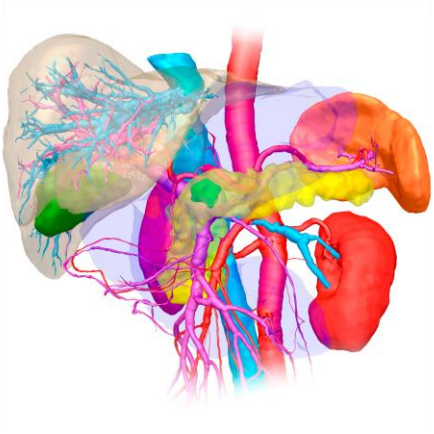
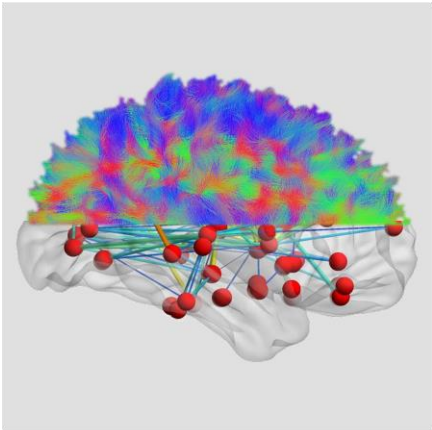
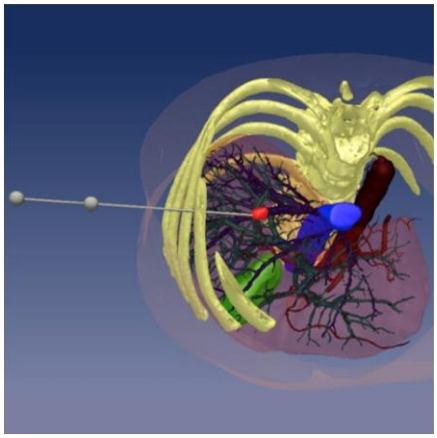
MITK Users Meeting 2016







April 24-26, 2016

Medical and Biological Informatics
German Cancer Research Center DKFZ
Heidelberg, Germany

Wifi Guest-Account

Username g-mitk
Password yovejeso

Local Organization

Diana Nabers [d.nabers@dkfz-heidelberg.de]
Jasmin Metzger [jasmin.metzger@dkfz-heidelberg.de]

WELCOME TO THE MITK USERS MEETING 2016 IN HEIDELBERG!

We are happy to welcome you to the second MITK Users Meeting in the city of Heidelberg, home of the oldest university in Germany.

The initial motivation for the MITK Users Meeting was the consistent growth of the MITK community in size and activity over the last years, which was an exciting process for us. By organizing this event as a forum for developers and users to meet and exchange, we hope that we can strengthen and bring together the international MITK cooperation. Last year we had already the first users meeting, which was very successful with a large variety of participants and contributions.

This year's program will hopefully give you new insights into the MITK world as well as foster discussions about present and future developments and projects.

For the first time, we offer a tutorial for new users and developers of MITK on Sunday which will help you to understand basic concepts and get started with your own application. During the workshop on Monday and Tuesday, members of the MITK community will present their projects and experiences with 15 min talks in the three *User Experience* sessions. We scheduled this with plenty of time reserved for feedback and discussions so we encourage you to be an active part of it. During the poster and software demonstrations on Monday afternoon, you will have the opportunity to showcase and discuss your project in smaller groups. Even if you did not register for this please don't hesitate to grab an empty spot, start your laptop and show what you are doing with MITK.

In the new established *MITK Developer Session*, the local MITK team will give insights in some more advanced features that can be useful you in your projects. In *MITK Status and Future* we will present current and future developments and would like to discuss with you any concerns and wishes about these. There will be also plenty of time and space to break out in smaller groups to get into more in-depth discussions if necessary. Feel free to let us know any subject you would like to talk about! Just talk to us or pin it to the whiteboard we set up for this in the foyer to collect discussion topics.

If you want to do some real work after all that talking we invite you to join the new *Project Day* on Wednesday. There is no fixed program for this, just bring your laptop, start hacking on your project or polish your contribution while the local MITK team is around and can help you if you run into any problems.

On Monday evening we will be guided by Prof. Meinzer through the impressive Old Town of Heidelberg, where he will share his collection of historical and enjoyable anecdotes. We close the day with a joint dinner in the Kulturbrauerei Heidelberg for some beer, food and socializing.

At this point we would especially like to thank everyone who helped us to organize this event and all the contributors. Without you this event wouldn't be possible.

Enjoy the meeting and have a great time in Heidelberg!

The MITK Team 2016

Program Overview

Sunday April 24, 2016

12.00	Registration and Welcome Coffee
13.00 - 14.00	Introductory Session
14.00	Coffee Break
14.15 - 15.45	Theory Session
15.45	Coffee Break and Snacks
16.15 - 17.45	Practice Session
17.45	Coffee Break
18.00 - 18.30	MITK in the Web

Monday April 25, 2016

09.00	Registration and Welcome Coffee
10.00 - 10.20	Welcome Session
10.20 - 12.00	User Experiences I
12.00	Lunch
13.00 - 14.30	MITK Developments
14.30	Coffee Break and Snacks
14.30 - 16.30	Demo/Poster Session
18.00	Special Tour of the Old Town Guided by Prof. Meinzer
19.30	Get-together at Kulturbrauerei Heidelberg

Tuesday, April 26, 2016

8.30	Morning Coffee
9.00 - 10.15	User Experiences II
10.15	Coffee Break
10.30 - 12.10	User Experiences III
12.10	Lunch
13.00 - 14.30	MITK Status & Future
14.30	Coffee Break
14.45 - 16.00	Discussion Forum
16.00	Coffee Break
16.30 - 17.00	Wrap-Up Session & Closing Remarks

Wednesday, April 27, 2016

9.30	Project Day

Sunday April 24, 2016

12.00	Registration and Welcome Coffee	Foyer

13.00 - 14.00	Introductory Session	K1 + K2
Introduction and History		
MITK Workbench Demo		
MITK as application vs. MITK as toolkit		

14.00	Coffee Break	Foyer

14.15 - 15.45	Theory Session	K1 + K2
Superbuild vs. Build		
The MITK Architecture		

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15.45	Coffee Break and Snacks	Foyer

16.15-17.45	Practice Session	K1 + K2
Prerequisites		
MITK-Project Templates		
Awesome Modules, Plugins and Apps		
Programming example		

17.45	Coffee Break	Foyer

18.00-18.30	MITK in the Web	K1 + K2

MONDAY APRIL 25, 2016

9.00	Registration and Welcome Coffee	Foyer

10.00	Welcome Session	K1 + K2

10.20 – 12.00	User Experiences I	K1 + K2
10.20	OraMod	Florian Jung
10.45	GraphMIC: Easy Prototyping of Medical Image Computing Applications	Alexander Zehner Alexander E. Szalo
11.10	byst: A novel workflow-based software for adaptive radiation therapy	Christian Bierstedt
11.35	NifTK Software Platform - Applications for Surgical Planning and Image Analysis for Clinical Studies	Miklos Espak Rachel Sparks

12.00	Lunch	Foyer

13.00 – 14.30	MITK Developments	K1 + K2
13.00	Practical Applications of Micro Services in MITK	Keno März
13.25	MITK Python	Eric Heim
13.50	MITK meets MatchPoint	Ralf Floca
14.15	Life after 5000 MITK commits	Sascha Zelzer

14.30	Coffee Break and Snacks	Foyer

14.30-16.30	Demo/Poster Session	Foyer
Poster	Pre-operative and Intra-operative Navigation for Endoscopic Interventions	Sara Noureldin
Demo	Semantic research data access and annotation using XNAT and MITK	Jasmin Metzger
Demo	Cognition-guided mitral valve surgery using MITK	Sandy Engelhardt
Demo	Ultrasound Guided Navigation: Application Example in MITK	Matthias Eisenmann Keno März

14.30-16.30	Demo/Poster Session	Foyer
Poster	MITK as a multi-functional evaluation tool in modern adaptive radiation therapy	Maximilian Witte
Demo	A new research particle therapy planning plugin for MITK/DIPP	Niklas Wahl Hans-Peter Wieser
Demo	GraphMIC: Easy Prototyping of Medical Image Computing Applications	Alexander Zehner Alexander E. Szalo
Demo	OraMod	Florian Jung

18.00	**Special Tour of the Old Town Guided by Prof. Meinzer** Meeting point: Gate at the Old Bridge

19.30	**Social Event at Kulturbrauerei Heidelberg**

The famous Old Bridge (Alte Brücke)

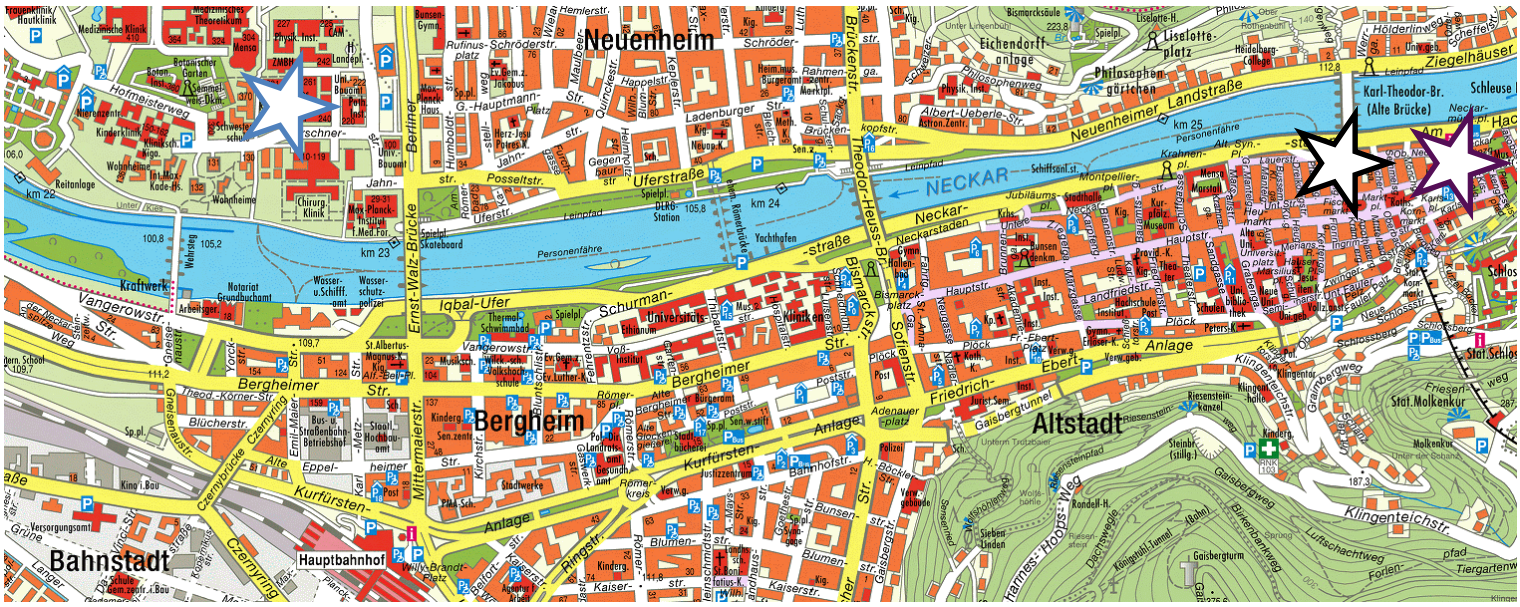
Kulturbrauerei Heidelberg
Leyergasse 6, 69117 Heidelberg
Tel.: 06221/ 502980
http://www.heidelberger-kulturbrauerei.de/

Points of Interest

☆ German Cancer Research Center

☆ Meeting Point: Old Bridge Gate

☆ Kulturbrauerei Heidelberg



Tuesday, April 26, 2016

8.30	Morning Coffee	Foyer

9.00-10.15	User Experiences II	K1 + K2
9.00	Mint Lesion: An approved medical product based on MITK	Daniel Maleike
9.25	A mRay-based extension for radiotherapy data	Lars Woitzik
09.50	ImageExplorer - Strykers MITK Workbench	Ingmar Wegner

10.15	Coffee Break	Foyer

10.30-12.10	User Experiences III	K1 + K2
10.30	Impact of fitting strategy on DCE parameter estimates and performance : a simulation study in image space	Charlotte Debus
10.55	Monte Carlo Simulation for Biophotonic Research within MITK	Janek Gröhl
11.20	Autoplan, innovative MITK-based product	Konstantin Bychenkov
11.45	New Structure for IGT Tracking Devices: Simple Integration in External Projects	Esther Wild Alfred Franz

12.10	Lunch	Foyer

13.00-14.30	MITK Status & Future	K1 + K2
Development process + user contribution		
Presenting the new release		
Future of MITK		

14.30	Coffee Break	Foyer

14.45-16.00	Discussion Forum	K1 / K2

16.00	Coffee Break	Foyer

16.30-17.00	Wrap-Up Session & Closing Remarks	K1 + K2

WEDNESDAY, APRIL 27, 2016

9.30	Project Day	H1.00.028 [DKFZ main lobby]

CONTRIBUTION ABSTRACTS

Talks

OraMod

F. Jung
Fraunhofer IGD, Darmstadt, Germany

Head and Neck Cancer is the 7th most common cancer worldwide. In addition the reoccurrence probability is one of the highest among cancer. Until today the causes of the diseases reoccurrence are not well known.

The goal of the OraMod project is the development of a statistical model for the prediction of an oral cancers reoccurrence probability. The model is based on the biomarkers of 150 patients. The biomarkers consist of genetic biomarkers, biomarkers extracted from medical image data and meta-information of the patient (e.g. smoker, sex, age). Once the model has been successfully trained it can be used for the prediction of the survival rate and reoccurrence probability of future patients.

We at Fraunhofer IGD have developed a medical image software based on the MITK toolkit for our clinical project partners, VUMC from Amsterdam, the university clinic Parma and the university clinic Düsseldorf. The main goal of the OraMod Imaging Software is to enable the clinical partners in the OraMod project to enhance clinical images with segmentations of tumors and lymph nodes as well as semi-automatically classify the found medical conditions of the patient and to extract these biomarkers for later analysis.

The image data can be accessed directly from a clinical PACS server. The clinician's task is to do a segmentation of the tumor and all relevant lymph nodes. This can be an extremely time consuming task, if done manually. Therefore, several algorithms have been developed to reduce the workload of the clinicians as much as possible.

Additionally the software features algorithms which can automatically determine the T-staging of tumor as well as the N-staging of the lymph nodes once the needed parameters are present.

The extracted biomarkers finally can be uploaded to a clinical PACs server and the OraMod research platform for evaluation purposes.

More information about the project can be found at www.oramod.eu

GraphMIC: Easy Prototyping of Medical Image Computing Applications

A. Zehner and A. E. Szalo
OTH Regensburg, Regensburg, Germany

GraphMIC is a cross-platform image processing application utilizing the libraries ITK and OpenCV. The abstract structure of image processing pipelines is visually represented by user interface componsents based on modern QtQuick technology and allows users to focus on arrangement and parameterization of operations rather than implementing the equivalent functionality natively in C++. The application's central goal is to improve and simplify the typical workflow by providing various high level features and functions like multi threading, image sequence processing and advanced error handling. A built-in python interpreter allows the creation of custom nodes, where user defined algorithms can be integrated to extend basic functionality. An embedded 2d/3d visualizer based on the MITK Framework gives feedback of the resulting image of an operation or the whole pipeline. User inputs like seed points, contours or regions are forwarded to the processing pipeline as parameters to offer semi-automatic image computing.

byst: A novel workflow-based software for adaptive radiation therapy

C. Bierstedt, P. Mercea, H. Teske, M. Stoll, K. Löpprich, K. Heib, H. Müssemann, S. Back, A. Pfaffenberger, K. Giske, O. Jäkel and R. Bendl
German Cancer Research Center (DKFZ) / HIRO, Heidelberg / Heilbronn University; Germany

In adaptive radiation therapy (ART), newly acquired image data and available data from former fractions need to be carefully analyzed to evaluate the current treatment progress and take the right decision. There is a necessity to organize and automatically process the overwhelming amount of data for usage in clinical routine. Besides this fact, more than one adaptive workflow is imaginable. Thus, lot of research has to be done in order to develop adaptive workflows.

It is worthwhile to build those workflows upon a solid software base in order to reuse, optimize and compare the created workflows. In comparison to solutions that rely on scripting or batch file processing, this approach is more persistent. Furthermore, it has the potential to be used for building standalone applications for each use case / workflow. This could be a reliable and reproducible approach to translate research work into clinical routine.

We present byst, a dedicated application designed for ART, based on MITK functionality which allows the user to create data processing pipelines (workflows) for ART via a graphical user interface (GUI).

NifTK Software Platform - Applications for Surgical Planning and Image Analysis for Clinical Studies

M. Espak, R. Sparks and M. Clarkson
Translational Imaging Group (TIG), University College London, London, UK

The Centre for Medical Image Computing (CMIC) at University College London (UCL) has been using MITK since 2011. During this time, we have developed 4 main GUI applications, and many command line applications. In this talk, we will give an overview of key technologies we have developed including an application for computer assisted planning of electrode placement in epilepsy surgery and another for image quality control and interactive brain segmentation for dementia research.

Practical Applications of Micro Services in MITK

K. März
German Cancer Research Center (DKFZ), Heidelberg, Germany

In MITK, the C++ Micro Services provide a convenient framework to implement a dynamic service registry which is partially based on the OSGi specifications. Using Micro Services leads to loose coupling, separation of concerns and extensible systems. This talk covers a quick-start tutorial for Micro Service implementation and shows where and how the concepts are already applied in MITK.

MITK Python

E. Heim
German Cancer Research Center (DKFZ), Heidelberg, Germany

MITK provides an integrated python runtime that can be used for rapid prototyping of algorithms. The MITK Python plugin provides an interface to ITK, VTK and OpenCV python wrapping. An interactive python console enables the user to run python code to modify images, surfaces and display them within the MITK Workbench. Furthermore code snippets can be created to facilitate automatic processing.

MITK meets MatchPoint: New (image) registration infrastructure for MITK

R. Floca
German Cancer Research Center (DKFZ), Heidelberg, Germany

Registration is a basic and crucial step in many clinical image processing tasks. Despite the importance of registration we have a sophisticated but fragmented library landscape and the lacking transfer into clinical practice is still serious challenges. The translational registration framework MatchPoint tackles problems in this context in order to offer an easy

to use, standardized access to registration resources (e.g. ITK algorithms, Plastimatch, Elastix, ANTs). We want to present the integration of MatchPoint into the MITK technology stack and the possibilities/features now available (e.g. (batch) registration; motion artifact correction; advanced mapping of images, segmentations and point sets; visualization of transformation).

Life after 5000 MITK commits

S. Zelzer

Sascha Zelzer contributed more than 5000 commits to MITK during his time at DKFZ and is still an active community member. Since it is hard to say good bye we invited him and he will talk about life after being a MITK developer, how he stays in touch with MITK and which exciting projects he is now working on.

Mint Lesion: An approved medical product based on MITK

D. Maleike
Mint Medical GmbH, Dossenheim, Germany

mint Lesion™ is an MITK-based application that supports radiologists and oncologists in assessing the stage of oncological diseases and the effectiveness of cancer therapies. Based on medical image interpretation, it provides immediate feedback about individual patient cases or clinical trial patient cohorts in terms of whether and how patients are responding to a particular treatment. mint Lesion™ is an approved medical product in the European Union (CE-labeled) and further countries. It has received 510(k) clearance for the US market. The talk will comprise an overview of the company Mint Medical, its product mint Lesion™, and look into technical and regulatory aspects.

A mRay-based extension for radiotherapy data

L. Woitzik
mbits imaging GmbH, Heidelberg, Germany

An extension for the medical radiological image viewer "mRay" allows loading and displaying of radiotherapy (RT) data.

The loading of RT structure sets and RT dose files is done by using DCMTK via MITK. A special displaying is done for RT dose files which will be rendered by using a custom isoline shader. This allows a quick interaction and realtime rendering on mobile devices like tablets, smartphones. Furthermore the builtin messenger of mRay makes it possible to share RT structure sets, RT dose files and the current view parameters with other people.

ImageExplorer - Strykers MITK Workbench

I. Wegner
Stryker Leibinger GmbH & Co. KG, Freiburg, Germany

The ImageExplorer is an important infrastructure within Stryker. From a developers perspective it is a highly customized mitkWorkbench which is extended by several modules and plugins. Not as a product but as an internal tool it is used worldwide by approximately 30 colleagues with the need for a viewer, debugger and a toolkit for prototyping. In the past three years we have built up an efficient environment around ImageExplorer and implemented additional features that were also contributed back to the MITK repository. The project won the Stryker Innovation Award at Campus Freiburg in the category Infrastructure in 2014.

Impact of fitting strategy on DCE parameter estimates and performance : a simulation study in image space

C. Debus
German Cancer Research Center (DKFZ), Heidelberg, Germany

The two compartment exchange model can be described by either a system of two coupled differential equations or a closed-form analytitical solution.

We compared both representations of the model function by non-linear least square fitting of simulated data for different parameter scenarios in 4D concentration images in a large number of pixels. The sums of squared residuals were calculated by either numeric integration with Runge-Kutta method or convolution.

The resulting parameter estimates were evaluated in terms of accuracy, precision and computational speed. Both approaches yieldes similar results in parameter determination, however the convolution excelled in computational speed.

Monte Carlo Simulation for Biophotonic Research within MITK

J. Gröhl
German Cancer Research Center (DKFZ), Heidelberg, Germany

This talk presents our preliminary work integrating mcxyz, a Monte Carlo simulation framework widely used for Biophotonic research, into MITK. The incorporation of the external code utilizes MITK Command Line tools. In this ongoing work, time performance was increased by an order of magnitude and usability was enhanced by porting the original matlab scripts. As part of the Photoacoustics project a vessel structure modeling plugin has been implemented providing adjustable tissue volumes as simulation settings. This talk includes a demo of the workflow and will touch on the research context in which this workflow is currently used.

Autoplan, innovative MITK-based product

K. Bychenkov
SamSMU, Samara, Russia

Changing the surgical workflow turned out to be easier than we thought and does not typically consume more time than with a standard preoperative process. First we perform the scanning: CT, MRT. Then, using the scans, we reconstruct the working field – create 3D models of organs, blood vessels, ducts, affected areas. With this information, a doctor creates a preoperative plan: what needs to be performed, in what sequence, and which key anatomical features of a patient a surgeon should pay attention to.

We perform segmentation with our own set of algorithms based on fast-marching, random forest with some texture descriptors (Haralick and so on), CNN.

We were working with real surgeons and this has led us to successful integration with few state clinics already.

New Structure for IGT Tracking Devices: Simple Integration in External Projects

E. Wild and A. Franz
German Cancer Research Center (DKFZ), Heidelberg, Germany

Intraoperative registration of preoperative data during laparoscopic interventions can help surgeons to find structures of interest like tumors and organs at risk. Our research project focuses on fluorescence guided surgery to improve this intraoperative registration with fluorescent markers.

Motivated by this project, we developed a new structure for IGT tracking devices, which enables a simple integration of new tracking devices from external projects. During this talk, we will explain how to implement and use tracking devices in external projects with MITK.

Demos/Posters

Pre-operative and Intra-operative Navigation for Endoscopic Interventions

S. Noureldin[1], M. Ceresa[1], G. Fernández Esparrach[2] and M. Á. González Ballester[1,3]
[1] Simbiosys Group, Universitat Pompeu Fabra, Barcelona,Spain
[2] Endoscopy Unit, Hospital Clnic, Barcelona, Spain
[3] ICREA, Barcelona, Spain

Colonoscopic interventions are challenging due to the nature of the colon, it undergoes a lot of twisting folding, its shape deforms due to endoscope insertion and CO_2 insufflation during colonoscopy. With very few indefinite landmarks scattered across different segments, the surgeons may not know the precise location of the endoscope nor the location of lesions to be removed in colonic resection laparoscopic surgery. Our work aims to develop solutions to increase the efficiency of the interventions using MITK by allowing preoperative localization of polyps and lesions, by mapping them between the optical colonoscopy and the CT image. In addition, a statistical shape model of the colon will be constructed considering shape deformations. Moreover, intraoperative visualization of the position and orientation of the endoscope with respect to the patient position whether the patient is in supine, prone, or lateral position.

Semantic research data access and annotation using XNAT and MITK

J. Metzger, A. Fetzer and M. Nolden
German Cancer Research Center (DKFZ), Heidelberg, Germany

We demonstrate an open-source semantic data infrastructure for integrating clinical and scientific data in cognition-guided surgery. It integrates the flexible imaging informatics platform XNAT with semantic web technologies and a MITK-Workbench based graphical user interface. Imaging research data of various typed can be stored and retrieved through an intuitive representation of the XNAT data model. Image segmentations and annotations can be created interactively and stored together with RDF-based semantic descriptions of the data, based on templates that are collaboratively modelled in a Semantic MediaWiki.

Cognition-guided mitral valve surgery using MITK

S. Engelhardt[1], R. De Simone[2], S. Al-Maisary[2] and I. Wolf[3]
[1] German Cancer Research Center (DKFZ), Heidelberg, Germany
[2] University of Heidelberg, Heidelberg, Germany
[3] Mannheim University of Applied Sciences, Mannheim, Germany

Reconstructive mitral valve surgery is done in patients with severe mitral valve insufficiency as alternative to valve replacement. However, surgical methods are versatile and

quantitatively little explored. Decisions which have to be made during surgery highly depend on the individual know-how and experiences of the cardiac surgeon. We will demonstrate our MITK-based assistance system which serves as planning software as well as intraoperative decision-support system during reconstructive surgery. This system has been developed in the scope of the Collaborative Research Center SFB TRR 125 "Cognition-guided surgery" in close cooperation with the Cardiac Surgery, University Hospital Heidelberg, Germany, and has already been applied several times during surgery.

Ultrasound Guided Navigation: Application Example in MITK

M. Eisenmann and K. März
German Cancer Research Center (DKFZ), Heidelberg, Germany

Minimally invasive needle punctures play an important role in minimally invasive surgery. Using MITK, we developed a system that combines tracking- and ultrasound imaging data to support the physician during the intervention. In this demonstration we will show the workflow of such a navigated intervention with our MITK-based application. We will also demonstrate how knowledge acquired during that intervention is directly incorporated in a knowledge-based liver tumor treatment planning tool that has been developed in the scope of the Collaborative Research Center SFB TRR 125 'Cognition-guided surgery'.

MITK as a multi-functional evaluation tool in modern adaptive radiation therapy

M. Witte
German Cancer Research Center (DKFZ), Heidelberg, Germany

Intrafractional motion-compensating radiation techniques have the potential of normal tissue sparing. These techniques need to be verified in terms of image contrast, motion monitoring and dose delivery. For this purpose, an experimental setup has been established which allows a markerless, fluoroscopic, real-time tumor tracking using an anthropomorphic lung phantom in combination with 3D polymer gel dosimetry. The entire workflow requires real-time image read-out, image monitoring, tumor detection and gel evaluation (tbd). This is realized using different MITK functionalities, like image monitoring, segmentation tools and data fitting.

A new research particle therapy planning plugin for MITK/DIPP

N. Wahl, H.-P. Wieser and M. Bangert
German Cancer Research Center (DKFZ), Heidelberg, Germany

We present the development status of a new plugin for research particle therapy planning within MITK/DIPP. The current status allows for setting up basic plan and beam parameters, a pencil-beam particle dose calculation algorithm and dose optimization for spot scanning by integration of IPOPT. Planning can be performed on imported CT cubes with binary masks for the relevant ROIs. The plugin uses Eigen for sparse linear algebra, and is designed to allow easy extension with custom algorithms for the above-mentioned planning steps as well as their optimization. Focus of further development will be on algorithms for robust and probabilistic dose analysis and optimization.

NOTES