Recent Developments on Quantitative Multimodal Imaging at Fraunhofer MEVIS

From Research to Clinical Use

Horst Hahn
Fraunhofer MEVIS and Jacobs University

NA-MIC all hands meeting
10 Jan 2013, Salt Lake City
Fraunhofer MEVIS
Institute for Medical Image Computing

Bremen, Lübeck, Nijmegen, Heidelberg, Berlin*

Horst Hahn
Bremen Townhall (~1400) & Cathedral (~1100)
Diagnosis, Intervention, Therapy:
Image Processing, Visualization, HCl, IGT/Navigation, CAD, Registration, MR Sequence Development, Biophysical Modeling and Simulation
Fraunhofer MEVIS and MeVis Medical Solutions

two independent institutions originating from Bremen

non-profit research organisation

~100

Fraunhofer
MEVIS

INSTITUTE FOR MEDICAL IMAGE COMPUTING

www.mevis.fraunhofer.de

commercial, Inc., AG,
stock exchange since Nov 2007

~170

MeVis
MEDICAL SOLUTIONS

51% → MeVis
BREASTCARE

41% → Medis
Fraunhofer Gesellschaft

- 60 institutes and 20+ centers in Germany
- 20,326 employees in 2011
- 1.85 billion (Mrd) EUR total budget in 2011
- 200 million EUR foreign revenues in 2011
- > 70% external revenues

7 Groups:
- Information and Communication Technology
- Life Sciences
- Microelectronics
- Light & Surfaces
- Production
- Materials and Components - MATERIALS
- Defense and Security
Internal Structure

* domains
* foci
* projects

no bordered departments or groups
Lung Domain: Computer-based Methods for Quantitative Analysis of Pulmonary MR- and CT Images
Onco Domain: Multimodal Diagnosis of Oncological Diseases and Optimization of Radiation Therapy Through Molecular Imaging
Neuro Domain: An Extendible Software Assistant for Efficient and Reproducible Evaluation of Neuroimaging Data
MeVisLab User Community

>13,500 downloads in 2012

5 Continents – 20 Nations
350 + Active Users Worldwide

Fraunhofer
Institute for Medical Image Computing
MeVisLab Community

The MeVisLab Community project provides add-on modules that extend the functionality of the MeVisLab software. All modules provided here are distributed as open-source software and maintained by the MeVisLab developer community.

Source Code

The MeVisLab Community source code is managed in a central Subversion repository hosted on SourceForge.net. The latest version of the project's trunk can be checked out with the following instruction set:

```
svn co https://mevislabmodules.svn.sourceforge.net/svnroot/mevislabmodules/trunk
```

In order to build the MeVisLab Community source code, you need the MeVisLab Software Development Kit (SDK) which can be downloaded for free here.

Builds

The MeVisLab Community repository is continuously being compiled for Windows and Linux (Mac builds will be offered soon). Build reports and the current installers can be downloaded from the MeVisLab Community Builds page.
# MeVisLab Community Builds

Wednesday, 20. April 2011, 08:27:58

Trunk builds with MeVisLab2.1 Release SDKs of 24th of June 2010 with Qt fix.

Community Sources Main Page
View Sources
Doxygen Documentation from recent VC Rebuild
MeVisLab SDK Download Page

Community Sources Public and Administration Forum

## Source Code

The MeVisLab Community hosted on SourceForge.net out with the following instructions:

svn co https://mevislabmodelling.sourceforge.net/MeVisLab

In order to build the MeVisLab Software Development Kit, you need to build:

## Builds

The MeVisLab Community builds Linux (Mac builds will be coming soon) will be downloaded from the MeVisLab SourceForge project.

### Rebuild

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</table>
A Framework for Algorithm Evaluation and Clinical Application Prototyping using ITK

Rexilius J., Spindler W., Jomier J., Koenig M., Hahn H., Link F., Peitgen H.
MeVis, Center for Medical Diagnostic Systems and Visualization, Bremen, Germany

Please use this identifier to cite or link to this publication: http://hdl.handle.net/1926/12

Published in The Insight Journal - 2005 MICCAI Open-Source Workshop.

Submitted by Jan Rexilius on 08-01-2005.

The usage of image processing has become an important and continuous growing field in medical imaging. Although a large amount of algorithms is available, only few are routinely applied within applications for clinical diagnosis support and treatment planning. New tools are required that allow for efficient evaluation and comparison of algorithms as well as the generation of dedicated user interfaces with sophisticated visualization for clinical applications. We propose a generic integration of ITK algorithms into the visual programming and rapid prototyping platform MeVisLab. One of the main limitations of ITK is its lack of visualization and interaction functionality through a dedicated development platform. MeVisLab provides a modular visual programming interface with a comprehensive suite of image processing and visualization tools. The linkage of ITK algorithms to MeVisLab is based on a two step process that consists of a generic XML description for each ITK algorithm and an automatic code generator to create new MeVisLab modules, which will be made publicly available within the free version of MeVisLab. Each module can handle different image types and data dimensions dynamically at runtime. Example applications using registration, segmentation, and visualization modules are presented in order to show the capabilities of the described integration concept.
Introduction

**PythonQt** is a dynamic Python binding for the Qt framework. It offers an easy way to embed the Python scripting language into your C++ Qt applications. It makes heavy use of the QMetaObject system and thus requires Qt 4.x.

The focus of **PythonQt** is on embedding Python into an existing C++ application, not on writing the whole application completely in Python. If you want to write your whole application in Python, you should use PyQt or PySide instead.

If you are looking for a simple way to embed Python objects into your C++/Qt Application and to script parts of your application via Python, **PythonQt** is the way to go!

**PythonQt** is a stable library that was developed to make the Image Processing and Visualization platform MeVisLab scriptable from Python.

- Features
- Download
- License
- Developer
- Building
- Examples
NCI’s Open Source Workstation

The eXtensible Imaging Platform™ (XIP™) project is an open source environment for rapidly developing medical imaging applications from an extensible set of modular elements. Researchers will be able to easily develop and evaluate new approaches to medical imaging problems, and use them in a translational research setting.

The applications developed with the XIP™ tools and libraries can either run stand-alone, or as Hosted Applications utilizing the DICOM Application Hosting interfaces being defined by DICOM WG-23. The XIP™ project includes an open source reference implementations of the those interfaces, as well as a clinical research oriented Hosting System for running such Hosted Applications.
Four Major Challenges
from R&D to Productization “S-P-V-R”

- Product integration for routine use “RELEASE”
- Prospective evaluation and use in clinical trials “VALIDATION”
- Automated and interactive large scale processing “PROTOTYPE”
- Algorithm exchange and easy integration “SYNERGIES”
Selected Research Topics

- Multimodal breast imaging
- Image guided surgery
- Radiation oncology
- 4D flow quantification
  - Aorta
  - Pulmonary Artery
  - Left Ventricle
Modeling and Simulation

- Jacobs University Bremen
- Foundation professorship by Conrad and Lotti Naber
- Modeling of bio-physical processes for improved outcome prediction

Examples
- RF ablation of liver tumors
- Numerical flow simulation
- Stochastic PDEs
SAFIR
Software Assistant for Interventional Radiology
MR Imaging

- University Bremen – FB Physics
- Foundation professorship by Stiftung Bremer Wertpapierbörse
- Co-optimization of medical imaging
- Development of new sequences and imaging protocols

Examples
- Moving Table Diffusion Imaging
- Arterial Spin-Label Imaging outside of the brain
Image Registration

- Strategic collaboration
  Fraunhofer MEVIS – University Lübeck

- MEVIS Project Group Lübeck
  Basic funding by State Schleswig-Holstein

- Multimodal and temporal mapping
  and fusion of medical image data

- Examples
  - Discretize-then-optimize
  - Variational implementation of hard/soft constraints
  - Newton-type minimization methods
  - Normalized gradient fields, curvature regularization,…
Image Registration

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- Multimodal and temporal registration and fusion of medical images

- Examples
  - Discretize-then-optimize
  - Variational implementation of hard/soft constraints
  - Newton-type minimization methods
  - Normalized gradient fields, curvature regularization,…
Computer Aided Diagnosis

- Strategic collaboration Fraunhofer MEVIS – Radboud University Nijmegen Medical Center (NL)
- Computer Aided Detection
- Complexity Reduction of Diagnostic Processes
- Examples
  - Detection in breast cancer screening
  - Detection in lung cancer screening
  - Decision support in breast imaging
Main Types of Surgery for Service based Extended Risk Assessment

- Living donor liver transplantations
- Challenging and extended tumor resections
3rd Success: Visia LIVER-DS
Distant Service via Internet

USA
Japan
Korea
Australia
Taiwan
Egypt
China
Singapore
3rd Success: Visia LIVER-DS
Distant Service via Internet

MeVis
MEDICAL SOLUTIONS

FDA Certified

Fraunhofer
MEVIS Institute for Medical Image Computing
Clinical Partners/Clients (>200)

Kobe City General Hospital, Japan
Kyoto University Hospital, Japan
Nagoya University Hospital, Japan
Yokohama City University Medical School, Japan
Gleneagles Hospital, Singapore
Singapure General Hospital, Singapore
National University Hospital, Singapore
Samsung Medical Center, Seoul, South Korea
Kaohsiung University Hospital, Kaohsiung, Taiwan
Taipei National University Hospital, Taiwan

Charité Campus Benjamin Franklin, Berlin
Charité Campus Virchow-Klinikum, Berlin
Klinikum Bremen-Mitte, Bremen
Augusta Krankenanstalten, Bochum
Universitätsklinikum Bonn
Allgemeines Krankenhaus Celle
Klinikum Düsseldorf-Gerresheim
Universitätsklinikum Essen
Johann Wolfgang Goethe Universität Frankfurt
Chirurgische Universitätsklinik, Freiburg
Sinusoidal Remodeling

dilated vascularized sinusoidal canals connecting the obstruction zone with the normal zone

microcirculation visualized by orthogonal polarization spectroscopy

Dirsch Dahmen, Transplantation 2008

HDR-021-TP4-43HRS-BZ-1 [36]
Mobile LiverExplorer
(Alexander Köhn Sep-Nov 2012, Yokohama)

Bringing the liver planning data into the operation room
Mobile LiverExplorer
(Alexander Köhn Sep-Nov 2012, Yokohama)

Bringing the liver planning data into the operation room

“If we can use iPad software in our OR, intraoperative blood loss could be further reduced since the hepatic venous branches are the main source of intraoperative blood loss. […] According to the reduction of the intraoperative blood loss, postoperative morbidity must be decreased, and thus, hospital stay may be shortened.”

Dr. Itaru Endo MD PhD
With whom?

Yokohama City University Hospital
Department of Gastroenterological Surgery

- First demo at Fraunhofer Tokyo (Laptop based, March 2012: „When can we have this?!“ – „Christmas this year?“
iOS MeVisLab Remote Library

MeVisLab can power Webapplications
Used this for the Neuro GirlsDay 2012
iPad Application (via phoneGap)
→ Image update not fast enough

Needed a native, binary implementation of the remote protocol
(instead of Websocket based one)

Simon Benten implemented big part of the protocol, thanks Simon!
iPad in the OR
multimodal breast imaging

image guided surgery

4D flow quantification

Selected Research Topics

Aorta
Pulmonary Artery
Left Ventricle

radiation oncology
MeVisLab in Cardiovascular Applications
Flow Visualization

- Fast GPU-based flow visualization
- Streamlines and pathlines
- Different coloring options
  - direction
  - velocity
  - angles
  - anatomic region

Hennemuth et al., SPIE 2011
Flow Visualization

- Fast GPU-based flow visualization
- Streamlines and pathlines
- Different coloring options
  - direction
  - velocity
  - angles
  - anatomic region

Hennemuth et al., SPIE 2011
Probabilistic Tracking

Conventional streamline

\[ x_0 \xrightarrow{s_0} s_1 \cdots \xrightarrow{s_{k-1}} x_k = x_0 + \sum_{j=0}^{k-1} s_j \]

Vector field
Step length
Probabilistic Tracking

Conventional streamline

Alternative trajectories?

$x_k = x_0 + \sum_{j=0}^{k-1} s_j$

$s_k = f(x_k, V; T)$

$p(x_k) = p(s_0, \ldots, s_{k-1})$

Vector field
Step length
Incorporation of measurement uncertainty

- trajectories as minimal paths in tensor field based on PC-MRI flow field

- tensor field as metric for anisotropic Fast Marching
  + restriction of direction for propagation in the Fast Marching

Distance map

Schwenke et al., MICCAI 2011
Incorporation of measurement uncertainty

- trajectories as minimal paths in tensor field based on PC-MRI flow field

- tensor field as metric for anisotropic Fast Marching
  + restriction of direction for propagation in the Fast Marching

Schwenke et al., MICCAI 2011
Probabilistic Bloodflow Analysis 2

Incorporation of measurement uncertainty

- trajectories as minimal paths in tensor field based on PC-MRI flow field
- tensor field as metric for anisotropic Fast Marching
  + restriction of direction for propagation in the Fast Marching

Most likely trajectories

Schwenke et al., MICCAI 2011
Pressure difference mapping

- Navier-Stokes-based 3D pressure difference maps

\[-\nabla p = \rho \frac{\partial \mathbf{v}}{\partial t} + \rho \mathbf{v} \cdot \nabla \mathbf{v} + \eta \nabla^2 \mathbf{v} - \rho \mathbf{g}\]

- pressure differences over time
- interactive pressure curves over selected vessels

Meier et al. CINC 2010
Bloodflow simulation

Support of therapy planning through flow simulation

Comparison with measured data

Meier et al., GI Workshop ETM 2011
Flow pattern analysis

Goal: Quantitative assessment of flow features

Problems: Classical Approaches amplify noise and are resolution-sensitive → limited applicability to PC MRI data

Solution: Adaptive Vector Pattern Matching

DrexI et al., submitted to ISBI 2013
Comparison with ground truth for multispectral plaque MRI

Segmentation and fusion of MR contrasts
Alignment of histological slice

- Joint 3D color images of different contrasts
- Arithmetic combinations of different contrasts

Images courtesy of PD Dr. Markus Dr. Harlo
CAIPI: A research tool for cardiac image analysis
Plug-in for OsiriX

**OsiriX**
- DICOM PACS workstation
- Integrated data management
- Distributed under Open Source Licensing
- Extendable by plugin-architecture
- Established tool for cardiovascular image analysis

**MeVisLab**
- Modular cross-platform framework for medical image processing and visualization.
- Extendable by visual rapid prototyping.
- Support of large n-dimensional volumes by page-based image processing.
CAIPI: A research tool for cardiac image analysis
Plug-in for OsiriX

Synchronized Analysis of Cardiac Image Data

- Cardiac Function
- Bloodflow
- Tissue Characterization
  - T1-Mapping
  - T2*-Mapping
  - Late Enhancement

Huellebrand et al., ESCR 2011
Highly Accurate Breast Cancer Diagnosis through Integration of Biomedical Knowledge, Novel Imaging Modalities and Modelling

FP7 ICT – Virtual Physiological Human Call

- Specific Targeted Research Project (STREP)
- medium sized

Duration: 9/08 – 2/12

EIBIR – European Institute for Biomedical Imaging Research (Coordinator; AT)
Fraunhofer MEVIS, Bremen (Scientific Coordinator; DE)
MeVis Medical Solutions, Bremen (DE)
University College London (UK)
Swiss Federal Institute of Technology, Zuerich (CH)
Radboud University Medical Centre, Nijmegen (NL)
University of Dundee (UK)
Charité Medical University Berlin (DE)
Boca Raton Regional Hospital (USA)
Rapid pulse, sweating, shallow breathing. According to the computer, you’ve got gallstones.

1. CAD system development
2. Data and knowledge annotation
3. Clinical validation
4. Product integration
CAD Required for Extended Imaging Protocols?

Here: Fast Breast MRI

with work by B. Platel et al.
High Temporal and High Spatial Resolution MRI (TWIST vs. VIBE)

- 154 lesions (71 benign, 83 malignant)
- 20 timepoints TWIST with 4.3 sec temporal resolution and 0.9x0.9x2.5 mm³ voxel size
- 1+4 pre/post-con VIBE volumes with 82 sec temporal resolution and 0.8x0.8x1.0 mm³ voxel size

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Occurrence</th>
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<tbody>
<tr>
<td>Benign</td>
<td></td>
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<tr>
<td>FA</td>
<td>36</td>
</tr>
<tr>
<td>Lymph Node</td>
<td>12</td>
</tr>
<tr>
<td>Adenosis</td>
<td>7</td>
</tr>
<tr>
<td>Nodular fasciitis</td>
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<tr>
<td>Other</td>
<td>14</td>
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<tr>
<td>Malignant</td>
<td></td>
</tr>
<tr>
<td>IDC</td>
<td>56</td>
</tr>
<tr>
<td>ILC</td>
<td>14</td>
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<tr>
<td>DCIS</td>
<td>10</td>
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<td>Other</td>
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</table>

B. Platel et al.

<table>
<thead>
<tr>
<th>TWIST</th>
<th>VIBE</th>
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<tbody>
<tr>
<td>voxelsize</td>
<td>0.9<em>0.9</em>2.5 mm</td>
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<tr>
<td>TE</td>
<td>2.02 ms</td>
</tr>
<tr>
<td>TR</td>
<td>3.96 ms</td>
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<tr>
<td>flip angle</td>
<td>20°</td>
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<tr>
<td>FOV</td>
<td>360 mm</td>
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<td>parallel imaging acceleration factor</td>
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<tr>
<td>temporal resolution</td>
<td>4.3 sec</td>
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<tr>
<td>size region A</td>
<td>15% of k-space points</td>
</tr>
<tr>
<td>sampling density region B</td>
<td>10% per image volume</td>
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Results
TWIST vs VIBE

- kinetic parameters: TWIST superior to VIBE
- morphological parameters: similar for TWIST and VIBE

### Table

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<thead>
<tr>
<th>Method</th>
<th>VIBE</th>
<th>TWIST</th>
<th>both</th>
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<tr>
<td>LDA</td>
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<td>significance</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>kNN</td>
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<td>0.78</td>
<td>0.78</td>
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<tr>
<td>TWIST</td>
<td>0.82</td>
<td>0.78</td>
<td>0.81</td>
</tr>
<tr>
<td>significance</td>
<td>$p = 0.012$</td>
<td>-</td>
<td>-</td>
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<tr>
<td>SVM-poly</td>
<td>0.70</td>
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<td>0.73</td>
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<tr>
<td>TWIST</td>
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<tr>
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<td>0.73</td>
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<td>TWIST</td>
<td>0.86</td>
<td>0.79</td>
<td>0.86</td>
</tr>
<tr>
<td>significance</td>
<td>$p &lt; 0.001$</td>
<td>-</td>
<td>$p &lt; 0.001$</td>
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</table>

### Graphs
- AUC = 0.85 (TWIST)
- AUC = 0.82 (VIBE)
What About Multimodal CAD?

with results of HAMAM and Medical Valley
HAMAM Workstation: Interactive CAD

*(here: ABUS – MG)*
HAMAM Workstation: Fuzzy Cursor

*(here: MRI – MG)*
Comparison of current and prior scans
Comparison with prior scans

in particular for high-risk group

T. Böhler et al.
Elastic Prior-Current Image Registration

without and with registration

T. Böhler et al.
Spatial Correlation of Automated 3D US and Tomosynthesis
Compression Simulation

L. Han et al.
Compression Simulation

L. Han et al.
Compression Simulation

L. Han et al.
Compression Simulation
Compression Simulation
Screening:
Patient individual protocol optimization
Cost-efficient patient stratification

ASSURE
Adapting Breast Cancer Screening Strategy Using Personalised Risk Estimation
Breast Density and Breast Cancer Risk

Two types of risk associated with breast density:

- *Increased incidence:* Risk of developing a new cancer
- *Masking risk:* Risk of missing a cancer due to difficult conditions
Multimodal spatial and histo-pathological correlation
(new EC FP7 project VPH-PRISM)
Multimodal spatial and histo-pathological correlation (new EC FP7 project VPH-PRISM)

Sclerotic Stroma of the breast

Hardened collagen

M. Harz et al.
Quantification of Proliferation

A. Homeyer et al.
Quantification of Proliferation
Fall 2

22-jähriger Patient, Tumor rechter Lungenoberlappen, klinisch bestehen multiple unterschiedlich große Knoten im Bereich der rechten Lunge
Fall 2

22-jähriger Patient, Tumor rechter Lungenoberlappen, klinisch bestehen multiple unterschiedlich große Knoten im Bereich der rechten Lunge.
Fall 2

22-jähriger Patient, Tumor rechter Lungenoberlappen, klinisch bestehen multiple unterschiedlich große Knoten im Bereich der rechten Lunge.
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Fall 2

22-jähriger Patient, Tumor rechter Lungenoberlappen, klinisch bestehen multiple unterschiedlich große Knoten im Bereich der rechten Lunge
Fall 2

22-jähriger Patient, Tumor rechter Lungenoberlappen, klinisch bestehen multiple unterschiedlich große Knoten im Bereich der rechten Lunge
Choose Application

Web Applications

Fraunhofer MEVIS
Lung Parenchyma Analysis

Include LAV Cluster Analysis

Start Processing

Dataset loaded.
Lung Parenchyma Analysis

Left Lung Volume: 2.8 litres
Emphysema: 3.0%

Right Lung Volume: 3.2 litres
Emphysema: 9.6%

Include LAV Cluster Analysis

Start Processing
Lung Parenchyma Analysis

Left Lung Volume: 2.8 litres
Emphysema: 3.0%

Right Lung Volume: 3.2 litres
Emphysema: 9.6%

Include LAV Cluster Analysis

Start Processing

Done.
Lung Parenchyma Analysis

YACTA 438519
19420531 M
438519
Radiologie
Volume Zoom
ThreadsRoutine 1.25 B30f - B30f
20020506

YACTA 438519
19420531 M
438519
Radiologie
Volume Zoom
ThreadsRoutine 1.25 B30f - B30f
20020506

Left Lung Volume: 2.8 litres
Emphysema: 3.0%

Right Lung Volume: 3.2 litres
Emphysema: 9.6%

Include LAV Cluster Analysis

Start Processing

Done.
Welcome to the home of the MeVisLab development environment for medical image processing and visualization.

MeVisLab represents a powerful, modular framework for the development of image processing algorithms and visualization and interaction methods, with a special focus on medical imaging.

Besides basic image processing and visualization modules, MeVisLab includes advanced medical imaging algorithms for segmentation, registration, and quantitative morphological and functional image analysis.

The MeVisLab Development Environment

MeVisLab is being developed and used by MeVis Medical Solutions AG and Fraunhofer MEVIS (formerly MeVis Research GmbH) in Bremen, Germany. MeVis Medical Solutions and Fraunhofer MEVIS develop scientific methods and software for computer assistance in medicine in general and radiology in particular, including computer aided diagnosis, therapy planning and monitoring, and computer aided teaching and training.

**Recent News**

2-10-12

**MeVisLab 2.3.1 Bugfix Release Available**

MeVis Medical Solutions and Fraunhofer MEVIS announce the MeVisLab 2.3.1 Bugfix Release [read more]

19-07-12

**MeVisLab 2.3 Stable Release**

MeVis Medical Solutions and Fraunhofer MEVIS announce the MeVisLab 2.3 Stable Release [read more]

26-06-12

**MeVisLab 2.3 Release Candidate**

MeVis Medical Solutions and Fraunhofer MEVIS announce the MeVisLab 2.3 Release Candidate [read more]

7-09-11

**MeVisLab 2.2.1 Bugfix Release Available**

MeVis Medical Solutions and Fraunhofer MEVIS announce the MeVisLab 2.2.1 Bugfix Release [read more]

28-06-11
Documentation

Please refer to the following documents to learn about the features of MeVisLab.

Getting Started

- [PDF] Getting Started Tutorial gives an introduction to the MeVisLab user interface and explains first steps
- [PDF] MeVisLab Reference Manual lists all details of the MeVisLab user interface and IDE
- Movies showing MeVisLab in action

SDK Documentation

- The MeVisLab SDK Documentation Index provides detailed information on the documentation for module development and scripting.

Toolkit AddOns

- ITK AddOn provides information on the ITK modules.
- VTK AddOn provides information on the VTK modules.

Release Notes

- MeVisLab Release Notes include information on current and past releases.

Read more on the following pages...

- SDK
- ITK AddOn
- VTK AddOn
- Open Inventor
- Publications
MeVisLab Help Resources

Using MeVisLab
MeVisLab Reference Manual  PDF
Getting Started  PDF

This Version
New in MeVisLab 2.3  PDF
New in MeVisLab 2.2  PDF
New in MeVisLab 2.1  PDF
New in MeVisLab 2.0  PDF
Release Notes  PDF

SDK General Help
Tool Runner  PDF
MDL (Panel/GUI) Reference  PDF
Scripting Reference (Python/JavaScript)  PDF
Package Structure  PDF
TestCenter Manual  PDF
TestCenter Reference

SDK C++ Help and References
QMake  PDF
The ML Guide  PDF
Kernel Programming  PDF
ML Reference
ToolBox Reference
Open Inventor Reference

External Library References
C++
Python 2.6.4
NumPy 1.3.x
ILK
Vtk
Qt 4.8

Overviews
CSO Overview
GLSL shader framework
Giga Voxel Renderer
LUT Functions
MLImageFormat
Open Inventor
SoView2DExtensions
What's New in MeVisLab 2.2?

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1.2. Integrated Python Debugger

- MATE now contains a GUI front-end for MeVisLab's integrated Python debugger.
- The debugger supports:
  - Breakpoints in Python code and on exceptions
  - Conditional breakpoints
  - Introspection of the stack frames including all local variables
  - Breaking into running Python code
- Tedium setup of external debugger is no longer needed.

Figure 1.1. Python Debugger
1.4. Profiling Improvements

- Profiling now supports function profiling and offers a call graph view.
- The call graph now includes: Field Listeners, MDL commands, Python calls and MeVisLab API/Qt calls.
- Function details view shows calling and called functions overview.

Figure 1.3. Profiling Call Graph

<table>
<thead>
<tr>
<th>Function</th>
<th>Type</th>
<th>Elap Time</th>
<th>Elap Self</th>
<th>Self Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>renderers.subVolumeStartX</td>
<td>Field Notification</td>
<td>1.6...</td>
<td>82...</td>
<td>21...</td>
</tr>
<tr>
<td>renderers.subVolumeStartY</td>
<td>Field Notification</td>
<td>1.6...</td>
<td>82...</td>
<td>21...</td>
</tr>
<tr>
<td>renderers.subVolumeStartZ</td>
<td>Field Notification</td>
<td>1.6...</td>
<td>82...</td>
<td>21...</td>
</tr>
<tr>
<td>ViewScriptFieldCommand</td>
<td>MDL Command</td>
<td>1.4...</td>
<td>14...</td>
<td>19...</td>
</tr>
<tr>
<td>triggerViewAll</td>
<td>Python Function</td>
<td>1.2...</td>
<td>12...</td>
<td>92...</td>
</tr>
<tr>
<td>MLABBoolField.getProperty(value)</td>
<td>Python Qt Function</td>
<td>6.5...</td>
<td>6.5...</td>
<td>6.5...</td>
</tr>
<tr>
<td>MLABMacroModuleField(QString)</td>
<td>Python Qt Function</td>
<td>30...</td>
<td>10...</td>
<td>30...</td>
</tr>
<tr>
<td>MLABTriggerField.touch()</td>
<td>Python Qt Function</td>
<td>28...</td>
<td>14...</td>
<td>27...</td>
</tr>
</tbody>
</table>

Figure 1.4. Profiling Function Details

<table>
<thead>
<tr>
<th>Function</th>
<th>Elapsed Time</th>
<th>Self Time</th>
<th>Time in Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>TestPython</td>
<td>182.3640 ms</td>
<td>173.1543 ms</td>
<td>9.2098 ms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Called By</th>
<th>Elapsed Time</th>
<th>Elapsed Time</th>
<th>Self Time</th>
<th>Self Time Per</th>
</tr>
</thead>
<tbody>
<tr>
<td>TestPython</td>
<td>182.3640 ms</td>
<td>182.3640 ms</td>
<td>182.3640 ms</td>
<td>182.3640 ms</td>
</tr>
</tbody>
</table>
1.1. Open Inventor Renovation and New Modules

- Renovated the Open Inventor core by using vertex arrays and VBO to enhance efficiency of renderings.
- Added new class SoIndexedTriangleSet to further enhance speed.
- Added modules to render screen space ambient occlusion, and cascaded shadow mapping and soft-shadows (PCSS).
  - SoScreenSpaceAmbientOcclusion
  - SoShadowMapping
- Added SoRenderSurfaceIntersection to render 3D surface intersections on 2D slices.
  - SoRenderSurfaceIntersection
- Added SoFixedFunctionShader to extent the fixed function OpenGL pipeline with user shaders.
  - SoFixedFunctionShader
- Supporting MSAA (multisample anti-aliasing) in SoExaminerViewer, SoFramebufferSampler2D, and OffscreenRenderer.
- Module SoDiagram2D replaces Diagram2D and offers extension modules for rendering curves.
  - SoDiagram2D

Figure 1.1. Open Inventor scene without any SSAO or shadow mapping.

Figure 1.2. Open Inventor scene with screen space ambient occlusion.
Figure 1.3. Open Inventor scene with soft shadows.

Figure 1.4. Open Inventor scene with SSAO and soft shadows.

Figure 1.5. Polygonal surfaces cut and filled on a 2D viewer.
1.2. New GVR Modules

- Added module for local ambient occlusion (LAO) and deep shadow map rendering
  - GVR Ambient Occlusion
  - GVR Deep Shadow Mapping

Figure 1.6. GVR rendering without any LAO or shadows.

Figure 1.7. GVR rendering with local ambient occlusion.
Figure 1.7. GVR rendering with local ambient occlusion.

Figure 1.8. GVR rendering with deep shadow mapping.
1.5. MDL Control GraphicsView

Chapter 1. What’s New in MeVisLab 2.3?

1.5. MDL Control GraphicsView

- The QGraphicsView is now available as an MDL control to mix OpenGL renderings with MDL controls.
  - The GraphicsView features:
    - Supports arbitrary item layout, layering, and animations.
    - Fully scriptable via Python.
    - It offers support for:
      - Inventor render areas,
      - MDL panels,
      - Line,Pixmap,Polygon,Rect,Ellipse items,
      - WebKit WebView, and
      - HotAreas with transitions.
    - Have a look at the macro module GraphicsViewPresentation that itself implemented using a GraphicsView.

Figure 1.11. Viewer implemented with GraphicsView showing a GVR rendering with an MDL control and a 2D viewer overlaid.

Window: 1
Level: 0.662
The GraphicsView

New user interface possibilities

Florian Link
MeVis Medical Solutions AG
Introduction

- **GraphicsView** is a new MDL control
- It is scriptable via Python
- Items can be:
  - laid out arbitrarily
  - overlayed with transparent background and alpha
  - animated
Available Items

- Offered items:
  - Graphics items (Lines, Pixmaps, RichText, ...)
  - Inventor Render Areas
  - MDL Panels
  - WebKit HTML
  - Vertical, Horizontal, Grid and Anchor layouts
  - HotArea layout with HotAreas
  - Frame with gradient or box image
  - MouseArea for interaction
MSAA Example
MSAA Example
Surface Intersection

MeVis Medical Solutions  April 2012  Florian Link  Visualization News
Surface Intersection
Surface Intersection
Deep Shadow Mapping
Deep Shadow Mapping
Deep Shadow Mapping
Thanks!
Thanks!
Thanks!
Thanks!
Thanks!
1.7. Contributions by Fraunhofer MEVIS

Chapter 1. What’s New in MeVisLab 2.3?

1.7. Contributions by Fraunhofer MEVIS

- Added the registration module MERIT.
  The MERIT (MeVis Image Registration Toolkit) module is a software framework for image registration. It is particularly aimed at the rapid prototyping of registration methods often required in everyday work with MeVisLab. Among its core features are:
  - 2-D/3-D affine-linear image transformations (translation, rigid, similarity, rigid+scale, affine) with customizable component orders.
  - Newton-type optimization (and approximation thereof) with line-searching (linear or Armijo’s rule).
  - Multi-resolution image pyramids with custom downsampling, stop levels, and number of levels.
  - Inherent pre-registration initialization schemes (e.g., initial matching of centers of gravity).
  - Five common image similarity measures (SSD, NCC, NMI, LCC, NGF).
  - Nearest neighbor, cubic, Lanczos, and linear image interpolation methods.
  - Multi-threading support using OpenMP processor threads.
  - Robust convergence criteria, e.g. Gill-Murray-Wright, for a unified convergence behavior of all algorithms.
  - Entirely graphical usage through a consistent user interface.
  - Error curve output, mask image support, plugin methods, and much more.
- The python-based 2D plotting library Matplotlib (http://matplotlib.sourceforge.net/) has been integrated into MeVisLab.
  - Qt4 backend has been ported to PythonQt/MeVisLab.
  - MatplotlibCanvas MDL control allows to embed plots in MeVisLab UIs.
  - See MatplotlibMDLExample for an example usage.

Figure 1.12. Example graph plotted with matplotlib.

Example graph plotted with matplotlib.
“Current medical software platforms are incomplete and inefficient.”

San Diego, Feb 2012
COMIC
Welcome to the web framework of the Consortium of Open Medical Image Computing. On this website you can

**Create a project**

A project is a website like the ones listed here. To create a project, sign in and use the Create new project link in the gray box to the left. Once there, choose a url and a skin, create pages, and set permissions. For detailed instructions on how to create a new project, check out the support section.

Example projects:

**Share data**

You can connect to your dropbox account and render HTML and images directly on project pages. You can upload data via this website or FTP, or link to an XNAT database. You can specify which persons or groups can download the data.

**Visualize**

Use web rendering to interactively scroll through uploaded scans, add masks and annotations. See an example here.

**Receive data**
Perspectives

- Quantification and Characterization of Change Over Time
- Automated Analysis of Digital Pathology
- Interactive Multimodal CAD
- Combined Phenotyping and Decision Support
- Optimized Contrast-Agent Less MRI Protocols
- Knowledge Prototyping (today: tool development)
- Cloud Based Applications, iPad etc.