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Disclaimer

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To the Reader

Dear Ladies and Gentleman, dear colleagues

The year 2012 was a year of continuation for ICCAS. After the beginning of the second funding period for centers of innovation competence by the German Federal Ministry of Education and Research (BMBF) the institute developed continuously to be a leading site for computer-assisted surgery in Europe.

Our scientific efforts focused on the extension of future-promising research fields such as the development of IT infrastructure for the operating room of the future, the creation and effective use of patient models in surgery, and the standardization efforts of surgical assist systems. These three research directions were represented by our three venture areas Model-based Automation and Integration (MAI), Digital Patient Model (DPM) and Standardization (STD).

Due to its expertise in these areas, ICCAS was selected to take e.g. a significant role in the nation-wide research project "OR.NET – Safe and dynamic networks in the OR". The project is funded between 2012 and 2015 by the BMBF with more than 18 Mio € and combines Germany's market leading companies and research institutions to form visions and concepts for the technical integration of systems in future operating rooms.

We emphasized on establishing our international networks with scientists from all over the world in conferences, workshops, and think tanks. In October 2012 we had the opportunity to welcome international experts at the Leipzig Forum on Computer-Assisted Surgery to discuss future developments of CAS and the role of ICCAS within the scientific community. ICCAS was further involved in the organization of scientific events focusing on advanced research in surgical workflows and OR information systems at the CARS conference in Pisa and MICCAI in Nice. Additionally, several best paper awards were received by ICCAS researchers on international conferences.

ICCAS continued to be the central column for medical engineering research in Saxony and actively participated in the academic education of young professionals in computer-assisted surgery at the University of Leipzig to strengthen the economic attractiveness of Middle Germany.

Prof. Dr. Jürgen Meixensberger
Head of the board

Model-based Automation and Integration

Research vision: to enable the technical infrastructure in the operating room for situation-dependent support of the surgical staff.

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Operating rooms are one of the cost- and work intensive units in hospitals. The development of new concepts and systems for operating rooms is of extraordinary interest. For the purpose of this, the venture area "Model-based Automation and Integration" (MAI) develops future-oriented and advanced technical systems to provide an optimal support for the work of the operating room staff. The current research focus is on the integration and presentation of pre- and intraoperative information to support the surgical management.

The main project of the area, the BMBF-funded working group, has meanwhile successfully finished its first year. Current major developments emphasize surgical workflow recognition systems, situation monitoring and storage infrastructure, workflow management systems, for treatment planning and integration systems. Groundbreaking work was performed for key infrastructure components, such as the recognition of the current surgical situation and the prediction of the future surgical work steps from this (cp. publications Neumuth et al. and Franke et al.) as well as information integration in oncological treatment planning (see Bohn et al.)

Projects in the venture area are currently funded by funds from the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF), the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie, BMWI) and by Siemens Healthcare.

The OR as a system has to know the current situation to provide optimum support to the surgeon.

Selected Publications

T. Neumuth, P. Liebmann, P. Wiedemann, J. Meixensberger, Surgical Workflow Management Schemata for Cataract Procedures. Process Model-based Design and Validation of Workflow Schemata. Methods Inf Med. 2012; 51(5): 371-82.

S. Franke, J. Meixensberger, T. Neumuth, Intervention time prediction from surgical low-level tasks. J Biomed Inform. 2012. doi:pii: S1532-0464(12)00156-6. 10.1016/j.jbi.2012.10.002.

S. Bohn, J. Meier, T. Neumuth, G. Wichmann, G. Strauss, A. Dietz, A. Boehm, Design of an integrated IT platform to support the oncologic ENT treatment process and concept of a surgical planning unit. Int J Comput Assisted Radiol Surg. 2012; 7 (Sup 1): 402–3.

S. Bohn, S. Franke, T. Neumuth, Interoperability of medical devices within the operating room using service-oriented integration. Proc. of IEEE Engineering in Medicine and Biology 2012.

G. Strauss, I. Gollnick, T. Neumuth, J. Meixensberger, T. C. Lueth, „The Surgical Deck": A New Generation of Integrated Operational Rooms for ENT. Laryngorhinootologie. 2012.

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ZENTREN FÜR INNOVATIONSKOMPETENZ
UNTERNEHMEN REGION
Die BMBF-Innovationsinitiative Neue Länder


Surgical Process Navigator
DOE, Jane * 01.01.1970
Tumor resection
Demo OR (ICCAS)
iccas
UNIVERSITÄT LEIPZIG
apply
Raney clips
skin
11:06:26
Current time
03:16:52
Remaining term
14:23:18
Estimated end point
SONY

Multi-perspective surgical process models for the digital operating room

The operating room (OR) is one of the most complex and expensive units in a hospital. Support for time and resource management might improve surgical patient care and reduce costs. Hence, we are developing a technical support system based on surgical workflows.

The starting points of our work were actual surgical procedures recorded as individual surgical process models. The recordings were compiled into generalized surgical process models (gSPMs). These models represented averaged courses of specific intervention types. The model structure was based on fine-granular work steps. A developed surgical Workflow Management System (sWfMS) could use a gSPM together with workflow recognition information to follow the surgical procedure. The remaining intervention time could be estimated based on the current surgical situation and the process model. The continuously updated information might be used for dynamic OR allocation and prevention of resource conflicts.

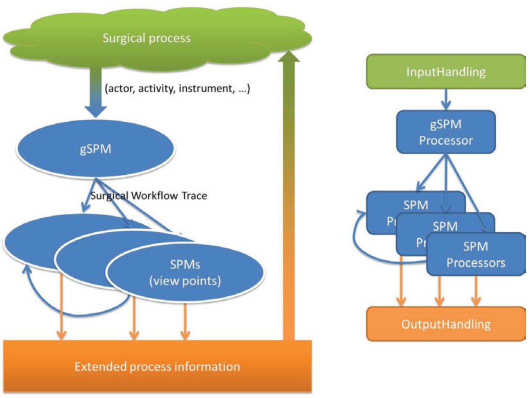

Fig. 1 - The concept of process model handling within the surgical workflow management system

Beyond the description of the current surgical activity as well as potential upcoming tasks the sWfMS used abstract surgical process models to capture larger contextual information such as intervention phases, patient status and technical perspective.

A pipeline-based infrastructure within the sWf-MS allowed intra-operatively updating and condensing these data into comprehensive surgical workflow information.

Fig. 2 - A screenshot of the process information visualization with the Process Navigator for a brain tumor removal

Furthermore, we developed a system, called Process Navigator, which is able to visualize the generated information. This will help the OR staff to keep track of resource and time management. The information of multiple ORs of a clinical department can also be integrated for centralized monitoring and management.

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Project Funding Reference Number: 03Z1LN12

IT infrastructure for the integrated Treatment Planning Unit (TPU)

The treatment of head and neck malignomas is a long-term process, which requires collaboration of interdisciplinary departments and the appropriate handling of diverse information such as pretherapeutic imaging, histologic findings, therapy decisions and a precise planning due to the complex anatomy. However, current IT systems and paper based records do not reflect the actual clinical data flow sufficiently. Furthermore, the process of treatment decisions within clinical team meetings (tumorboards) is mostly based on images within PACS and paper based patient records. A web-based clinical information system oncoFlow has been designed and implemented as modular software architecture (c.f. site 11).

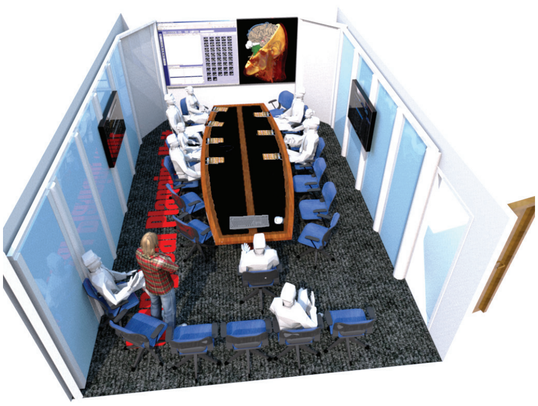

Fig. 1 - Design of the Treatment Planning Unit (TPU) as integrated meeting room for tumor boards

Clinical team meetings within tumorboards are being improved by the new concept of the Treatment Planning Unit (TPU). The design of a TPU has been conceptualized as an integrated meeting room (Fig. 1) that enables seamless electronic access to all relevant patient data from oncoFlow as well as the presentation of 3D patient models at large widescreen plasma displays and HD beamer projections.

To improve interdisciplinary team work, the seats within the TPU are rearranged to a collaborative setting. The protocol of tumor board attendees is automatically generated by electronic identification of the employee ID cards using RFID readers.

The development of the overall system is close to clinical application.

Fig. 2 - Planned realization of the integrated tumorboard environment at the University Hospital Leipzig

Registration of patients for the tumor board and agreement on therapeutic decision are designed as complete paperless processes with e-mail based invitation of attendees as well as electronic documentation of the tumor board's decisions.

The result is a consistent and automatically generated tumor board protocol with therapy decision for each individual patient. Thus, the proposed system forms the basis for a completely integrated oncologic treatment process.

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Development of a modular IT-Framework supporting the oncological patient treatment process in ENT surgery

The oncological workflows in most hospitals are supported by heterogeneous IT systems and paper records, where different kinds of patient specific information is stored. Information, which is important for the patient treatment, clinical evaluations or quality management, has to be gathered and integrated manually by the clinical personnel, thus leading to less-than-ideal processes and error-prone data handling.

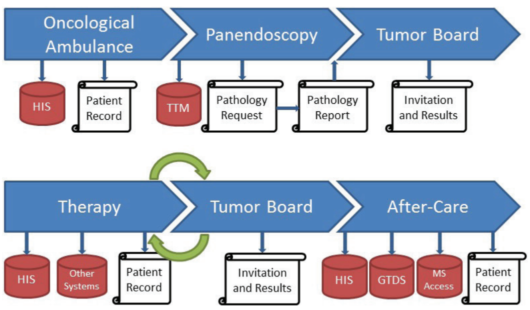

Fig. 1 - The current oncological workflow in ENT surgery and associated IT-systems and paper records

The central clinical information systems are powerful instruments offering the physician numerous functionalities and are available at many computer workstations in the hospital. Unfortunately these systems often suffer from an inefficient design and inappropriate integration into the workflow so the physician does not find relevant information at a glance. Many documents have to be browsed before the appropriate information is found. The developed information system oncoFlow aims to overcome the previously described shortcomings.

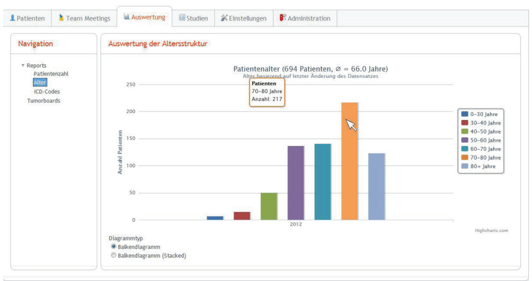

Fig. 2 - Statistical evaluation with one click

The system is designed to support the oncological workflow in ENT surgery (see Fig. 1). Automatic import of patient specific information from existing clinical information systems should prevent manual reentering of patient details and save valuable time. Systematically categorized and structured information should be available for further processing. Data and functionalities are available as web based rich-internet application, that allows instant access from each workstation within the hospital (see Fig. 2).

A key design requirement is to provide only functionalities to the user that are needed within a certain context. The first step towards the management and support of the entire oncological workflow in ENT surgery is the seamless integration from existing patient information, panendoscopy results and management of team meetings. In daily clinical usage the system will provide a large information basis containing patient, diagnosis and therapy specific data in a structured manner. This information is very valuable for further scientific research. Hence, the oncoFlow system will serve as a basis for the development of a Digital Patient Model (DPM) for ENT surgery.

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Towards an architecture and a graphical user interface for intraoperative detection of surgical instruments

Automatic detection of the status of a running intervention in the operating room using multiple sensors will allow future support systems to provide situation-based support of the staff during the workflow and contribute to efficiency and patient safety. In order to reach an integral automatic covering of processes in the OR, the identification of the used surgical instruments during an operation is crucial. The decision not to rely on RFID technology, but to focus on visual detection by cameras (Fig. 1) creates specific requirements that the underlying software architecture has to fulfill.

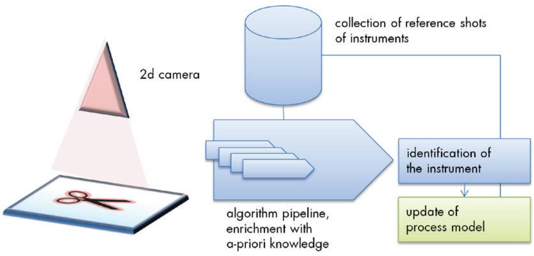

Fig. 1 - Conceptual sketch of the overall system structure.

A requirements analysis for a component containing the data for all possibly detectable instruments on the instrument table resulted in a series of key demands: A non-technician must be able to operate the system, especially by getting graphical support for easy data inspection.

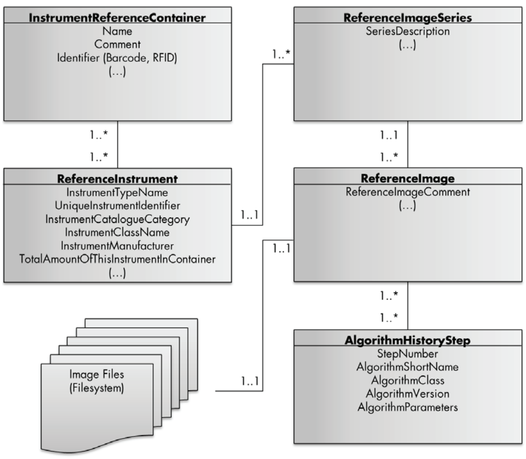

Fig. 2 - Architecture of the collection of reference shots (excerpt).

Traceability of steps within the instrument detection algorithm pipeline has to be established in order to be able to reconstruct which combinations led to which output. Furthermore the architecture must be prepared for distributed and parallel computing, which requires transportability of the data and an independence of the programming language.

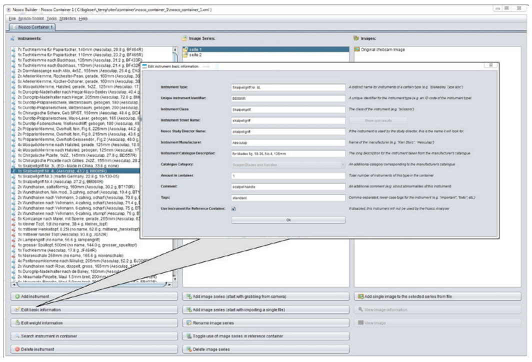

Fig. 3 - A screenshot of the current prototype

In a prototypical implementation all the demands of the conducted structured requirements analysis have been realized in a graphical user interface and with an XML-based data core (Fig. 2).

First tests with the instrument data of several complete surgical trays have confirmed that the architecture is able to handle the needs. An upcoming study based on the presented application will show the applicability to the instrument table situation in the OR.

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A surgical recorder for intraoperative device data

Due to the increasing complexity of the surgical working environment and the increasing technization solutions must be found to relieve the surgeon. In the scientific group "Model-based Automation and Integration" (MAI) the ultimate goal is the detection of the current situation in the operating room. To achieve this, all relevant data should be available on a central location and in a structured way.

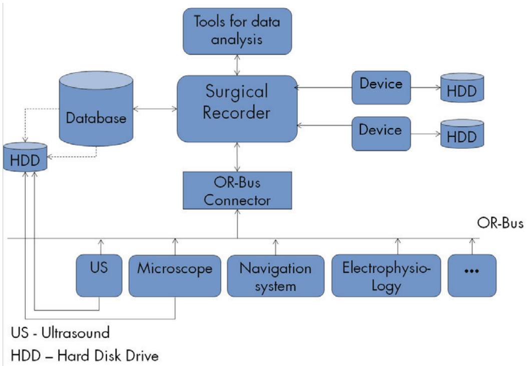

Fig. 1 - Integration of the surgical recorder in the OR environment

This project presents a concept and a prototypical development of a storage system with the ability to deal with all incoming intra-operative medical device data. For this purpose, the requirements for such a system are described and a solution for the data transfer, the data processing and the data storage is presented. In a subsequent study the prototype is tested for correct and complete data transmission and storage, as well as for the ability to record a complete neurosurgical intervention with low processing latencies.

The developed system based on the presented concept is able to store the generated data correct, complete and fast enough even if much more data is sent as expected during a surgical intervention.

In a subsequent step, a query interface was implemented based on the Google protocol buffers. With that interface other software is able to get the currently connected devices and can access the stored data as well as the current data.

Project Funding Reference Number: 03Z1LN12

Fig. 2 - Graphical User Interface (GUI). The red circles show which devices are connected to the blackbox. After choosing one of these circles the available services and the currently available data is shown on the right side. On the console at the bottom the technican can view status and error messages

The surgical recorder supports automatic recognition of the interventional situation by providing a centralized data storage and access interface to the OR communication bus. In the course of the project, more devices will be connected to the surgical recorder and further technologies (such as RFID, time-of-flight cameras, etc.) are intended to be used. The data generated by these devices should also be stored or referenced in the surgical recorder in order to support the analysis of the OR situation.

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Intraoperative detection of device information based on video data

A lot of devices in the operating room are missing structured interfaces, as a consequence ways must be found to obtain the relevant information by other means. A significant proportion of the available devices in the operating room provide a video output (e.g. ultrasound, endoscopy, microscopy, navigation). For generic analysis of the published video data, an editor has been developed in which different significant areas can be defined within the video stream. Each of these areas can be associated with meta information like the type of the field such as textual information. The storage of the regions of interest is performed in XML format.

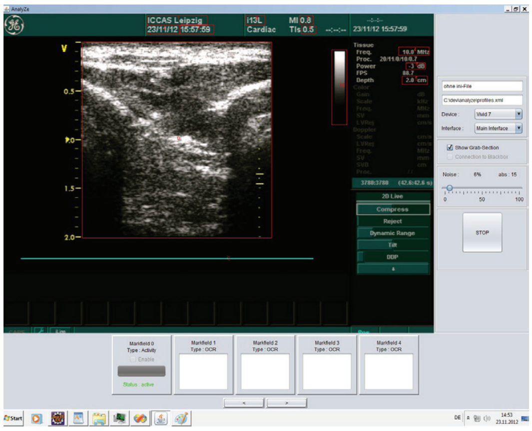

Fig. 2 - Graphical user interface of the analyzing software. The red areas indicate the analyzed fields. Depending on the type of the marks different analysis algorithms are used. In this picture the ultrasound device is currently in use.

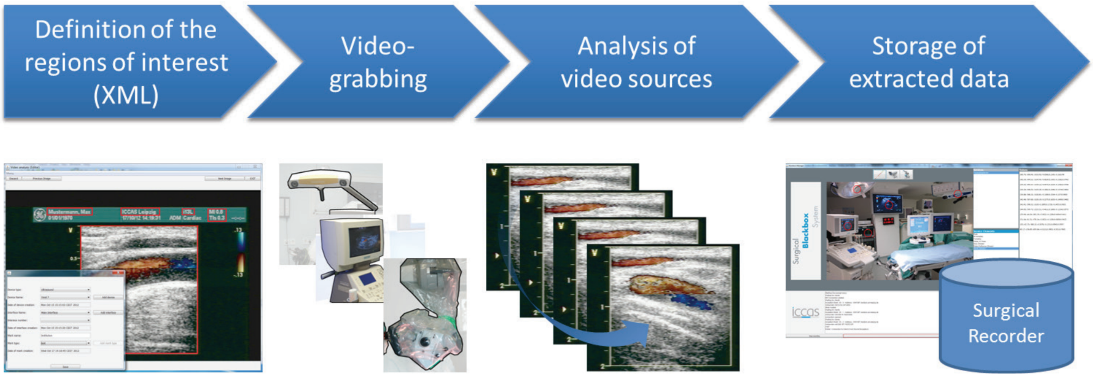

Fig. 1 - Sequence of data acquisition based on video data. From left to right: Relevant areas within the video data are marked and saved with an editor. The video signal is duplicated by video splitters and transmitted using video grabbing devices. The analyzing software monitors the relevant areas and stores the extracted information into the "surgical recorder".

In a second step the intraoperative video data is transmitted to the analyzing computer by a video grabbing device. The analysis software monitors defined areas and analyzes the changes depending on the type of the region. Each device which provides information via a video output can be monitored by its own video grabbing device and associated analysis software. If a change occurs in an area it is transmitted to the "surgical recorder", where the data is stored in a structured manner and is made available for further analysis.

During first tests, the device activity of an ultrasound device could be detected. The data is stored in the Surgical recorder and could be requested by other software or devices.

Hereafter OCR based text recognition will be implemented to obtain additional device information. The project enables subsequent systems to analyze the surgical situation by providing device and activity information which cannot be detected through existing interfaces. In a subsequent study the functionality will be proved. In this study the stored information will be compared to manually recorded workflows.

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Project Funding Reference Number: 03Z1LN12

smartOR: connecting surgical workflow management to the open surgical communication bus

Especially during complex surgery a variety of technical devices is involved in modern operating rooms. Due to a lack of common interfaces interaction between these devices is limited. The smartOR consortium focuses on common interfaces and protocols as well as a comprehensive risk management strategy.

The consortium developed a first draft for a common OR communication interface named Open Surgical Communication Bus (OSCB). The OSCB provides a communication infrastructure for plug and play OR networks including automatic discovery, description and dynamic use of functionalities. A major challenge is to combine and configure the services respectively to facilitate the current task during the intervention.

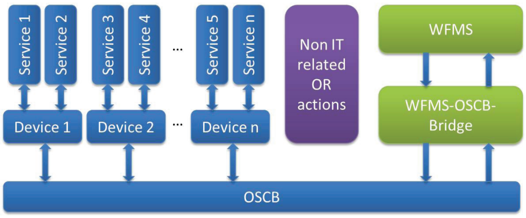

Fig. 1 - Integration of the aWA Concept (green) into the overall system

As a part of this consortium, it is the main task for ICCAS to develop a system to automatically adapt a workflow based on the current situation. This so called automatically situation based workflow adaption system (aWA) is a combination of a Workflow Management System (WfMS) and a bridge to connect the WfMS and the OSCB.

The WfMS handles process information based on a generalized model. The model describes possible courses of the corresponding intervention type by consecutive work steps. The devices, connected to the OSCB, shall get information on the actual and the following steps. This requires a transformation of the process information from activity-oriented to technology-oriented viewpoint as well as a transformation of the network protocols. The WfMS-OSCB-Bridge provides these functionalities. The implementation of an integrated OR network combined with surgical process

Fig. 2 - The surgical workflow management system (right) integrated into a smartOR network

management tools may contribute to automatic configuration and adaption of devices in the OR.

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smartOR: surgical workflow management systems

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.

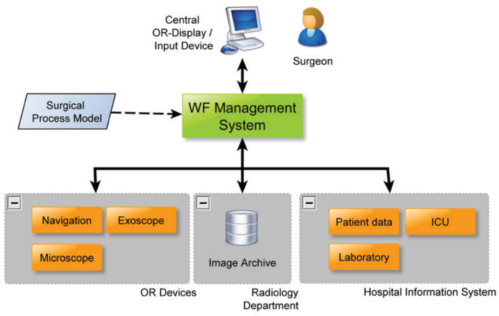

Fig. 1 - Workflow Management System (WFMS) as a central, context sensitive knowledge distribution unit

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 investigation the preconditions for a robust surgical workflow management system (S-WFMS).

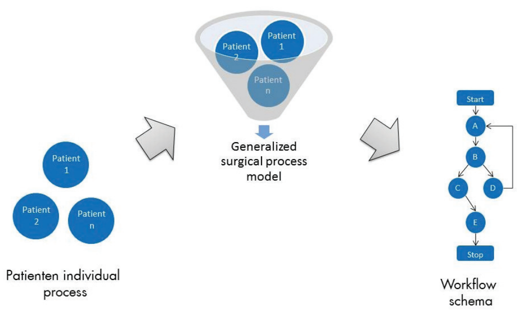

Fig. 2 - Generation of a workflow schema from patient individual processes

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 status of the current intervention is interpreted by fusing multiple sensor information. These come from multiple sensors within the OR. A robust WFMS must rely on this sensor information as well as it needs a fault tolerant process model.

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

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Distance measures for surgical process models

The development of new surgical techniques and approaches leads to a continuous modification of surgical work. To evaluate the modifications, it is necessary to quantify their impact on the surgical processes. This induced the necessity to have a measurement that quantifies the distance between the conventional and the new approaches.

Process distance measures have the objective to quantify variations between processes. Using these methods, it is possible to assess similarity between sequences of surgical activities.

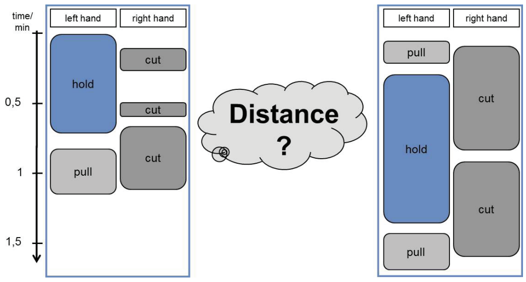

Fig.1 - Illustration of the problem for measuring distances between surgical process models

We evaluate four distance measurements: Jaccard distance, Levenshtein distance, Adjacency distance, and Graph matching distance by applying them to clinical data sets from laparoscopic training in pediatric surgery. In our evaluation study, we have analyzed distances of 450 surgical processes with a total number of about 28600 activities, using these four measures.

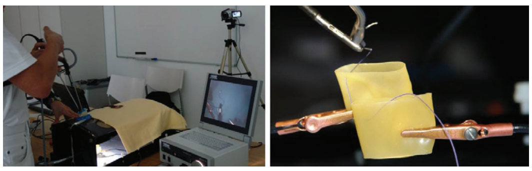

Fig. 2 - Setup of the training session: Subject, Pelvitrainer, video of endoscopy and camera for documentation (left) and silicone manikin for a complex suturing task with angled laparoscopic instruments (right)

We measured training sessions of novice and expert surgeons, performing several complex exercises in laparoscopic training and assessed the distances between both groups. We followed the assumption that surgical processes of expert surgeons have significantly lower distances compared to one another than surgical processes between novice surgeons.

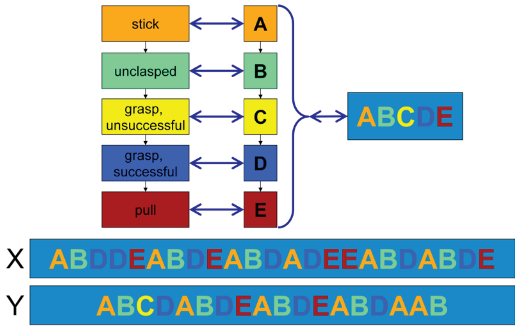

Fig. 3 - Above: necessary preprocessing: conversion of activity sequence into a character string in a definite and reversible way. Below: two different example workflows X and Y.

The results showed that Levenshtein and Adjacency distance are best suited to measure process distances in surgery. The distance measurements are able to represent the differences between the courses of surgical interventions, provided that the measurement is contextually sensible, correct, and objective.

With these methods, it is possible to comprehend if the variation of the course of surgical intervention using a new tool or method is small in comparison to the conventional one, or if the variation is substantial.

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Thermosensor: surgical activity recognition system with thermal imaging

During the recent years methods to describe complex processes were developed. Using these methods it is possible to describe surgical processes despite its complexity (Surgical Process Model - SPM). Information of surgical processes is currently used for post-surgical analysis and studies.

A surgical intervention can be divided into separate High Level Tasks (HLT). These HLTs are marking a certain phase of an operation. A HLT can be sub-divided into one or more Low Level Tasks (LLT). A LLT consists of single, eventually reoccurring, activity. Identification of LLTs is done using various sensors, for example RFID-tags are used to track surgical instruments and personnel, ultra-sound sensors and cameras are used to identify the movement of persons.

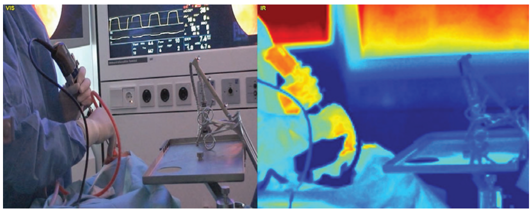

Fig. 1 - Visual and thermal image of suction during a FESS operation

Currently only motion data and visual images are used for the identification of tasks. Information from thermal imaging is omitted. Thermal imaging gives precious information because the hand of the personnel and the used instruments show characteristical temperature features (Fig. 1).

The project's aims are to recognize surgical activities (tasks) from thermal images. The thermal images are pre-processed to remove the background and to segment the areas containing the hand and the surgical instruments. Afterwards a Hierarchical Temporal Memory (HTM) network is used to distinguish between different surgical activities.

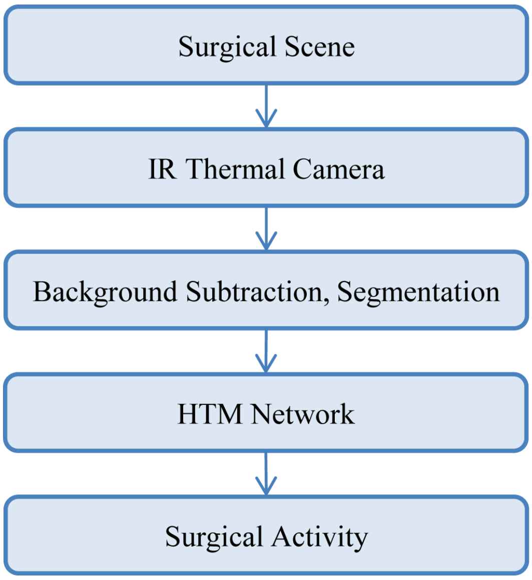

Fig. 2 - Pipeline of the software

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impulse für wachstum ZIM Zentrales Innovationsprogramm Mittelstand

Gefördert durch:

Bundesministerium für Wirtschaft und Technologie

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Sensor fusion for automatic recognition of surgical workflows

Since the number of medical devices in operating rooms is increasing, surgeons and their assistants have to handle more and more complex user interfaces and their specific parameters and configuration options. This not only takes the focus away from the surgery itself but it is also a great source of failures. One approach to overcome this is to control the devices by an automatism by means of assistants to let the involved actors refocus on the real task. To achieve this, such a system has to be aware of the current surgical activity and state of the intervention.

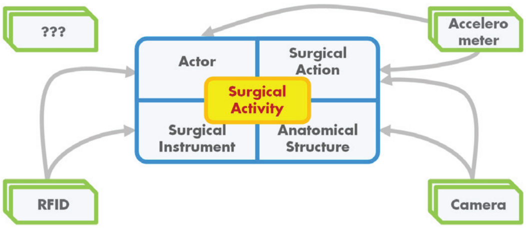

Fig. 1 - the surgical activity and it's aspects

Previous works dealt with manual recording of surgical activities using human observers and tablet PCs. The main concept of this work is to replace the manual input of a human observer with automatically acquired data. The high complexity of activity recognition in the surgical context makes it difficult to replace the manual input in one technological step. Our approach is the successive substitution of activity aspects with an automatic system. A first step was the development of a "Radio Frequency Identification" (RFID) based instrument detection system to omit the "used instrument" information in the surgical workflow record.

The results of an evaluation study showed that the system achieved this goal. The second step was the integration of an acceleration measurement system to infer surgical actions like "cutting" etc. Since every system alone tends to produce ambiguities it is necessary to combine their information using a methodology based on sensor fusion.

Fig. 2 - Surgical intervention play and manual workflow recording

The goal of this approach is the automatic inference of the surgical activity and all its aspects. The next step in this project will be the integration of additional measurement systems to cover remaining activity aspects like "treated structure".

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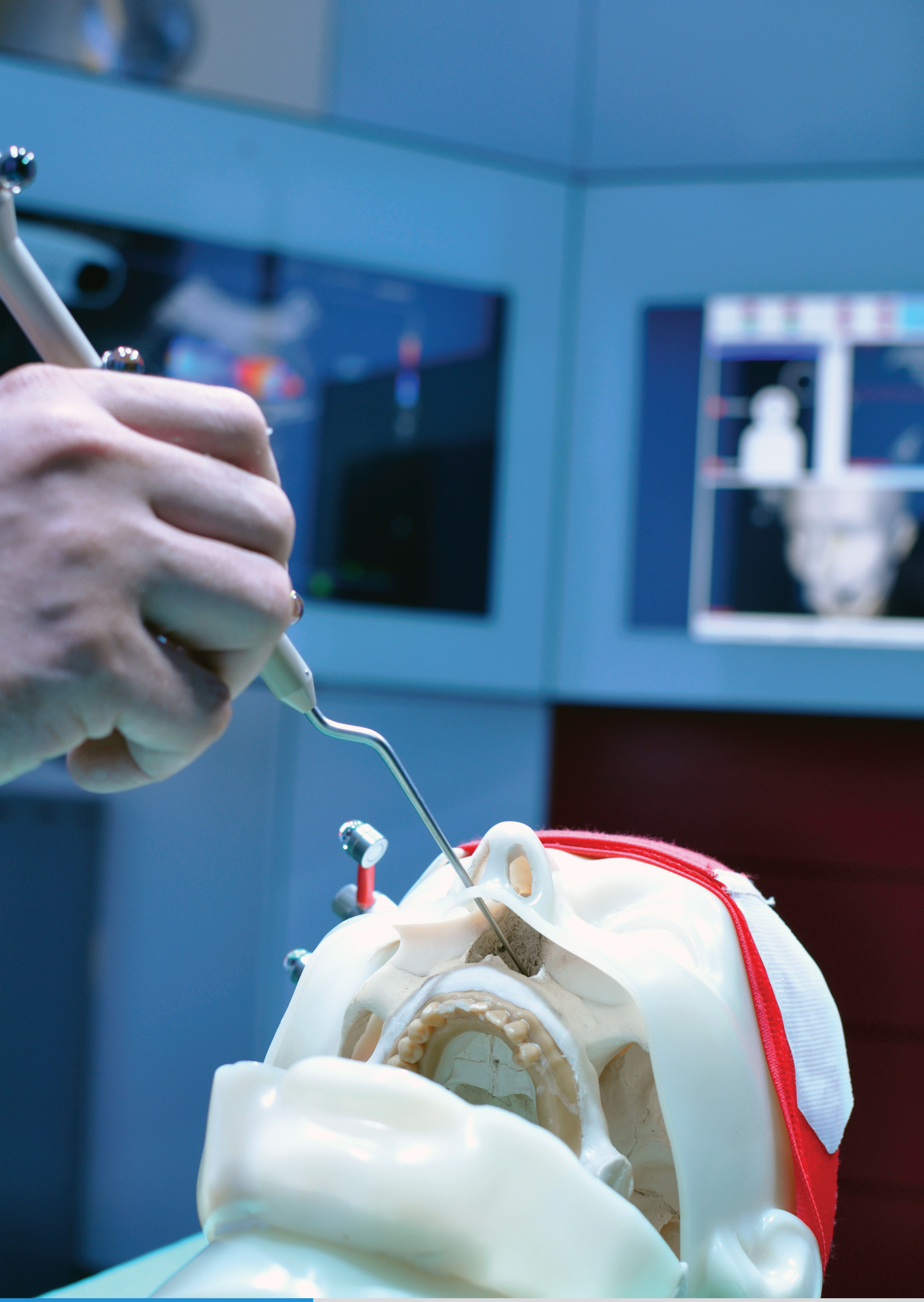


Digital Patient Model

Research vision: Consistent representation of pre- and intraoperative patient data for model guided therapy.

The venture area "Digital Patient Model" has the vision to create digital models of patients from simple data sets. The research work comprises the representation of morphological, functional, static and dynamic patient data, which are currently available in clinical routine but not usable for model guided therapy. It is the objective of the group to acquire, structure, and link this data mathematically to provide a sufficient base for clinical applications.

Digital patient models have the objectives to build the base for future applications in computer-assisted surgery, such as model-guided diagnosis and therapy, tissue simulation, implant design etc. Therefore, projects within the DPM area target specific clinical applications such as imaging in brain tumor surgery, spine modeling, blood flow visualization, or segmentation and visualization of anatomical structures.

The venture area is currently funded by several funds from the German Federal Ministry of Education and Research (BMBF), the European Fund for Regional Development (EFRE) and the Deutsche Forschungsgemeinschaft (DFG).

The patient has to be presented as a model usable by information systems.

Selected Publications

S. von Sachsen, H. J. Florek, B. Senf, F. W. Mohr, C. D. Etz, Modellbasierte Unterstützung von Stentgraftauswahl, Gefässchirurgie 2012; 17:480.

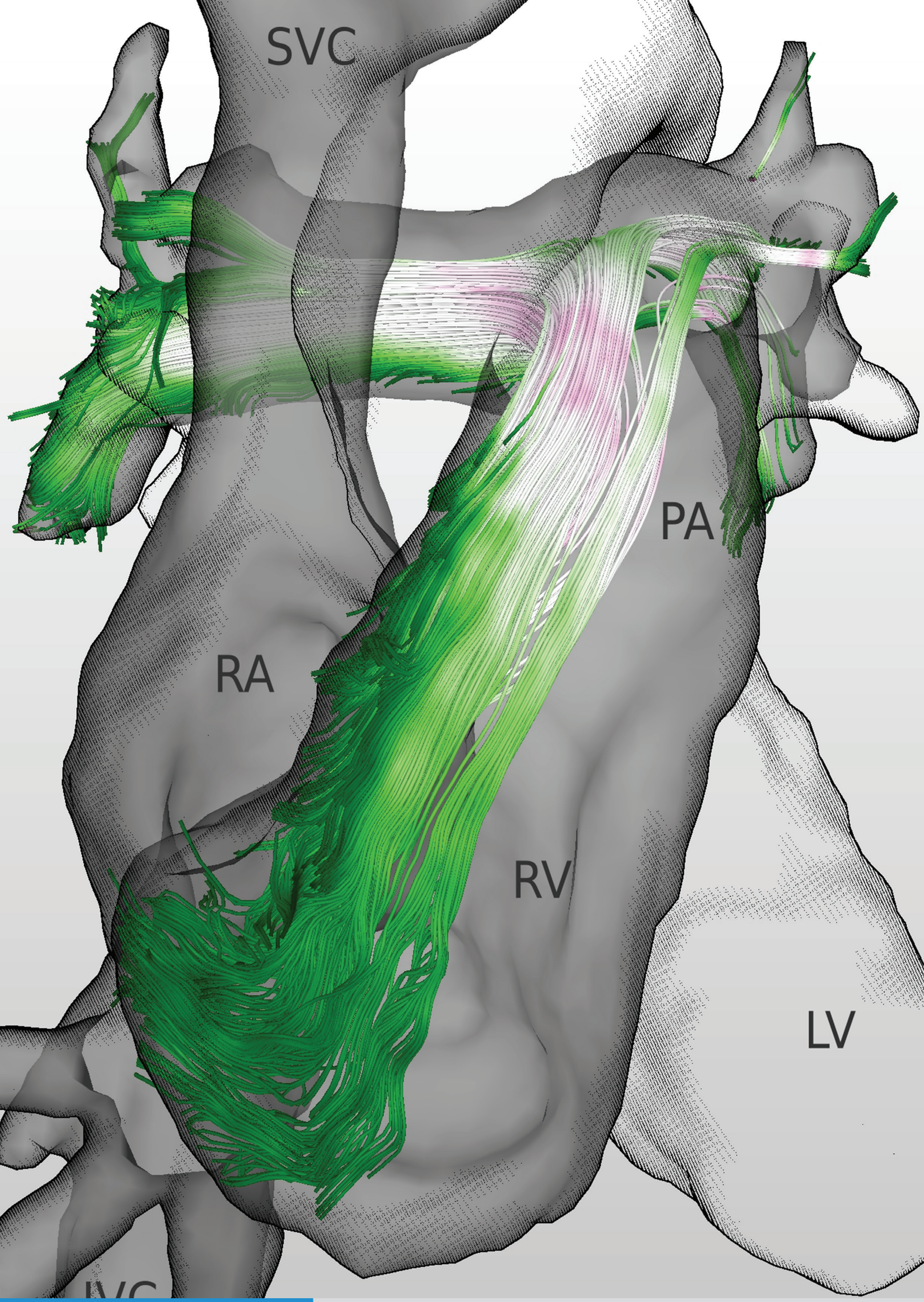
S. Born, M. Pfeifle, M. Markl, G. Scheuermann, Visual 4D MRI Blood Flow Analysis with Line Predicates, IEEE Pacific Visualization 2012, pp. 105-112.

S. von Sachsen, C. D. Etz, F. W. Mohr, R. Neugebauer, B. Senf, Finite element models for assisting implant selection - feasibility and potential for use in EVAR, The Leipzig Interventional Course (LINC), January 25-28, 2012, Leipzig, 2012.

S. von Sachsen, O. Burgert, B. Senf, H. J. Florek, C. D. Etz, F. W. Mohr, Durchgängige Prozesskette zur Integration eines patientenspezifischen Finite Elemente Modells in den EVAR-Planungsprozess, Annual Meeting of the German Society for Medical Informatics, Biometry and Epidemiology 2012.

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung


SVC
PA
RA
RV
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IVC

Structural mechanical defect classification and modeling of the cervical spine

In case of age-related degenerative diseases of the cervical spine osteosynthesis is performed to reconstruct the ossal anatomy. In those circumstances a secure anchorage of the implant is extremely difficult due to the diseased vertebrae structures. Subjected to overstressing, implant loosening or breaking can occur which requires revision surgery. Performing main movements like flexion/extension the dorsal ligament structures and the anterior longitudinal ligament are the hindering structures and therefore contribute to the stability of the cervical spine. However, in ventral surgical sessions they are severed and resected.

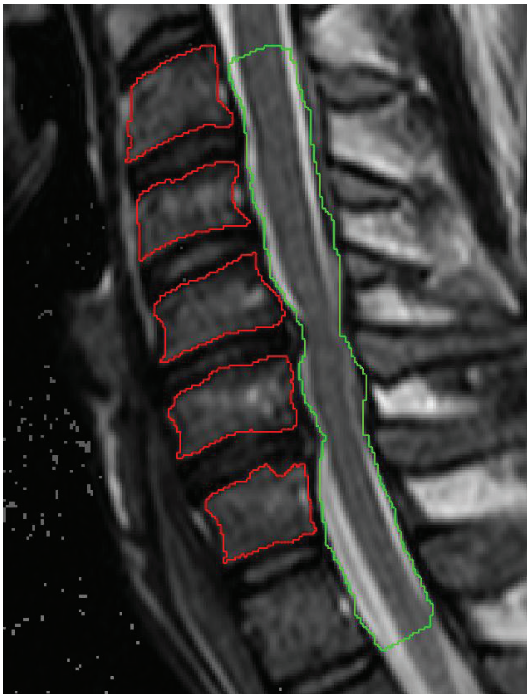

Fig. 1 - Segmentation of vertebraes (red) and spinal canal (green) in MRI slice

The mentioned work steps "determination of access operation" and „implant selection" have a great influence of the therapeutic outcome and are only assisted by CT/MRT-data and planning software with measurement functions and implant templates. So far, there exists no defect classification for degenerative modified vertebraes with adapted treatment strategies.

Within the interdisciplinary research project a solution for an extended patient model is developed which contains defect specific parameters for vertebrae structures and parameters for describing ligaments. For this purpose a method for model based segmentation will be developed, which aims to consider defect specific anatomical features. Furthermore the defined defect classification for degenerative modified vertebra will be integrated in a planning software module. For providing an efficient data handling for all intervention related data a suitable user interface will be developed together with the surgeons.

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Gefördert aus Mitteln der Europäischen Union

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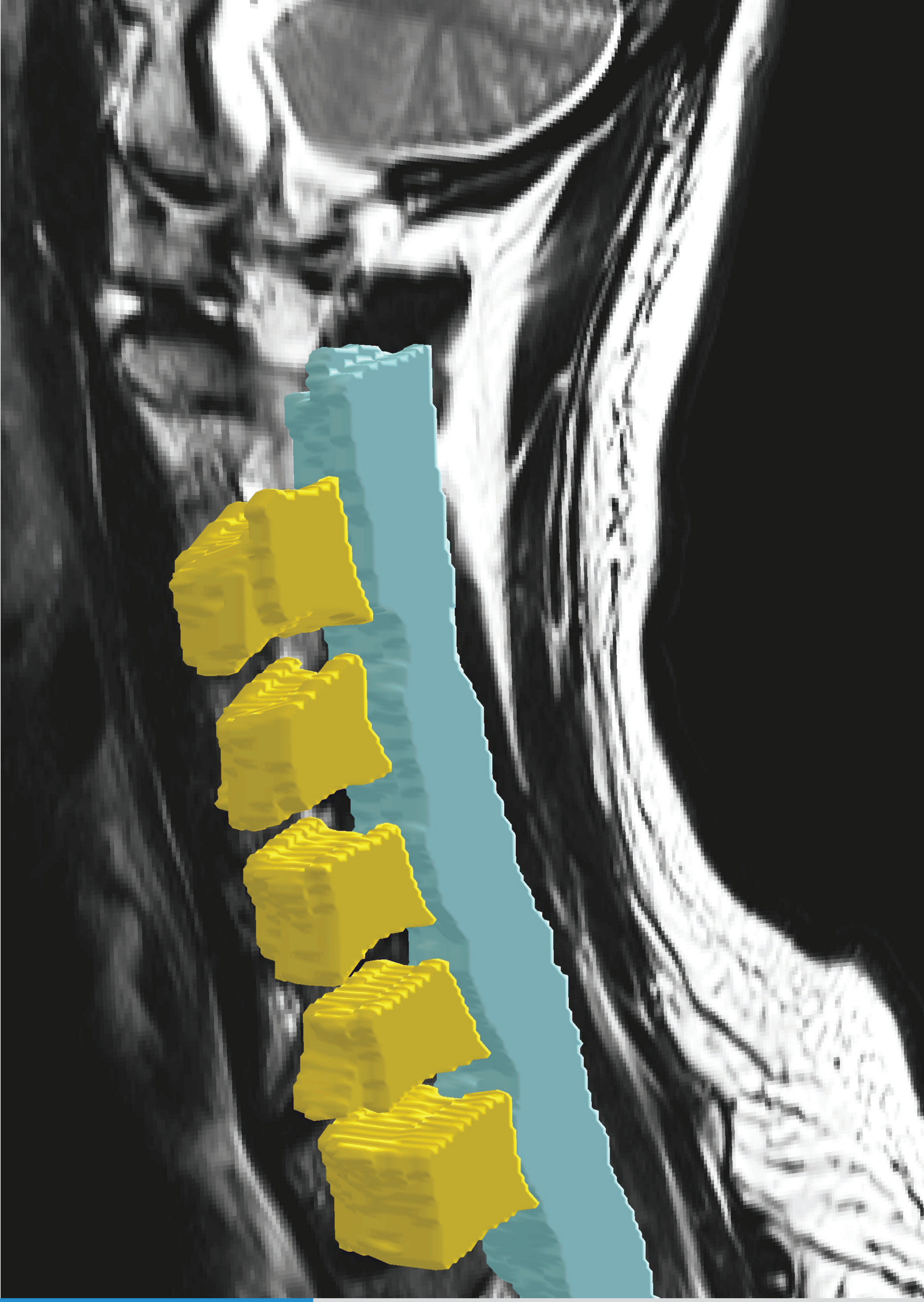
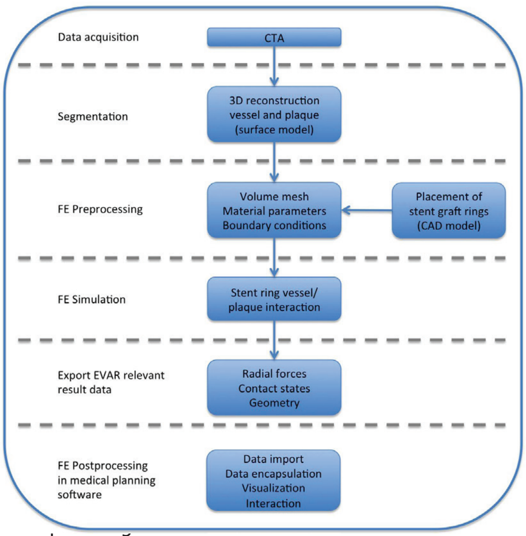
EFRE
Europäischer Fonds für regionale Entwicklung



Patient-specific optimization of Stentgraft selection

The short and long-term outcome of endovascular aortic aneurysm repair (EVAR) is influenced by selection of stent graft design and, in particular, correct oversizing. To optimize these work steps a finite element analysis (FE) might be helpful which enables the calculation of stent graft vessel interaction. This may assist the vascular surgeon in estimating fixation and sealing potential of different devices in context with the patient-specific vessel morphology.

The interpretation of the simulation results have to be performed directly by the vascular surgeon. For this purpose a software module was developed, which enables an evaluation of single stent graft configuration and a comparison of multiple devices. The implemented software features allow an explicit color-coded visualization of calculated stent graft forces and contact states directly on the 3D model. Parallel presentation of multiple configurations can be used for comparing sealing potentials. Furthermore the migration risk for each landing zone is depicted in an overview map.



The new planning method was discussed with 15 surgeons of 14 hospitals all over Germany performing usability tests.

Moreover 10 vascular surgeons evaluated software features and data presentation methods using a questionnaire specially designed for this purpose.

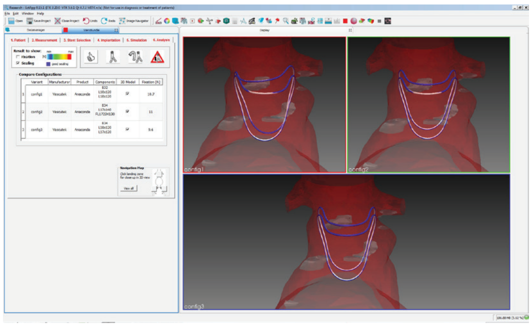


Fig. 2 - Parallel visualization of contact states for three stent graft configurations (blue = sealed)

The user interface usability was evaluated with a standardized questionnaire ISONORM 9241-110 answered by 10 vascular surgeons. Determined evaluation values for stent graft comparison as well as 2D/3D data presentation forms and interaction methods for interpreting simulation results were evaluated as helpful. Assessment of the user interface considering ISO Standard 9241-110 principles results in an ISONORM-conform user interface.

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Evaluation of 3D enhanced intraoperative ultrasound imaging for brain tumor resection

Intraoperative B-mode ultrasound (US) imaging is nowadays a standard for brain tumor resection surgeries. However, the differentiation between the tumor boundary, the edema or the vascular structures is not easy to perform. The use of a US contrast agent is expected to clearly depict the tumor borders in the image. The goal of this project is to quantitatively evaluate intraoperative, navigated, 3D and contrast enhanced ultrasound imaging for the representation of brain tumors during resection surgeries.

The method consists in acquiring in the operating room navigated 3D US data of the patient tumor before and after the resection, and with and without the use of a contrast agent. The tumor and the tumor remnant are segmented in the 3D US data and compared with the segmented tumor and the segmented tumor remnant in the preoperative and postoperative MR data, considered as gold standard. The comparison is performed through the computation of quantitative values like the Dice similarity index (DSI) and the mean distance between the tumor surfaces.

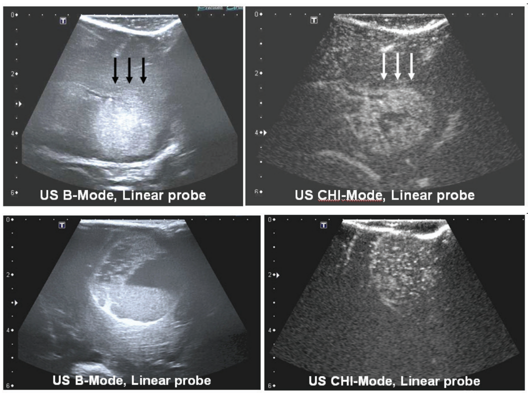

Fig. 1 - Improvement of the representation of a brain glioblastoma multiform tumor (figure above) and of a metastasis (figure below) in intraoperative US imaging using a contrast agent. The tumor boundary appears more clearly in the contrast enhanced US image (right) than in the B-mode image (left)

The image data of more than 70 patients were so far collected. The first quantitative results were obtained on 16 glioblastoma multiform (GBM) tumors and on 14 metastasis acquired before resection. They showed that in 10 cases of the GBM and in 8 cases of the metastasis the DSI increased while the mean surface distance decreased with the use of the contrast agent. Therefore in more than the half of the cases, the representation of the tumor in the 3D enhanced intraoperative US data was improved. Moreover, the visualization of the US images after resection lead in several cases to improve the resection.

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Illustrative visualization of cardiac and aortic blood flow from 4D MRI data

In the last years, illustrative methods have found their way into flow visualization since they communicate difficult information in a comprehensible way. This is of great benefit especially in domains where the audience does not necessarily have flow expertise.
One such domain is the medical field where the development of 4D MR imaging (for in-vivo 3D blood flow measurement) lead to an increased demand for easy flow analysis techniques. The goal and the challenge is to transfer the data into simple visualizations supporting the physician with flow interpretation and decision making.

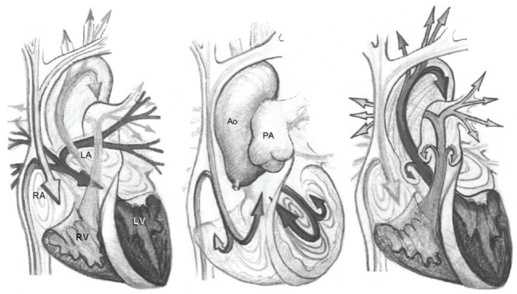

Fig. 1 - Schematic drawing of cardiac blood flow. Reprinted by permission from Macmillan Publishers Ltd: Nature 404(6779): Kilner et al., p.759-761 © 2000

In this project, we take one step towards this goal. We developed an approach for the illustrative visualization of steady flow features occurring in 4D MRI data of heart and aorta. Just like in manually created illustrations (see Fig. 1), we restrict our visualization to the main data characteristics and do not depict every flow detail. The input for our method are flow features extracted from the dataset's complete set of streamlines with the help of line predicates.

We create an abstract depiction of these line bundles by selecting a set of bundle representatives reflecting the most important flow aspects. These lines are rendered as three-dimensional arrows that are fused in areas where they represent the same flow.

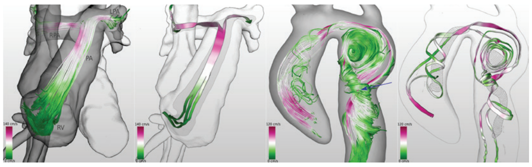

Fig. 2 - Comparison of flow structures of a healthy heart (left) and an aorta (right) visualized as line bundles and illustrative arrows. Abbreviations: RV, right ventricle; PA, pulmonary artery; LPA, left pulmonary artery; RPA, right pulmonary artery

Since vortices are another important flow information for a physician, we identify these regions in the 4D MRI data and display them as unobtrusive, tube-like structures.

By applying our illustration technique to diverse flow structures of several 4D MRI datasets (see Fig. 2), we demonstrate that the abstract visualization is useful to gain an easier insight into the data. Our method has great potential and offers many possible applications, e.g., in comparative visualization and also beyond the medical domain.

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Segmentation and visualization of ear structures for Cochlea implant planning

The insertion of a cochlear implant (CI) is an appropriate treatment for patients with different kinds of hearing loss. In a surgical intervention, an electrode array is inserted into the cochlea through the round window. These electrodes pass acoustic signals from a microphone and a sound processor to the hearing nerve. With that, a hearing sensation is evoked. The surgery is complex since the situs' size is in the range of only a few millimeters and many risk structures (mainly nerves) are located in the vicinity of the access path.

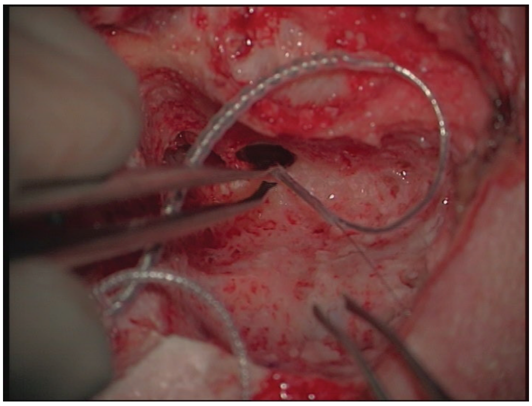

Fig. 1 - Insertion of the electrode array into the cochlea (not visible). The risk structures (nerves) are hidden in bone, which makes navigation difficult.

So far, the implantation is planned by examining preoperatively acquired CT slice data for anatomical anomalies and to estimate the access path. For that, especially the course of the nervus facialis (facial nerve) and the chorda tympani (gustative nerve) and the distance between them is of great importance. However, the planning on CT slice data requires very good spatial comprehension skills. A 3D visualization of the patient's ear anatomy can be of great help during this task.

In this project, eight CI implantations have been supported with our 3D visualization tool. The feedback of the surgeons was iteratively used for the improvement of the visualization with respect to the displayed anatomical structures, the used rendering techniques and new interaction methods.

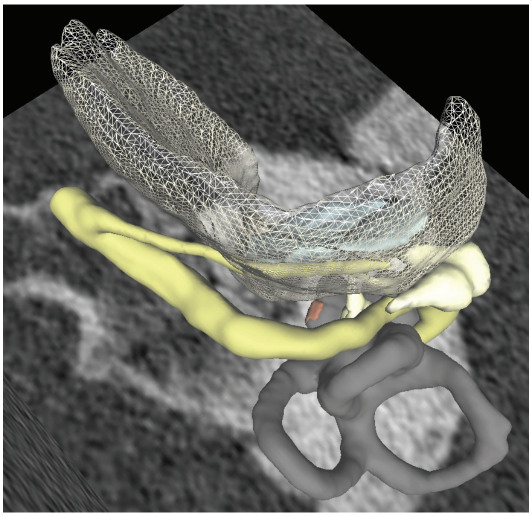

Fig. 2 - Visualization of the anatomical structures of a left ear (same viewing direction as in Fig. 1): occipital part of the acoustic meatus wall (yellow, wire display), tympanic membrane (light blue), nerves (yellow), ossicles (light yellow), cochlea and semicircular canals (grey) and the target structure - the round window (red).

Further, the methods used for the segmentation of nervus facialis and chorda tympani were enhanced. In the future, a structured evaluation of the benefit for the surgeon needs to be carried out. However, during the surgeries it became evident that anatomical anomalies can be very well observed with our 3D visualization.

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Visual analysis of cardiac 4D MRI blood flow

Phase-contrast magnetic resonance imaging (4D MRI) is an in vivo flow imaging modality that is expected to significantly enhance the understanding of cardiovascular diseases. Among other fields, 4D MRI provides valuable data for the research of cardiac blood flow and with that the development, diagnosis, and treatment of various cardiac pathologies.

However, to gain insights from larger research studies or to apply 4D MRI in the clinical routine later on, analysis techniques become necessary that allow to robustly identify important flow characteristics without demanding too much time and expert knowledge. Heart muscle contractions and the particular complexity of the flow in the heart imply further challenges when analyzing cardiac blood flow.

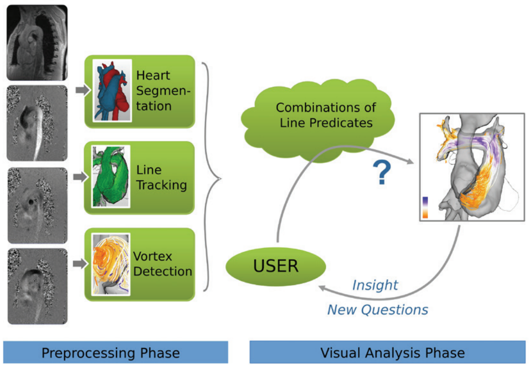

Fig. 1 - Workflow of our visual analysis method. After preparing the data in a preprocessing phase, the user can interactively combine and apply line predicates to carve out flow structures of interest

Working towards the goal of simplifying the analysis of 4D MRI heart data, we developed a visual analysis method using line predicates. With line predicates precalculated integral lines are sorted into bundles with similar flow properties, such as velocity, vorticity, or flow paths. The user can combine the line predicates flexibly and by that carve out interesting flow features helping to gain overview (see Fig. 1).

We applied our analysis technique to 4D MRI data of healthy and pathological hearts and could identify several flow aspects that could not be shown with current methods (see Fig. 2).

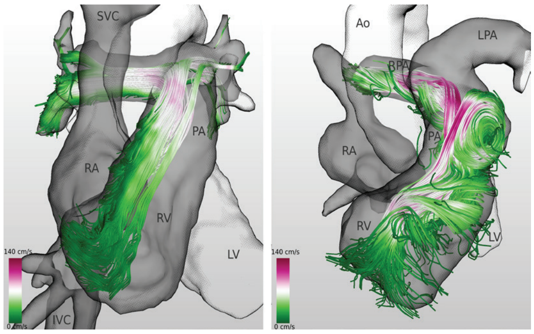

Fig. 2 - Our method clearly shows the different blood flow behaviour during the systolic phase in a healthy (left) and a pathological heart (right)

Three 4D MRI experts gave feedback and confirmed the additional benefit of our method for their understanding of cardiac blood flow.

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Ontology for assessment studies of the Man-Computer-Interaction in surgery

Surgery is the most high-risk domain of the modern medicine. Technological improvements and automated systems are essential components of numerous surgical procedures to reduce risks or to improve benefits. But the use of automation creates additional risks followed by errors. The majority of these errors result from the underlying Man-Computer-Interaction (MCI). The latter is therefore a key factor to be evaluated. This area of research is complicated (there are numerous relevant aspects to assess) and complex (the existing interrelations of MCI require an interdisciplinary analysis). Therefore current MCI studies are often small sample studies with heterogeneous study conditions. These are implemented by different research groups and cannot easily be compared.

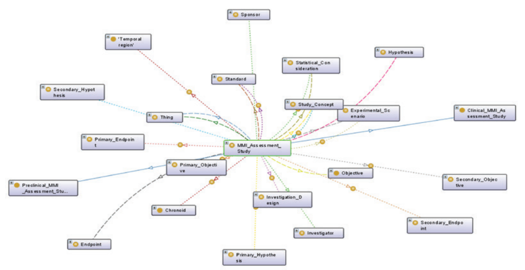

Fig. 1 - Ontology diagram with inhered interrelations (top level overview)

To facilitate the MCI research and to provide a systematic assessment approach an investigation model was developed. The model concepts were derived from two frameworks: the ISO 14155 standard "Clinical investigation of medical devices for human subjects" and a framework developed by Jannin and Korb for designing and reporting assessment studies. The derived concepts were adapted to the domain of automation in surgery, structured identifying the necessary relationships and organized in a hierarchy addressing the different scopes of the MCI evaluation. The developed investigation model was evaluated with regard to its structure, completeness and adequate representation of MCI assessment studies.

For the adequate formalisation of the model concepts three different approaches were evaluated: Unified Modelling Language (UML), Database and Ontology. The evaluation considered the pros and cons of using these three approaches, based on previously defined key requirements. The results have shown that the formalisation in an ontology fits the defined requirements adequately, while the application of the other candidates contains generic limitations. Therefore the Investigation Model Ontology (IMO) was developed to formalise the investigation model concepts.

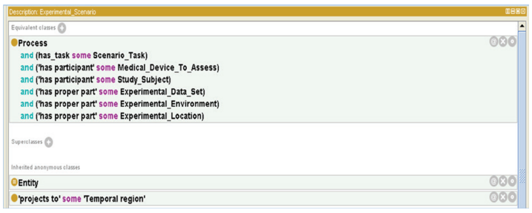

Fig. 2 - Category example within the ontology

The IMO together with the underlying investigation model provide a possibility for standardized representation and reporting of studies for MCI evaluation in surgery and helps understanding the underlying study concepts in a formal and unambiguous way. Furthermore the developed ontology is scalable and can be used to compare different studies or to check their completeness (i.e. the granularity of study descriptions).

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HEINRICH BÖLL STIFTUNG

Standards for Modular System Architectures for Computer Assisted Surgery

Research vision: ***Usage and development of international standards are required to connect surgical assistance systems from different vendors to provide the surgeon with all relevant data intra-operatively.***

ICCAS aims to complement image based surgery, as it is practiced today, with additional information towards a model based surgery. In a model based surgical workflow the patient is presented not only by images but also by other relevant patient specific information acquired from a large variety of sources.

As there is a wide spectrum of manufacturers providing devices to collect and process this information, a common standard to interconnect these devices is needed. One of the generally accepted standards, very well established in radiology, to fulfill this need also for surgery is the Digital Imaging and Communication in Medicine (DICOM) standard.

Through the development of two novel DICOM supplements for surgery in 2010, the ICCAS Standards Group, as the driving partner for this activity, has established itself as an internationally recognized group for standards in surgery. One of the next work item handled by the ICCAS Standards Group, carried out in close cooperation with its industrial partners, focuses on the development of a DICOM supplement for optical surface scanners.

In addition to the work on the DICOM standard, the ICCAS Standards Group has continued its effort in 2011 to prepare a new Integrating the Healthcare Enterprise (IHE) domain "Surgery". By means of integration profiles, IHE gives explicit guidelines for using well established standards to harmonize industry-wide efforts in order to connect devices across company borders. In partnership with ISCAS and IFCARS, ICCAS is one of the driving forces behind the intention of establishing the domain "IHE in Surgery".

In 2012 ICCAS Standards group increased its effort in establishing the IHE domain "Surgery" as well as finishing the latest DICOM supplement "Optical Surface Scanners". Both decisions will be made by the respective committee by the end of 2012.

Selected Publications

O. Burgert, P. Liebmann , T. Treichel, H.U. Lemke, IHE in surgery - proposal for a new domain within the integrating the healthcare enterprise initiative, International Journal of Computer Assisted Radiology and Surgery 6 (2011), no. 1, 156.

S. Bohn, S. Franke, O. Burgert, J. Meixensberger, D. Lindner, First clinical application of an open standards based OR integration system, Journal of Biomedizinische Technik/Biomedical Engineering 56 (2011), no. 1, ISSN. 0939-4990.

C. Dressler, M. Rockstroh, P. Liebmann, O. Burgert, Anforderungsanalyse und Entwurf zur Integration von optischen Oberflächenscannern als neue Modalität im DICOM-Standard, 10. Jahrestagung der Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V. (2011), 157-160.

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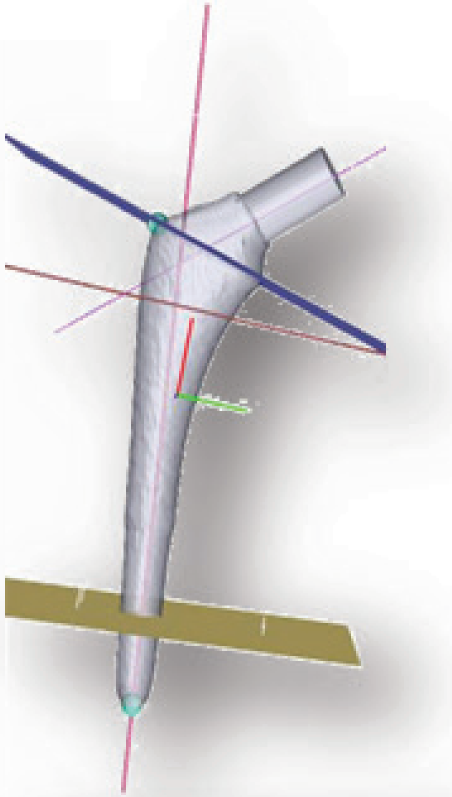
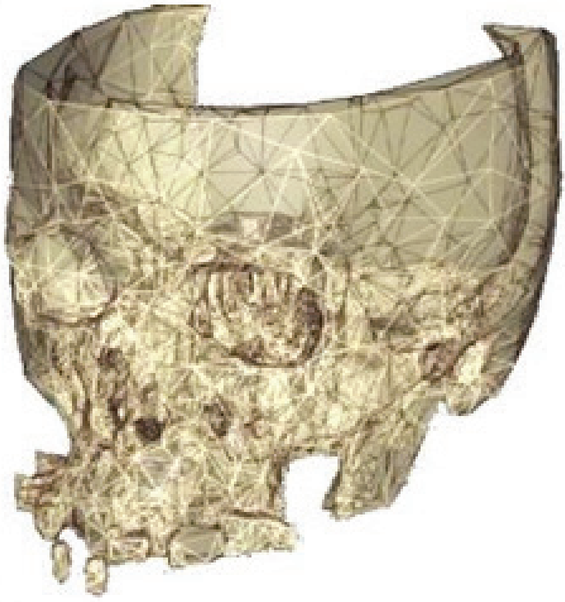
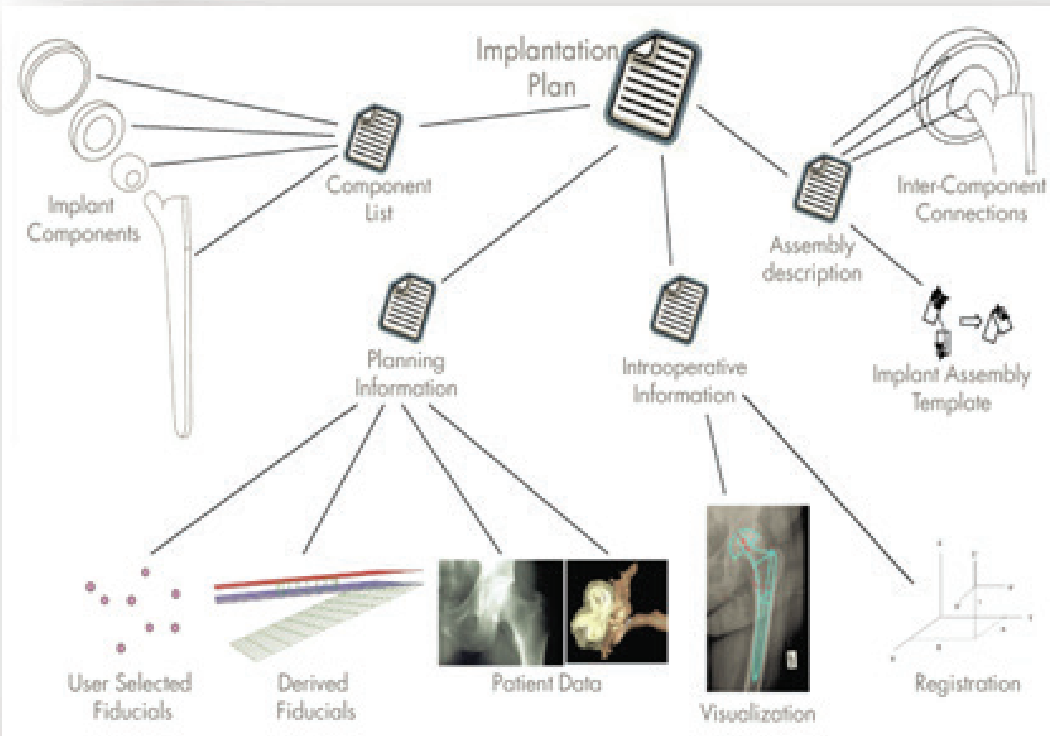
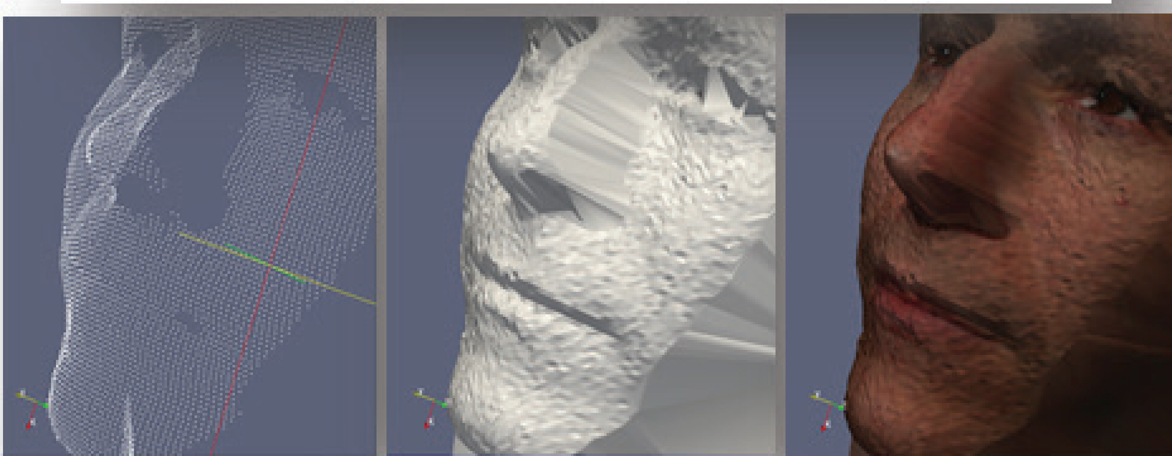





Implantation Plan
Component List
Implant Components
Inter-Component Connections
Assembly description
Planning Information
Intraoperative Information
Implant Assembly Template
User Selected Fiducials
Derived Fiducials
Patient Data
Visualization
Registration



DICOM support for optical surface scanners

In many medical fields, such as Cranio-Maxillofacial Surgery, Dentistry, ENT or Reconstructive Surgery, optical surface scanners (OSS) are gaining more and more importance. 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. Due to this fact the development of applications and clinical use cases based on surface scans are hindered as well as the clinical acceptance of OSS. A requirement and use case analysis for OSS in medicine was performed. Therefore meetings with vendors and stakeholders have been held to identify the individual needs. Based on this analysis, a “Work Item Proposal” was created and granted by the Digital Imaging and Communications in Medicine committee in April 2010. Since the DICOM standard supports most medical imaging devices, such as CT, MRT, or ultrasound it seems natural to add a modality for optical surface scanners to this standard.

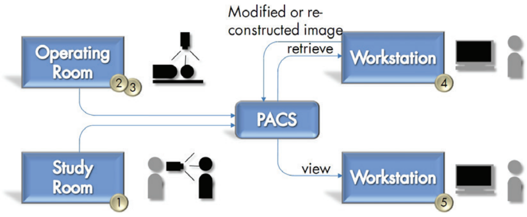


Fig. 1 - Considered workflow for scanning procedure

At the DICOM committee meeting, ICCAS got the assignment to develop an extension of the DICOM standard, a so-called “supplement” for OSS. A first draft of the Supplement has been created and successfully reviewed by the working group six (WG06) “base standard” in November 2010. In 2012 the supplement was under constant development and was reviewed two times by the WG06.

To verify the theoretical approach, a clinical project has been initiated, which allows us to implement one of the use cases: With a mobile pattern scanner, the patient’s nose was recorded inside the study room and in the OR, before and after the surgical intervention.

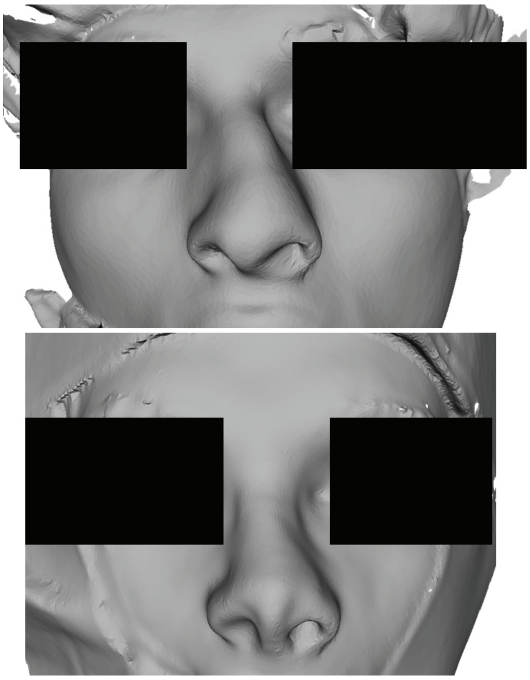


Fig. 2 - 3D surface of face before and immediately after rhinoplasty

Several patients’ noses have been scanned before and after rhinoplasty surgery and the resulting requirements were applied to the supplement proposal. The use of a scanner within the rhinoplasty surgeries improved the development of the DICOM supplement.

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Sirona, CAPS, Planmeca, Frauenhofer IOF
Vialux, Straumann, Steinbichler, 3dMD, Faro

Project Funding Reference Number: 100080517

Gefördert aus Mitteln der Europäischen Union

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EFRE
Europäischer Fonds für regionale Entwicklung

IHE in surgery

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. The aim is to provide interoperability on various levels of integration. This should lead to more robust systems which may also provide a wider range of functionalities and systems features. The “Integrating the Healthcare Enterprise (IHE)” initiative “promotes the coordinated use of established standards such as DICOM and HL7 to address specific clinical need in support of optimal patient care.

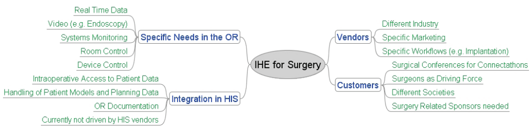

Fig. 1 - Image of the distinguished characteristics of the surgical domain

Systems developed in accordance with IHE communicate with one another better, are easier to implement, and enable care providers to use information more effectively.”[1] It provides the appropriate domain and technical framework structures for a holistic approach to a number of selected areas in health care such as radiology, cardiology, eye care, pharmacy and many others. Surgery and specifically the operating room (OR), however, have not been addressed and covered by IHE integration profiles. Within the surgical domain generally and the OR specifically, there are characteristic needs regarding the technical infrastructure and communication features.

To evaluate the potential benefits of a new IHE Domain “Surgery”, we chose a two-fold approach. First we analysed the existing IHE Profiles regarding their applicability to the surgical domain. In a second step we identified specific characteristics of the surgical domain which are not covered by existing IHE Domains. The analysis of the existing IHE domains and the relevant Integration Profiles (IPs) shows that IHE’s focus is currently on Hospital Information Systems (HIS) and Radiology.

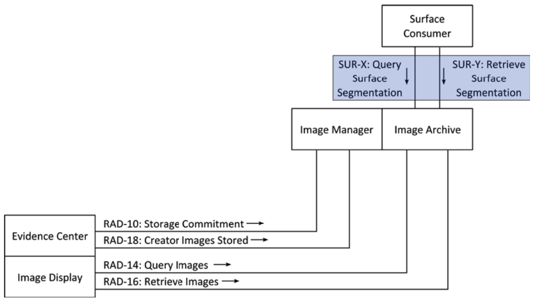

Fig. 2 - Surface Segmentation Actor Diagram

Those Integration Profiles cover only a very limited subset of functionalities needed in a Digital Operating Room. Therefore this project aims on the establishment of an IHE Domain “Surgery”.

[1] *http://www.ihe.net*

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Development of a IHE surgery profile for implant template distribution

Rigid implants like plates, nails, and pins are widely used in everyday clinical practice for several reasons like restoring mobility (e.g. prosthesis for fractures, total hip replacements) or dental implants.

The Digital Imaging and Communications in Medicine (DICOM) standard supports this by offering a standardized way of storing, accessing and sharing implant templates through the DICOM Supplement 131. But DICOM only works in specific environments and does not work between different clinics or between manufacturers and customers. The Integrating the Healthcare Enterprise (IHE) initiative can close this gap, because it offers standardized descriptions on how to use certain well-known and widely used standards like DICOM or HL/7. In IHE healthcare professionals and industry work together to optimize sharing of information in healthcare IT systems. The coordinated use of established standards improves specific clinical processes hence the overall patient care.

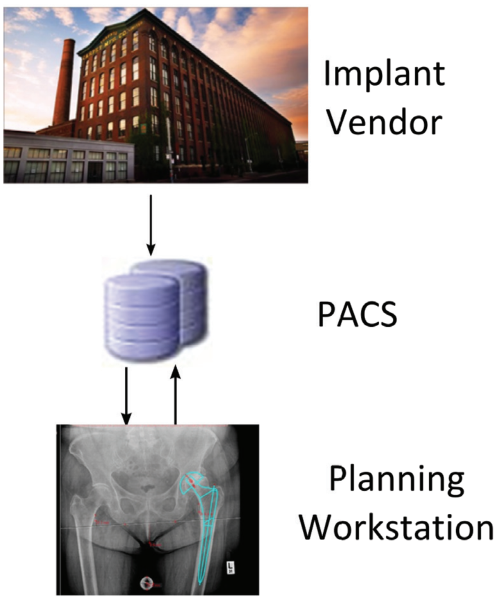

Fig. 1 - Implant Vendors are offering digital implant data for PACS which can be used e.g. within the implantation planning workflow

IHE is organized internally by clinical and operational domains, where experienced users develop consensus with vendors, to address specific integration and information sharing priorities with standards-based solutions.

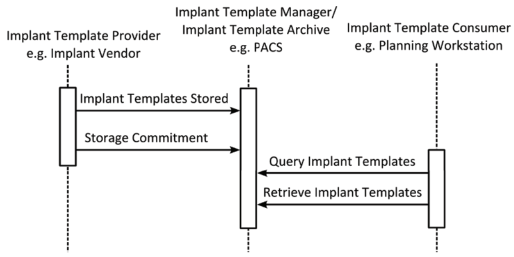

Fig. 2 - Basic Process Flow in Implant Template Distribution Profile

A new domain „Surgery“ will be established soon and Implant Template Distribution (ITD) will be one of the first profiles within this new domain. It defines how the new DICOM standard for implant templates is to be communicated between IHE-conform devices improving interoperability. So implant manufacturers will have a new standardized way to offer digital data about their products, while medical engineers and vendors of relevant medical devices, can ensure a broader use of consistent implant template data throughout the whole clinic.

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IHE/XDS-based infrastructure for information management of model guided therapy

The patient care process evolves from image guided to model guided diagnosis and therapy (MGD/MGT). Patient information such as demographic data, medical images, laboratory results or genome information which is actually stored in different IT systems as well as paper records will be transferred into a central patient model. The creation of this patient specific model starts at the first consultation with a medical practitioner and continuously grows with the resulting information in each treatment step. The complete treatment process from anamnesis, over surgical interventions, and adjuvant therapies ending with after care will also be modeled in a standardized way and stored in numerous process models. These generalized process models are enriched with information from the patient model. Hence, each patient has a customized process model which is tailored to the actual situation and provides the best possible support for the attending physician and therapy for the patient.

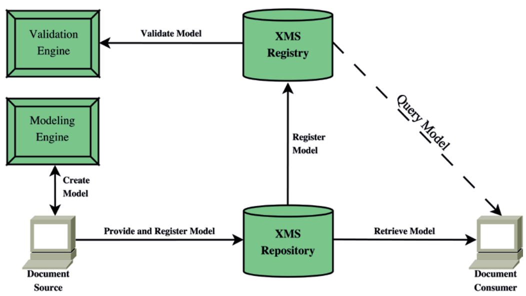

Fig. 1 - Cross-Enterprise Model Sharing System Architecture

The storage of these models should be realized in decentralized and scalable database systems. The access to these databases must not be limited to the site of one hospital but shared between different hospitals and primary healthcare providers, so that all patient relevant information is instantly available to all attending physicians.

The Integrating the Healthcare Enterprise (IHE) association developed an integration profile named Cross Enterprise Document Sharing (XDS), which describes a standardized approach of storing medical information in different repositories and access to this information through a centralized registry all by the use of well-established standards. The information can be shared between multiple hospitals and related facilities.

So far there are no standardized methods presented to store, access and transfer medical process and models. Therefore the IHE XDS profile has been reviewed in order of its abilities to facilitate the requirements of MGD and MGT. The drawbacks of this profile have been pointed out and solutions are proposed for extending XDS to a Cross Enterprise Model Sharing (XMS) integration profile. The XMS System has been realized and evaluated within a prototype implementation.

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GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

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Project Funding Reference Number: 03Z1LN12

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Activities in teaching

ICCAS is the leading research institution in Saxony which is committed to the interdisciplinary education in the field of computer-assisted surgery for Medicine and Computer Science Studies at 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 department, 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 numereous opportunities to students to get acquainted with the highly innovative research topic Computer Assisted Surgery, including project thesis, as well as medical doctor's theses and research internships. The following are offered regulary at the University of Leipzig:

» Medizinische Planungs- und Simulationssysteme (Master, Computer Science)
» Praktikum Computerassistierte Chirurgie (Master, Computer Science)
» Chirurgische Navigation, Mechatronik und Robotik (Master, Computer Science)
» Seminar Informatik in der Chirurgie (Master, Computer Science)
» Berufsfelderkundung für Mediziner (Human Medicine)
» Technische Informatik in der Biomedizin (Master, Computer Science, TU Berlin)
» Bachelorseminar „Grundlagen der medizinischen Informatik (in cooperation with others)" (Bachelor, Computer Science)
» Vorlesungsreihe Computerassistierte Chirurgie (Human Medicine)

Public events

Lange Nacht der Wissenschaften
Leipzig | 2012

Girl's Day
Leipzig | 2012

Scientific events

98th Scientific Assembly and Annual Meeting Radiological Society of North America (RSNA)
Chicago 2012

» M. Sc. Computer Science Philipp Liebmann „DICOM WG24 Meeting"

26th Int. Congress for Computer Assisted Radiology and Surgery (CARS)
Pisa 2012

» **Presentation:** Dipl. Ing. Stefan Bohn „Design of an integrated IT platform to support the oncologic ENT treatment process and concept of a surgical planning unit"
» **Tutorial:** PD Dr. Thomas Neumuth „Surgical Process Modelling and Surgical Workflow"
» M. Sc. Computer Science Philipp Liebmann „DICOM WG24 Meeting"

15th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)
Nice 2012

» **Workshop organization:** PD Dr. Thomas Neumuth "3rd Workshop on Modeling and Monitoring of Computer Assisted Interventions"
» **Workshop organization:** Dipl. Ing. Stefan Bohn "Fifth International Workshop on Systems and Architectures for Computer Assisted Interventions (SACAI)"
» **Presentation:** Dipl. Inf.Stefan Franke "M2CAI 2012 – 3rd Workshop on Modeling and Monitoring of Computer Assisted Interventions"

24th International Conference of the Society for Medical Innovation and Technology (SMIT)
Barcelona 2012

» **Presentation:** Dipl. Ing. Stefan Bohn "A modular and open OR integration system and its application to neurosurgery"

46th German Society for Biomedical Engineering within VDE Annual Conference (DGBMT)
Jena 2012

» **Session chair and Presentation:** Dipl. Ing. Stefan Bohn "An integrated IT-platform for personalized healthcare in oncologic ENT treatment"
» **Presentation:** Dipl. Ing. Jens Meier "Development of a modular IT-framework supporting the oncological patient treatment in ENT surgery"
» **Presentation:** Dr. Claire Chalopin "Brain tumor enhancement revealed by 3D intraoperative ultrasound imaging in a navigation system"
» **Presentation:** Dipl. Ing. Christian Meißner "RFID-based surgical instrument detection using Hidden Markov models"
» **Presentation:** M.Sc. Philipp Liebmann "Prediction of surgical work steps in neurosurgery"

28th Annual Conference German Society for Endovascular and Vascular Surgery (DGG)
Wiesbaden 2012

» **Presentation:** Master en Multimédia Sandra v. Sachsen „Modellbasierten Unterstützung von Stentgraftauswahl"

11th Annual Conference German Society for Computer and Roboter-Assisted Surgery (CURAC)
Düsseldorf 2012

- **Presentation:** Dipl. Inf. Stefan Bohn „Ein Framework zur Datenintegration in der HNO-Tumortherapie“
- **Presentation:** Dipl. Inf. Bernhard Glaser „Konzeption und Basisarchitektur eines OP-Instrumententisch-Überwachungssystems“
- **Presentation:** Master en Multimédia Sandra v. Sachsen „Simulationsgestützte Planung von EVAR Interventionen – Einsatzpotential der Finite Elemente Methode“

57th Annual Conference German Association for Medical Informatics, Biometry and Epidemiology (GMDS)
Braunschweig 2012

- **Presentation:** Master en Multimédia Sandra v. Sachsen “Durchgängige Prozesskette zur Integration eines patientenspezifischen Finite Elemente Modells in den EVAR-Planungsprozess”

ICCAS Kolloquium
Leipzig 2012

- **Presentation:** Dr.-Ing. Stefanie Speidel, KIT, Institute for Anthropomatics Karlsruhe „Kognitive Assistenz in der Chirurgie“
- **Presentation:** Dr. Leiber und Dipl.-Ing Daniel Schubert, Technische Universität Chemnitz „Einfach sicher – Usability in der Medizintechnik“
- **Presentation:** Dr. Alexander Schläfer, Universität Lübeck „Medizinische Robotik: Anwendungen für Prozeß- und Patientenmodelle“
- **Presentation:** Dr.-Ing. Armin Schneider, Technische Universität München „Effektiver Einsatz von Sensorik zur Datenerfassung im Operationssaal“

Leipzig Forum CAS
Leipzig 2012

- Elizabeth Beckmann - Lanmark Mecial Innovations, Kent, England „Development of standards and how to secure industry involvement“
- Prof. Leonard Berliner, MD - New York Methodist Hospital, Department of Radiology „Patient modelling for applications in therapy“
- Prof. Pierre Jannin - Univerité des Rennes 1, MediCIS - Inserm „New developments of process modelling techniques for surgery“
- Prof. Leo Joskowicz - The Hebrew University of Jerusalem, CASIP Lab „“Future surgical navigation technologies”“
- Prof. Brent Liu - University od Southern California, Image Processing and Informatics Lab „EPR-based systems for the OR“
- Prof. Terry Peters, PhD - University of Western Onatrio, Robarts Research Institute „Examples of interdisciplinary cooperation in BIRC”
- Prof. Michael W. Vannier, MD - University of Chicago - Medicine „“The role of molecular imaging for decision making in therapy”

11th Leipzig Research Festival for Life Sciences
Leipzig 2012

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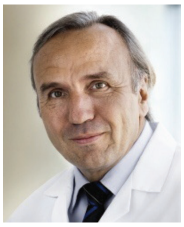

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Invited lectures

Society of Thoracic Surgeons (STS)
31.01.2012 | Florida

» **Lecture:** Prof. Dr. Friedrich W. Mohr „Hands across the ocean - revisited“ (C. Walton Lillehei Lecture)

Siemens Healthcare
09.02.2012 | Erlangen

» **Lecture:** PD Dr. Thomas Neumuth „Prozess- und Workflowmanagement im Operationssaal“

MMVR19/NextMed – „Medicine Meets Virtual Reality“ 2012
10.02.2012 | Newport Beach, USA

» **Lecture:** Prof. Dr. Heinz U. Lemke „The Digital Operating Room - Present and Future“

IfK – Institut für Krankenhauswesen
24.02.2012 | Heiligendamm

» **Lecture:** Prof. Dr. Gero Strauß „eHealth und Telecare - Das Surgical Deck: Erste klinische Erfahrungen mit einem vollintegrierten spezialchirurgischen OP-Saal“

European Congress of Radiology 2012 (ECR)
05.03.2012 | Vienna, Austria

» **Lecture:** Prof. Dr. Heinz U. Lemke „New PACS architecture: decoupling image management from image navigation“

Dräger Medical
23.03.2012 | Lübeck

» **Lecture:** PD Dr. Thomas Neumuth „Prozess- und Workflowmanagement im Operationssaal“

OP Management Kongress
28.03.2012 | Bremen

» **Lecture:** Prof. Dr. Gero Strauß „OP der Zukunft Prozess- und Ablauforientierte Lösungen für den OP“

Symposium 60th Birthday Prof. Kuck
21.04.2012 | Hamburg

» **Lecture:** Prof. Dr. Friedrich W. Mohr „What is left for the cardiac surgeon in 2012?“

129th Congress of the German Society of Surgeons 2012 (DChK 2012)
24.04.2012 | Berlin

» **Lecture:** Prof. Dr. Heinz U. Lemke „Mit Modellen und Standards zum integrierten OP“

Institute for Advanced Study (TUM-IAS)
25.04.2012 | Munich

» **Lecture:** Prof. Dr. Heinz U. Lemke „From Traditional to Model-Guided Medicine"

84th Annual Meeting 2012 of the German Society of Oto-Rhino-Laryngology, Head and Neck Surgery (DGHNO)
19.05.2012 | Mainz

» **Session Chair:** Prof. Dr. Gero Strauß „Round Table Discussion: 468. Interventional Endoscopy"

MIHEalth Health Management & Clinical Innovation Forum 2012
25.05.2012 | Barcelona

» **Lecture:** Prof. Dr. Heinz U. Lemke „The Digital Operating Room - Revolution or Evolution"

iMESS - International Mastercourse on Endoscopic Sinus Surgery
31.05.2012 | Brüssel

» **Lecture:** Prof. Dr. Gero Strauß „Surgical management and Guidance System"

63rd Annual Meeting oft he German Scoiety of Neurosurgery (DGNC) and 7. Joint – Meeting with the japanese Nuerosurgical Society (JNS)
14.06.2012 | Leipzig

» **Präsidentensymposium** „Innovationen im Operationssaal - Implikationen für Patient und Neurochirurg"
Lecture: Prof. Dr. Jürgen Meixensberger „Einführung aus klinischer Sicht" (Computerassistierte Chirurgie)

26th International Congress and Exhibition Computer Assisted Radiology and Surgery 2012 (CARS)
27. – 30.06.2012 | Pisa

» **Tutorial:** Prof. Dr. Heinz U. Lemke „Tutorial on Medical Workstations and Model-Guided Medicine„
» **Lecture:** Prof. Dr. Heinz U. Lemke „Information integration for patient-specific modelling using Multi-Entity Bayesian Networks: example of larygeal carcinoma"
» **Session Chair:** Prof. Dr. Gero Strauß „Computer Assisted ENT Surgery"

34th Annual International Conference of the IEEE Engineering in Medicine & Biology Society "Engineering Innovation in global Health" 2012 (IEEE EMBS)
28.08.2012 | San Diego

» **Tutorial:** Prof. Dr. Heinz U. Lemke „Tutorial on The Digital Operating Room - Present and Future"

24th International Conference of the Society for Medical Innovation and Technology 2012 (SMIT)
22.09.2012 | Barcelona

» **Lecture:** Prof. Dr. Heinz U. Lemke „The Digital Operating Room - Evolution of Modeling and Standards"

Medica 2012
15.11.2012 | Düsseldorf

- **Lecture:** Prof. Dr. Heinz U. Lemke „Modellgeführte personalisierte Chirurgie"
- **Lecture:** Prof. Dr. Heinz U. Lemke „smartOR – plug&play im OP der Zukunft"

Annual Meeting of CTAC at CURAC 2012
16.11.2012 | Düsseldorf

- **Lecture:** PD Dr. Thomas Neumuth „Workflowanalyse und –prädiktion"

8th Einthoven Cardiology Course
14.12.2012 | Leiden

- **Lecture:** Prof. Dr. Friedrich W. Mohr „Heart Failure: towards an integrated approach"

Dallas - Leipzig Valve 2012
05.12.2012 | Dallas

- **Lecture:** Prof. Dr. Friedrich W. Mohr „What Will Cardiac Surgery Look Like in 2020?"

6th Cairo International Conference on Biomedical Engineering 2012 (CIBEC)
20.12.2012 | Cairo

- **Lecture:** Prof. Dr. Heinz U. Lemke „The Digital Operating Room: The impact of patient modeling, workflow management and standards"

Honors and Awards

- Prof. Dr. Andreas Dietz is now honorary member of the austrian ENT Society
- Dr. Thomas Neumuth has been appointed as Privatdozent at the Universität Leipzig
- Silvia Born is awardee of the Karl-Heinz-Höhne Preis for outstanding research in the field of „Visual Computing in Biology and Medicine“
- Silvia Born was awarded with the „Best Paper Award“ at the PacificVis in Korea
- Poster Award of the American Head and Neck Society 2012 in Toronto for Andreas Boehm, Thomas Neumuth, Thomas Pankau, Gero Strauß, Bernhard Preim, Andreas Dietz for their poster: “Documentation and visualization for panendoscopy: Results of workflow analysis with and without 3-D-tumor visualization with the TTM (Tumor Therapy Manager)“

List of Publications

Articles

H.U. Lemke, L. Berliner
PACS for surgery and interventional radiology: Features of a Therapy Imaging and Model Management System (TIMMS), Eur J Radiol (2011), 78(2): 39-242.

H.U. Lemke
Short History of PACS (Part II: Europe), Eur J Radiol (2011), 78(2): 177-183.

T. Beck; S. Gollapudi, S. Brunak, N. Graf, H.U. Lemke, D. Dash, I. Buchan, C. Díaz, F. Sanz, AJ. Brookes Knowledge engineering for health: A new discipline required to bridge the "ICT gap" between research and healthcare, Human Mutation (2012), Vol. 33(5): 797-802.

H.U. Lemke, MW. Vannier, K. Inamura, A.G. Farman, K. Doi, K. Cleary, P. Jannin, D. Caramella, Proceedings of the 26th International Congress and Exhibition Computer Assisted Radiology and Surgery, Int J CARS (2012): 7(Suppl. 1).

H.U. Lemke, M. Cypko, L. Berliner
Information integration for patient specific modelling using MEBNs: example of laryngeal carcinoma, Int J CARS (2012) 7(Suppl 1): 246-248.

W. Niederlag, H.U. Lemke et al.
Der virtuelle Patient, Vol. 16, Health Academy, Dresden (2012).

H.U. Lemke, M. Cypko, L. Berliner
Der virtuelle Patient im Rahmen der Therapieplanung am Beispiel des Larynxkarzinoms, In: W. Niederlag, HU. Lemke et al: Der virtuelle Patient, Vol. 16, Health Academy, Dresden (2012).

W. Niederlag, H.U. Lemke et al.
Der Digitale OP-Saal, Vol. 17, Health Academy, Dresden (2012).

H.U. Lemke
Needed: a holistic patient approach, International Hospital (2012) 38: 27.

H.U. Lemke, L. Berliner
Der digitale Operationssaal – Stand und zukünftige Entwicklungsphasen, In: W. Niederlag, HU. Lemke et al: Der Digitale OP-Saal, Vol. 17, Health Academy, Dresden (2012).

S. Mueller, G. Wichmann, L. Dornheim, I. Roessling, J. Bertolini, B. Preim, A. Dietz, A. Boehm
Different approaches to volume assessment of lymph nodes in computer tomography scans of head and neck squamous cell carcinoma in comparison with a real gold standard, ANZ J Surg (2012), 82(10): 737-41.

A. Dietz, W. Quach, S.K. Lund, M. McKelvey
AAC assessment and clinical-decision making: the impact of experience, Augment Altern Commun (2012), 28(3): 148-59.

G. Strauss, T. Maier, M. Krinninger, T. Berger, A. Dietz, T.C. Lüth
Clinical use of a micromanipulator system: preliminary clinical experience in middle ear surgery, HNO (2012), 60(9): 807-13.

M. Fischer, C. Gröbner, A. Dietz, T.C. Lüth, G. Strauss
First clinical experiences with an endoscope manipulator system in endo- and transnasal surgery, Laryngorhinootologie (2012), 91(8): 487-93.

M. Hofer, T.C. Lüth, A. Dietz, G. Strauss
Potential of the navigated controlled surgery at the lateral skull base with the navigated control unit (NCU 2.0), Stud Health Technol Inform (2012), 173: 183-5.

G. Strauss, S. Schaller, W. Wittmann, B. Zaminer, M. Strauss, S. Nowatschin, M. Hofer, J. Meixensberger, A. Dietz, T.C. Lüth
The first clinical use of an Dynamic Registration Tool for Navigation in FESS, Laryngorhinootologie (2012), 91(3): 168-73.

M. Fischer, C. Mozet, U. Hesse, A. Dietz, G. Strauss
Impact of transtympanic miniature endoscopy of the middle ear--a conceptual cadaver study, Laryngorhinootologie (2012), 91(3): 174-81.

A. Müns, S. Arnold, A. Schmitgen, C. Chalopin, F. Arlt, J. Meixensberger, D. Lindner
Improvement of neuronavigation based on ultrasound by means of the digital video interface, Biomed Tech (2012).

G. Strauss, S. Schaller, W. Wittmann, B. Zaminer, M. Strauss
Der erste klinische Einsatz einer dynamischen (Nach)Registrierung für die Navigation in der FESS (Dynamic Registration Supply DRS), Laryngo-Rhino-Otol (2012), 91(03): 168-173.

G. Strauss, T. Maier, M. Krinninger, T. Berger, A. Dietz, T.C. Lüth
Klinischer Einsatz eines Mikromanipulators Erste Erfahrungen in der Mittelohr- und Felsenbeinchirurgie HNO (2012), 60: 807–813.

M. Hofer, T.C. Lüth, A. Dietz, G. Strauss
Potential of the navigated controlled surgery at the lateral skull base with the navigated control unit (NCU 2.0), Stud Health Technol Inform (2012), 173: 183-5.

T. Neumuth, C. Meißner
Online recognition of surgical instruments by information fusion, Int J CARS (2012).

T. Neumuth, F. Loebe, P. Jannin
Similarity metrics for surgical process models, Artif Intell Med (2012).

M. Hofer, A. Runge, R. Haase, T. Neumuth, T. Maier, T.C. Lüth, A. Dietz, G. Strauss
A surgical micromanipulator in ear surgery: potential and comparison to freehand preparation, HNO (2012), 60(2): 109-16.

A. Krauss, T. Neumuth, R. Wachowiak, B. Donaubauer, W. Korb, O. Burgert, O. J. Muensterer
Laparoscopic versus robot-assisted Nissen fundoplication in an infant pig model. Pediatr Surg Int (2012), 28(4): 357-362.

C. Meißner, T. Neumuth
RFID-based surgical instrument detection using Hidden Markov models, Biomed Tech (2012).

A. Boese, M. Schmidt, T. Neumuth, G. Rose
Definition of product requirements of a MR compatible bone biopsy system using workflow analysis, Biomed Tech (2012).

J. Meier, A. Boehm, E. Schreiber, S. Lippert, T. Neumuth, S. Bohn
Development of a modular IT-Framework supporting the oncological Patient Treatment in ENT Surgery, Biomed Tech (2012).

J. Seeburger, S. Leontjev, T. Neumuth, T. Noack, M. Höbartner, M. Misfeld, M.A. Borger, F.W. Mohr
Trans-apical beating-heart implantation of neo-chordae to mitral valve leaflets: results of an acute animal study Eur J Cardiothorac Surg (2012), 7: 402-403.

G. Strauss, I. Gollnick, T. Neumuth, J. Meixensberger, T.C. Lüth
The ‚Surgical Deck': A New Generation of Integrated Operational Rooms for ENT, Laryngorhinootologie (2012).

T. Neumuth, P. Liebmann, P. Wiedemann, J. Meixensberger
Surgical Workflow Management Schemata for Cataract Procedures. Process Model-based Design and Validation of Workflow Schemata, Methods Inf Med (2012), 51(5): 371-382.

S. Franke, J. Meixensberger, T. Neumuth
Intervention time prediction from surgical low-level tasks, J Biomed Informatics (2012).

S. Bohn, D. Lindner, S. Franke, T. Neumuth, J. Meixensberger
A modular and open OR integration system and its application to neurosurgery, Minimally Invasive Therapy & Allied Technologies (2012).

S. Bohn, J. Meier, T. Neumuth, G. Wichmann, G. Strauß, A. Dietz, A. Boehm
Design of an integrated IT platform to support the oncologic ENT treatment process and concept of a surgical planning unit, Int J CARS (2012), 7(Suppl. 1): 402-403.

S. Bohn, T. Neumuth, J. Meier, G. Strauß, A. Boehm
An integrated IT-platform for personalized healthcare in oncologic ENT treatment, Biomed Tech (2012).

S. Bohn, S. Franke, T. Neumuth
Interoperability of medical devices within the operating room using service-oriented integration, Abstract Book of the 34th Annual Int. Conf. of IEEE Engineering in Medicine and Biology Society (EMBC 2012).

J. Meier, P. Liebmann, T. Neumuth, H.U. Lemke
IHE/XDS-based infrastructure for information management of model guided therapy, Int J CARS (2012), 7(Suppl. 1): 469-482.

S. Franke, E. Schreiber, T. Neumuth
A time and resource management support system for the digital operating room based on surgical process models, Int J CARS (2012), 7(Suppl. 1): 507-508.

Conference Proceedings

C. Meißner, T. Neumuth
Recognition of Surgical Actions using Acceleration Sensor Signals and Hidden Markov Models, Leipzig Research Festival for Life Sciences, Leipzig (2012).

C. Chalopin, F. Artl, A. Müns, J. Meixensberger, B. Preim, D. Lindner
3D intraoperative contrast enhanced ultrasound imaging for the representation of glioblastoma tumors, Leipzig Research Festival for Life Sciences, Leipzig (2012).

J. Meier, A. Boehm, A. Kielhorn, T. Neumuth, S. Bohn
oncoFlow - Oncological Workflow Assistance in ENT Surgery ,Leipzig Research Festival for Life Sciences, Leipzig (2012).

M. Rockstroh, T. Neumuth
Detection of device activities and the extraction of relevant information based on video data, Leipzig Research Festival for Life Sciences, Leipzig (2012).

M. Unger, C. Chalopin, T. Neumuth
Monitoring of Surgical Activity using Thermal Imaging, Leipzig Research Festival for Life Sciences, Leipzig (2012).

P. Liebmann, S. Franke, T. Neumuth
Towards a conceptual framework for a situation aware autonomic workflow adaption in the OR, Leipzig Research Festival for Life Sciences, Leipzig (2012).

S. von Sachsen, B. Senf, H.-J. Florek, J. Meixensberger, F.W. Mohr, C. D. Etz
Simulation-based Approach for Implant Planning in Aortic Aneurysm Repair, Leipzig Research Festival for Life Sciences, Leipzig (2012).

S. Born, M. Markl, G. Scheuermann
Illustrative Visualization of Cardiac and Aortic Blood Flow from 4D MRI Data, Leipzig Research Festival for Life Sciences, Leipzig (2012).

S. Bohn, J. Meier, A. Boehm
An IT-Infrastructure to improve the process of decision making in interdisciplinary tumorboards, Leipzig Research Festival for Life Sciences, Leipzig (2012).

B. Glaser, T. Neumuth
Towards an architecture and a graphical user interface for intra-operative detection of surgical instruments, Leipzig Research Festival for Life Sciences, Leipzig (2012).

S. Schumann, R. Wachowiak, H. Till, U. Bühlingen, T. Neumuth
Correlation of distance measures and quality outcome in surgical processes. Leipzig Research Festival for Life Sciences, Leipzig (2012).

S. Dänzer, S. Freitag, S. v. Sachsen, H. Steinke, M. Leimert, M. J. Groll, J. Meixensberger
Statistical Model-based Segmentation Method for assisting Cervical Spine Interventions
Leipzig Research Festival for Life Sciences, Leipzig (2012).

B. Glaser, T. Neumuth
Konzeption und Basisarchitektur eines OP-Instrumententisch-Überwachungssystems, 11. Jahrestagung der Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V. – CURAC, Düsseldorf (2012).

S. von Sachsen, O. Burgert, J. Meixensberger, B. Senf, F.W. Mohr, C. D. Etz
Simulationsgestützte Planung von EVAR Interventionen – Einsatzpotenzial der Finite Elemente Methode, 11. Jahrestagung der Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V. – CURAC, Düsseldorf (2012).

S. Bohn, J. Meier, T. Neumuth, A. Dietz, A. Boehm
Ein Framework zur Datenintegration in der HNO-Tumortherapie, 11. Jahrestagung der Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V. – CURAC, Düsseldorf (2012).

S. Bohn, S. Franke, O. Burgert, T. Neumuth
An integration architecture with centralized control for medical devices in the digital operating room, Proceedings of Fifth International Workshop on Systems and Architectures for Computer Assisted Interventions (SACAI), 15th International Conference on Medical Image Computing and Computer Assisted Intervent, Nizza (2012).

A. Boehm, S. Bohn, T. Neumuth, G. Wichmann, B. Preim, A. Dietz
Entwicklung einer integrierten IT Plattform zur Unterstützung des gesamten onkologischen Behandlungsprozesses und Konzept für eine surgical planning unit (SPU), 2. Symposium zur experimentellen und klinischen Forschung in der Kopf-Hals-Onkologie, Lübeck (2012).

S. Franke, P. Liebmann, T. Neumuth
Prediction of remaining procedure time from current surgical activities, Proceedings of 3rd International MICCAI Workshop on Modeling and Monitoring of Computer-Assisted interventions, Nizza (2012).

A. Boehm, T. Neumuth, T. Pankau, S. Müller, B. Preim, A. Dietz
Documentation and visualization with the TTM (Tumor Therapy Manager) for panendoscopy: results of workflow analysis of the panendoscopy and the documentation process with and without the TTM, 8th International Conference on Head and Neck Cancer, Toronto (2012).

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