UNIVERSITÄT LEIPZIG

Faculty of Medicine

Innovation Center Computer Assisted Surgery

RESEARCH REPORT 2010

iccas innovation center computer assisted surgery

Imprint

Editor

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Dipl.-Ing.Christian Dressler

Disclaimer

Contents

To the reader

Prof. Dr. med.
Jürgen Meixensberger

Dear Ladies and Gentlemen, dear colleagues,

For ICCAS, the year 2010 was a year of change: The initial funding period of ICCAS phased out, but due to the numerous projects which were acquired in between, we were able to continue our scientific work on modular systems architectures and standardization for the OR of the future, on patient modeling and on surgical workflow support with undiminished effort. On the other hand a lot of work, especially of the ICCAS board, focused on building the structure of our institute for the next 5–year period. The new group leaders were nominated by the German Federal Ministry of Education and Research (BMBF). We welcome Dr. Neumuth and Prof. Cardoso and their coworkers starting working on their scientific programs at ICCAS in 2011. At the end of the year 2010, our work of the recent years and our strategy ICCAS 2010+ was externally evaluated by the ICCAS advisory board consisting of renowned scientists and industry representatives in the field of computer assisted surgery. At the end of a one-day status meeting in December the advisory board stated that the first funding period of ICCAS was indeed successful. ICCAS has become one of the leading sites for computer–assisted surgery in Europe. Looking to the future the advisory board recommends one of our strengths in the relationship between engineers, practical computer scientists and surgeons tackling clinical problems in the CAS-field. Those should be maintained and developed. The field of assessment of surgical technologies and surgical training has now moved to our partner Hochschule für Technik, Wirtschaft und Kultur (HTWK, university of applied sciences), within the Leipzig Cluster for Medical Technology. We wish Dr. Werner Korb and his coworkers the best success for continuing his work there and in collaboration with ICCAS, the International Reference and Development Center (IRDC) Leipzig and the participating clinicians at the University Hospital Leipzig.

Unfortunately, we also experienced a mournful event: Prof. Dr. Dirk Bartz, leader of the ICCAS research group Visual Computing since 2007, died unexpectedly on March 28 during the Berlin Half Marathon at age of 42. His personal commitment was accompanied by a great application to the scientific community. In addition, he was an open-minded person of contact for all professional and non-professional issues. His cheerful and honest manner, in combination with his great dedication to science, will be sorely missed by all of us. Dirk Bartz has shown us that it is possible to combine a family-life with a demanding leading position - his family meant everything to him. Therefore, our first and foremost thoughts and sympathies go out to his wife and his children.

All the more we are very pleased that Silvia Born and Daniela Wellein working in Dirk Bartz's Visual Computing Group won two prices in 2010 for their remarkable research in the visualization of neuro-radiologic data sets. Additionally, Stefan Bohn won the science slam on occasion of the Dies Academicus of the Leipzig University.

Prof Dr. Jüergen. Meixensberger
Head of the board

Research Activities

Dr.-Ing. Oliver Burgert

Modular System Architectures for Computer Assisted Surgery

To provide the surgeon intra-operatively with all relevant information technical systems built by different vendors must be interconnected. This requires the usage and development of international standards.

One strategic goal of ICCAS is to provide the surgeon with all relevant information about the patient and the intra-operative situation. To achieve this goal, all technical systems which are generating and using information about the patient must be interconnected. Interaction and communication between devices require protocols and data types. We demonstrate the feasibility of modular system architectures for computer assisted surgery by development and implementation of a modular reference architecture which is capable of integrating devices of different vendors and diverse modalities. Several applied projects in the fields of neuro-, ENT- and cardiac surgery showed the feasibility of the modular approach.

All technical systems in the OR must be interconnected

To assure interoperability between devices manufactured by different vendors, these protocols and data types need to be standardized. One important standard this architecture uses is "Digital Imaging and Communication in Medicine" (DICOM). In 2010, two novel supplements for implantation planning, namely "Implant Templates" and "Implantation Plan SR Document" were added to the DICOM standard. The supplements have been developed by ICCAS in cooperation with industrial partners. On top of that, we prepared a new domain "Surgery" for the Integrating the Healthcare Enterprise (IHE) initiative. IHE gives recommendations on the coordinated use of standards in the medical field and can harmonize all industry-wide efforts in the field of computer assisted surgery technology.

Selected Publications

Bohn S, Gessat M, Voruganti A, Franke S, Burgert O An open source framework for systems integration in the operating room. Minim Invasiv Ther 2010; 19:e 19

Scherer S, Treichel T, Ritter N, Triebel G, Drossel WG, Burgert O Surgical stent planning - Simulation parameter study for models based on DICOM standards. Int J Comput Assist Radiol Surg 2010

Treichel T, Liebmann P, Burgert O, Gessat M Applicability of DICOM structured reporting for the standardized exchange of implantation plans. Int J Comput Assist Radiol Surg 2010; 5(1):1–9

Voruganti AKR, Mayoral R, Vazquez A, Burgert O A modular video streaming method for surgical assistance in operating room networks Int J Comput Assist Radiol Surg 2010; 5(5): 489-499

Digital Patient Models and Visualization

Medical systems, such as CT, MR, PET, or an electronic patient record provide comprehensive information about a patient. Geometric models, which aggregate this information may be used for planning of surgeries or during surgeries.

Due to the constant increase in the number of modalities, sensors, and computing capability it is possible to gather a huge amount of patient data which is hard to handle by the surgeon. Digital patient-specific models are designed as central aspect of "model-based diagnostic and therapy". These comprehensive models flexibly store all relevant medical pre-operative and intra-operative data supporting specific interventions and clinical workflows. Using those models, the surgeon can have immediate access to the relevant information needed at a specific point in time during surgical planning or during surgery.

The visualization of geometric models plays an important role in this process; this involves several steps from image acquisition, image analysis and processing, visualization, to advanced visual interaction and examining perceptual issues in that context. The resulting visual analysis and exploration provides more powerful tools to enable more insights into these information sets.

The digital patient models can be examined

The digital patient models can be examined and used for surgical planning in the novel "Surgical Planning Unit" (SPU) which has been established at ICCAS in 2010. Digital patients have also served as basis of several applied projects in different surgical fields.

Selected Publications

Born S, Wiebel A, Friedrich J, Scheuermann G, Bartz D Illustrative Stream Surfaces IEEE Transactions on Visualization and Computer Graphics 2010; 16(6): 1329-1338

Karar ME, Merk D, Chalopin C, Walther T, Falk V, Burgert O Aortic valve prosthesis for transapical aortic valve implantation. Int J Comput Assist Radiol Surg 2010

Wellein D, Born S, Pfeifle M, Duffner F, Bartz D A pipeline for interactive cortex segmentation, Comput Sci Res Dev 2010

Dr. Thomas Neumuth

Surgical Workflows

The group developes methods for workflow acquisition. Surgical workflows may be used to develop future surgical assist systems by considering surgical routine. If the actions of a surgeon may be detected automatically, situation-dependent assistance can be provided to the surgeon.

The development of new and future Surgical Assist Systems (SAS) is highly influenced by emerging technological enhancements. Unfortunately, this technology-based approach does not pay heed to the central characters during a surgical intervention, and the end-users of these systems: the surgeons. Rather than adapting these systems to the surgical routine in the actual operating rooms, it is tried to adapt the surgical routine to the systems. To give more emphasis to the requirements and demands of the surgeons, a substantially new approach should take both into consideration: emerging and upcoming technologies, but also a methodical and scientific analysis of the underlying surgical procedures.

The research field of surgical process modeling and surgical workflow analysis focuses on the topic from different perspectives. The development of surgical workflow management systems has the objective to provide an optimum intraoperative support for the surgeon. In support of surgical workflow management, automatic data acquisition strategies provide intraoperative situation recognition and combine observer-based with knowledge-based acquisition methods. A clinical application project that uses surgical process modeling is the assessment of surgical training with new developed instruments. Additionally, clinical and technical projects are promoted by theoretical projects in the context of surgical ontologies and assessment projects in the context of risk management in man-machine interaction.

Intraoperative support and assessment of surgical training

Selected Publications

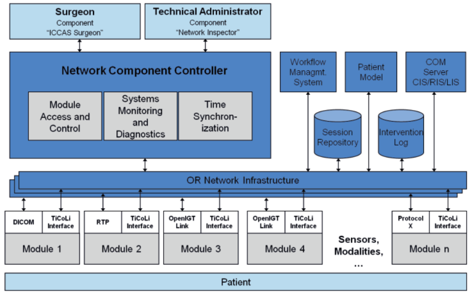
Neumuth T, Jannin P, Schlomberg J, Meixensberger J, Wiedemann P, Burgert O Analysis of surgical intervention populations using generic surgical process models.
Int J Comput Assist Radiol Surg 2010

Neumuth T, Kaschek B, Goldstein D, Ceschia M, Meixensberger J, Strauss G, Burgert O An observation support system with an adaptive ontology-driven user interface for the modeling of complex behaviors during surgical interventions.
Behav Res Methods 2010

Riffaud L, Neumuth T, Morandi X, Trantakis C, Meixensberger J, Burgert O, Trelhu B, Jannin P Recording of surgical processes: a study comparing senior and junior neurosurgeons during lumbar disc herniation surgery Neurosurgery 2010; 67(2 Suppl Operative)

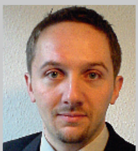
Modular System Architectures for Computer Assisted Surgery

The Modular Integrated Operating Room Based on Open Standards



Left: ICCAS integrated OR prototype within demonstrator lab. Right: System architecture, which integrates medical hardware and software components into a common research platform based on open standards.

Integration of medical devices and IT systems as well as centralized control of the integrated system in the operating room (OR) has been recognized for its potential to increase the overall surgical efficacy, ergonomics and the clinical workflow. An open standards based OR integration system has been designed, which is modeled as component-based service-oriented architecture. Each medical device is integrated as independent component and physically interconnected through an Ethernet network. The integration framework “TiCoLi” is a C++ library, which facilitates service discovery (using ZeroConf), time synchronization (NTP according to the IHE profile "Consistent Time"), system diagnosis (using Simple Network Management Protocol SNMP and application response measurement), messaging and event handling (using OpenIGTLink and DPWS) as well as streaming of continuous signals (using RTP). Several core components form the backbone functionality of the integrated system. The central surgical console with sterile user interface allows access to the functions of the integrated system. The central managing component supports technical administration and systems supervision. Common electronic patient context is maintained by the context module while the session repository stores all data generated pre- and intra-operatively for post-operative documentation. The modular OR system integrates a) data, e.g. preoperative imaging and planning data of surgical target structures (using the DICOM surface segmentation SOP classes), tracking data, biosignals and patient context; b) device functions with centralized device control at the surgical console; as well as c) user interfaces (using Universal Remote Console URC standard) and applications using display integration and video routing technologies. A prototype setup has been established in a demonstrator OR. A clinical evaluation study of the integrated system is currently under preparation.



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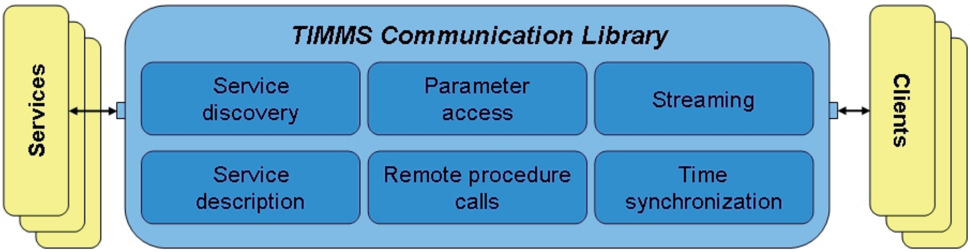
TiCoLi – An Open Software Infrastructure for Device Integration in the Modular Operating Room



Functionalities covered by TIMMS Communication Library

Standardized interfaces for systems and devices in the operating room (OR) are key requirements for successful vendor-independent device communication. Various initiatives as well as vendor-specific integration solutions already exist, which specify or adapt protocol stacks for the surgical domain. A rapid development of innovative components and assistance systems for the OR also requires a software toolkit for fundamental integration tasks. The toolkit should cover repeatedly arising functional requirements, such as automatic service discovery, device and service description, access to device parameters, remote-procedure calls and continuous data exchange (streaming).

The TIMMS Communication Library (TiCoLi) developed at ICCAS encapsulates and abstracts these requirements into one comprehensive and easy-to-use C++ Application Programming Interface (API). Applications based on TiCoLi can access these functionalities in an abstract manner and independent from the underlying protocol stacks. TiCoLi currently supports two different protocol stacks as realizations of the abstract functionalities, OpenIGTLink and Device Profiles for Web Services (DPWS). Since both protocol stacks do not cover all required functionalities, the TiCoLi is extended with additional protocols, e.g. ZeroConf for service discovery, NTP for time synchronization or RTP for data streaming. The object-oriented toolkit design guarantees high flexibility regarding the integration of new protocols and the adaptation to the needs of a particular clinical application. The TiCoLi toolkit was successfully used as surgical middleware solution in various projects at ICCAS.

TiCoLi has turned into an open-source project and is freely available at http://www.iccas.de/ticoli. This step will encourage the development process and enable the incorporation of external user feedback.

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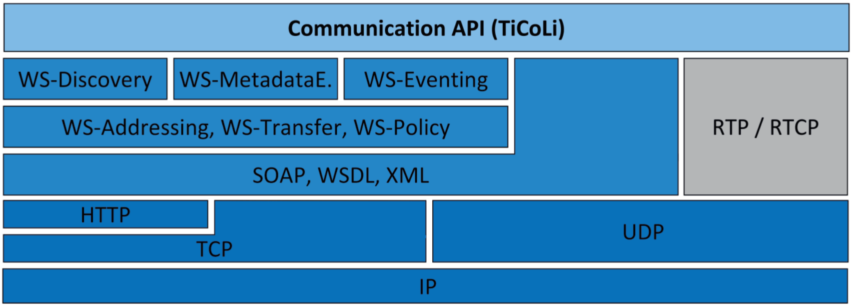
DPWS-based Communication for the Modular Operating Room



Overview of the various protocols in our DPWS-based communication framework

The increasing amount of medical devices and systems in the surgical environment requires complex and distributed information processing. The paradigm of Service-Oriented Architectures (SOA) is a common concept to structure such processes. It is used in many fields of application and is also discussed as a paradigm for modern OR infrastructures.

The goal of this work is to develop an open communication framework for system integration in the OR based on Device Profiles for Web Services (DPWS). The DPWS 1.1 protocol stack is an OASIS standard that focuses on web services for resource-constrained devices. It is a modern technology built on various web services specifications. The communication framework developed at ICCAS covers the essential functional requirements for information exchange in dynamic surgical environments that repeatedly arise. Among them are automatic service discovery, device and service description, access to device parameters, remote-procedure calls and continuous data exchange (streaming).

The DPWS standard is a promising base for an open protocol stack for the OR but does not fulfil all of the identified requirements. Hence our protocol stack extends DPWS especially in the domains of service description and continuous data streaming. And overview of the current design is given in the figure above.

The described framework was implemented using C++ and integrated into our communication library, called TiCoLi. Sample applications have been implemented to perform first feasibility evaluations. Additionally, the framework prototype has been successfully used in exemplary scenarios and thus shown the suitability of DPWS as a base for communication in computer assisted surgery. The implementation is open source and will be freely available as a part of our TiCoLi project. A major part of the future work will focus on a common manner to express semantics in description entities.

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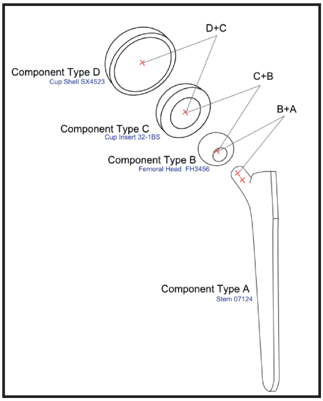
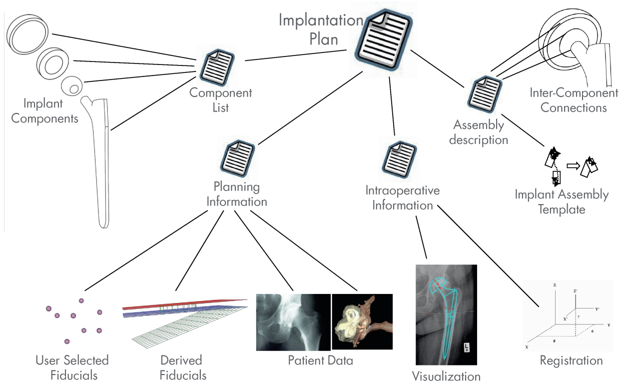
LOCALITE GmbH, Richard Wolf GmbH, SurgiTAIX AG, Synagon GmbH, VDE, Deutsche Gesellschaft für biomedizinsiche Technik

DICOM Support for Implant Planning





Left: Supplement 131 Implant Template description. Right: Supplement 134 - Implantation Plan description

The Surgical-DICOM Solutions (SDS) group develops DICOM supplements to enable the usage of DICOM in the surgical environment. Two supplements, namely “Implant Templates” (131) and the “Implantation Plan SR Document” (134) have succesfully passed standardization process in 2010. These extensions aim on improving the implantation planning workflow: The DICOM implant templates supplement describes the 2D and 3D representation of the implant. Additional information, such as material and fixation method, is also included in the implant description. Applications that use the DICOM implant templates will be able to help the surgeon to compose complex implants out of several implant components by providing information about which implants are compatible and how they are connected. To accelerate the implant selection, the DICOM template assemblies predefine which implants may be used for a certain purpose. Once the surgeon has decided on the right implant sizes and types, the DICOM implantation plan, can be used to store this planning. The implantation plan bases on DICOM Structured Reporting (SR), which gives it a great flexibility. Not only the selected implant components and their combination are stored in this document, but also the used patient data is referenced. Due to the PACS infrastructure, which is available in most hospitals, the implantation plan can be archived and transmitted easily. Additionally, the Implantation Plan can be shown to the surgeon. For this case it is important that this DICOM extension is capable to reference visualizations that were created during the surgery. With these two supplements the digital implantation planning can benefit from the advantages modern PACS systems provide: interoperability between different planning systems and assistance devices in the OR, common infrastructure and data sources and reliable archiving of patient data.

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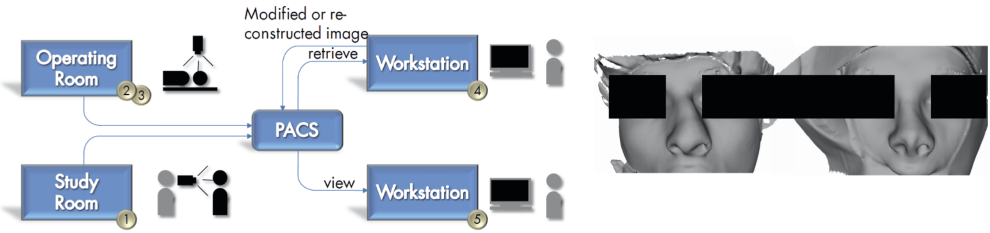
Requirements of a DICOM Supplement for Optical Surface Scanners Regarding the Use-Case of Rhinoplasty Surgery



Left: Considered workflow for scanning procedure, right: 3D surface of face before and immediately after rhinoplasty

Optical surface scanners (OSS) are gaining importance in many medical fields like cranio-maxillofacial surgery, dentistry, ENT or reconstructive surgery. An OSS generates a point cloud or triangular mesh describing the surface of an object. Regardless of the increased importance of this modality, there is no standardized file format for the resulting clinical data. This hinders the development of applications based on surface scans and clinical acceptance. The Digital Imaging and Communications in Medicine (DICOM) standard supports most medical imaging devices, such as CT, MRT, or ultrasound. Therefore it seems natural to add a modality for optical surface scanners to this standard. A requirement and use cases analysis for OSS in medicine was performed. Based on this analysis, a "work item proposal" was created and granted by the DICOM committee in April 2010. By this, ICCAS got the assignment to develop an extension of the DICOM standard, a so-called "supplement" for OSS. Meetings with vendors and stakeholders have been held to identify the individual needs. Based on the meetings, a first draft of the Supplement has been created and successfully reviewed by the working group "base standard" in November 2010.

To verify the theoretical approach, a clinical project has been initiated, which allows us to implement one of the use cases: The use of a scanner within the rhinoplasty surgeries shall reveal improvements for the DICOM supplement. With a mobile pattern scanner, the patient's nose was recorded within the study room and in the OR, before and after the surgical intervention. Seven patients' noses have been scanned and the experienced requirements were considered while developing the supplement proposal.

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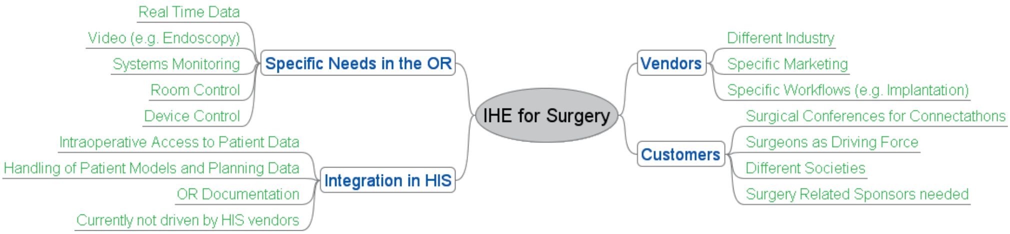
IHE in Surgery



MindMap showing distinguishing characteristics of the surgical domain

At present, several research institutions and parts of the medical device industry are driving forward a movement towards open, modular systems solutions in health care settings. These initiatives are based on open standards such as DICOM, HL/7, etc. This should lead to more robust systems which may also provide a wider range of functionalities and systems features.

Unfortunately, there are many proposed solutions which are not fully compatible with given standards; sometimes there are different interpretations of the same standard. It is therefore essential to engage a normative or quasi-normative body to discuss integration issues among all stakeholders. The initiative “Integrating the Healthcare Enterprise” (IHE) could be such a normative body.

IHE’s current focus is on radiology. Within the Operating Room, there are specific needs regarding the technical infrastructure and communication. Patient model information, device and room control must be integrated. For safety reasons, systems monitoring and diagnosis of OR equipment are required. These topics must be addressed by domain experts since they are very OR specific. Therefore, in 2010 we paved the way towards new IHE domain “Surgery”.

We propose three new profiles, which could be the beginning of the Technical Framework Surgery: Surface Segmentation Profile (SSE), Implant Template Distribution Profile (ITD) and Implantation Plan Distribution Profile (IPD). Based on our projects on modular systems architectures for the operating room, we have a set of potential further supplements which could be integrated in the mid-future.

We believe that IHE could play a major role for the integration of devices and modules for Image and Model Guided Therapy. The coordinated use of standards within this industry will lead to more reliable systems and foster new applications of this technology.

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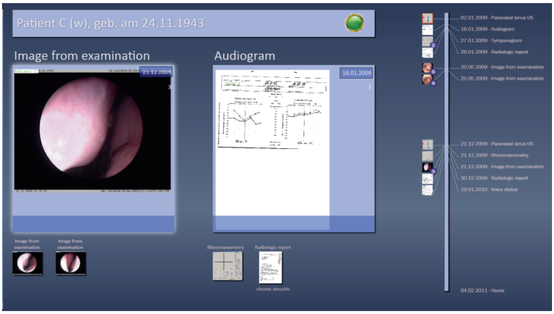
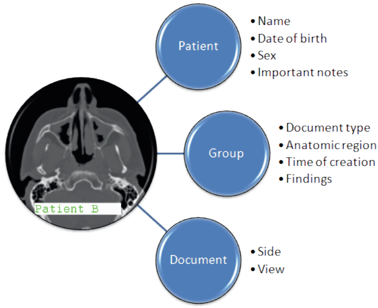
Partners
Numerous companies, clinicians and other stakeholders from medical device industry

Impact of Medical Standards on the Intra-Operative Access to the Patient Record by the Surgeon





Left: Screenshot of the developed software, which displays documents by priority. Right: Metadata assigned to a document of the EPR

If a surgeon is interested in patient data during surgery, he normally has two options: reading and touching the patient record, thus getting unsterile, or instructing the OR personnel to present the desired information. Both variants are tedious and interrupt the surgeon's workflow. It is difficult for a surgeon to memorize any detail of a patient record pre-operatively. With the usage of appropriate systems, Electronic Patient Records (EPR) may be displayed within the OR on a large screen. It is assumed, that an easy access to the EPR will improve the quality of therapy. Additional information is required describing the content of the document. This may be for example information about the time of creation, content of document, or side of the patient. A system has been developed, which automatically sorts the documents of the EPR by priority. The documents, which are supposed to be of most interest to the type of surgery, are automatically displayed prominently, those of low priority may only be displayed after multiple steps of interaction. The goal is to completely release the surgeon from interacting with the system. The context-sensitive presentation of documents and the display of additional information requires metadata, which comes with each document. As the documents of an EPR origin from different sources and every clinic is using different software products, standardization is required. A guideline to meet the requirements of EPR systems in the OR is needed to make the manual assignment of metadata obsolete. The guideline should describe how to use DICOM or HL7 and determine mandatory attributes. It could be realized within the emerging IHE domain "Surgery". Thus, this guideline would be another step to the interoperable OR of the future.

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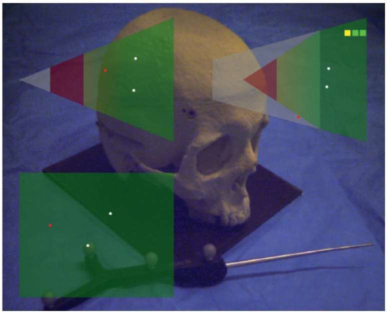
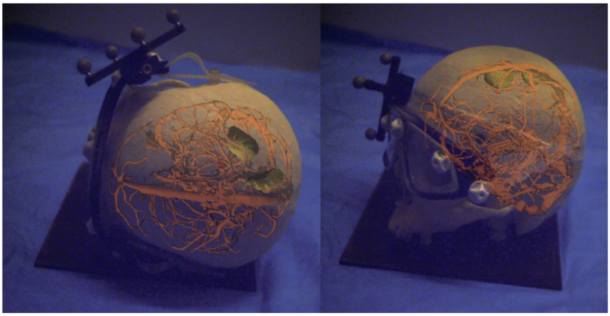
Modular Augmented Reality for the NeuroComrade Project





The tracking range and the position of the tools are visualized, simplifying the orientation of the tracking camera. Colors for the tracking range: gray (no tracking possible), red to yellowish (reduced tracking reliablity), green (highest accuracy for tracking). Right: Test setup with a phantom. The life video stream is augmented with anatomical and functional preoperative planning data.

Surgical interventions of the head rely on careful planning, due to the complex anatomy and the close proximity of risk structures, such as blood vessels, functional areas like motor or speech areas, or nerve fibers. This issue is aggravated in minimally-invasive surgery, since the field of view is further limited.

One approach to address this situation is augmented reality (AR), where a visual representation of the anatomical structures or functional areas is extracted from tomographic image data (virtuality) and augmented in an intraoperative scenario (reality).

We developed a modular AR system for neurosurgery, which is designed for use with different hardware components. The system is video-based and can acquire images with high definition or standard resolution video cameras. We therefore can optionally provide high quality images or use standard imaging devices.

Since the correct overlay (registration) of a real and virtual scene is very important for medical AR applications, we also investigated accuracy issues of the system as a whole and identify error sources in the respective modules. The correct depth perception in the augmented scene is provided through perception corrected visualization techniques, such as transparent overlays.

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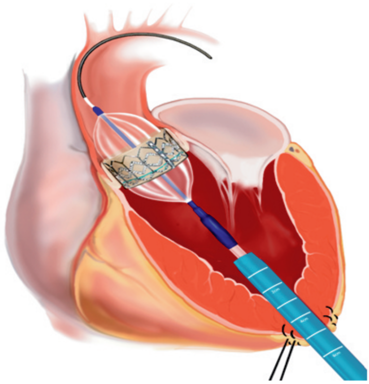
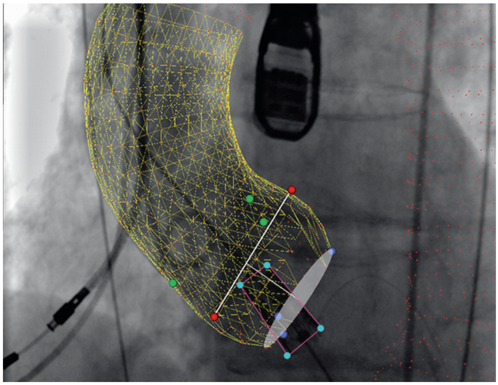
Fluoroscopic Assistance System for Transapical Aortic Valve Implantation





Left: Schematic view of transapical surgical technique for stenotic aortic valve replacement. Right: Results of the developed assistance system for the transapical aortic valve implantation

Transapical Aortic Valve Implantation (TAVI) is a new surgical technique to treat severe aortic valve stenosis for high-risk patients. The correct placement of stented aortic valve prosthesis is crucial, it is currently performed under fluoroscopic X-ray imaging guidance with a C-arm system. For assisting the TAVI intra-operatively, a new assistance system is being developed to support the physician in finding the exact positioning of prosthesis under live 2D fluoroscopy guidance.

The fluoroscopic assistance system is connected with an interventional C-arm to import a 3D model of aorta with anatomical valve landmarks and live 2D fluoroscopic images. Based on image analysis and visualization techniques, the developed system defines automatically the exact placement of aortic valve prosthesis by tracking the prosthesis and calculating the target area of implantation such that the prosthesis is placed one-third to one-half above the mid-level of the valve annulus as shown in the right figure above.

The developed assistance system has been tested on different 3D aorta models and fluoroscopic image sequences from the clinical routine of the TAVI. The results demonstrated the feasibility of the developed system for assisting the TAVI. We are now preparing the fluoroscopic assistance system for clinical evaluation during the intervention.

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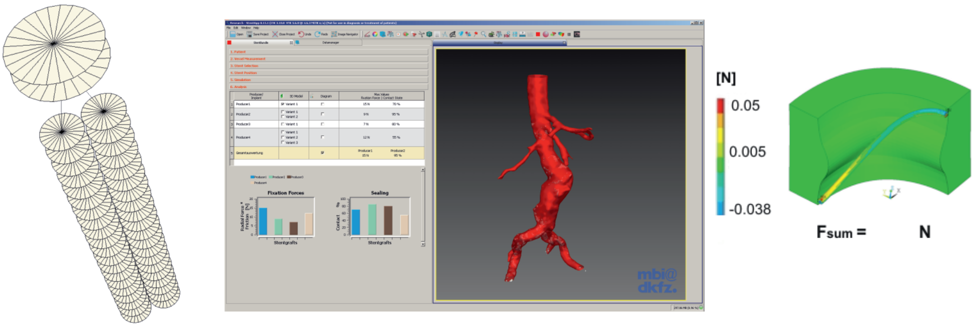
Sim4Stent – A Planning Software for Stent Implantation



Left: Functional stent model representing flexibility properties. Middle: Planning software with simulation results and segmented vessel. Right: Radial forces of a nitinol-stentring considering vessel properties (quarter model)

The vascular surgeons' software for planning a stent graft implantation is presently limited to simple measurement methods. A planning software, that firstly assists the vascular surgeon during the planning process by selecting and positioning a digital stent graft model in a reconstructed model of a vessel, and secondly simulates the vessel-stent graft interaction using Finite Element Method (FEM) simulation, is believed to improve the outcome of a stent implantation. Simulation-sensitive parameters for stent graft vessel interaction and material attributes were specified. A data format for digital stents, which meets the "Digital Imaging and Communications in Medicine" (DICOM) standard and its "Implant Template IOD", is used, thereby ensuring the compatibility to a clinics "Picture Archiving and Communication System" (PACS). The stent´s flexible attributes are represented by parametric models that can be stored inside an "Implant Template IOD" along with the digital geometric model of the stent graft. The DICOM "Implantation Plan SR Document" IOD was examined for the capability of storing the planning result and the integration into the planning software commenced. The MITK framework, developed by the DKFZ Heidelberg, was used for the second prototype of the system and previously existing components were integrated. In order to provide a certain level of guidance throughout the planning process, the internal structure was designed to favor the introduction of a state machine into the application. The human-machine-interface also shares this design and was optimized following DIN (German Institute for Standardization) guidelines for user interfaces. This improved user interface was integrated in the MITK prototype.

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Automated Soft Tissue Manipulation with Mechatronic Assistance Using Endoscopic Doppler Guidance (ASTMA)

A surgeon working with the ASTMA system during the clincal evaluation phase in the UniversitätsSpital Zürich, August 2010. 1) Human Machine Interface 2) Modal Keyboard 3) MiroSurge Robot 4) Actuator with Ultra sound probe and electrocauter attached to it 5) Anterior-wall chest phantom

The ASTMA project was established to demonstrate applicability of semi-automatic control of surgical instruments in cardiovascular surgery. For this purpose, a system consisting of a new universal robot (MiroSurg) with a monopolar blade electrode, an ultrasound probe attached as actuators, and a novel HMI, was designed, constructed and evaluated. The evaluation phase of the project was conducted along the year 2010. For this porpuse two keyboard interfaces were designed and built, each one following different usability criteria. During the ASTMA-project, the following project phases were successfully completed:

a) Design and construction of a novell anterior-wall chest phantom using 3D rapid prototyping tecnology. b) Design and construction of two keyboard interfaces: modal and non-modal. c) Design and implementation of a simulator of the ASTMA system. d) New DICOM-based streaming architecture for video and control stream. e) Usability study carried out with 20 participants using the simulator in Heartcenter Leipzig. This study provided qualitative and quantitative information to determine the effectiveness of using each keyboard-based interface together with the ASTMA HMI. f) Integration of the ASTMA HMI with the MiroSurg robot in the laboratories of the German Aerospace Center (DLR). g) Clinical study conducted in the UniversitätsSpital Zürich using the integrated system ASTMA HMI – MiroSurg.

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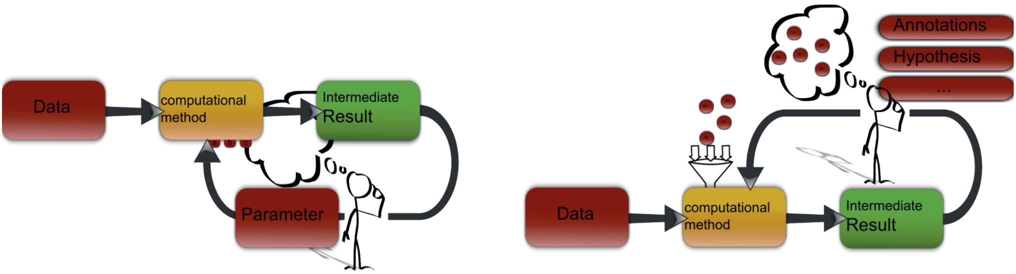
Digital Patient Models and Visualization

Visual Analytics for Large and Heterogeneous Life Science Data with Emphasis on Expression Data (VAExpress)



User control beyond parameter selection. Visual steering (right) allows for integration of additional data, such as annotations to influence the underlying algorithm

Visual analytics envisions a seamless integration of computational data analysis and human interaction based on visual interfaces. In the context of large high-throughput expression experiments, microarrays were the dominating platform of the last decade for assessing the transcriptome of an organism. The introduction of high-throughput next-generation DNA sequencing technologies has now begun to change this field substantially, and it is envisioned that these will become the dominating technologies. These technologies generate vast amounts of complex data, that need additional computational and visual methods. We address the new challenges that are posed by these new technologies by integration of expert human judgment of this complex data.

Regardless of the underlying technology, our main focus remains on the original question how to generate biologically meaningful visual interpretations of complex biological datasets. Completely automatic data transformation can not be at the heart of this analytic discourse since humans want to influence the computation. With semi-supervised methods being used as data transformations, there is a whole new dimension to take advantage of interactive visualization. Within the context of our visualizations, we use interactive techniques such as selection and filtering not only downstream of the visualization pipeline for isolation of data, but also for encoding domain-specific knowledge as input to computational data transformations. In particular, we advocate the interactive visual steering of computational methods beyond parameter selection.

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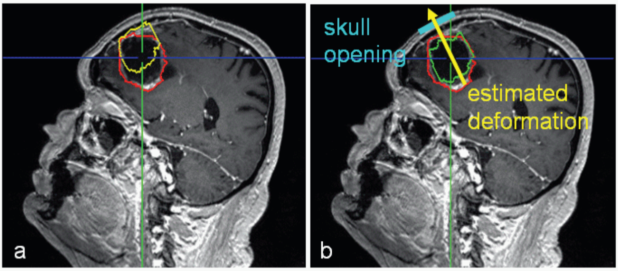
Intraoperative Enhanced 3D Ultrasound Imaging for Brain Tumor Resection



Tumor contours segmented in the preoperative MR data (red contour in a an b) and in the intraoperative enhanced 3D ultrasound data before (yellow contour in a) and after (green contour in b) estimating and correcting the deformation. Figure b shows that the green contour matches better the red contour and that the estimated deformation is mainly represented by a translation vector pointed towards the skull opening

Intra-operative ultrasound (US) is a well established imaging modality in neurosurgery. It provides to the surgeon real time information about the brain which deforms during the surgery. For brain tumor resection in particular, the visualization of intraoperative US data enables supervising the operation. The main objective of this study is the evaluation of intra-operative 3D US imaging using a contrast agent for brain tumor resection. If the tumor is well vascularized, the tumor appears in high intensity in the US data, which facilitates its treatment. The evaluation method consists in comparing the 3D US data with a gold standard, the MR data, which requires image processing techniques. The developed pipeline includes three steps. First, the tumors are extracted from the volumes using semi-automatic segmentation methods. Second, since the volume data are represented in their own coordinate system, the segmented tumors have to be aligned to be compared. The transformation includes two terms: transform T_{world} into the world coordinate system and transform $T_{deformation}$ correcting the remaining deformation. The deformation is estimated in automatically registering corresponding anatomical structures in the MR and US data. Third, the segmented tumors are compared by calculating quantitative values, such as overlap indices and distances between tumor surfaces. The pipeline was tested on different patient data sets including pre-operative T1 MR data and 3D intraoperative US data. Acquisition of the US data was performed transdural and before resection with a conventional US device (aplioXG, Toshiba) and a navigation system (SonoNavigator, Localite) with injection of a contrast agent (SonoVue, Bracco). Tumors were segmented with the software ITK-SNAP. Transform T_{world} was provided by the navigation system while $T_{deformation}$ was estimated and corrected based on the ventricles. The comparison values have been computed using the software Valmet.

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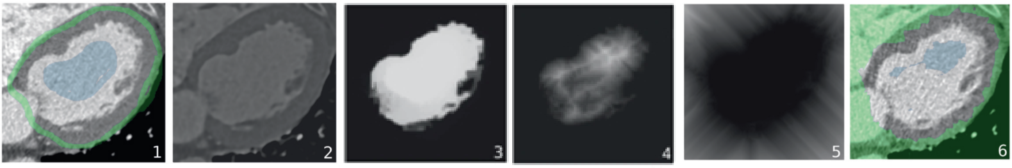
Segmentation of the Left Cardiac Ventricle in Time-Varying CT Data



The image processing pipeline and its intermediate results in the axial viewing plane

The segmentation of the left cardiac ventricle in time-varying CT datasets is the basis for functional analyses and virtual pre-operative intervention planning. The volumetric extraction along with the calculation of clinical relevant parameters such as ejection fraction and volume over time allow an accurate diagnostic and therapy planning.

In this work, a pipeline concept aside approaches incorporating annotated databases, statistical shape modeling or atlas-based segmentation was realized. As main approach within the segmentation step, the random walker algorithm proposed by Grady has been implemented. In combination with an appropriate pre- and post-processing, the segmentation pipeline works successfully through CT datasets including pathologies. Problematic structures, such as the cardiac valves, the papillary muscle and the apex of the heart, are correctly detected. This work has also investigated in three different thresholding routines to finally binarize the computed data: a manual selection of a threshold, fixing the threshold to a predefined intensity, and computing the minimum in a histogram. The figure shows the pipeline and its intermediate results in the axial viewing plane. 1) Original data overlayed with the manually selected seed points (blue: foreground, green: background). 2) Image after pre-processing: the ventricular structure is smoothed, the object boundaries are enhanced. 3) The calculated probabilities of the random walker with high probabilities equal to high intensities. 4) The distance transform for the foreground voxels. 5) The distance transform for the background voxels. 6) Original data of a consecutive time step overlayed with the final combined set of seed points as new input for the segmentation pipeline.

Within the validation, sensitivity scores > 86 % and specificity scores > 96 % have been achieved. The fixed intensity threshold method has presented the best results, especially when dealing with pathologies. In addition, the ejection fraction has been calculated with a mean error of 2,2 % in the manual and fixed threshold approach, which is comparable to results presented in literature.

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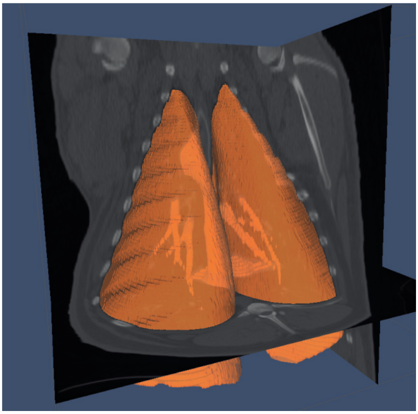
LungWizard – User-Guided Lung Segmentation



Segmentation result of the LungWizard. The red border (left) can be adjusted manually by the user. The segmented lung tissue can also be viewed as 3D model (right)

Polytrauma patients have a very high risk of dying from acute lung failure. Being able to predict this risk for a specific patient, helps the doctors deciding for the most appropriate treatment and by that save many lives. However, it is not yet clear which lung parameters are adequate for this stratification / risk assessment, which makes this research topic the central question of many clinical and animal studies.

In the course of these studies, a large number of CT datasets need to be evaluated. For that, the segmentation of the lung tissue in these data is an important preprocessing step. Completing this segmentation task manually, however, is tedious, time-consuming, and makes the handling of the large amount of datasets oftentimes the real challenge.

We support the researchers with a tool (LungWizard) that allows a semiautomatic and fast lung segmentation. There is no software training or prior image processing knowledge necessary, since the user is guided through the required processing steps one after another and receives instructions when necessary. The segmentation is reproducible, which minimizes the inter-user variance of the results. The user interaction is usually limited to seed point selection and loading and saving the data. Still, if the lung shows pathologies, which cannot be handled by the algorithms yet, the user also has the possibility to adjust the result. Up to now, the LungWizard was used in one study and saved the researchers very much time. For healthy lungs the segmentation time was reduced from 4 h to 30 min. The segmentation of pathological lung tissue still requires more effort, but can now be done in 4 h instead of 8 h with the manual segmentation.

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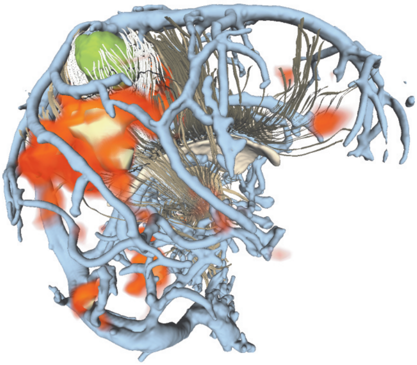
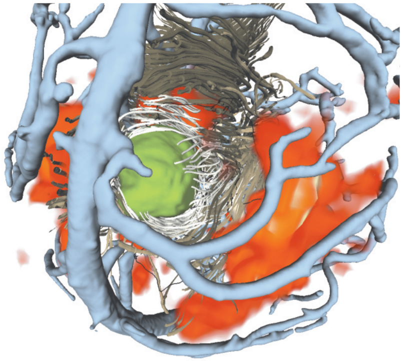
Pathological Effects of Cerebral Edema on Brain Connectivity and Function





A lateral view of combined MRI data acquired from a tumor patient. Visible is the tumor (green), fMRI (red / orange), vessels (blue), and fiber tracts (brown / white). Right: A view along a possible surgical access path, displaying the same modalities as in the figure on the left

The effects of a peritumoral edema on brain connectivity and function are being examined with both Diffusion Tensor Imaging (DTI) and fMRI studies conducted on brain tumor patients.

Of special interest is the comparative analysis of data acquired both before and after a neurosurgical intervention, with special attention directed toward the quantification of post-operative brain function improvement.

The studies are attempting to answer the following key questions: Is it possible to identify functional white matter tracts despite impairment of both measurability and function by an edema? Which fiber tracking algorithm is best to answer this question? Can intrinsic tumors (e.g.

astrocytomas) and extrinsic tumors (e.g. meningeomas) be reliably differentiated by their respective effects on brain matter as determined by the DTI / fMRI studies?

To effectively answer these questions, ICCAS has developed software which can determine the degree of functional impairment of the fiber tracts and display the results graphically in 3D in an intuitive way for experts in the field. Additionally, the software may be used to conduct statistical analyses on the data, such as comparing an impaired region with its contralateral correlate. The software development and a clinical study is currently being carried out as part of a medical doctoral thesis.

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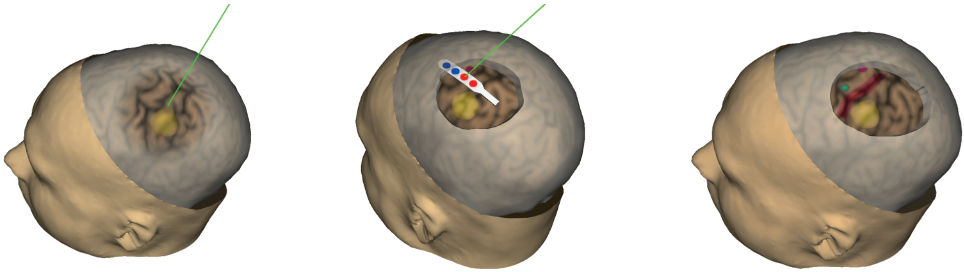
A Multimodal Patient Model for Computer Assisted Brain Tumour Surgeries



Intra-operative screenshots of the 3D visualisation of a patient-specific model within the neurosurgical navigation

In neurosurgery, the safe resection of tumour tissue in the central region of the brain requires an accurate intra-operative localization of eloquent areas. The aim is to perform incisions and tissue resection as minimally invasive as possible to preserve brain functionality to the largest possible extend. Due to brain tissue deformations caused by the tumour, brain shift effects and the resection, it is necessary to determine landmarks like the central sulcus intra-operatively since they provide orientation information. Intra-operative measurement of evoked potentials is a common technique to reliably localise these areas on the cortical surface using a strip electrode. A multimodal patient model was developed at ICCAS to integrate the information gathered by evoked potential measurements into neurosurgical navigation. The patient model combines pre-operative MRI, polygonal segmentations and neurophysiological information by spatial relation. Based upon the model, pre- and intra-operative software components were developed to build and utilize patient-specific models for corresponding surgical tumour treatments. The software components provide semi-automatic data pre-processing, intra-operative integration of neurophysiological measurements and a comprehensive visualisation within the neurosurgical navigation. The system was technically evaluated and already used in chosen clinical cases that showed reasonable additional effort, promising accurate results and usefulness. Screenshots of the intra-operative visualisation are presented in the figure above. The intraoperative system, called NeuroMapper, supports the surgeon in planning of the trepanation, localization of eloquent areas and orientation within the situs. Futhermore the software allows an objective documentation by integrating the relevant information into the clinical database via DICOM. The overall modular system architecture enables the NeuroMapper to be totally based on information sources and devices commonly used and to preserve the established clinical workflow. The NeuroMapper is fully embedded in an open communication framework based on TiCoLi, a communication library developed at ICCAS. Hence the project links multimodal patient models and service-oriented architectures and shows the feasibility of those concepts for modern surgical assistance systems.

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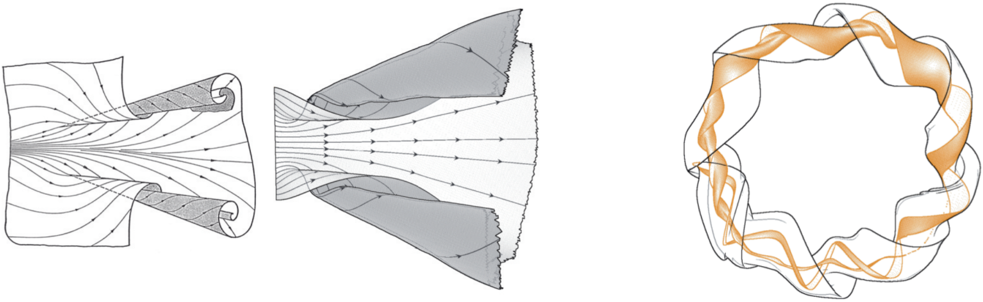
Illustrative Flow Visualization



We enhance stream surface visualizations by mimicking text book illlustrations. On the left, a comparison of a hand-drawn illustration and visualization (middle) is shown

Visualizing blood flow adequately can be of great help during diagnosis and treatment of vascular diseases, such as aneurysms or cardiomyopathies. The advancements in medical imaging make this possible. Instead of costly CFD simulations, the patient-specific blood flow can now be measured with an MRI scanner (4D phase-contrast MRI). However, it is still an issue of ongoing research to present this data to doctors in way, that they can draw conclusions.

Our goal is to use modern flow visualization methods to turn these complex data into clear depictions of blood flow.

This would for example allow the doctors to assessing the risk of rupture for a specific aneurysm and giving decision support if a surgery is indicated. Another example is the left ventricular reconstruction, which is a successful way of alleviating the symptoms of cardiomyopathy. However, it is not yet known in advance, how the intervention affects the functionality of the heart precisely. Being able to systematically compare pre-operative and post-operative flow structures in the heart would allow to make studies what operation techniques are the most successful.

A first step towards this goal was to improve the way stream surfaces are visualized. Stream surfaces are a very common and intuitive flow visualization technique. Their drawback, however, is that they become rather confusing with increasing complexity of the flow. We applied illustrative visualization methods mimicking the illustration techniques used, e.g. in traditional flow text books or anatomical atlases. With this and additional interaction possiblities the display of stream surfaces became clearer and more intuitive.

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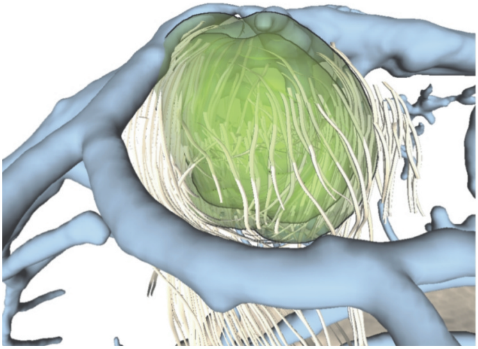
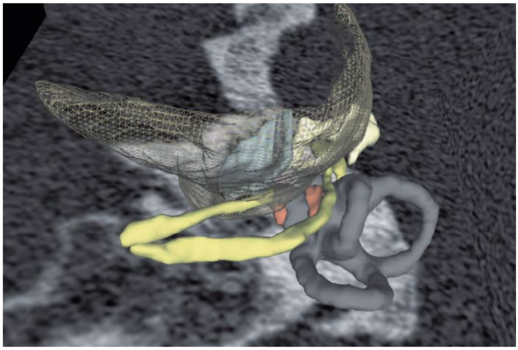
Visualization for the Surgical Planning Unit





Left: 3D visualizaton of a tumor case displaying the course of nerve fibers in the surroundings of the tumor. Right: 3D visualization for a cochlear implant planning

The development of the Surgical Planning Unit (SPU) as the venue for a more efficient and patient-specific therapy planning procedure is one of the main research interests of ICCAS. The SPU is a room where all necessary information about the patient (digital patient model) are gathered, and provided to the doctors appropriately. In this large amount of information, the medical image data is of special importance. Viewing all these datasets as 2D slices and separated from each other is very inefficient. In this project we produce patient-specific 3D visualizations of these datasets. According to the surgeons' requirements the risk structures as well as the tumor are segmented in the various datasets and integrated into the interactive visualization. This allows a quicker and sometimes more thorough understanding of the patient's anatomy and will support the surgeons during intervention planning.

Apart from tumor cases, this approach is also useful for other interventions, such as the insertion of cochlear implants. The access path to the round window, where the implant is inserted, is complicated and special care has to be taken that, e.g. the facial nerve is not injured. A 3D visualization of the CT dataset allows the surgeon to understand the patient-specific anatomy and determine the trajectory with the least risk of side-effects.

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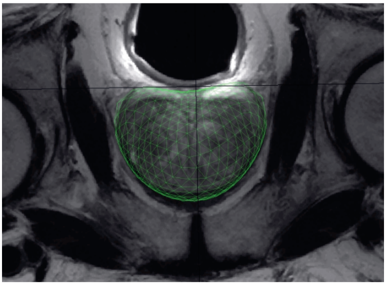
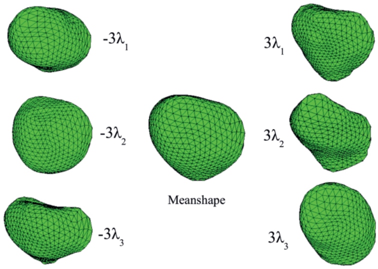
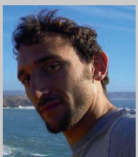
Semi-Automatic Segmentation of Anatomic Structures in 3D Images





Left: Sample segmentation of the prostate boundary. Right: Visualization of the statistical shape model of the prostate (middle: meanshape, left / right: statistical variations)

Visualisation and modelling of anatomical structures has become a viable tool for therapy-planning and computer-assisted surgery. In order to visualize patient specific structures, these have to be segmented in radiological images. However, accurate manual segmentation is a very time consuming task. In this project, a model based segmentation method has been developed to segment anatomical structures with minimal user interaction. The presented method uses a statistical shape model and a local statistical appearance model which are generated from manually segmented training data. On the basis of these models, a robust search algorithm has been implemented to accurately delineate the contour of the structure in a given image. The search algorithm is based on a deformable model which is iteratively deformed by internal and external forces according to the Lagrange equations of motion. Internal forces are based on the concept of tension and rigidity. These forces ensure that the model stays in a geometrically sound state compared to the statistical shape model. External forces pull the contour of the model towards statistically sound locations in the target volume. These forces are calculated using the image information at the location of the model during search and the image information captured in the statistical appearance model. A novelty in this work represents the development of a new cost function based on a Shrinkage Estimator used to calculate the external forces. The proposed method has been validated on MRI images of the prostate. The shape and appearance models were built using 90 T2-weighted MRI images. Experiments on ten MRI datasets show that the contour of the prostate can be found within a mean surface deviation of 1,7 to 2,2 mm, which is a superior result compared to the methods found in the literature.



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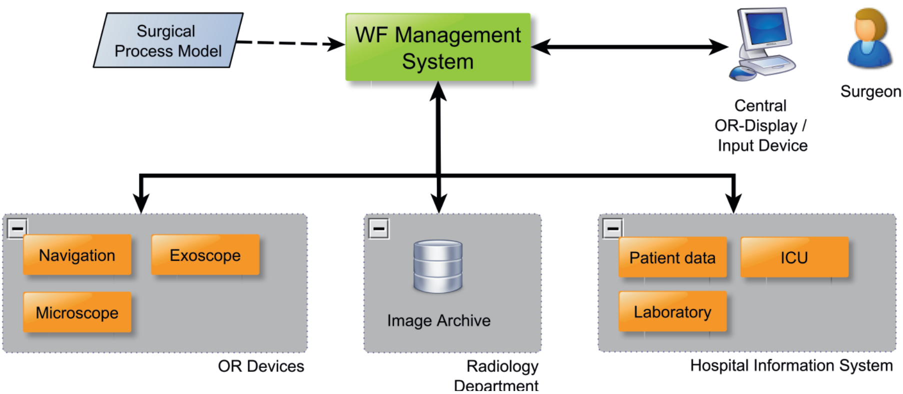
Surgical Workflows

Surgical Workflow Management Systems



Workflow Management System (WFMS) as a central, context sensitive knowledge distribution unit

In modern operating rooms, especially during complex surgery, a variety of technical devices are involved. These devices support the surgeons in their work so that many tasks either are reduced in complexity, or the result can be significantly improved. All these assistance systems are stand–alone systems, created to fulfill their task at a particular time. Due to a lack of common interfaces, an interaction between these devices is limited. A central workflow control holding global knowledge about the surgical intervention to preconfigure devices or to integrated data is not available in the modern OR.

This workflow management system is the basis for context aware actions in the OR. Focus of the project is the development of a surgical workflow management system (S-WFMS). The S-WFMS gets the global knowledge about the surgical procedure from a process description called workflow schema. A workflow schema describes the process in a model language which is processable by the WFMS. It is generated from a generalized surgical process model (gSPM). Due to the fact of the high variability of surgical interventions, the gSPM is a statically averaged model based on many patient individual process observations (iSPM).

The S-WFMS can assist the surgeon by gathering the necessary information for the current process step and present this information on a central screen in the OR. It can also pre-configure devices or can be used as a decision support system for the surgeon.

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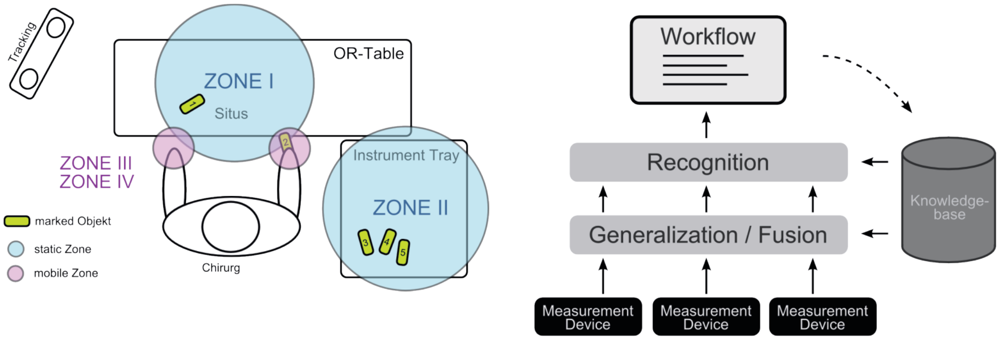
Data Acquisition Strategies for Surgical Workflows



Left: Example of zones and marked objects in the OR. Right: Information flow in the prototype system

After using human observers to capture surgical actions, the next logical step is an automatic or semiautomatic acquisition of workflow data in the operating room. The approach of ICCAS is to track presence and absence of all used objects and to combine this information with other techniques like gesture recognition. The observed Objects are equipped with wireless sensors so that they can be recognized in predefined zones. This localization data can be used to reduce significantly the solution space of possible actions in the phases of the intervention. Sensor-Fusion techniques enhance the performance and robustness of the recognition process by taking advantage of hardware capabilities and information abstraction. The prototype System was optimized for use of sensor fusion strategies and evaluated in this context. The goal is to successive reduce human interaction in the workflow acquisition process. It was shown that the current system is able to assume specific tasks of human observers and to fulfill them. The system is based on a stack of abstraction layers that filters, combines and generalizes the outcome of the involved measurement devices. By using universally valid ids it is possible to compare and optimize workflows. For that reason a knowledgebase holds all information about instruments as well as intervention types, their workflows, phases and actions. The intelligent combination of this information and the smart use of hardware leads to a detailed image of the surgical process in the OR. The next steps of this project are to identify and evaluate additional measurement systems for the use as components of the recognition process and to find methods to enhance robustness and adaptability of the system.

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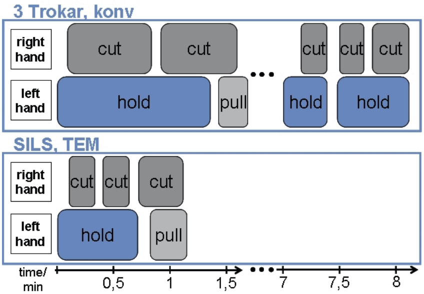
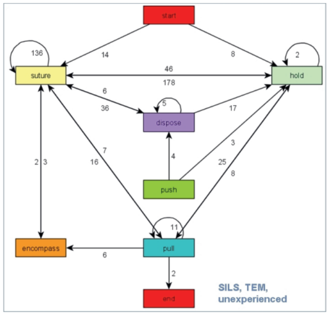
An Experimental Setup to Evaluate Laparoscopic Instruments by Analyzing Surgical Process Models





Surgical Process Model (SPM) record, visualized in a semiformal way; the task "cutting off" by an experienced proband. Right: Generalized SPM after superimposing all SPMs of a setup. Identification of the mean process; here for the task "anastomosis"

The objective of this study series is the investigation of the impact of new surgical instruments on the surgical process. In the presented study, we evaluate which access setup is most fit to guarantee a high quality of results concerning minimally invasive laparoscopic pediatric surgery. Today, a new access technique, the Single Incision Laparoscopic Surgery (SILS) is used, which is still less invasive than the conventional 3-Trokar access to the situs. Furthermore, we analyze which instrument design in connection with which access technique is more sensible. To analyze this kind of surgical intervention, we have devised three different tasks that were derived from standard intervention procedures, these included cutting off, suturing, and anastomosis. These tasks were performed by two populations (experienced vs. inexperienced), who had to perform each of these tasks five times in a mockup scenario using a silicone phantom while their physiological parameters were measured. Also, a questionnaire, the NASA task load index, had to be filled in by the subjects to be able to assess their stress load. In addition, the quality of the tasks' results was reviewed. To analyze a complex process, such as a surgical intervention, it is sensible to split it up into single activities. A surgical process model (SPM), recorded with the help of the Surgical Workflow Editor and trained observers, represents this process in a formal or semiformal way including single, temporally extended process steps (activities). These SPMs allow for a multitude of possible analyzing scopes especially with respect to the complex or variable environment of the OR. Not only is it possible to analyze intervention courses with the presented method, but also to evaluate different instruments.

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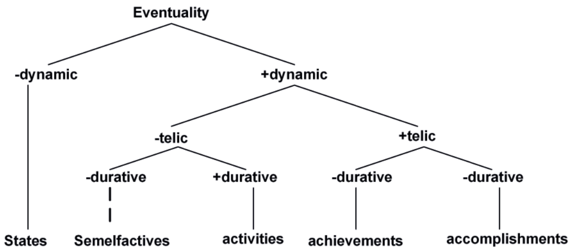
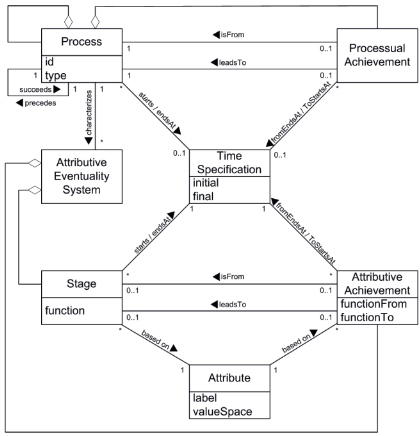
Surgical Ontologies





Left: Classification of Eventualities in Linguistics. Right: Generic XML-model to represent surgical processes

The precise and formal specification of surgical interventions is a necessary requirement for many applications in surgery, including teaching and learning, quality assessment and evaluation, and computer-assisted surgery. Currently, surgical processes are modeled by following various approaches. This diversity lacks a commonly agreed-upon conceptual foundation and thus impedes the comparability, the interoperability, and the uniform interpretation of process data. The objective of the project is to provide a beneficial base for scientific models, and a shared and coherent conceptual and formal mathematical basis. Such a uniform foundation simplifies the acquisition and exchange of data, the transition and interpretation of study results, and the transfer and adaptation of methods and tools. The project proposes a generic, formal framework for specifying surgical processes, which is presented together with its design methodology. The methodology follows a four-level translational approach and comprises an ontological foundation for the formal level that orients itself by linguistic theories. Inspired by the linguistic theories, a unifying framework for modeling surgical processes that is ontologically founded and formally and mathematically precise is developed. The expressive power and the unifying capacity of the presented framework are demonstrated by applying it to four contemporary approaches for surgical processes modeling by using the common underlying formalization. The results of the project allow for capturing knowledge of the surgical intervention formally. Natural language terms are consistently translated into an implementation level to support research fields where users express their expert knowledge about processes in natural language, but, in contrast to this, statistical analysis or data mining needs to be performed based on mathematically formalized data sets. The availability of such a translational approach is a valuable extension for research regarding the operating room of the future.

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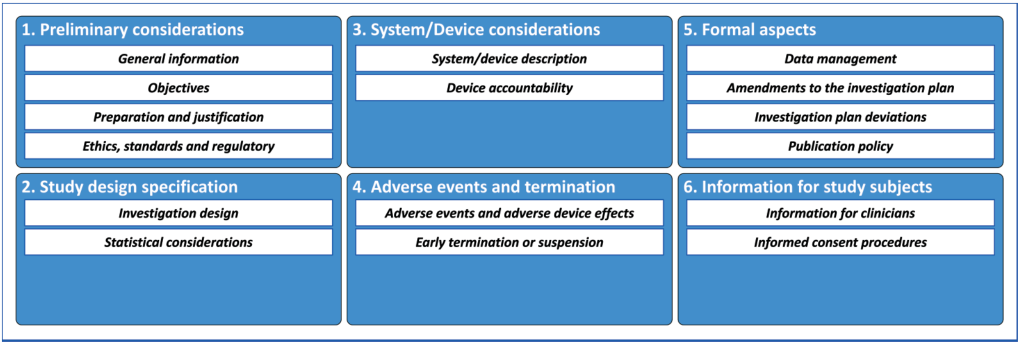
Assessment Concepts for the Man-Machine-Interaction in Surgery



Global overview of the developed model for study planning and execution

Automation in surgery creates risks in the Man-Machine-Interaction (MMI). The central objective of the project is the development of assessment concepts for MMI in surgery. These concepts are supposed to facilitate the study planning and execution by using systematic assessment approaches and evidence based decision guidance. The focus concentrates on the investigation of the effects of automation. The concepts shall comprise several human performance consequences, arranged in different modular templates. The proposed assessment concepts are based on the ISO 14155 standard for clinical investigation of medical devices for human subjects. The extracted contents were modified to comply with the MMI investigation requirements. Further, relevant concepts were integrated. An interdisciplinary expert team was involved to consider the different areas of expertise: medicine and surgery, informatics and computer assisted surgery, psychology and human factors, statistics and biometrics, industry and medical devices.

An initial model for investigation of the MMI in surgery was created. It is subdivided in modules representing the several aspects of study planning and implementation methodology. To meet the requirements of the MMI assessment in surgery different aspects were integrated. E.g. study subjects are clinicians (surgeons etc.) instead of patients. Furthermore the trade-off between clinical realism and effective control to the parameters was integrated. In the next step the model will be formalized to specify the relationships and rules within. Thus several templates could be generated concerning different study requirements.

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Activities in Teaching

ICCAS actively participates in the education of students at the Faculty of Medicine and the Department of Computer Science of the Universität Leipzig. At the Faculty of Medicine, ICCAS manages the elective subject "Computer Assisted Surgery" and offers a comprehensive course on this topic to fifth year medical students. Lectures offer an interdisciplinary view on computer assisted surgery from the clinical perspective of various surgical departments, as well as engineering aspects to introduce future surgeons to the technical boundary conditions.

Additionally, within the Master's on "Medical Computer Science", a number of lectures and seminars in the field of computer assisted surgery are also offered to computer science students at the University of Leipzig.

ICCAS offers numerous opportunities to students to get acquainted with the highly innovative research topic computer assisted surgery, including project theses, as well as medical doctor's theses and research internships. The following lectures are offered regularly at the Universität Leipzig:

Medicine

Computerassistierte Chirurgie

Master in Computer Science

Chirurgische Navigation, Mechatronik und Robotik

Medizinische Planungs- und Simulationssysteme

Praktikum Computer-assistierte Chirurgie

Seminar Informatik in der Chirurgie

Bachelor in Computer Science

Grundlagen der medizinischen Informatik (in cooperation with others)

Organization

ICCAS Board

Prof.
Jürgen Meixensberger

Prof. Andreas Dietz

Prof. Gero Strauß

Prof.
Friedrich W. Mohr

Prof. Heinz U. Lemke

Advisory Board

Prof. Bernhard Preim (Department of Simulation and Graphics, Otto-von-Guericke-Universität Magdeburg)

Prof. Volkmar Falk (Division of Cardiac and Vascular Surgery, University Hospital Zürich)

Dr. Klaus Irion (Karl Storz GmbH & Co. KG, Research and Technology)

Prof. Tim C. Lueth (Institute of Micro Technology and Medical Device Technology, TU München)

Prof. Georg Nollert (Siemens AG Healthcare Sector)

Dr.-Ing. Gerd Uhlmann, Ministerialrat i. R. (formerly affiliated to the Saxon Ministry of Science and the Fine Arts)

Prof. Charl P. Botha (Computer Graphics, TU Delft and Division of Image Processing, Leiden University Medical Centre)

ICCAS Staff

Athner, Katrin
Bohn, Stefan
Born, Silvia
Burgert, Oliver
Chalopin, Claire
Dänzer, Stefan
Dressler, Christian
Evfimevskiy, Leonid
Franke, Stefan
Karar, Mohamed
Liebmann, Philipp
Machno, Andrej
Meißner, Christian
Neumuth, Dayana
Neumuth, Thomas
Pritzkau, Albert
Ritter, Nils
Vazquez, Adrian
Weiße, Karin
Wellein, Daniela

Assistants

The student and research assistants listed below have been with ICCAS in 2010. Their program of study is shown in brackets.

Allenstein, Francie (Medicine)
Amann, Dorothee (Medicine)
Appelt, Nadine (Economics)
Arnold, Ulrike (Psychology)
Baalcke, Jean (Medicine)
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Clauß, Martin (Computer science)
Dinse, Juliane (Computer science)
Eisenhut, Christian (Electrical engineering)
Eißner, Martin (Physics)
El Khaoua, Inka (Psychology)
Elzner, Caroline (Statistics)
Ewald, Ricardo (Computer science)
Felke, Stephan (Computer science)
Fischer, Sven (Computer science)
Franke, Stefan (Computer science)
Fricke, Christopher (Medicine)
Friedrich, Jan (Computer science)
Genauck, Enrico (Computer science)
Georgi, Jan (Economics)
Godau, Claudia (Psychology)
Götze, Doreen (Computer science)
Handwerk, Jochen (Product design)
Haupt, Peter (Electrical engineering)
Heinisch, Katharina (Mathematics)
Hofmann, Susanne (Psychology)
Kielhorn, Anne (Medicine)
Kongtso, Patrick (Computer science)
Kurth, Tony (Physics)
Ledig, Robin (Computer science)
Leßnau, Michael (Computer science)
Lindenberg, Ren (Chemistry)
Lubrich, Anke (Psychology)
Machno, Andrej (Computer science)
Maschke, Christina (Design)
Meier, Jens (Computer science)
Meißner, Christian (Electrical engineering)
Müller, Maik (Computer science)
Neumann, Juliane (Computer science)
Neupert, Stephan (Medicine)
Nußbaum, Enrico (Electrical engineering)
Patschureck, Christiana (Medicine)
Priemer, Daniela (Medicine)
Reichmann, Christian (Computer science)
Rhone, Peter (Medicine)
Rockstroh, Max (Computer science)
Schmidt, Claudia (Sociology)
Schneider, Stefan (Electrical engineering)
Schönwald, Liane (Psychology)
Scholl, Christoph (Medicine)
Schumann, Sandra (Physics, economics)
Skibba, Gero (Computer science)
Sommer, Christin (Pharmaceutics)
Tahar, Kais (Computer science)
Thiem, Stefan (Electrical engineering)
Thiele, Michael (Computer science)
Vazquez, Adrian (Computer science)
Voitel, Lars (Computer science)
Vorungati, Arun (Electrical engineering)
Wilhelm, Christian (Computer science)

Miscellaneous

Public Outreach

Besides the scientific work, ICCAS gives the public an understanding of the field of Computer Assisted Surgery by appearing in TV documentations or organizing hands-on demos at research events.

March 2010

Buchmesse-Akadamie

April 2010

Girls' Day

September 2010

Lange Nacht der Wissenschaften

Movies from ICCAS for the innovation atlas of the BMBF

Interested audience listening to an ICCAS researcher at the Girls' Day

Scientific Events

17.02.2010

Grand opening of the Surgical Planning Unit (SPU) with attendence of representatives of the Saxon Ministry of Science and the Fine Arts

21.04.2010

Inauguration of the Cochlear Implant Center (CIZL)

23.06.2010

Tutorial "Surgical Workflow" at CARS, Geneva, Switzerland
Thomas Neumuth, PhD, Univ. of Leipzig
Xavier Morandi, MD, PhD, Univ. of Rennes, France

26.06.2010

Tutorial on Surgical DICOM, IHE and interoperability at CARS, Geneva Switzerland
Oliver Burgert, PhD, Innovation Center Computer Assisted Surgery (ICCAS), Leipzig
Michael Gessat, ETH Zurich, Switzerland

01 - 02.07.2010

Second **Eurographics Workshop on Visual Computing** for Biology and Medicine (VCBM held in Leipzig)

20 - 24.09.2010

Workshop on Systems and Architectures for Computer Assisted Interventions (MICCAI 2010, China National Convention Center, Beijing, China)
Organisation:
Oliver Burgert, Stefan Bohn (ICCAS)
Andinet Enquobahrie, Kitware, Inc., USA
Kiyo Chinzei, National Institute of Advanced Industrial Science and Technology (AIST), Japan
Rajesh Kumar, Center for Computer-Integrated Surgical Systems and Technology (CISST ERC), Johns Hopkins University, USA
Peter Kazanzides Center for Computer-Integrated Surgical Systems and Technology (CISST ERC), Johns Hopkins University, USA

19.11.2010

Workshop Surgical Workflow, CURAC Jahrestagung, Düsseldorf, Germany
Dr. Thomas Neumuth, Universität Leipzig, ICCAS
Dr.-Ing. Stefanie Speidel, Karlsruhe Institute for Technology, Institute for Anthropomatic

06.12.2010

Status seminar and meeting of advisory board

Opening of the SPU. From left to right: Prof. Strauß (ICCAS-Board), Prof. von Schorlemer, Minister of State for Science and the Fine Arts and Prof. Meixensberger (Iccas-Board)

Invited Lectures

CARS, Geneve:
"CAS in Neurosurgery: what we really need"
Prof. Meixensberger

Congreso Internacional de Ciencia y Tecnologia de Medicina Virtual y Cirugia Robotica Chiapas, Tuxtla Gutierrez, Mexico:
"Modular surgical assist Systems"
Dr. Burgert

EURO PCR, Paris:
"Catheter-based mitral treatment: fantasy or near reality? A surgeons point of view"
Prof. Mohr

IHE Nederland Jaarcongres, Bussum, Niederlande.
"IHE for Surgery"
Dr. Burgert

Invitation of the Federal Ministry of the Interior, Berlin, Germany. Contribution to the workshop:
"Redistributive modes and commericialization activities of the research environment in Eastern Germany / Future conference on technology transfer in Eastern Germany" (Transferorientierung und Kommerzialisierungsaktivitäten der ostdeutschen Forschungslandschaft/ Zukunftskonferenz Technologietransfer in Ostdeutschland)
Prof. Meixensberger

Kopenhagen, 40-Year Anniversary Meeting of Danish Thoracic Society:
"The future in cardiac surgery"
Prof. Mohr

Sino European Course, Peking:
"Mitral valve surgery: from sternotomy to video assisted and robotic surgery"
Prof. Mohr

Valves in the Heart of the Big Apple, New York:
"The Howard Gilman Foundation Lecture - Transapical valve replacement/repair"
Prof. Mohr

Honors and Awards

The German Society for Neurosurgery (DGNC) appointed **Prof. Meixensberger** as new president for 2010 to 2012.

The Federal Republic of Germany awarded **Prof. Mohr** the Cross of Merit, 1st Class.

Dr. Oliver Burgert has been voted on the board of the German Society for Computer and Robot Assisted Surgery (CURAC) as treasurer.

Prof. Strauß has been appointed as professor.

Silvia Born, Daniela Wellein, Peter Rhone, Albert Pritzkau, Jan Friedrich recieved "honorable-mention" at IEEE Visualization Contest 2010 (http://viscontest.sdsc.edu/2010/) Salt Lake City, USA.

Silvia Born won poster prize for outstanding research on the field of medical and life science by the committee of the Research Festival Leipzig.

Stefan Bohn got first place at the Science Slam, which was held on the occasion of the 601st Dies Academicus of the Universität Leipzig.

Appendices

List of Publications

Articles

A.K.R. Voruganti, R. Mayoral, A. Vazquez, O. Burgert, A modular video streaming method for surgical assistance in operating room networks, International Journal of Computer Assisted Radiology and Surgery 5 (2010), no. 5, 489-499

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T. Treichel, P. Liebmann, O. Burgert, M. Gessat, Applicability of DICOM structured reporting for the standardized exchange of implantation plans., International Journal of CARS 5 (2010), no. 1, 1-9

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M.E. Karar, D. Merk, C. Chalopin, T. Walther, V. Falk, O. Burgert, Aortic valve prosthesis tracking for transapical aortic valve implantation, International Journal of Computer Assisted Radiology and Surgery (2010), accepted for publication

S. Bohn, M. Gessat, A. Voruganti, S. Franke, O. Burgert, An open source framework for systems integration in the operating room, Journal of Minimally Invasive Therapy 19, Supplement 1 (2010)

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D.Wellein, S.Born, M.Pfeifle, F.Duffner, D.Bartz, A Pipeline for Interactive Cortex Segmentation, Computer Science - Research and Development (2010), Vol. 26, no. 1-2, pp. 87-96, DOI: 10.1007/s00450-010-0130-4

S. Born, A. Wiebel, J. Friedrich, G. Scheuermann, D. Bartz, Illustrative Stream Surfaces, IEEE Transactions on Visualization and Computer Graphics 16 (2010), no. 6, 1329 - 1338

R. Grunert, W. Korb, P. Jannin, M. Dengl, H. Möckel, T. Neumuth, Systematic user-based assessment of Navigated Control Spine / Systematische, nutzerzentrierte Evaluation von Navigated Control Spine, Biomed Tech (Berl) 55 (2010), no. 6, 351-359

G. Lohmann, S. Bohn, K. Müller, R. Trampel, R. Turner, Image restoration and spatial resolution in 7 Tesla magnetic resonance imaging, Magnetic Resonance in Medicine 64 (2010), no. 1, 15-22

J. Seeburger, T. Neumuth, T. Noack, S. Leontjev, F.W. Mohr, Transapical beating heart implantation of neochordae - procedural performance of a brand-new technique using surgical work flow analysis, Interactive CardioVascular and Thoracic Surgery 11 (2010), no. 2, 175

Books and contributions to books

O. Burgert, L.A. Kahrs, B. Preim, J. Schipper, CURAC.10 Tagungsband.- 9. Jahrestagung der Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V., 2010.

O. Burgert and T. Neumuth, Analyse und Beschreibung chirurgischer Workflows, Computerassistierte Chirurgie, vol. , Elsevier GmbH, 2010

P. Hastreiter, D. Bartz, B. Preim, Visualisierung, Computer-Assistierte Chirurgie, vol. , Elsevier GmbH, 2010

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W. Korb and P. Jannin, Bewertung der Mensch-Maschine-Interaktion, Computerassistierte Chirurgie.,
vol. , Elsevier GmbH, 2010

Conference proceedings

O. Burgert, Implantatplanung auf Basis von DICOM-SOP-Klassen, Mainz, 2010. DICOM 2010: KIS - RIS - PACS und 12. DICOM Treffen

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C. Dressler, Optical Surface Scan IOD, Mainz, 2010. DICOM 2010: KIS - RIS - PACS und 12. DICOM Treffen

C. Dressler, Lösungen zur sterilen Bedienung von Systemen im Operationssaal durch den Operateur, Embedded Goes Medical 2010, Nürnberg, 2010

C. Dressler, Gründe für die mangelnde Interoperabilität in Operationssälen, Embedded goes medical 2010, Nürnberg, 2010

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S. Born, D. Wellein, S. Bohn, G. Strauß, D. Bartz, 3D Visualization for tumor intervention planning, 9th Leipzig Research Festival for Life Sciences 2010, (J. Thiery, A. Beck-Sickinger, T. Arendt, ed.), vol. 9, 2010

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Medical Imaging and Technology Alliance (MITA) / DICOM
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Funding

ZENTREN FÜR INNOVATIONSKOMPETENZ
UNTERNEHMEN REGION
Die BMBF-Innovationsinitiative Neue Länder

Bundesministerium für Wirtschaft und Technologie

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