UNIVERSITÄT LEIPZIG

Faculty of Medicine

Innovation Center Computer Assisted Surgery

RESEARCH REPORT

2011

iccas innovation center computer assisted surgery

Imprint

Editor

Innovation Center Computer Assisted Surgery (ICCAS)
Faculty of Medicine
Universität Leipzig
Semmelweisstrasse 14
04103 Leipzig
Germany
e-Mail: info@iccas.de
Tel: +49 (0)341 97 – 12000
Fax: +49 (0)341 97 – 12009

Layout

Bernhard Glaser
Max Rockstroh

Disclaimer

Contents

To the reader

Prof. Dr. med.
Jürgen Meixensberger

Dear Ladies and Gentleman, dear colleagues

For ICCAS, the year 2011 was a year of reopening. Supported by the second funding period for centers of innovation competence by the German Federal Ministry of Education and Research (BMBF) the institute continued its promising research in computer-assisted surgery. In the upcoming five years until 2016 we will focus on advanced research topics to emphasize the development of our unique characteristics and to achieve a permanent continuation of the institute.

The research field Digital Patient and Process Model (DPM) and Model-based Automation and Integration (MAI) will be the focal points of the new working groups at ICCAS. Additionally, the third ICCAS-column Standardization (STD) that is supported by the European Fund for Regional Development (EFRE), will play an important role in the ICCAS research landscape. The research groups MAI and STD started their works mid of 2011. MAI, headed by Dr. Thomas Neumuth, develops high-technology for the operating room of the future, accompanied by the general strategy of model-guided therapy. The research group STD under scientific supervision of Prof. Dr. Heinz U. Lemke focuses on the development of standardized interfaces for modular model-based surgical assist systems based on DICOM and IHE. The start of the research group DPM is expected for beginning 2012. For the convenient support of the ICCAS research groups, the demonstrator operating room 2.0, also funded by the BMBF, was inaugurated in December 2011. ICCAS is the scientific initiator of the development of medical research cluster Leipzig including University of Applied Science Leipzig (HTWK) , International Research and Development Center (IRDC) and other partners.

ICCAS has become one of the leading sites for computer-assisted surgery in Europe that was approved by the leading involvement of ICCAS scientists in scientific events for advanced research topic such as Surgical Workflows and modular system architectures for computer-assisted surgery at international conferences like CARS and MICCAI. The ongoing research projects at ICCAS were positively and externally evaluated by the ICCAS advisory board, consisting of renowned scientists and industry representatives, at the end of 2011.

We are delighted, that Oliver Burgert, group leader from the first funding period, was announced as professor at the Reutlingen University due to his remarkable working results. All the more, ICCAS researcher Sandra Schumann received the price for advanced scientific achievements in medicine and life science at the research festival of the Leipzig University.

Prof. Dr. Jürgen Meixensberger
Head of the board

Research Activities

Dr. Thomas Neumuth

Model-based Automation and Integration

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

The strategic goal of the working group „Model-based Automation and Integration“ is the development and integration of information systems and technologies for the 'digital' operating room of the future. These information systems are designed to automatically supervise the technologies that participate in the surgical intervention, to visualize the current intervention progress to the surgeon, the nurses, and the technical staff, as well as to initiate situation-dependent parameterization of the technical OR environment to provide an optimum support for patient treatment. Furthermore, the objective of the group is the design of a "Surgical Cockpit" that assists the surgeon to help him to focus on surgical tasks.

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

The group has started at May 1, 2011. Current major development objectives are the development of a centralized data retrieval and storage system to capture data from the technical OR infrastructure, the development of strategies and systems for online situation recognition in the OR, the design and evaluation of process navigation strategies and user interfaces in the context of a surgical management and guidance system as well as the optimization and technical streamlining of surgical planning and the provisioning of preoperative data in the operating room.

Selected Publications

Neumuth T, Jannin P, Schlomberg J, Meixensberger J, Wiedemann P, Burgert O. Analysis of Surgical Intervention Populations Using Generic Surgical Process Models. Int J Comput Assist Radiol Surg. 2011;6(1):59-71.

Neumuth T, Krauss A, Meixensberger J, Muensterer O. Impact quantification of the DaVinci Telemanipulator system on the surgical workflow using resource impact profiles. Int J Med Robot. 2011; 7(2):156-164.

Liebmann P, Müller M, Meixensberger J, Wiedemann P, Neumuth T. A method for surgical workflow schema generation from patient individual process models. International Journal of Computer Assisted Radiology and Surgery 2011. 6(sup 1):139-140.

Neumuth D, Loebe F, Herre H, Neumuth T. Modeling Surgical Processes: A Four-Level Translational Approach. Artificial Intelligence in Medicine. 2011;51(3):147-161.

Digital Patient Model

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

The strategic goal of the working group "Digital Patient Model" is the further development of patient data sets towards a digital model of the patient. This digital patient model has the purpose to serve as central instance for model guided diagnosis and therapy and contains all therapy relevant pre- and intraoperative data. In 2011, previous works which were related to concrete clinical applications have been continued. The official start of the new group "Digital Patient Model" is expected at January 1st, 2012.

Recent works comprise 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.

The patient has to be presented as a model.

The requirements for the group are:

- The description of static and dynamic patient properties.
- The highlighting of the relevance of these properties.
- The identification of relations between the parameters.
- The integration of static and dynamic causes and relations with varying significances, uncertainty, and predictability.

Selected Publications

M.E. Karar, M. John, D. Holzhey, V. Falk, F.W. Mohr, O. Burgert, Model-Updated Image-Guided Minimally Invasive Off-Pump Transcatheter Aortic Valve Implantation,14th International Conference on Medical Image Computing and Computer Assisted Intervention (2011), 273-280.

D.R. Merk, M.E. Karar, C. Chalopin, D. Holzhey, V. Falk, F.W. Mohr, O. Burgert O, Image-guided transapical aortic valve implantation: Sensorless tracking of stenotic valve landmarks in live fluoroscopic images, Journal of Innovations: Technology and Techniques in Cardiothoracic and Vascular Surgery (2011), 6: 231-236.

R. Neugebauer, M. Werner, C. Voigt, H. Steinke, R. Scholz, S. Scherer, M. Quickert, Experimental modal analysis on fresh-frozen human hemipelvic bones employing a 3D laser vibrometer for the purpose of modal parameter identification, J Biomech (2011), 44(8): 1610-1613.

S. Scherer, T. Treichel, N. Ritter, G. Triebel, W.G. Drossel, O. Burgert O, Surgical stent planning - Simulation parameter study for models based on DICOM standards, Int J CARS (2011), 6(3): 319-327.

Prof. Lemke

Standards

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.

Devices must be connected across company borders.

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".

Selected Publications

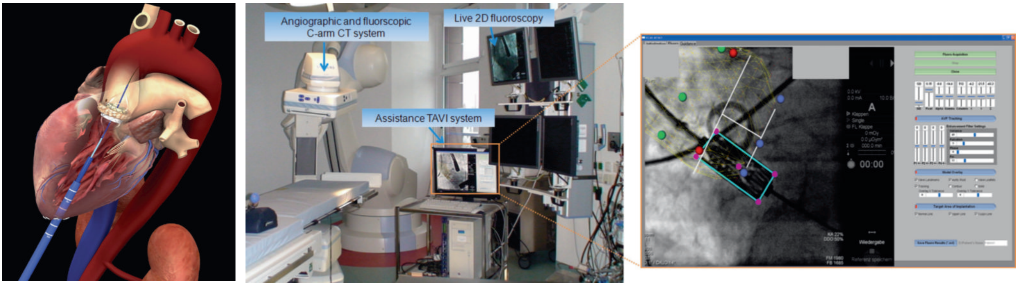
O. Burgert, P. Liebmann, T. Treichel,
IHE in surgery - proposal for a new domain within the integrating the healthcare enterprise initiative,
International Journal of Computer Assisted Radiology and Surgery 6 (2011), no. 1, 156

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

Model-based Automation and Integration

Development of a Surgical Assistance System for Guiding Transcatheter Aortic Valve Implantation



Left: schematic view of transapical TAVI approach (Courtesy of Edwards Lifesciences, Irvine, CA, USA).
Center and Right: Integration of the assistance system to guide the TAVI in a hybrid operating room and a screenshot of the developed graphical user interface.

Transcatheter aortic valve implantation (TAVI) is a new minimally invasive surgical technique to treat severe aortic valve stenosis in elderly and high-risk patients. The placement of stented aortic valve prosthesis is crucial under intraoperative fluoroscopy guidance. Thus, a new fluoroscopy-based assistance system has been developed to assist the placement of the prosthesis during the intervention.

The developed assistance system augments a 3D geometrical aortic mesh model and anatomical valve landmarks with live 2D fluoroscopic images. The 3D aortic mesh model and landmarks are derived from angiographic and fluoroscopic C-arm CT system. A target area of valve implantation is automatically estimated using these valve landmarks. Based on template matching approach, the overlay of 3D aortic root model onto 2D fluoroscopic images is updated by approximating the aortic root motion from a pigtail catheter motion without contrast agent. A rigid intensity-based registration method has been used to continuously track the aortic root motion in the presence of contrast agent. The aortic valve prosthesis is also tracked to assist the valve deployment. Interactive graphical user interface is developed to initialize the system algorithms, to control the visualization view of guidance results, and to correct manually overlay errors if needed.

Experiments were retrospectively carried out on 15 patient datasets from the clinical routine of TAVI in a hybrid operating room. The maximum displacement errors were less than 2.0 mm and 0.5 mm for the dynamic overlay of aortic root models and tracking the prosthesis respectively, and within the clinically accepted ranges. The developed assistance system provides a potentially helpful tool for the surgeon by automatically defining the appropriate placement position of the prosthesis in live fluoroscopic images.

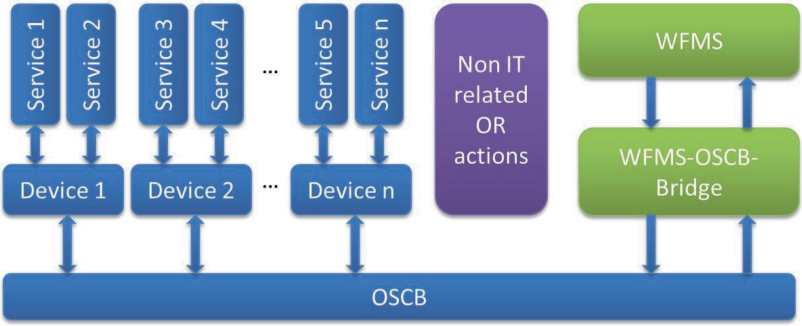
Mohamed Esmail Karar
(M.Sc. Eng.)

Mohamed.Karar@iccas.de

Universität Leipzig Partners
Department of Cardiovascular Surgery, Heart Center

External Partners
Siemens Healthcare, Forchheim
DAAD

Surgical Workflow Management Systems for the operating room of the future



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

In modern operating rooms, especially during complex surgery, a variety of technical devices are involved. Interaction between these devices is limited due to a lack of common interfaces. 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.

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

Stefan Franke
(Dipl.-Inf.)

Stefan.Franke@iccas.de

Philipp Liebmann
(M.Sc. Computer Science)

Philipp.Liebmann@iccas.de

Thomas Neumuth
(Dr.)

Thomas.Neumuth@iccas.de

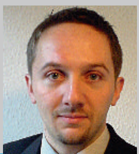
External Partners

Deutsche Gesellschaft für Biomedizinische Technik (DGBMT) im VDE
LOCALITE GmbH
Richard Wolf GmbH
RWTH Aachen, Lehrstuhl für Medizintechnik
SurgiTAIX AG
Synagon GmbH

Evaluation and first clinical application of a modular and open OR integration system in neurosurgical interventions

Left: The sterile surgical control console with touchscreen provides access to primary device functions of the integrated OR system. Right: Review and selection of images acquired during intervention for postoperative documentation.

Systems integration in the operating room (OR) has the potential to increase the ergonomic conditions by centralized access and control as well as a consistent electronic perioperative data-flow. An OR integration infrastructure, which is based on open and standardized communication protocols has been developed and clinically evaluated within neurosurgical interventions. The OR integration system encapsulates medical devices and clinical information systems within a service-oriented architecture. Methods of context and data integration enable seamless electronic transfer of preoperative planning data into the OR and to postoperative documentation. A surgical control console has been developed, which allows the surgeon or scrub nurse to control basic functions of the integrated system, such as PACS access, display switching, application control, and screenshot capturing within the sterile field. Methods of context synchronization eliminate the need of error-prone manual entering of patient information in each of the separate modalities. Clinical user acceptance has been evaluated using workflow studies and questionnaires addressing 15 ergonomic and functional aspects. The developed system integrates imaging modalities, navigation systems and PACS at a ceiling mounted display, thus increasing ergonomic conditions. Basic functions, which formerly interrupted the surgical workflow, e.g. waiting for the unsterile OR assistant to control devices can immediately be accomplished by the surgeon or scrub nurse using the surgical control console. Data acquired during intervention are automatically assigned with the patient context and seamlessly documented within the PACS, thus eliminating the need for removable media. The clinical evaluation successfully demonstrated the practical feasibility of the OR integration system. Ergonomic centralized information display close to the surgical situs and access to planning or preoperative data supports the surgeon to better assess the current surgical situation. The surgical control console within the sterile field provides the surgeon with additional flexibility in controlling device functions immediately on demand.

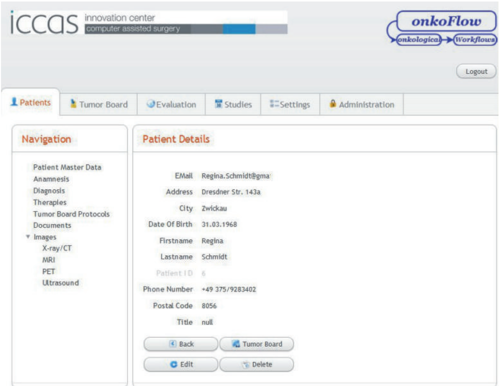


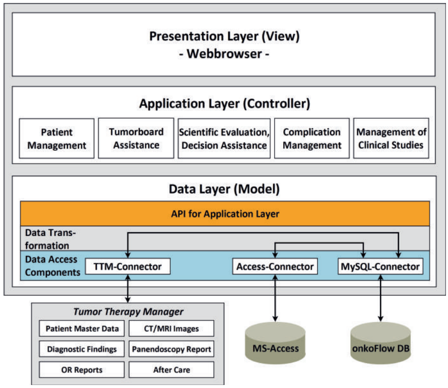
Stefan Bohn
(M. Eng.)

Stefan.Bohn@iccas.de

Universität Leipzig Partners
Department of Neurosurgery

Design of a Workflow Based Oncological Patient Care Support System with Clinical Decision Support





Left: onkoFlow user interface with toolbar for choosing the modules, module specific navigation panel and tumor board list. Right: onkoFlow modular system architecture with user interface, assistance components and interfaces for data exchange.

The workflows in the oncology department in many hospitals are characterized by lacking sufficient IT support throughout the whole patient care process. This results in information which is not accessible for all physicians in digital form as well as a large amount of paper based records. Furthermore, the tasks of printing, scanning and searching of documents by clinical staff is time consuming, hence, expensive. The concept of onkoFlow will support the patient treatment process in oncology departments with an intuitive-to- use IT system. The modular onkoFlow architecture has interfaces to the main clinical information systems and collects patient master data, reports, laboratory results, tumor classifications, tumor board protocols, OR reports and after-care. This information is stored in an electronic patient record and ist instaltly accessible from each hospital computer workstation via web browser and through each physician involved in the patient treatment. In addition the system will offer scientific evaluations, which are based on the large amount of structured patient information in the database. These evaluations can be used for a therapy assistance and decision support module, which helps the attending physician finding the best therapy for the individual patient. Further modules provide the management of complications and clinical studies. The clinical studies benefit from the integrated scientific evaluation module, so that new patient information will instantly be checked against study requirements and onkoFlow informs the physician. In summary onkoFlow is expected to support the physicians along the whole oncological patient care process, to support the creation and easy access to clinical documents as well as can save time that can be spent in patient treatment.

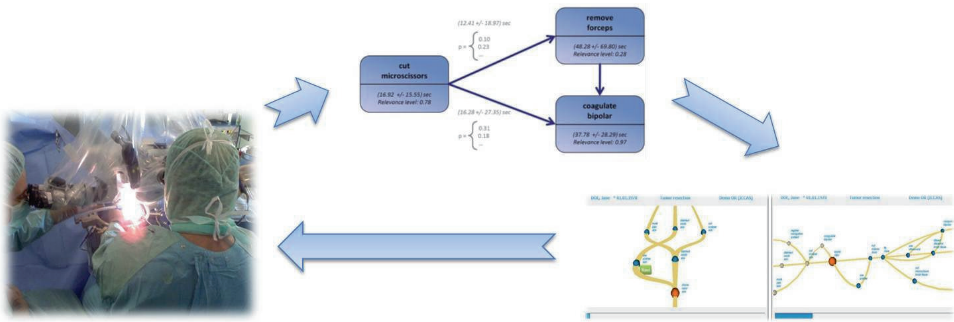
Jens Meier
(Dipl.-Ing.)

Jens.Meier@iccas.de

Universität Leipzig Partners
Department of ENT Surgery

External Partners
How to organize GmbH

Metronom - Intra-operative prediction of intervention time parameters based on surgical workflows



Schematic representation of the integration of surgical process and the Metronom software.

Operating rooms are one of the most expensive units in a hospital. A technical support of time and resource management in the operating room itself as well as across departments might help in improving surgical patient care and reducing costs. The expected time left during interventions is one of the main aspects for enhanced scheduling and resource management. Patient-individual surgical process models represent the course of an intervention with several tasks on a time line. Hence, these data is a promising starting point for the development of a technical support for time management.

We developed a process model for brain tumor resections based on Markov Model Theory. It includes over 80 different tasks performed by the surgeon and the operating room personnel during surgery. The tasks are interconnected via transitions based on the recorded interventions. Additionally, averaged duration information is attached to each task and transition within the generalized surgical process model. It is automatically constructed using 40 patient-individual process models (iSPM) recorded by ICCAS since 2007. A simplified detail of the generalized surgical process model for brain tumor resections is shown in figure 1.

Furthermore, a modular system supporting time management was developed. Its major prediction algorithm estimates several time parameters at any phase during a brain tumor resection. The algorithm simulates the various possible subsequent courses of the intervention according to the model. Finally, the results of these simulations are combined to generate the overall prediction.

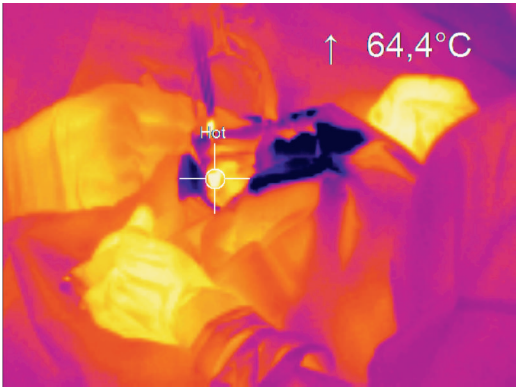
A concise 3D visualization of the surgical process model and chosen predicted parameters is included in the software prototype (figure 1, right).

The time management system will support intervention scheduling and the management of resources shared among different operating rooms, thus reducing resource conflicts. Thereby the presented method will also contribute to the improvement of surgical workflow and patient care.

Stefan Franke
(Dipl.-Inf.)

Stefan.Franke@iccas.de

Development of a miniature temperature sensor for medical applications



Left: Infrared camera PI160
Right: Heat generation during coagulation

During operations heat is generated by several processes which may damage healthy tissue. Heat is generated for example by milling operations. Preventing local heating during milling operations is important for the mending of the tissue. If there are nerves near the milling region these may be damages although not are mechanically damaged by the milling process itself. Another possibility of thermal damaging is the application of high frequency surgery or the use of a laser.

The goal of the project is the development of a temperature sensor including the measurement and processing system for medical applications. The temperature sensor should be of a miniature form factor to be able to attach it directly onto surgical instruments. The advantage of this solution is the unimpaired view of the surgeon onto the operating field.

For visualizing purposes the temperature distribution of the operating field should be displayed as a temperature encoded map. To reduce the amount of information only imported areas with an elevated temperature should be displayed.

Several systems exist to measure the temperature during such operations. Some of them are not practically applicable because of its invasive character. One system widely used for temperature measurements is infrared thermography. Infrared cameras allow a contactless temperature measurement. But there are some constraints which need to be considered when thermography is used for intraoperative temperature measurement. It is examined whether infrared thermography is applicable for intraoperative temperature measurement and which requirements need to be met. Therefore, an infrared camera's accuracy is examined. Furthermore, the influence of several parameters on the temperature measurement is examined.

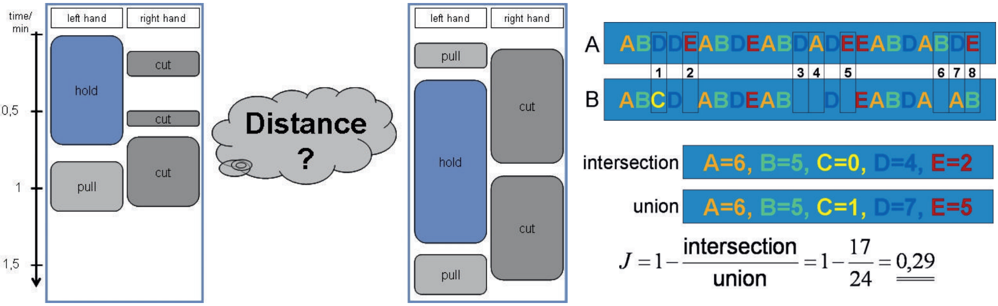
Michael Unger
(M.Sc.)

Michael.Unger@iccas.de

Universität Leipzig Partners
Department of ENT-surgery

External Partners
Phacon GmbH
Micro-Hybrid Electronic GmbH

Distance assessment between surgical processes



Left: Illustration of the problem, to measure the distance between surgical processes. Upper right: There are many options to transform workflow A into B. One using a minimal number of edit operations is shown here, the Levenshtein distance being L=8. Lower right: Computing the Jaccard distance for workflow A and B, result was J=0,29.

The focus of analyzing surgical processes should not be on quantitative issues, as frequency of activities or duration of the intervention only, but also on the work flow itself. The present work employs different strategies to compute the differences between surgical processes, resulting in concrete distances.

To analyze a complex process, it is sensible to split it up into single activities. Therefore, a surgical process model (SPM), recorded with the help of trained observers using the Surgical Workflow Editor, was used to represent the process in a semi-formal way. We adapted established methods to measure distances, such as the Jaccard and the Levenshtein distances. Using SPMs recorded in a mock-up scenario, we evaluated surgical access strategies for minimally invasive laparoscopic pediatric surgery. For the analysis, we have devised 3 tasks derived from standard intervention procedures. These were then performed by experienced and inexperienced surgeons. In addition, the quality of the tasks' results was reviewed. With the help of the distances we calculated how strong the difference between the work flows was.

Future work might analyze the prediction of management ratios or results of the distance, such as the correlation between the distance of SPMs and the quality outcome. Also, surgical training in new surgical techniques can be enhanced and the application of innovative procedures tested.

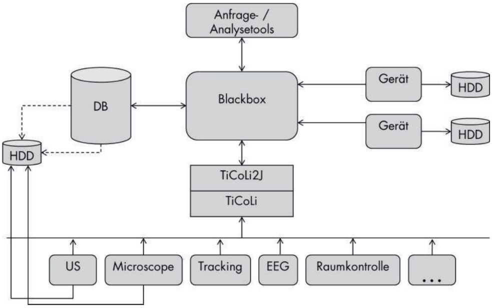
The methods to measure distances between SPMs allow for a multitude of possible analyzing scopes, especially with respect to the complex and variable environment of the OR.

Sandra Schumann
(Dipl.-Wirtsch.-Inf.)

Sandra.Schumann@iccas.de

Universität Leipzig Partners
Department of Pediatric Surgery

A concept of a surgical data recorder and the realtime provision of intraoperative data using the TiCoLi-Toolkit



Left: Embedding of the Blackbox into the operating room environment
Right: 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 technician can view status and error messages.

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

The TiCoLi is a toolkit developed at the ICCAS since 2009 which provides different functionalities for software integration in the operating room (OR). Some of these functionalities are the automatic device and service detection and the possibility to subscribe data streams (i.e. vital data) or attributes (i.e. whether a device is currently in use or not). The surgical blackbox uses the functionalities of the TiCoLi with a socket-based communication protocol (TiCoLi2J) to get all data available on the OR communication bus. Depending on the type of data the surgical blackbox stores them in a postgreSQL database as well as in a circular buffer for online access. Devices with a high data throughput such as HD-video cameras store their streams on local hard drives and promote the endpoint reference to the blackbox.

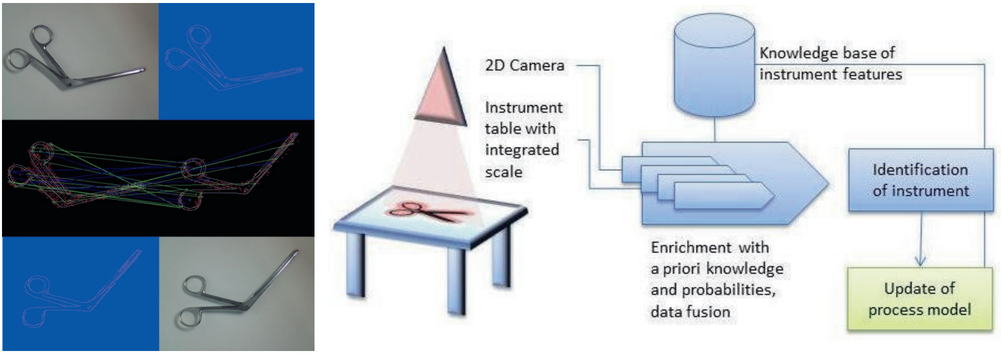
Currently there are two opportunities to access the data during intervention. The technician can check the currently acquired data using a graphical user interface. Furthermore, an easy to implement socket interface is provided for access to the stored information.

Hence the surgical blackbox supports automatic recognition of the interventional situation by providing a centralized data storage and access interface on the OR communication bus.

Max Rockstroh

Max.Rockstroh@medizin.uni-leipzig.de

A concept for intra-operative identification of surgical instruments using 2D camera data and scales



Left: Visualization of the matching of a straight Blakesley instrument camera image and image data from the reference container in a first prototype using a Canny Edge Detector and the SURF Algorithm. Right: A concept view on the architecture.

In order to accomplish an integral automatic covering of processes within the operating room, the identification of the used surgical instruments during an intervention is crucial. Existing automatic approaches concentrate on the detection by radio frequency identification (RFID) or rely on the existence of markers.

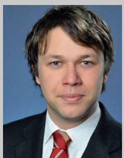
Both approaches demand the modification of the instruments, which is frequently not possible. Either the instruments become non-sterilizable, the surgeon feels affected in his work, or the instrument is simply not markable - e.g. because of its size.

The presented concept adds the idea of automatic instrument identification on a designated operating room table by detecting instruments with a combination of 2D camera data and by adding a scale to the instrument table in order to border the gained data furthermore through adding weight information of the individual instruments. Therefore, an underlying data pool of a set of surgical instruments is recorded and provided as base knowledge for the system.

A key design goal is the applicability in the operating room without seriously interfering modifications to the accustomed workflows of the staff or the instruments themselves.

Current work on the concept focuses on the possibly reachable accuracy levels with different hardware, algorithms and combinations of sensors.

Follow-up projects will then integrate the gained information in higher-ranked frameworks to enhance intra-operative surgical workflow information.



Bernhard Glaser
(Dipl.-Inf.)

Bernhard.Glaser@iccas.de

Visual Surgical Object Recognition

Data aquisition using a range image camera inside of the operation room (camera = black device)

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 fades the focus away from the surgery itself but 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 phase and state of the intervention.

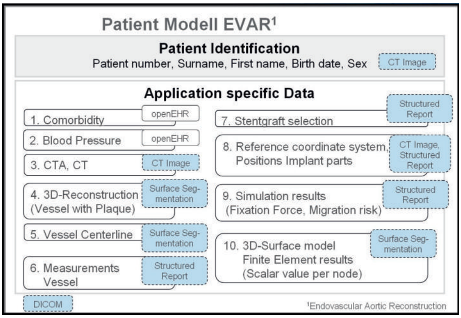
In previous works, surgical actions were captured by humans to produce a workflow of a specific intervention. Besides this is a very usable documentation and analysis tool, it's also a good base for the recognition of surgical phases. In this project we are using so called depth-cameras to recognize objects in the operating room and especially near the situs to support inference of performed actions. As one of several measurement systems it integrates into the sensor fusion scheme of the recognition system. The main concept of this work is to use multiple depth-cameras to obtain a full 3D view of the operation scene. It is used to identify specific objects, which have a meaningful role during the intervention. The information of position and type of objects represents an aspect of surgical actions and therefore contributes to the recognition of them. Further aspects of surgical actions are covered by other measurement systems.

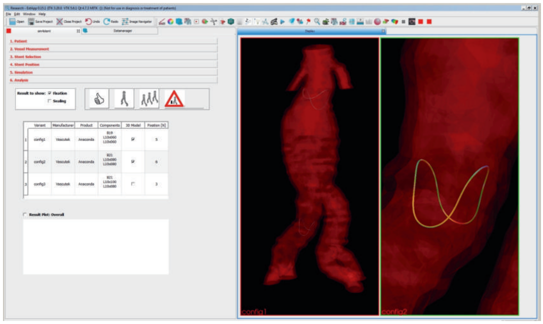
Christian Meißner
(M. Sc.)

Christian.Meissner@iccas.de

Digital Patient Model

Requirements Analysis for the Development of a Planning Software to assist Implantation of Vessel Prostheses





Left: Patient Model for Endovascular Aortic Aneurysm Repair (EVAR). Right: Graphical User Interface for FE- result evaluation and variant comparison

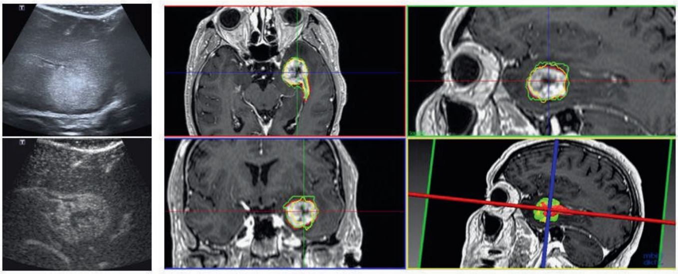
In the field of endovascular aneurysm repair stentgraft selection and positioning is based on the experiences of the vessel surgeon. Within a joint research project with the Fraunhofer IWU it is examined how far these work steps can be assisted by the use of a finite element model (FE model). This includes the development of an application specific simulation model for calculating implant´s fixation force and sealing potential (Fraunhofer IWU) as well as the integration of simulation results and other intervention specific data into the clinical work environment (ICCAS). For this purpose it was analyzed how far planning data can be described using standardized data structures to provide a patient model for EVAR (Endovascular Aortic Aneurysm Repair) (figure 1). Hereby a data transfer between the systems in the clinical environment is enabled for providing a continuous digital data flow. Furthermore, the DICOM „Implant Template" was analyzed referring the applicability to represent stentgraft properties with the aim to integrate perspectively a 3D implant data base into a medical planning software. A further important focus lies on the development of a graphical user interface which enables a descriptive allocation of data and a comparison of different stentgraft configurations (figure 2). For evaluation of the result analysis module a software demonstrator was developed using „Medical Imaging Interaction Tool Kit" (MITK). This is a free C++ based development environment implemented by the German Cancer Research Center Heidelberg which complements the "Visualization Tool Kit" (VTK) „„Insight Toolkit" (ITK), Qt-based user interfaces and enables the integration of an application specific plug-in into a medical planning software. Within an interactive user test with at least 15 surgeons the realization of the requirements for a FE analysis module will be evaluated as well as the usability of the user interface according to ISO NORM 9241.

Sandra von Sachsen
(Master Multimedia)
Sandra.VonSachsen@iccas.de

Nils Ritter
(Dipl.-Inf.)
Nils.Ritter@iccas.de

External Partners
Fraunhofer IWU Dresden

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



A patient brain tumor revealed in 3D intraoperative US data as B-mode (left up) and using an ultrasound contrast agent (left down). The tumors have been segmented in the preoperative MR data and in both iUS volumes, registered to correct the possible deformations and then can be compared (right).

The goal of this DFG project performed in close collaboration between ICCAS and the neurosurgery department at the University Hospital of Leipzig is the evaluation of 3D enhanced intraoperative ultrasound (iUS) imaging for brain tumor resection.

Our iUS acquisition system includes a conventional US device (AplioXG, Toshiba) with 2D free-hand US probes and a navigation system (SonoNavigator, Localite). The cerebral region of interest is scanned with the probe which is tracked. The obtained 2D US images are sent to the navigation system which compounds them into a volume and visualizes it. During the surgery the acquisition protocol is:

- Before resection: Right after craniotomy two iUS volumes are acquired through the dura, the first one as B-mode and the second one using a contrast agent (SonoVue, Bracco).

- After resection: Two iUS volumes are again similarly acquired. Moreover, three biopsies are performed at positions showing contrast agent in the enhanced volume.

The evaluation consists in comparing the tumor in the 3D iUS data with a gold standard, MR data preoperatively and postoperatively acquired. The tumors are extracted in the MR and US volumes using semi-automatic segmentation methods (SegmentationTool, Localite). If the segmented tumors do not totally overlap, because of inaccuracies of the navigation system and brain deformation, they are rigidly registered. Their comparison is eventually performed calculating quantitative values.

First results obtained on nearly 50 patients show:

- Before resection: The overlapping index of brain tumors between the preoperative MRI and the iUS volumes increases when using a contrast agent. Indeed, tumor borders in the enhanced iUS volume are more accurately defined than in the B-mode volumes. Moreover, the enhanced iUS data include fewer artifacts since only vascularized structures are represented.

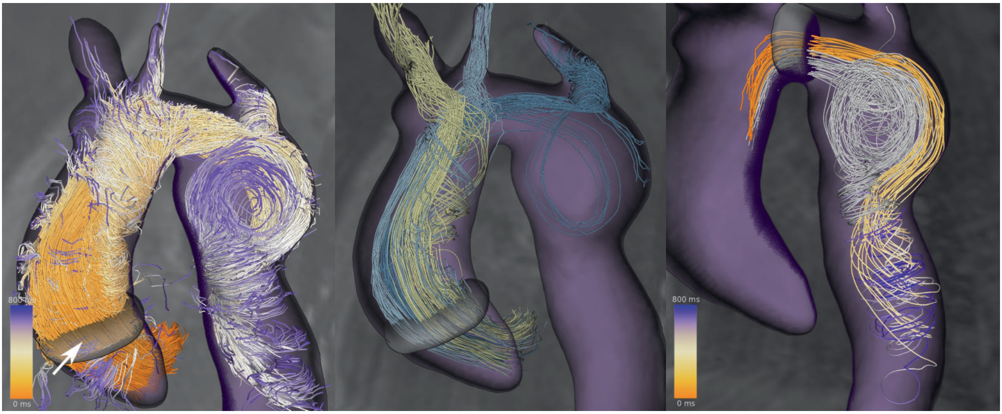
- After resection: The visualization of the acquired 3D enhanced iUS data, showing possible tumor rest, lead to continue the resection in several patient cases.

Claire Chalopin
(PhD Medical Image Processing)

Claire.Chalopin@iccas.de

Universität Leipzig Partners
Department of Neurosurgery

Visual Analysis of 4D MRI Blood Flow Data



Data of a patient with an aneurysm in the descending aorta. (1) Integral lines crossing the displayed region of interest (white arrow) at the beginning of the systole. (2) Subdivision of these lines into bundles entering the brachiocephalic artery (yellow), the left carotid artery (light blue), and the left subclavian artery (blue). (3) Gray lines represent particles residing in the aneurysm for more than 150ms whereas the color-coded lines pass the aneurysm in less than 150ms.

Phase-contrast magnetic resonance imaging (4D MRI) is an in vivo flow imaging modality which has the potential to significantly enhance diagnostics and therapy of cardiovascular diseases. So far, 4D MRI is not yet applied in the clinics or in larger patient studies since the data analysis is very time-consuming and user-dependent.

Appropriate analysis methods which allow a quick and reproducible insight into the data's main characteristics are still missing. The goal of this project is to help fill this gap by providing a method that displays the main flow structures and allows the user to explore the data interactively.

Integral lines are an intuitive way to visualize flow in 3D vector fields (and therefore also in 4D MRI). Our approach is based on the idea that the entity of all integral lines in a vector field captures the complete flow dynamics. Thus, we precalculate these integral lines and - as showing all integral lines is not helpful - apply line predicates which sort these lines into bundles. Each bundle incorporates all lines with a specific property, such as, e.g., a certain speed, vortical behaviour, the flow through a user-defined anatomical area and so on.

The user can combine these predicates flexibly and by that create flow structures that help to gain overview and carve out special features of the current dataset. The usefulness of our approach was shown by visualizing flow aspects of 4D MRI datasets of healthy and pathological aortas which could not be shown by other analysis methods presented in literature so far.

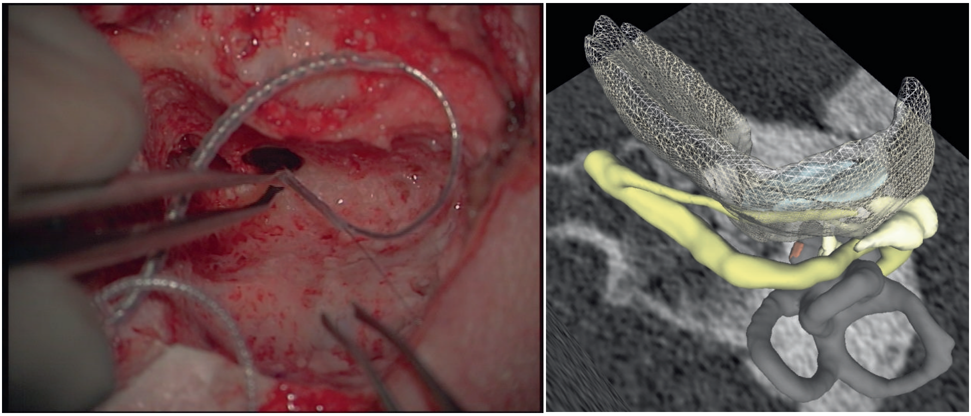
Silvia Born
(Dipl.-Inf.)

Silvia.Born@iccas.de

Universität Leipzig Partners
Department of Computer Science

External Partners
Northwestern University Chicago

Segmentation and Visualization of Ear Structures for Cochlea Implant Planning



Left: Insertion of the electrode array into the cochlea (not visible). The risk structures (nerves) are hidden in bone, which makes navigation difficult. Right: Visualization of the anatomical structures of a left ear (same viewing direction as in 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).

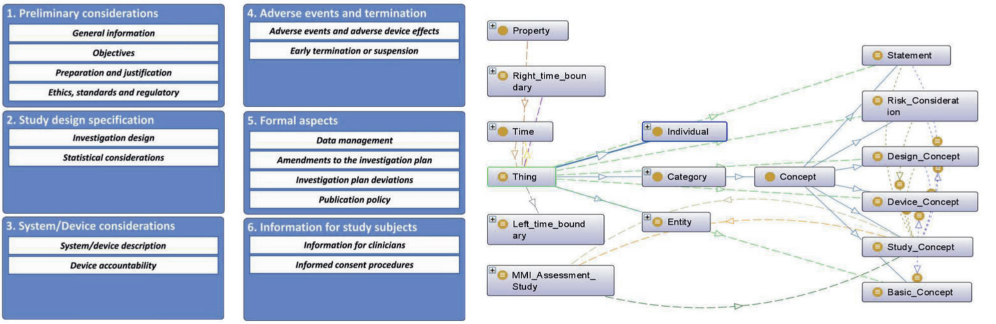
The insertion of a cochlear implant (CI) is an appropriate treatment for patients with different kinds of hearing loss. In a surgical intervention an electrode array is inserted into the cochlea. These electrodes pass the acoustic signals, which are transferred from a microphone and a sound processor, to the hearing nerve. With that a hearing sensation is evoked. The surgery is very complex since the situs' size is in the range of only a few millimeters and many risk structures (such as nerves) are located in the vicinity of the access path to the cochlea's round window. So far, the implantation is planned on the basis of preoperatively acquired CT data. The data is checked for anatomical anomalies and the access path is estimated. 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 and a 3D visualization of the patient's ear anatomy can be of great help during this task. For a 3D visualization, a prior segmentation of the relevant structures from the CT data is necessary. Until now, this segmentation was mainly carried out manually. In this project semiautomatic segmentation methods are selected and developed in order to speed up the processing time and to increase the reproducibility of the results. The goal is to evaluate this planning tool concerning the correct depiction of the patient anatomy and the benefit for the surgeon.

Silvia Born
(Dipl.-Inf.)

Silvia.Born@iccas.de

Universität Leipzig Partners
ENT department

Top-Level Ontology for Assessment Studies of the Man-Computer-Interaction in Surgery



Left: Structure overview of the investigation model.
Right: Ontological representation of the investigation model

Technical improvement in modern medicine makes it very capable, but the use of new technologies results in automation consequences concerning Man-Computer-Interaction (MCI). The high level of complexity of automated processes creates new risks and dangers. To assess these, an investigation model was developed, which should facilitate the planning, implementation and documentation of studies for MCI research in surgery. It elaborates on the framework of Jannin and Korb. The investigation model was subdivided in six major modules representing the several aspects and processes of study, inspired by the ISO 14155 standard; Primary considerations, Study design specification, System/Device considerations, Adverse events and termination, Formal aspects and Information for study subjects. The structure was evaluated in interviews with an interdisciplinary expert team. After the proper formalisation of the model in Unified Modelling Language (UML), the possible implementation in the form of an ontology was considered. Four different top-level ontologies were compared: Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE), Basic Formal Ontology (BFO), General Formal Ontology (GFO) and Object-Centered High-level Reference (OCHRE). Particular attention was paid to three major requirements of the investigation model: the domain-specific view, the experimental scenario and the representation of fundamental relations. Furthermore the distinction of "information model" and "model of meaning" and corresponding fundamental limitations were considered, if for model implementation a database is used instead. The results have shown that GFO fits the defined requirements sufficiently; the other candidates require additional approaches and further extensions. Therefore GFO was chosen to realise the implementation of the developed investigation model.

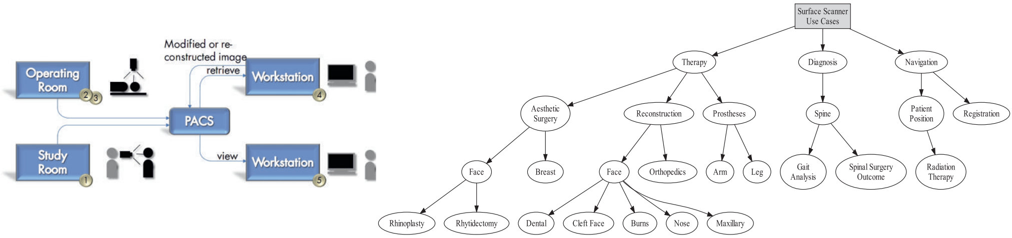
Andrej Machno
(Dipl.-Inf.)

andrej.machno@iccas.de

External Partners
INSERM, Faculté de Médecine, Université de Rennes

Standards

Development of a DICOM Supplement for Optical Surface Scanners



Left: Possible clinical workflow with scanners, workstations and PACS supporting the new DICOM supplement. Right: Surgical use-cases for optical surface scanners

Optical surface scanners (OSS) are gaining importance in many medical fields like cranio-maxillofacial surgery, dentistry, ENT or reconstructive surgery. An OSS generates a point cloud or triangular mesh describing the surface of an object. Regardless of the increased importance of this modality, there is no standardized file format for the resulting clinical data. This hinders the development of applications based on surface scans and clinical acceptance. The Digital Imaging and Communications in Medicine (DICOM) standard supports most medical imaging devices, such as CT, MRT, or ultrasound.

Therefore it seems natural to add a modality for optical surface scanners to this standard. A requirement and use cases analysis for OSS in medicine was performed. Based on this analysis, a "work item proposal" was created and granted by the DICOM committee in April 2010. By this, ICCAS got the assignment to develop an extension of the DICOM standard, a so-called "supplement" for OSS. Meetings with vendors and stakeholders have been held to identify the individual needs.

Based on the meetings, a first draft of the Supplement has been created and successfully reviewed by the working group "base standard" in November 2010. Based on that feedback a new version has been developed and reviewed within a second meeting of the project group at the 2nd International Conference on 3D Body Scanning Technologies. The final version will get part of the DICOM standard approximately end of 2012.

Christian Dressler
(Dipl.-Ing.)

Christian@dressler-netz.de

Philipp Liebmann
(M.Sc. Computer Science)

Philipp.Liebmann@iccas.de

External Partners
Vialux
Sirona
3dmd
Straumann
Steinbichler Optotechnik
3D-Shape
Hometrica
Vitronic
Geomagic
Fraunhofer IOF
CAPS-TU München
FARO
Imaging Sciences International
Select Research

IHE in Surgery

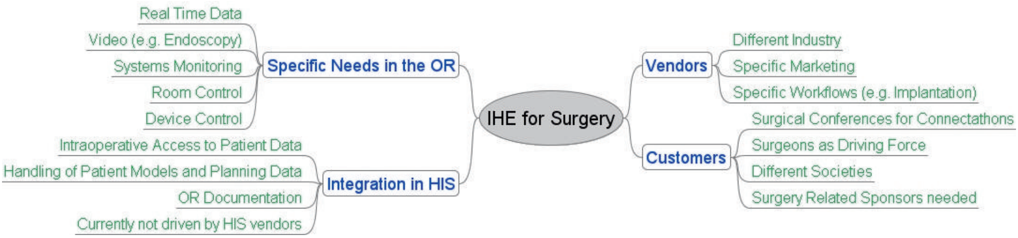


Image of the distinguished characteristics of the surgical domain

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

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

Philipp Liebmann
(M.Sc. Computer Science)

Philipp.Liebmann@iccas.de

Oliver Burgert
(Dr.-Ing.)

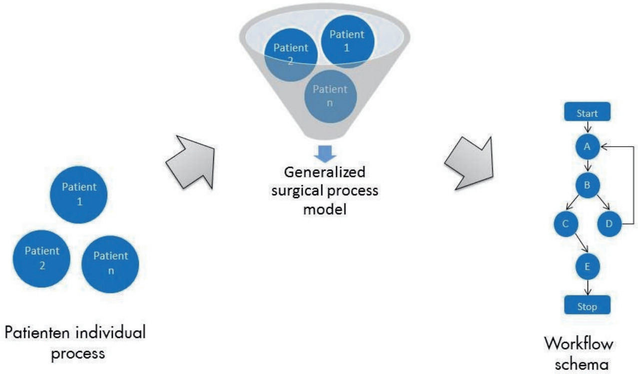
Oliver.Burgert@iccas.de

Thomas Treichel
(Dipl.-Inf.)

Thomas.Treichel@iccas.de

External Partners
IHE International

Generation of workflow schemata from generic process models



Generation of a workflow schema from patient individual processes

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

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

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

Philipp Liebmann
(M.Sc. Computer Science)

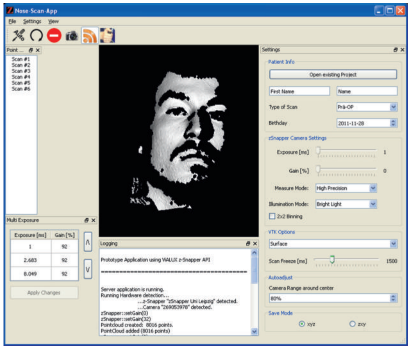
Philipp.Liebmann@iccas.de

Thomas Neumuth
(Dr.)

Thomas.Neumuth@iccas.de

Universität Leipzig Partners
Department of Neurosurgery

Evaluating quality and benefit of optical surface scanners regarding rhinoplasties



Left: Acquisition of the 3D surface of the patient's nose
Right: Screenshot of the developed software application for optimized scanning of rhinoplasty patients

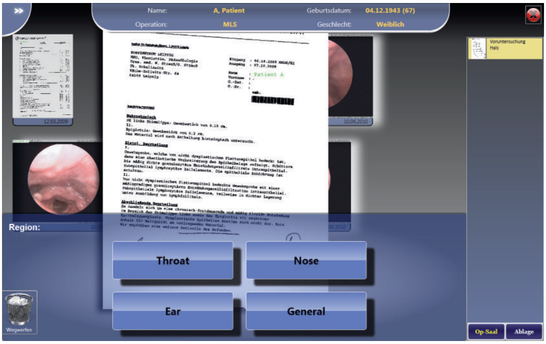
If a surgeon is interested in patient data during surgery, he normally has two options: reading and touching the patient record, thus getting unsterile, or instructing the OR personnel to present the desired information. Both variants are tedious and interrupt the surgeon's workflow. It is difficult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

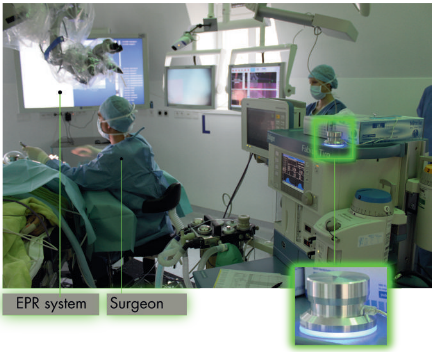
Christian Dressler
(Dipl.-Ing.)

Christian@dressler-netz.de

Universität Leipzig Partners
Department of Head Medicine and Oral Health

The Electronic Patient Record (EPR) within the Operating Room





Left: Screenshot of the Input Module to classify medical documents.
Right: Setting to evaluate the parallel usage of a turning knob by the anesthesiologist

Normally, a surgeon has to get unsterile or ask OR personnel to access the patient record during surgery. The human-machine-interface as well as the arrangement of documents on the screen and interoperability has to be considered. Especially the acceptance of the surgeon and the OR staff in clinical routine is of great interest.

A context-sensitive EPR system has been developed and evaluated, consisting of a visualization module in the OR and an input module with touch screen for the staff to classify the patient data in advance. The visualization module may be controlled via footswitch by the surgeon and via turning knob by the anesthesiologist.

In 55 surgical procedures, the system has been used 84 times. In 65 % of the cases no interaction was needed to present the desired document. The parallel usage of the system by the anesthesiologist did not influence the surgeon‘s workflow. The classification of all documents of a patient took in average about two minutes.

When an EPR is already installed to a hospital, a system to provide this data to the operating room in a sterile way is recommended. International standards have to be improved and should make the manual classification of documents obsolete in the far future. Regarding the growing number of digital data generated for each patient, a context-sensitive pre-selection will be mandatory in future information systems.

Christian Dressler
(Dipl.-Ing.)

Christian@dressler-netz.de

Universität Leipzig Partners
Department of Head Medicine and Oral Health

External partners
International Reference and Development Centre for Surgical Technology (IRDC), Leipzig

Evaluation of a bed-site QR code with surgical procedure information for improved patient safety

Left:A screenshot of the developed software application. The live view helps to find the correct position to scan the ticket at the laptop.
Right: On the central screen, the patient information is arranged in an optimized way.

This project aims at improving patient safety by attaching a card with a QR code to the patient before he is transferred from the ward to the operating room. The QR code contains information about location, type, and scheduling of the upcoming procedure as well as on the responsible surgeon (sees Figure 3). After the patient has reached the OR, a member of the staff scans the code. When the code has been recognized, the patient information is displayed on a large central screen, visible to surgeon, anesthesiologist, and OR personnel. The cooperation partner Karl Storz owns the intellectual property rights on the term "OR ticket".

To evaluate the benefit of an OR ticket as described above, the following data has been collected: read-out time of the OR ticket, correct patient information, pre-operative patient check by the surgeon, and time for creating the ticket. In more than 80 procedures in a standard OR (general ENT, rhinology, otology, oncology) these data have been recorded and experienced advantages and limitations have been noted. The study has not been finished yet.

Christian Dressler
(Dipl.-Ing.)

Christian@dressler-netz.de

Universität Leipzig Partners
Department of Head Medicine and Oral Health

Activities in Teaching

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

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

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

Medicine

Computerassistierte Chirurgie

Master in Computer Science

Chirurgische Navigation, Mechatronik und Robotik

Medizinische Planungs- und Simulationssysteme

Praktikum Computer-assistierte Chirurgie

Seminar Informatik in der Chirurgie

Bachelor in Computer Science

Grundlagen der medizinischen Informatik (in cooperation with others)

Interested audience listening to an ICCAS researcher.

Organization

ICCAS Board

Prof.
Jürgen Meixensberger

Prof. Andreas Dietz

Prof. Gero Strauß

Prof.
Friedrich W. Mohr

Prof. Heinz U. Lemke

Advisory Board

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

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

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

UniversitätsSpital Zürich

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

STORZ KARL STORZ—ENDOSKOPE

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

TUM MiMed

Prof. Georg Nollert
(Siemens AG Healthcare Sector)

SIEMENS

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

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

TUDelft Delft University of Technology
LUMC

ICCAS Staff

Athner, Katrin
Bohn, Stefan
Born, Silvia
Burgert, Oliver
Chalopin, Claire
Dressler, Christian
Franke, Stefan
Glaser, Bernhard
Karar, Mohamed
Liebmann, Philipp
Machno, Andrej
Meier, Jens
Meißner, Christian
Neumuth, Thomas
Pritzkau, Albert
Ritter, Nils
Unger, Michael
Vazquez, Adrian
von Sachsen, Sandra
Weiße, Karin

Assistants

The student and research assistants listed below have been with ICCAS in 2011. Their program of study is shown in brackets.

Aghaei, Ghazall (Computer science)
Böing, Anna-Lena (Medicine)
Dassler, David (Mathematics)
Eißner, Martin (Physics)
Elzner, Caroline (Mathematics)
Grünhage, Lisa (Mechatronics)
Hoffmann, Martin (Mechatronics)
Kurth, Tony (Physics)
Lebelt, Alexandra (Medicine)
Lindenberg, René (Chemistry)
Meißner, Christian (Electrical engineering)
Münch, Juliane (Medicine)
Pohle, Nadine (Medicine)
Priemer, Daniela (Medicine)
Rockstroh, Max (Computer science)
Schreiber, Erik (Computer science)
Scholz, Kathrin (Communication and media studies)
Schumann, Sandra (Physics, Economics)
Thiele, Michael (Computer science)

Miscellaneous

Scientific Events

25th Int. Congress for Computer Assisted Radiology and Surgery
Berlin 2011
Tutorial „Surgical Process Modeling and Surgical Workflows“

10. Jahrestagung der Dt. Gesellschaft für Computer und Roboterassistierte Chirurgie
Magdeburg 2011
Tutorial „Surgical Process Modeling and Surgical Workflows“

14th Int. Conference on Medical Image Computing and Computer Assisted Intervention
Toronto 2011
Workshop „Modeling and Monitoring of Computer-assisted Interventions“

14th Int. Conference on Medical Image Computing and Computer Assisted Intervention
Toronto 2011
Workshop „Systems and Architectures for Computer Assisted Interventions“

Official opening of the new Demo OR at ICCAS in December 2011.

Invited Lectures

ECR – European Congress of Radiology 2011 Vienna
07.03.2011
Lecture: Images and Models for Computer Assisted Surgery
Prof. Lemke

IHE Connectathon and Workshop, Pisa
15.04.2011
Lecture: Towards the integrated Digital Operating Room (DOR)
Prof. Lemke

ITFoM Meeting, Amsterdam
25.05.2011
Lecture: Model Guided Medicine
Prof. Lemke

"Spreestadt-Forum" zur Gesundheitsversorgung in Europa, IGE Berlin
30.05.2011
Lecture: Von der traditionellen zur modellgestützten Medizin
Prof. Lemke

VDI/VDE-IT SommerCampus Innovation + Technik, Berlin
21.06.2011
Lecture: Von der traditionellen zur modellgestützten Medizin
Prof. Lemke

CARS – Computer Assisted Radiology and Surgery 2011, Berlin
22.06.2011
Lecture: Medical Imaging Workstations and Model-guided Medicine: State-of-the-Art 2011
Prof. Lemke

Dresdner Palais-Gespräch, Der Virtuelle Mensch
02.09.2011
Lecture: The Virtual Patient and Interventional Therapy
Prof. Lemke

Dresdner Symposium, Der Digitale Operationssaal
03.09.2011
Lecture: The Digital Operating Room - Present and Future
Prof. Lemke

EPMA – European Association for Predictive, Preventive and Personalised Medicine, World Congress 2011, Bonn
18.09.2011
Lecture: Medical and IT Aspects of Personalized Medicine
Prof. Lemke

BMT – Biomedizinische Technik 2011, Freiburg
29.09.2011
Lecture: Medical and IT Aspects of Personalized Medicine
Prof. Lemke

I-Health 2011, Brussels, Belgium
04.10.2011
Lecture: The Role of Modelling and Standards in Personalized Medicine
Prof. Lemke

MICARS Mediterranean Institute of CARS 2011, Barcelona
20.10.2011
Lecture: The Digital Operating Room - Systems, Devices and Standards
Prof. Lemke

Workshop on Workflow Monitoring and Interfaces in Operating Rooms, Technical University Munich and Klinikum Rechts der Isar, Munich
16.12.2011
Lecture: The Role of Modelling and Standards for the Digital Operating Room
Prof. Lemke

Sino- German - Korean Neurosurgery Friendship Symposium 2011, Chongqing
26.05.2011
Lecture: Computer Assisted Neurosurgery: Trends in Neuronavigation and Intraoperative Ultrasound
Prof. J. Meixensberger

8th Current Trend in Aortic and Cardiothoracic Surgery, Houston
29.4.2011
Keynote: The Worldwide Direction of Cardiothoracic Surgery
Prof. Mohr

Robert Wood Johnson Medical School, New Brunswick
04.05.2011
Lecture: Views and experiences of minimally invasive mitral valve surgery and personal approaches
Prof. Mohr

ACTS, New York
04.05.2011
Featured Lectures: Transcatheter Aortic Valve Therapy: Current Status and Lessons Learned - European Perspective
Prof. Mohr

Mitral Conclave, New York
05.-06.05.2011
Lecture: Anterior Leaflet - Gortex Loops
Lecture: Complex Mitral Valve Repair: Endoscopic HOCM/Mitral Repair
Prof. Mohr

EHRA Europace, Madrid
28.06.2011
Lecture: Treatment of ventricular tachycardia: where is the cardiac surgeon needed?
Prof. Mohr

ISG Meeting, Zürich
20.08.2011
Lecture: Future Development of Cardiac Surgery - Worldwide Perspective
Prof. Mohr

ESC, Paris
28.08.2011
Lecture: Multivessel disease and cardiogenic shock: coronary artery bypass grafting is the optimal revascularisation therapy.
Prof. Mohr

ICCA Kongress, Leipzig
24.09.2011
Lecture: A glimpse into the heart
Prof. Mohr

1th Munich Aortic Conference DHM
05.11.2011
Lecture: Type A aortic dissection - current treatment strategies and future endovascular opportunities
Prof. Mohr

TCT, San Francisco
07.-08.11.2011
Provocative Debate: TAVR Clinical Use Patterns – Disciplined Appropriate Growth vs. Uncontrolled Inappropriate Overuse
- Surgery is being Unfairly Cannibalized and Surgical Volumes are Declining!
Lecture: Four-year Follow-up of the SYNTAX Trial: Optimal Revascularization Strategy in Patients with Three-vessel Disease
Prof. Mohr

Year End Cardio Expert Summit, Berlin
25.11.2011
Lecture: ESC Revaskularisierungsguideline - noch aktuell nach einem Jahr?
Prof. Mohr

Leipzig - LTCS
01.12.2011
Lecture: Hands across the ocean - The Leipzig-Dallas Perspective
Prof. Mohr

22. Rhythmologisches Expertengespräch in Berlin
10.12.2011
Expertengespräch Pro- und Contra-Debatte: AKE: Chirurgisch oder mittels Katheterintervention - Pro Chirurgie
Prof. Mohr

128. Kongress der Dt. Gesellschaft für Chirurgie, München
2.5.2011
Modellierung chirurgischer Prozesse
Dr. Neumuth

MedLogistica 2011, Leipzig
15.5.2011
Die Auswirkungen von Prozeßlogistik auf den chirurgischen Workflow im Alltag
Dr. Neumuth

5th IVMB-Symposium “Der digitale Operationssaal – Methoden, Werkzeuge, Systeme, Applikationen“, Dresden
3.9.2011
Chirurgische Prozesse und deren Modellierung
Dr. Neumuth

MEDICA Vision Forum 2011, Bundesministerium für Bildung und Forschung, Düsseldorf
16.11.2011
Prozess- und Workflowmanagement im Operationssaal
Dr. Neumuth

Workshop on “Workflow monitoring and interfaces in operating rooms”, München
16.12.2011
Research in Surgical Process Modeling and Surgical Workflows
Dr. Neumuth

Workshop, New Delhi
25.-27.2.2011
Lecture and Workshop: Navigation in FESS-Operations
Prof. Strauß

Professor Visiting Program King Saud University Hospital
10.-12.4.2011
Navigation in FESS-Operations
Prof. Strauß

Frühjahrstagung der wissenschaftlichen Gesellschaft für Produktionstechnik, Bautzen
5.5.2011
Lecture: Der integrierte OP-Saal
Prof. Strauß

Professor Visiting Program, Airforce Military Hospital, Cairo
27.-31.5.2011
Lecture: Integrated surgical system for ENT
Lecture: Navigated Functionalities
Prof. Strauß

DGHNO 2011, Freiburg
3.-5.6.2011
Lecture: Ergebnisse DCS in der endo- und transnasalen Chirurgie der NNH und Schädelbasis
Prof. Strauß

Dresdner Palais-Gespräch, Symposium "Der digitale Operationssaal“, Dresden
3.9.2011
Lecture: Der Chirurg im Cockpit
Prof. Strauß

Karnataka State Conference, Belgaum
14.-18.9.2011
Lecture: Navigation in FESS
Prof. Strauß

3rd international Congress of Rhinology and Facial Plastic Surgery, Teheran
3.-7.10.2011
Lecture: Navigation assisted FESS
Prof. Strauß

Honors and Awards

Prof. Meixensberger is now member of the scientific advisory council of the German Society for Computer and Robot Assisted Surgery (CURAC).

Dr. Oliver Burgert has been appointed as professor at Reutlingen University.

Sandra Schumann won poster prize for outstanding research on the field of medical and life science by the committee of the10th Research Festival Leipzig.

Appendices

List of Publications

Articles

A. Böhm, S. Müller, T. Pankau, G. Strauß, S. Bohn, M. Fuchs, A. Dietz A, Computergestützte Assistenz zur Verbesserung der Therapie-Planung in der Kopf-Hals-Onkologie, Laryngo-Rhino-Otologie (2011), 90(12): 732-738.

A. Böhm, F. Hemmann, H. Kunze, C. Rotsch, S. Scherer, B. Senf, M. Werner, Integration of Shape Memory Alloy into a Pedicle Screw for Increasing the Pullout Strength, Journal of Biomedizinische Technik/Biomedical Engineering (2011), 56(s1).

S. Bohn, S. Franke, O. Burgert, J. Meixensberger, D. Lindner, First clinical application of an open standards based OR integration system, Biomedizinische Technik / Biomedical Engineering (2011), 56(s1): 2.

L. Bouarfa, A. Schneider, H. Feussner, N. Navab, H.U. Lemke, J.P. Jonker, J. Dankelman J, Prediction of Intraoperative Complexity from Preoperative Patient Data for Laparoscopic Cholecystectomy, Journal of Artificial Intelligence in Medicine (2011), 52: 169-176.

O. Burgert, P. Liebmann, T. Treichel, H.U. Lemke, IHE in surgery – proposal for a new domain within the integrating the healthcare enterprise initiative, Int J CARS (2011), 6(Suppl.1): 156.

C.R. Dressler, M. Fischer, O. Burgert, G. Strauss, Requirements of a system to display intra-operatively documents of the Electronic Patient Record (EPR) depending on the current procedure in Ear Nose, Int J CARS (2011), 6(Suppl.1): 149.

C.R. Dressler, T. Neumuth, M. Fischer, O. Abri, G. Strauss, Evaluation of the electronic patient record system 'MI-Report', which may intra-operatively be controlled by the surgeon, HNO (2011), 59(9): 900-907.

C.R. Dressler, M. Fischer, O. Burgert, G. Strauss, Evaluation of a context sensitive system for intra-operative usage of the electronic patient record, Laryngorhinootologie (2011).

S. Franke, S. Bohn, O. Burgert, A communication framework for modular surgical assistance systems based on Device Profiles for Web Services (DPWS), Int J CARS (2011), 6(Suppl.1): 285.

M. Gessat, S. Bohn, A. Vorunganti, S. Franke, O. Burgert, TiCoLi: an open software infrastructure for device integration in the digital OR, Int J CARS (2011), 6(Suppl.1): 284.

M.E. Karar, M.A. El-Brawany, Automated Cardiac Drug Infusion System Using Adaptive Fuzzy Neural Networks Controller, Biomedical Engineering and Computational Biology (2011), 3: 1-11.

M.E. Karar, D. Merk, C. Chalopin, T. Walther, V. Falk, O. Burgert, Aortic valve prosthesis for transapical aortic valve implantation, Int J CARS (2011), 6(5): 583-90.

M.E. Karar, T. Noack, D. Holzhey, V. Falk, F.W. Mohr, O. Burgert, Intra-operative assistance system for minimally invasive transapical aortic valve implantation based on 2D fluoroscopic image guidance, Int J CARS (2011), 6(Suppl.1): 92-93.

H.U. Lemke, L. Berliner, DOR Maturity Levels (2005-2025 and beyond): Evolutionary growth path, Int J CARS (2011), 6(Suppl. 1): 144-146D

D.R. Merk, M.E. Karar, C. Chalopin, D. Holzhey, V. Falk, F.W. Mohr, O. Burgert O, Image-guided transapical aortic valve implantation: Sensorless tracking of stenotic valve landmarks in live fluoroscopic images, Journal of Innovations: Technology and Techniques in Cardiothoracic and Vascular Surgery (2011), 6: 231-236.

A. Müns, J. Meixensberger, S. Arnold, A. Schmitgen, F. Arlt, C. Chalopin, D. Lindner, Integration of a 3D ultrasound probe into neuronavigation, Acta Neurochirurgica (2011), 153(7): 1529-1533.

A. Müns, S. Arnold, A. Schmitgen, F. Arlt, C. Chalopin, J. Meixensberger, D. Lindner, Enhancement of neuronavigation based on digital video transfer of intraoperative ultrasound, Int J CARS (2011), 6(Suppl. 1): S226-227.

R. Neugebauer, M. Werner, C. Voigt, H. Steinke, R. Scholz, S. Scherer, M. Quickert, Experimental modal analysis on fresh-frozen human hemipelvic bones employing a 3D laser vibrometer for the purpose of modal parameter identification, J Biomech (2011), 44(8): 1610-1613.

D. Neumuth, F. Loebe, H. Herre, T. Neumuth, Modeling surgical processes: a four-level translational approach, Artif Intell in Med (2011), 51(3): 147-161.

T. Neumuth, R. Wiedemann, C. Foja, P. Meier, D. Neumuth, P. Wiedemann, Identification of surgeon-individual treatment profiles to support the provision of an optimum treatment service for cataract patients, J Ocul Biol Dis Infor (2011), 3(2): 73-83.

T. Neumuth, P. Jannin, J. Schlomberg, J. Meixensberger, P. Wiedemann, O. Burgert O, Analysis of surgical intervention populations using generic surgical process models, Int J CARS (2011), 6(1): 59-71.

T. Neumuth, A. Krauss, J. Meixensberger, O. Muensterer, Impact quantification of the DaVinci Telemanipulator system on the surgical workflow using resource impact profiles, Int J Med Robot Comp (2011), 7(2): 156-164.

A. Runge, M. Hofer, E. Dittrich, T. Neumuth, R. Haase, M. Strauss, Manual accuracy in comparison with a miniature master slave device--preclinical evaluation for ear surgery, Stud Health Technol Inform (2011), 163: 524-530.

S. Scherer, T. Treichel, N. Ritter, G. Triebel, W.G. Drossel, O. Burgert O, Surgical stent planning - Simulation parameter study for models based on DICOM standards, Int J CARS (2011), 6(3): 319-327.

J. Seeburger, S. Leontjev, T. Neumuth, T. Noack, M. Höbartner, M. Misfeld, Trans-apical beating-heart implantation of neo-chordae to mitral valve leaflets: results of an acute animal study, Eur J Cardiothorac Surg (2011).

D. Wellein, S. Born, M. Pfeifle, F. Duffner, D. Bartz, A pipeline for interactive cortex segmentation, Comput Sci Res Dev (2011), 26(1): 87-96.

Books and contributions to books

O. Burgert, T. Neumuth, Analyse und Beschreibung chirurgischer Workflows, In: P.M. Schlag, S. Eulenstein, T. Lange: Computerassistierte Chirurgie, Elsevier Verlag, München (2011), 303-310.

P. Hastreiter, D. Bartz, B. Preim, Visualisierung, In: P.M. Schlag, S. Eulenstein, T. Lange, M. Kleeman: Computer-Assisterte Chirurgie, Elsevier Verlag, München (2011), 17-62.

M.E. Karar, D. Holzhey, M. John, A. Rastan, F.W. Mohr, O. Burgert, Image-Guided Transcatheter Aortic Valve Implantation Assistance System, In: C. Ying-Fu: Aortic Valve/Book 1, InTech Publisher, Rijeka (2011), 251-263.

H.U. Lemke, L. Berliner, DOR Maturity Levels (2005-2025 and beyond): Evolutionary growth path, Int J CARS (2011), 6(Suppl. 1): 144-146D

Conference proceedings

F. Arlt, A. Müns, C. Chalopin, J. Meixensberger, D. Lindner, 3D Kontrastmittel – Ultraschall in der Behandlung maligner Hirntumore – intraoperative Anwendung, In: O. Burgert, J. Schipper, S. Zachow: 10. Jahrestagung der Deutschen Gesellschaft für Computer- und Roboterunterstützte Chirurgie e.V., Verlag Univ Magdeburg, Magdeburg (2011), 7-9.

S. Bohn, T. Hilbert, S. Franke, O. Burgert, Remote User Interfaces for Centralized Control in the Integrated Operating Room, In: Proceedings of 23rd Conference of the society for medical innovation and technology (SMIT), Tel Aviv (2011).

S. Bohn, D. Lindner, C. Petzold, O. Burgert, A framework for data and context integration in the modular digital OR, In: The MIDAS Journal - Systems and Architectures for Computer Assisted Interventions, 14th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2011), Toronto, Canada (2011).

S. Bohn, D. Lindner, S. Franke, J. Meixensberger, Evaluation and first clinical application of a modular and open OR integration system in neurosurgical interventions, Leipzig Research Festival for Life Sciences, Leipzig (2011): 158.

S. Born, M. Pfeifle, M. Markl, G. Scheurmenn, Visual analysis of 4D MRI blood flow data, Leipzig Research Festival for Life Sciences, Leipzig (2011): 157.

J. Brus, C. Dressler, M. Rockstroh, A. Dietz, Dreidimensionales Oberflächenscanning der Nase im Rahmen der Septorhinoplastik, In: 82. Jahresversammlung der Deutschen Gesellschaft für Hals-Nasen-Ohren-Heilkunde, Kopf- und Hals-Chirurgie e. V. (2011).

O. Burgert, P. Liebmann, T. Treichel, IHE for Surgery - Scope and first proposals for a new domain within the "Integrating the Healthcare Enterprise" initiative, SPIE Medical Imaging, Orlando, USA (2011).

O. Burgert, S. Franke, M. Gessat, S. Bohn, TiCoLi - An Open Software Library for Device Integration in the Digital OR based on Open Software and Open Standards, In: The MIDAS Journal - Systems and Architectures for Computer Assisted Interventions 2011, 13th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2010), Toronto, Canada (2011).

O. Burgert, Update on DICOM and IHE in Surgery, Workshop “Toolkits and Research Interfaces for Image-Guidance and Visualization”, SPIE Medical Imaging 2011, Orlando, USA (2011).

C. Chalopin, K. Krissian, A. Müns, F. Arlt, J. Meixensberger, D. Lindner, Phantom-based evaluation of a semi-automatic segmentation algorithm for cerebral vascular structures in 3D ultrasound angiography (3D USA), In: O. Burgert, J. Schipper, S. Zachow: 10. Jahrestagung der Deutschen Gesellschaft für Computer- und Roboterunterstützte Chirurgie e.V., Verlag Univ Magdeburg, Magdeburg (2011); 75-79.

C. Chalopin, R. Lindenberg, F. Arlt, A. Müns, D. Lindner, Brain tumor segmentation in 3D intraoperative ultrasound data, Leipzig Research Festival for Life Sciences, Leipzig (2011): 148.

C. Dressler, M. Rockstroh, P. Liebmann, O. Burgert, Anforderungsanalyse und Entwurf zur Integration von optischen Oberflächenscannern als neue Modalität im DICOM-Standard, In: O. Burgert, J. Schipper, S. Zachow: 10. Jahrestagung der Deutschen Gesellschaft für Computer- und Roboterunterstützte Chirurgie e.V., Verlag Univ Magdeburg, Magdeburg (2011), 157-160.

M. Fischer, C. Dressler, A. Dietz, G. Strauss, Surgical Patient Tracking with the Karl Storz OR ticket, In: Annual Meeting of the American Academy of Otolaryngology - Head and Neck Surgery Foundation, San Francisco (2011), 145(Supl. 2): 41.

S. Franke, O. Burgert, Integration based on OpenIGTLink, IGSTK User Group Meeting, SPIE Medical Imaging 2011, Orlando, USA (2011).

S. Franke, E. Schreiber, J. Meixensberger, T. Neumuth, A model based approach towards prediction of intervention time for brain tumor resections based on surgical workflows, Leipzig Research Festival for Life Sciences, Leipzig (2011): 159.

B. Glaser, T. Neumuth, A concept for intra-operative identification of surgical instruments using 2D camera data and scales, Leipzig Research Festival for Life Sciences, Leipzig (2011): 146.

H. Herre, D. Neumuth, F. Loebe, T. Neumuth, Modeling surgical processes: an ontological approach, In: 56th Annual meeting of the German society for Medical informatics, Biometry, and Epidemiology, Mainz (2011).

M.E. Karar, M. John, D. Holzhey, V. Falk, F.W. Mohr, O. Burgert, Model-Updated Image-Guided Minimally Invasive Off-Pump Transcatheter Aortic Valve Implantation,14th International Conference on Medical Image Computing and Computer Assisted Intervention (2011), 273-280.

M. Karar, M. John, D. Holzney, V. Falk, F.W. Mohr, O. Burgert, New assistance system for transcatheter aortic valve implantation based on intraoperative fluoroscopy guidance, Leipzig Research Festival for Life Sciences, Leipzig (2011): 152.

K. Krissian, F. Santana-Jorge, D. Santana-Cedres, C. Falcon-Torres, S. Arencibia, S. Illera, A. Trujillo, C. Chalopin, L. Alvarez, AMILab software: medical image analysis, processing and visualization, In Proceedings of MMVR, Newport Beach CA, USA, (2011).

P. Liebmann, S. Bohn, T. Neumuth, Design and validation of a robust surgical workflow management system, In: 2nd Workshop on Modeling and Monitoring of Computer Assisted Interventions, Toronto (2011), 20-28.

P. Liebmann, J. Meixensberger, T. neumuth T, Validation of a model based approach for surgical workflow schema generation, Leipzig Research Festival for Life Sciences, Leipzig (2011): 154.

A. Machno, A. Seifert, W. Korb, CIRS und Risikomanagement im Krankenhaus, In: 57. Frühjahrskongress der Gesellschaft für Arbeitswissenschaft Mensch, Technik, Organisation - Vernetzung im Produktentstehungs- und –herstellungsprozess, GfA-Press, Chemnitz (2011); 425-428.

A. Machno, P. Jannin, O. Dameron, W. Korb, G. Scheurmann, J. Meixensberger, Man-Computer-Interaction in Surgery - Requirements for ontological Representation, Leipzig Research Festival for Life Sciences, Leipzig (2011): 145.

J. Meier, A. Boehm, T. Neumuth, S. Bohn, Design of a Workflow Based Oncological Patient Care Support System with Clinical Decision Support, Leipzig Research Festival for Life Sciences, Leipzig (2011): 149.

C. Meißner, T. Neumuth, Towards on automatic recognition of surgical workflow actions, Leipzig Research Festival for Life Sciences, Leipzig (2011): 147.

R. Neugebauer, C. Rotsch, S. Scherer, M. Werner, A. Böhm, Topology-optimized Implants – Medical Requirements and Partial Aspects of a Design Engineering Process Chain, In: 1. WGP-Jahreskongress, Berlin (2011).

T. Neumuth, P. Liebmann, Generierung von Workflowschemata aus patientenindividuellen Prozessmodellen zur Unterstützung chirurgischer Eingriffe, In: 56th Annual meeting of the German society for Medical informatics, Biometry, and Epidemiology, Mainz (2011).

T. Neumuth, Clinical evaluation studies based on surgical process models, In: 5th National symposium of working group “Chirurgische Workflows”, Magdeburg (2011).

N. Ritter, S. von Sachsen, O. Burgert, J. Meixensberger, Applicability of DICOM's "Implant Template" to describe stentgrafts, Leipzig Research Festival for Life Sciences, Leipzig (2011): 153.

M. Rockstroh, S. Franke, T. Neumuth, A concept of a surgical data recover and the realtime provision of intraoperative data using the TiCoLi-toolkit, Leipzig Research Festival for Life Sciences, Leipzig (2011): 151.

S. von Sachsen, C.D. Etz, F.W. Mohr, B. Senf, R. Neugebauer, H.J. Florek, A Method for Integrating Finite Element Results in a Surgical Planning Software for Evaluating Stent Graft Properties in Endovascular Surgery, In: IEEE-Proceedings of the 4th International Conference on Biomedical Engineering and Informatics, Shanghai, China, (2011).

S. von Sachsen, B. Senf, C.D. Etz, W.G. Drossel, F.W. Mohr, Semi-automated evaluation of stentgrafts, Leipzig Research Festival for Life Sciences, Leipzig (2011): 156.

S. Schumann, R. Wachowiak, T. Kurth, H. Hill, U. Bühligen, T. Neumuth, Distance assessment between surgical processes, Leipzig Research Festival for Life Sciences, Leipzig (2011): 155.

M. Unger, R. Kromberg, G. Strauss, T. Neumuth, Determination of cutting-temperature during milling operations, Leipzig Research Festival for Life Sciences, Leipzig (2011): 150.

Cooperation Partners

National cooperation partners

Universität Leipzig

University Hospital, Department of Diagnostic Radiology
Prof. Dr. Thomas Kahn
Dr. med. Dominik Fritzsch

University Hospital, Department of Neuroradiology
Prof. Dr. Karl-Titus Hoffmann

University Hospital, Department of Ophthalmology
Prof. Dr. med. Peter Wiedemann

University Hospital, Department of Paediatric Surgery
Prof. Dr. H. Till

Medical Faculty, Heart Center Leipzig, Department of Diagnostic and Interventional Radiology
Prof. Dr. Matthias Gutberlet

Institute for Medical Informatics, Statistics, and Epidemiology (IMISE)
Prof. Dr. Alfred Winter
Prof. Dr. Heinrich Herre
M.Sc. Frank Loebe

Department of Computer Science
Prof. Dr. Gerik Scheuermann

Hochschule für Technik, Wirtschaft und Kultur (HTWK), Leipzig

Prof. Dr.-Ing. Andreas Pretschner

Fraunhofer Institut für Werkzeugmaschinen und Umformtechnik, Dresden
Mechatronische Medizintechnik

Weißeritztal Kliniken Freital, Klinik für Gefäßchirurgie
Prof. Dr. Hans-Joachim Florek

Konrad Zuse Zentrum für Informationstechnik, Berlin
Visualization, Medical Planning
Dr. Stefan Zachow

Technical University Berlin
Department of Work, Engineering, and Organizational Psychology
Prof. Dr. Dietrich Manzey

Otto-von-Guericke-Universität Magdeburg
Institute for Simulation and Graphics
Prof. Dr. Bernhard Preim

Ruprecht-Karls-Universität Heidelberg
Department of Oral and Cranio- Maxillofacial Surgery
Dr. med. Dr. med. dent. Georg Eggers

Technical University of Karlsruhe
Institute of Computer Science and Engineering
Prof. Dr. Rüdiger Dillmann
Dr. Stefanie Speidel

Technical University Munich
Micro Technology and Medical Device Technology
Prof. Dr. Tim C. Lüth

Computer Aided Medical Procedures (CAMP)
Prof. Dr. Nassir Navab

RWTH Aachen
mediTEC
Prof. Dr. Klaus Radermacher

International cooperation partners

Université de Rennes, Rennes, France
Visages-U746 INSERM, INRIA, IRISA
PD Dr. habil. Pierre Jannin

Centre hospitalier universitaire, Rennes, France
Department of Neurosurgery
Dr. Laurent Riffaud

Universidad de las Palmas de Gran Canaria, Spain
Centro de Tecnología Médica
Karl Krissian

University Hospital of Geneva, Genève, Switzerland
Medical Imaging Group
Prof. Dr. Osman Ratib

University of Alabama at Birmingham
Department of Pediatric Surgery, Children's Hospital of Alabama
Oliver J. Muensterer, MD, PhD

New York Methodist Hospital, New York, USA
Department of Radiology
Prof. Leonard Berliner

Georgetown University Medical Center, Washington, USA
Imaging Science and Information Systems (ISIS)
Prof. Dr. Kevin Cleary
Patrick Cheng

Johns Hopkins University, Baltimore, USA
Center for Computer Integrated Surgical Systems and Technology
Peter Kazanzides

UniversitätsSpital Zürich
Department of Cardiology and Vascular Surgery
Prof. Dr. med. Volkmar Falk
PD Dr. med. Stephan Jacobs
Dr. Michael Gessat

Industrial cooperation partners

Phacon GmbH
Leipzig

SWAN – Scientific Workflow Analysis GmbH
Leipzig

International Reference and Development Centre for Surgical Technology (IRDC)
Leipzig

IVS Solutions GmbH
Chemnitz

JoCoMed Jörg Fischer
Chemnitz

Localite GmbH Biomedical Visualization Systems
Sankt Augustin

Carl Zeiss Surgical GmbH
Oberkochen

Henke-Sass, Wolf GmbH
Tuttlingen

Karl Storz GmbH & Co. KG
Tuttlingen

Siemens Healthcare
Erlangen

Zimmer GmbH
Winterthur, Switzerland

Medical Imaging and Technology Alliance (MITA) / DICOM
Washington D.C.

Funding

UNIVERSITÄT LEIPZIG
Medizinische Fakultät

ZENTREN FÜR INNOVATIONSKOMPETENZ
UNTERNEHMEN REGION
Die BMBF-Innovationsinitiative Neue Länder

Gefördert aus Mitteln der Europäischen Union

Europa fördert Sachsen.
ESF
Europäischer Sozialfonds

DFG

DAAD

Europa fördert Sachsen.
EFRE
Europäischer Fonds für regionale Entwicklung

ZIM
impulse für wachstum
Zentrales Innovationsprogramm Mittelstand

Gefördert durch:
Bundesministerium für Wirtschaft und Technologie

Gefördert durch:
Bundesministerium für Bildung und Forschung