Plastimatch, 3D Slicer, Slicer-RT, RTK

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Disclosures

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I participate in sponsored research and beta testing agreements with Elekta and IBA Dosimetry
Disclaimer

“The Software has been designed for research purposes only and has not been reviewed or approved by the Food and Drug Administration or by any other agency”
What's on my desktop?

- CERR
- ConquestDICOM
- Cygwin
- dcmtk
- Emacs
- Firefox
- gcc
- gimp
- KeePass
- Inkscape
- LibreOffice
- Octave
- perl
- Synergy
- VirtualBox
- 3D Slicer
Why open source?

• Freedom!
  • Software can move with scientists
  • No license files needed

• Open development process
  • Documentation
  • Mailing lists
  • Source code management
  • Bug tracking
Today's outline

Plastimatch
plastimatch.org

SlicerRT
slicerrt.org

3DSlicer
slicer.org

RTK
openrtk.org
Plastimatch

- plastimatch.org
  - Registration
  - Segmentation
  - Analysis
- Open source since 2007

Deformable registration

Atlas-based segmentation
Plastimatch scripting

- Command-line oriented
- Highly configurable
- Multi-resolution schema
- Cost function
- Algorithm
- Optimization
- ROI
- Regularization
- Stopping criteria

Documentation on http://plastimatch.org
Hybrid registration

Week 1

LM = 100
Reg = 3

Week 2

LM = 100
Reg = 0.1
Voxel-specific stiffness
Multi-atlas segmentation

Subject

Atlas 1

DIR

Atlas 2

DIR

Atlas n

DIR

Warped contours

Warped contours

Warped contours

Label fusion

Final segmentation
3D Slicer

- Medical image analysis and visualization platform
- Since 1997
- $50M in funding (>2,000 years of labor)
- Professionally engineered
- 1,000+ analysis functions
- 200K downloads for 4.4
- www.slicer.org
Tour of 3D Slicer

- Volume rendering
- Segmentation
- Registration
- Tractography
- Dynamic analysis
3D printing

Step 1: Create labelmap

Step 2: Create surface model
3D printing

Step 3: Export as STL file
Step 4: Use STL for printing
Developing slicer modules

- Three kinds of modules:
  - Command line module
  - Scripted module
  - Loadable module
Command line module

- User interface is generated by slicer

C/C++ files → executable

XML file
(1) Slicer writes your input files, then launches your executable

(2) Your executable runs, and it writes output files

(3) Slicer loads your output files
SlicerRT ecosystem

3D Slicer
Several former SlicerRT features integrated:
Subject hierarchy, DICOM export, Transform visualizer, etc.

SlicerRT core
Common RT software tools:
DICOM-RT, Dose/Contour analysis, Beam planning, Batch processing
Acts as a platform

Utilities
MatlabBridge, Sequences

Streamlined applications
GelDosimetry
SlicerRT use case: Dose accumulation

- Register anatomical images
- Transform whole studies
- Accumulate dose
- Compute DVH

Collaboration with PMH, Toronto

Pinter et al., MedPhys, 2012

Evaluate plans using DVH

Visualize transforms, anatomy in 3D

Convenience features: Transform whole studies with a single click
SlicerRT use case: Gel dosimetry analysis

- Full 3D gel dosimetry
- Simplified user interface

Collaboration with KGH, Kingston, ON

Alexander et al., IC3DDose, 2014

Talk at World Congress: SP057.3
SlicerRT use case: Proton dose calculation

• External beam planning
  – Arbitrary dose engines
  – Using same user interface
  – Potentially replace TPS

• Evaluate plan

Collaboration with MGH, Boston and CRO, Italy

*Desplanques et al., MedPhys, 2014*

*Poster at World Congress: PS04.087*

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*Experimental*
• RTK = reconstruction toolkit

• openrtk.org
RTK Features

- Support for scanners: Elekta, Varian, IBA
- Flexible 3D geometry
  - Any source / detector positions
- Forward- and back-projectors
  - Multi-threaded CPU and GPU
- FDK and SART reconstruction algorithms
- Short scan and offset detector weightings
- Scatter correction
- Numerical phantoms
Results: Catphan acquisitions

Elekta (CLB)  Varian (MGH)  IBA (Testbench)

Data available online: http://midas3.kitware.com
Working example

// FDK reconstruction filtering
typedef rtk::FDKConeBeamReconstructionFilter<ImageType> FDKCPUPType;
FDKCPUPType::Pointer feldkamp = FDKCPUPType::New();
feldkamp->SetInput(0, imageSource->GetOutput());
feldkamp->SetInput(1, rei->GetOutput());
feldkamp->SetGeometry(geometry);
feldkamp->GetRampFilter()->SetTruncationCorrection(0.0);
feldkamp->GetRampFilter()->SetHannCutFrequency(0.0);
feldkamp->Update();

// Writer
typedef itk::ImageFileWriter<ImageType> WriterType;
WriterType::Pointer writer = WriterType::New();
writer->SetFileName("output.mha");
writer->SetUseCompression(true);
writer->SetInput(feldkamp->GetOutput());
writer->Update();
4D CBCT

Projection Images → Amsterdam Shroud → Motion Signal
Links

plastimatch.org

slicerrt.org

slicer.org

openrtk.org