

MITK in the context of NA-MIC

The Medical Imaging Interaction Toolkit

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Open-source Toolkits

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Powerful toolkits for

- Visualization: VTK (www.vtk.org)
- Segmentation/registration: ITK (www.itk.org)

But:
insufficient support for interactive software

MITK ...

- uses parts of NA-MIC: **ITK & VTK**
- adds features outside the scope of boths
- → is not at all a competitor to VTK or ITK


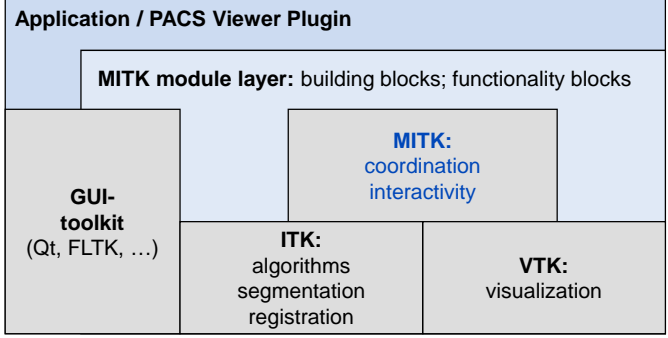
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MITK

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Medical Imaging Interaction Toolkit (MITK)

- open-source C++ toolkit based on ITK/VTK
- coordination of visualizations and interactions
- combine modules developed independently from each other

The diagram illustrates the MITK architecture. At the top is the 'Application / PACS Viewer Plugin' layer. Below it is the 'MITK module layer: building blocks; functionality blocks'. This layer is divided into three main components: 'GUI-toolkit (Qt, FLTK, ...)', 'MITK: coordination interactivity', and 'ITK: algorithms segmentation registration'. The 'ITK' component is further divided into 'VTK: visualization' and another sub-section.

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MITK

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- Object oriented C++ Framework/Toolkit
- Supports
 - gcc 3.3, 4.2, VC7.1, VC8, VC9
 - Latest VTK release
 - Latest two ITK releases
- MITK-Core does not depend on a GUI toolkit
- MITK-Application-Level provides
 - Qt3 base application
 - Many Qt3 widgets
 - FLTK example
 - Qt4 is work in progress

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Re-use of design and concepts

```

    graph TD
      FLTK --> FLmitk
      ITK --> MITK
      FLmitk --> MITK
      MITK --> VTK
  
```

- MITK's core is GUI independent

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Tools and software process

CMake:
config and build system

ITK Modules

- Data Representation Objects
- Image Representation Objects
- Mesh Representation Objects
- Path Representation Objects
- Geometry Representation Objects
- Data Access Objects

Doxygen:
documentation

Subversion:
version management

SourceForge:
mailing list

Bugzilla:
bug tracking

DART:
automatic builds and test runs

What MITK does – a quick overview



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original data
sliced original data
ellipse
segmentation
position of the other two slices
sliced original data in 3D
ellipsoid
position of the other two slices
sliced segmentation
volume rendering of segmentation

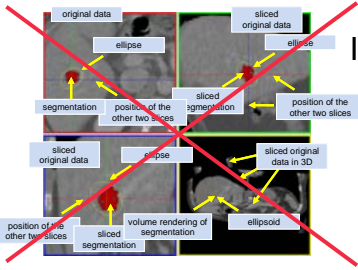
→ synchronization of ...
20 objects in 4 scene-graphs
... required !

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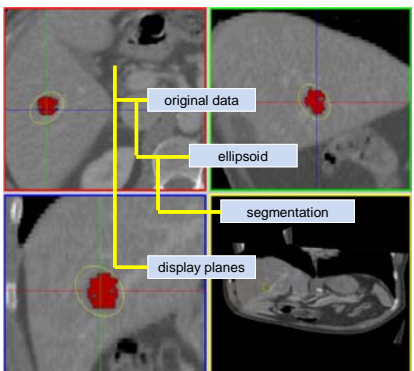
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Getting out of the maze ...

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Instead of creating **many** scene-graphs with **even more** elements ...

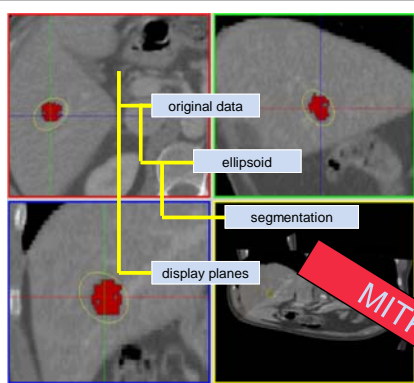


... create a **single** data repository with a **few** data-objects!

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MITK:
Data repository instead of scene-graphs


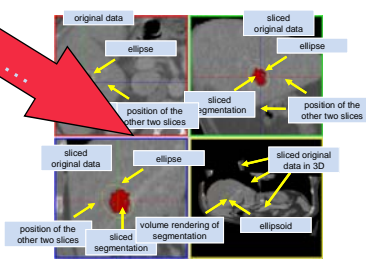
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MITK takes the data repository ... and builds ...

→ VTK scene graphs

MITK creates ...

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Data repository

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- Repositories for sharing data objects between modules
- Any number of data objects
- Any kind of data objects
- Data objects with geometry frame (bounding-box, transform, etc.)

```

graph LR
    Root[ ] --- A[Abdominal CT (Image)]
    Root --- B[MRI (Image)]
    Root --- C[Helper Objects]
    A --- D[Liver (Surface)]
    A --- E[Tumor (Surface)]
    A --- F[Vessels (Graph)]
    C --- G[Landmarks (Points)]
  
```

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Rendering the data repository

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RenderWindow:

- single RenderWindow class
- different types of views
 - 2D/3D
 - special views definable (e.g., for AR)
- point to the data repository
 - any number of views on the data:


```

renderer1->SetData(repository);
renderer2->SetData(repository);
...
          
```

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Defining how we want to see the data ...

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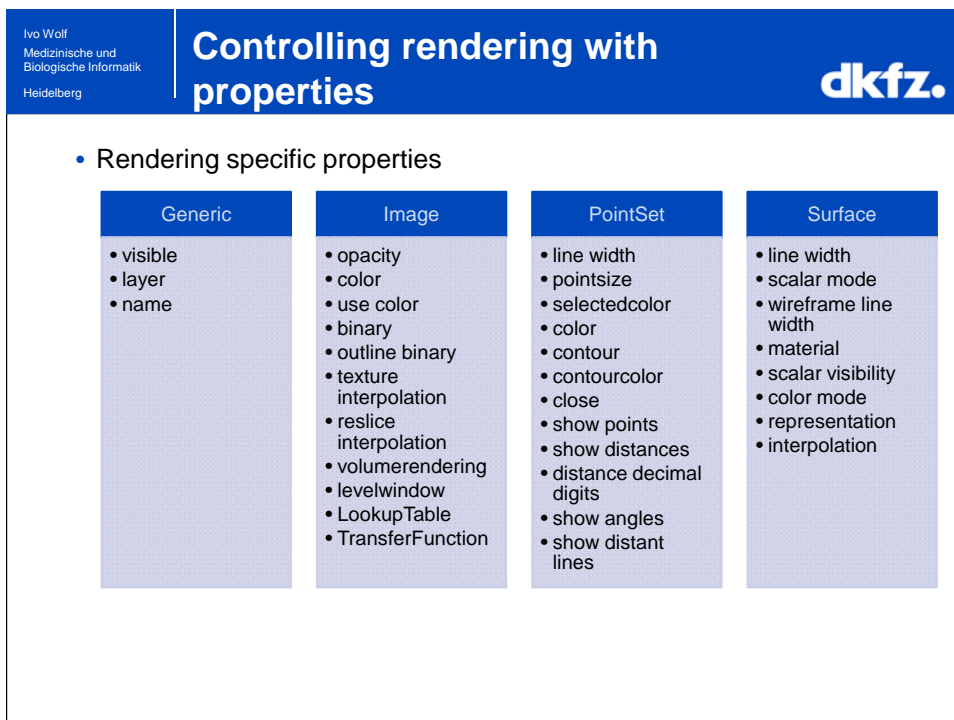
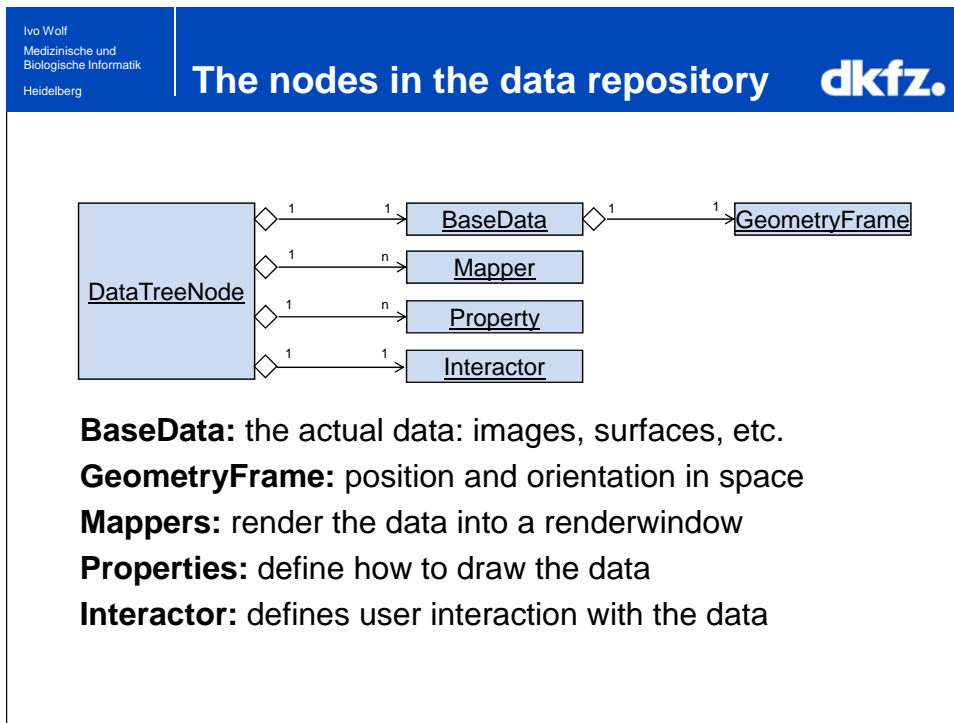
The diagram illustrates the process of defining data visualization. It features a central 3D volume with four views: original data, an ellipsoid, segmentation, and display planes. Labels with arrows point to these elements.

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Render and interact on curved planes

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The image displays four panels showing medical data rendered on curved planes. The top-left panel shows a heart cross-section with a curved yellow plane. The top-right panel shows a spine with a curved yellow plane. The bottom-left panel shows a heart cross-section with a curved yellow plane. The bottom-right panel shows a spine with a curved yellow plane and a green highlighted region.



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How to add a new data type


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Extension for new data types:

- derive data class
- derive mapper
- create file I/O
- Register mapper / I/O handler at factory

Example:

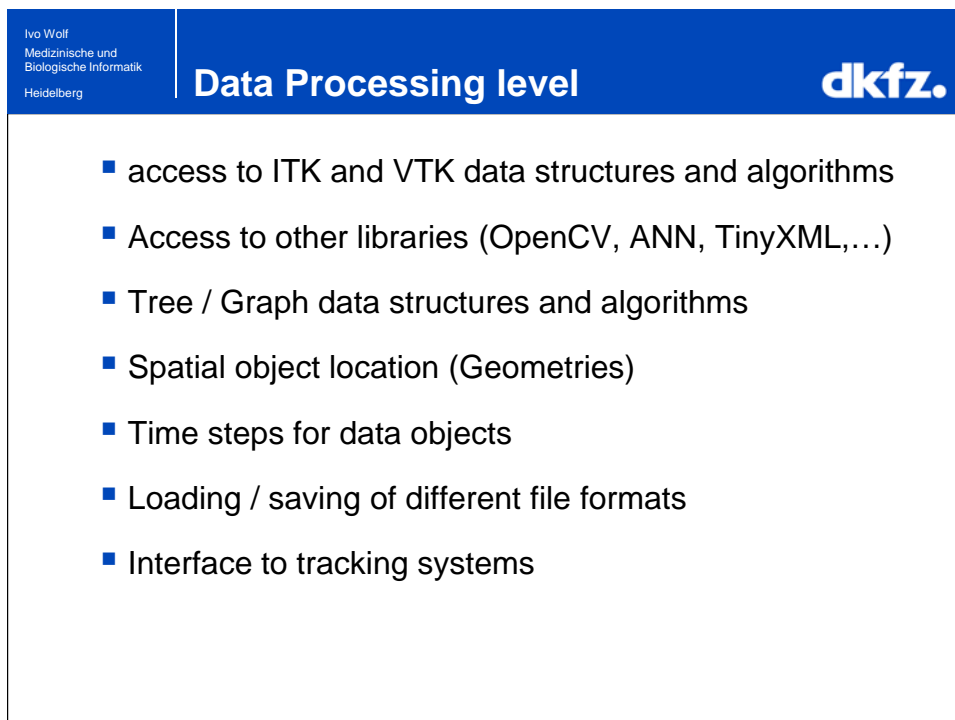
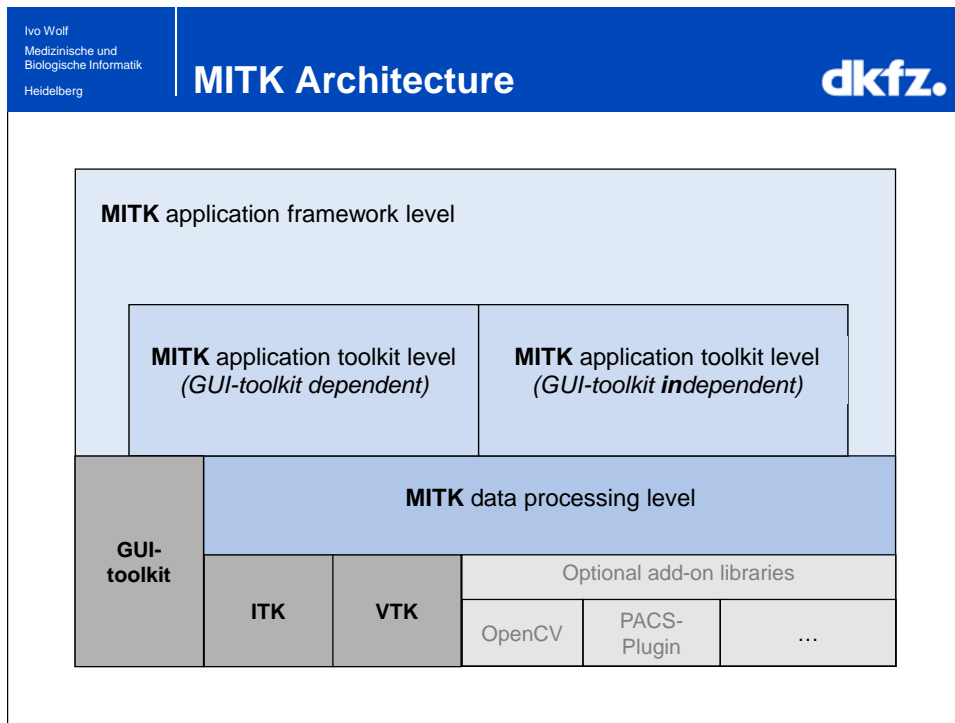
- attributed vessel graphs



[DKFZ and University of Tübingen]

MITK Architecture

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Application toolkit level

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- Rendering
 - Mappers, Update Management, Render Properties
- Data Management
 - Object Container, Object Properties, Scene Management
- Interaction
 - Statemachine based
- Undo/Redo
- Processing of tracking data
- Qt Widgets
 - TreeNodeSelector, StandardViews, PropertyEditor, LevelWindow, Renderwindow, SlicerControls, Navigationviews,...

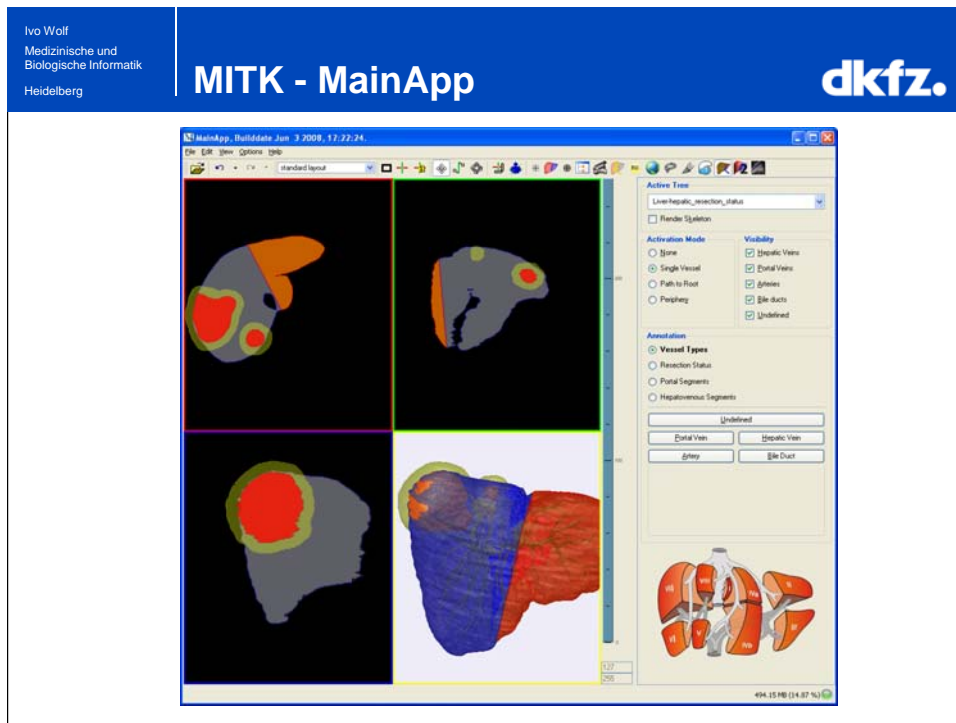
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Application framework

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Base application (*MITK-MainApp*):

- Container for functionalities
 - independent „Plug-Ins“ for specific problems
- Shared repository for data objects
- Persistence:
 - Application state can be saved and restored on next startup
- Interface to CHILI-PACS Workstation



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MITK functionality modules

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Functionality = a module with ...

- an identification (icon/tooltip/...)
- a workspace area
- a control area
- a option dialog
- a help page (manual)
- the algorithmic implementation

The screenshot shows a specific functionality module interface. It has a 2x2 grid of images: top-left and top-right show axial MRI slices with a green line indicating a vessel; bottom-left shows a similar slice with a different line; bottom-right shows a 3D reconstruction of a vessel. To the right is a control panel with 'Reference Surface' options, 'Display Mode' (3D/2D), 'Reformation Type' (crossed reformation/cross section), 'Quality', 'show points', 'Analysis' (Connect Mode), 'Length [mm]', 'Points' list, and 'File' options (Load Points, Save Points, Save Result View). Labels are placed over the image: 'icon/tooltip/...' points to the top-right image, 'workspace area' points to the bottom-left image, and 'control area' points to the right-hand control panel.

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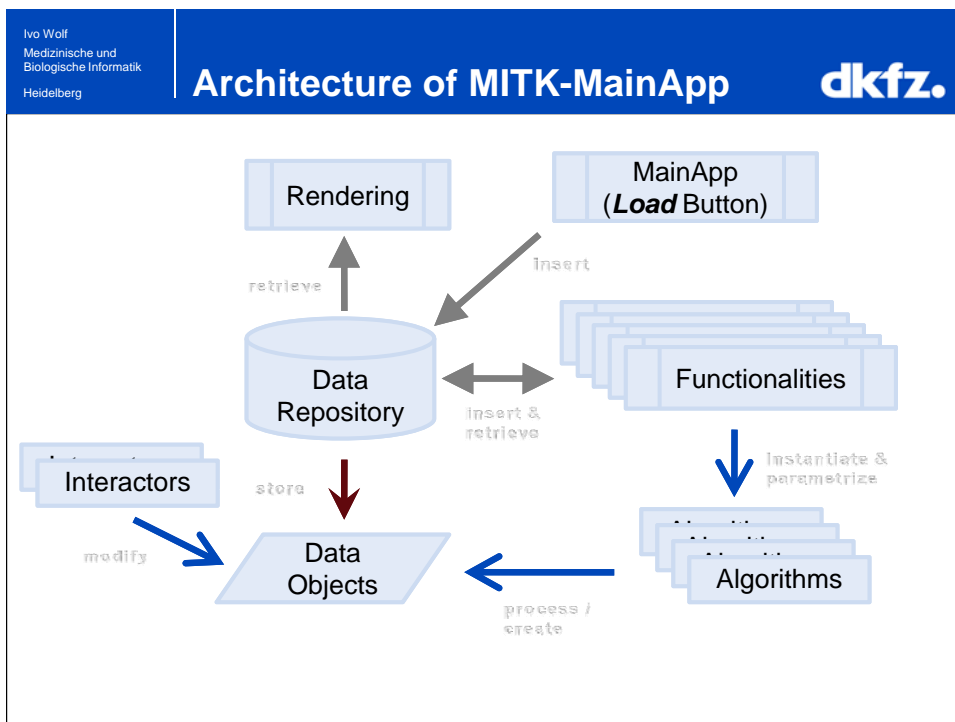
Combining functionality blocks dkfz.

- Functionalities are independent from each other
- They communicate via the data repository

The screenshot shows a software interface with a central tree view for 'Heart-ID694119'. The tree contains the following items:

- attractors
- epicardium
- masked epicardium
- local threshold region
- masked local threshold region
- simplex-mesh model

 Surrounding the tree are several windows displaying 3D and 2D heart models, with red arrows indicating data flow between the tree and the visualizations.



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Navigation / IGT with MITK

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- Tracking component allows access to different tracking systems:
 - NDI Polaris/Aurora
 - Microntracker
 - Our own video based Inside-Out-Tracking algorithm
- Filter pipelines for tracking coordinates (Kalmanfilter,...)
- Logging & replay of tracking data
- Geometry classes to manage different coordinate systems
- (not yet open source)

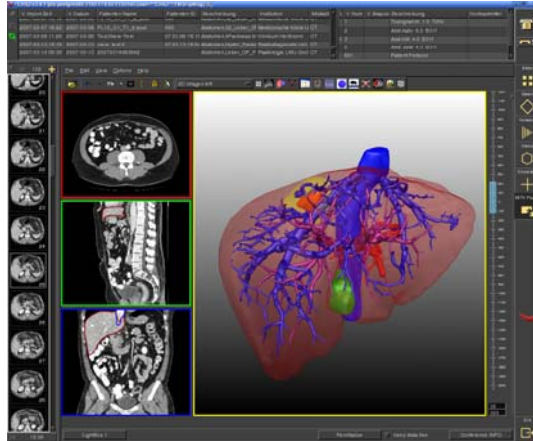
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Examples of IGT applications with MITK

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Integration in PACS/telemedicine system CHILI® as a PlugIn:

- PACS
 - Connection to modalities
 - DICOM import/export
 - DICOM "unification"
 - Data transfer
 - Tele-radiology
 - Management of results from image processing
- facilitates clinical integration



How to get started

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www.mitk.org

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Download options:

- anonymous svn:
svn co <http://svn.mitk.org/trunk/mitk/>
- zipped archive (v 0.8)
<https://sourceforge.net/projects/mitk/>

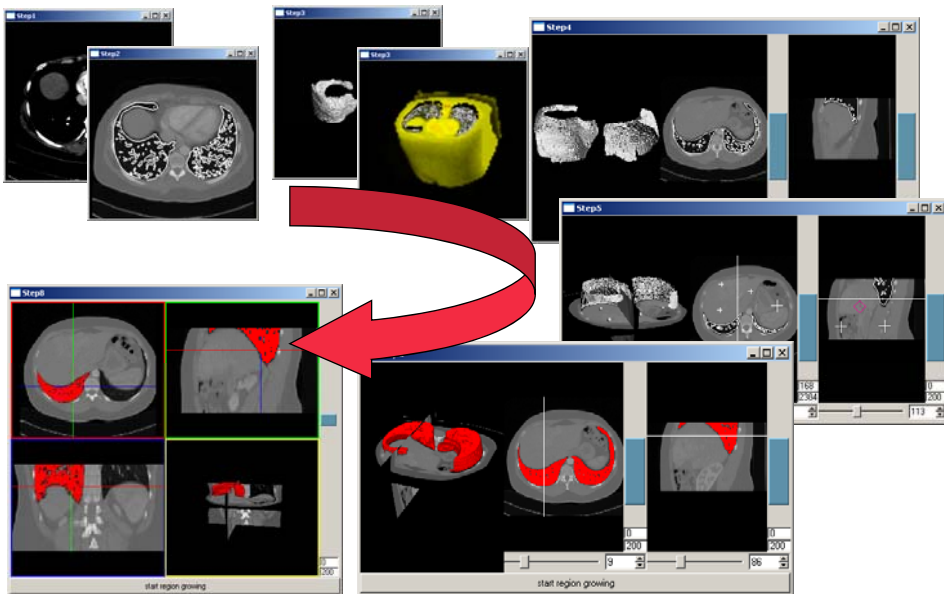
Tutorial:
<http://mitk.org/documentation/>



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9-step tutorial

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A small functionality

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We'll have a look at a very simple functionality for region growing:

0. (create a functionality)
1. select an image
2. set some seed points
3. react, when a GUI button is pressed
4. run a region grower from ITK
5. display the result in MITK

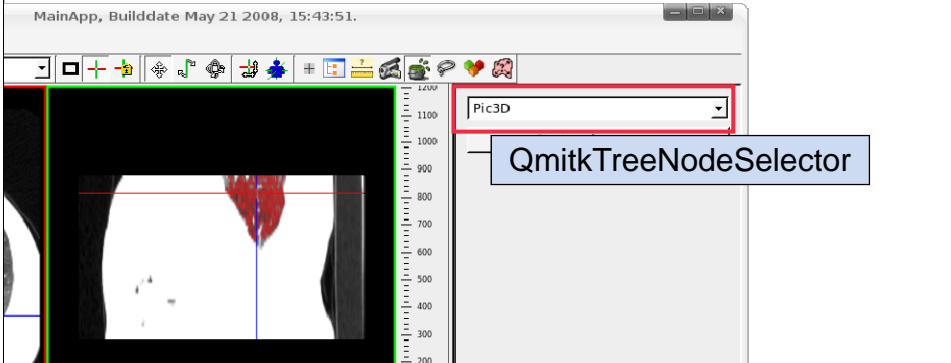
(can be downloaded at mitk.org)

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A small functionality

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1. selection of an image
2. set some seed points
3. react, when a GUI button is pressed
4. run a region grower from ITK
5. display the result in MITK



MainApp, Builddate May 21 2008, 15:43:51.

QmitkTreeNodeSelector

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A small functionality

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1. selection of an image
2. set some seed points
3. react, when a GUI button is pressed
4. run a region grower from ITK

PointSetInteractor

```

QmitkRegionGrowing.cpp (~:/mitk/extern/src/QFunctiona
File Edit View Terminal Tabs Help
92
93 void QmitkRegionGrowing::Activated()
94 {
95     QmitkFunctionality::Activated();
96
97     if ( m_PointSetNode.IsNull() )
98         // only once create a new DataTreeNode containing a PointSet with some interaction
99         {
100             // new node and data item
101             m_PointSetNode = mitk::DataTreeNode::New();
102             m_PointSetNode->GetPropertyList()->SetProperty("name", mitk::StringProperty::New("Seedpoints for region growing"));
103             m_PointSet = mitk::PointSet::New();
104             m_PointSetNode->SetData( m_PointSet );
105
106             // new behaviour/interaction for the pointset node
107             m_Interactor = mitk::PointSetInteractor::New("pointsetinteractor", m_PointSetNode);
108             mitk::GlobalInteraction::GetInstance()->AddInteractor( m_Interactor );
109
110             // add the pointset to the data tree (for rendering)
111             GetDataTreeIterator()->Add( m_PointSetNode );
112         }
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A small functionality

dkfz.

1. selection of an image
2. set some seed points
3. react, when a GUI button is pressed
4. **run a region grower from ITK**
5. display the result in MITK

```

graph TD
    A[mitk::Image] --> B[AccessByItk macro]
    B --> C["templated method for ITK code  
itk::Image<TPixel, VImageDimension>"]
    C --> D[mitk::ImportItkImage()]
    D --> E[mitk::Image]
  
```

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A small functionality

dkfz.

3. react, when a GUI button is pressed
4. run a region grower from ITK
5. **display the result in MITK**

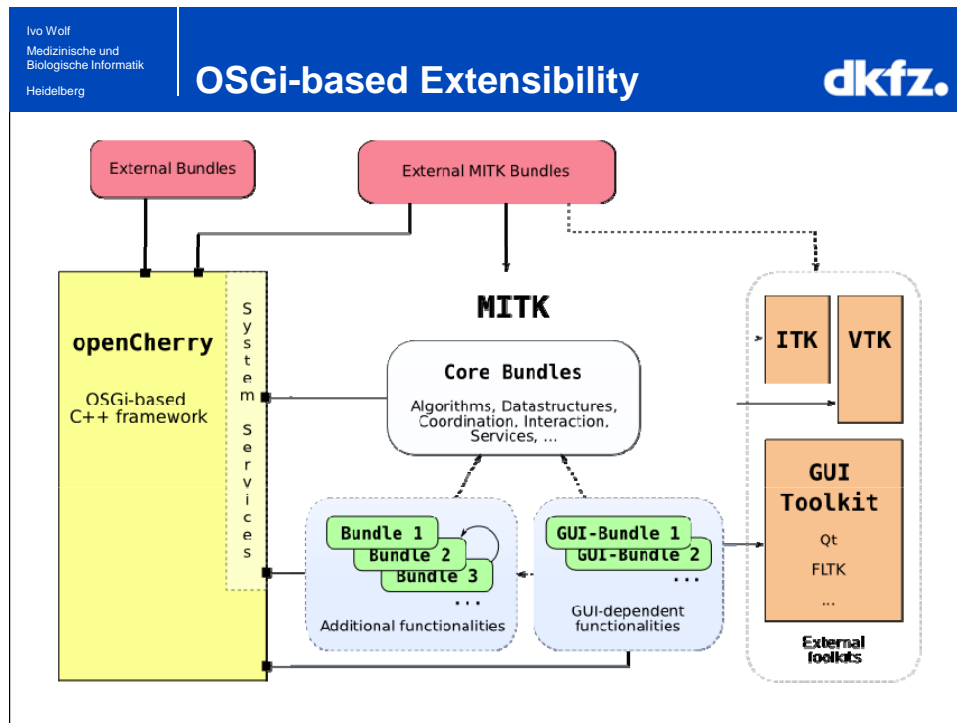
```

QmitkRegionGrowing.cpp (~/mitk/extern/...Functionalities/QmitkRegionGrowing) - VIM
File Edit View Terminal Tabs Help
217 regionGrower->Update();
218
219
220 mitk::Image::Pointer resultImage = mitk::ImportItkImage( regionGrower->GetOutput() );
221 mitk::DataTreeNode::Pointer newNode = mitk::DataTreeNode::New();
222 newNode->SetData( resultImage );
223
224 // set some properties
225 mitk::DataTreeNodeFactory::SetDefaultImageProperties( newNode );
226 newNode->SetProperty("binary", mitk::BoolProperty::New(true));
227 newNode->SetProperty("name", mitk::StringProperty::New("dumb segmentation"));
228 newNode->SetProperty("color", mitk::ColorProperty::New(1.0,0.0,0.0));
229 //newNode->SetProperty("volumerendering", mitk::BoolProperty::New(true));
230 newNode->SetProperty("layer", mitk::IntProperty::New(1));
231 newNode->SetProperty("opacity", mitk::FloatProperty::New(0.5));
232
233 // add result to data tree
234 mitk::DataStorage::GetInstance()->Add( newNode );
235
236 mitk::RenderingManager::GetInstance()->RequestUpdateAll();
237 }
238
238,0-1 Bot
  
```

The future

OSGi-based extensibility for MITK-applications:

- OSGi: component model originally designed for Java
- Basic building blocks are *bundles* (aka plugins) and *services*
- Easy extensibility through loose coupling
- Every plugin can define its own *extension points*
 - general concept for extensions
 - plugins within plugins at no additional costs
- MITK will provide a set of core *bundles* and *services* for complex imaging tasks and interactions



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Other enhancements

dkfz.

Hot topics:

- Release of two functionalities for registration
- Transition of the Qt3 MITK code to Qt4
- OSGi-based application platform providing views/editors, perspectives and GUI-services (openCherry plugins)
- Python scripting

Thank you !

