fiber Tractography. Jacobs University Bremen.

Hansen, Christian (2012). Software Assistance for Preoperative Risk Assessment and Intraoperative Support in Liver Resection Surgery. Jacobs University Bremen.

Hennemuth, Anja (2012). Computer-Assisted Diagnosis and Therapy Planning in Coronary Artery Disease Based on Cardiac CT and MRI. Universität Bremen.

Kramme, Johanna (2012). Robust Arterial Spin Labeling T2 Measurements. Universität Bremen.

Pätz, Torben (2012). Segmentation of Stochastic Images using Stochastic Partial Differential Equations. Jacobs University Bremen.

Ruthotto, Lars (2012). Hyperelastic Image Registration - Theory, Numerical Methods, and Applications. Universität zu Münster.

Schenk, Andrea (2012). Liver Segmentation and its Application to Hepatic Interventions. Universität Bremen.

Master and Diploma Theses

Biemann, R. (2012). Multi-Objekttracking mit Partikelfiltern. Universität zu Lübeck.

Blazevicius, K. (2012). On compartmental Tofts and Kermode model and its extension for modelling of kinetic diffusable tracer concentration dynamics. Jacobs University Bremen.

Chitiboi, T. (2012). Merging Strategies Based on Super-structure Information in Object Based Image Analysis. Jacobs University Bremen.

Drews, R. (2012). Bildanalyse von Kollagen-Matrices mittels verschiedener Segmentierungsmethoden. Universität zu Lübeck.

Düvel, A. (2012). Elastische Registrierung von stochastischen Bildern. Universität Bremen.

Graßhof, S. (2012). Registrierung von Flussdaten. Universität zu Lübeck.

Kocev, B. (2012). Projector-based Surgeon-Computer Interaction on Deformable Surfaces. Jacobs University Bremen.

Kwizera, I. (2012). Modeling and Simulation of Mechanical Adaptation of Trabecular Architecture Using the Finite Element Method. Jacobs University Bremen.

Linke, T. (2012). Topologie-Optimierung von Strömungsproblemen mit der Lattice-Boltzmann-Methode. Universität Bremen.

Marzahl, C. (2012). Konzeption und Implementierung eines interaktiven Segmentierungsverfahrens für dreidimensionale medizinische Bilddaten mittels Intelligent Paintbrush. Fachhochschule Stralsund.

Pohl, M. (2012). Bildregistrierung mit linearer und nicht-linearer Elastizität. Universität zu Lübeck.

Polzin T. (2012). Lungenregistrierung mittels automatisch detektierter Landmarken. Universität zu Lübeck.

Schomburg, H. (2012). Efficient Computational Approaches for Multiframe Blind Deconvolution. Universität zu Lübeck.

Soltow, E. (2012). Segmentierung komplexer Leberläsionen mit objektbasierter Bildanalyse. Universität zu Lübeck.

Bachelor Theses

Bauschulte, M. (2012). Konzeption eines kostengünstigen Fluoreszenzmikroskops zur In-vivo-Wundbeobachtung. Hochschule Bremerhaven.

Berg, R. (2012). Leistungssteigerung in der medizinischen Bildregistrierung durch Mehrkern-Signalprozessoren. Universität zu LübeckWilhelm Büchner Hochschule Darmstadt.

Capilnasiu, A. (2012). Modeling blood circulation in sinusoids. Jacobs University Bremen.

Majal, G. M. (2012). Mach number annealing applied to the Lattice Boltzmann method. Jacobs University Bremen.

Patents

Kohle, S.: Method, digital storage medium, and image data processing and visualization systems for coloring of voxels, which are selected via a maximum intensity projection-type technique using at least one color coordinate of a color continuum as intensity. US patent US 8,126,222 B2 issued on February 28, 2012.

Hahn, H. K.: Marking of location in a medical image. US patent US 8,295,564 B2 issued on October 23, 2012.

Filippatos, K., Twellmann, T., Zöhrer, F., & Hahn, H. K.: Image processing device for finding corresponding regions in two image data sets of an object. Worldwide patent application PCT/EP2011/053134 published on September 7, 2012.

Zöhrer, F., & Hahn, H. K.: Apparatus for adusting images. US patent application 13/162,494 published on December 20, 2012.

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