Updates in 3D software development

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Institutional framework
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NCBC Centers

Informatics for Integrating Biology and the Bedside
Brigham and Women’s Hospital

National Alliance for Medical Imaging Computing

National Center for Integrative Biomedical Informatics
University of Michigan

National Center for Biomedical Ontology
Physics-based Simulation of Biological Structures
Stanford University

National Center for Multi-Scale Study of Cellular Networks
Columbia University

Center for Computational Biology
University of California at Los Angeles

NIH Roadmap for Medical Research
NA-MIC Cores

**Leadership**
- PI: R. Kikinis

**DBP**
- MIND Institute CA
- JHU/Queens University, Canada
- UNC, NC
- HMS, MA

**DBP's, til 07**
- PNL, Brockton VA, HMS
- UCI, CA
- Dartmouth College, NH
- Indiana University, Indianapolis
- U of Toronto, Canada

**Algorithms**
- Core PI: R. Whitaker
- U of Utah
- Martinsos, MGH
- MIT, MA
- UNC, NC
- Georgia Tech, GA

**Engineering**
- Core PI: W. Schroeder
  - Kitware, Inc.
  - LONI, UCLA
  - BIRN CC, UCSD
  - NRG, WUSTL
  - GRC, GE
  - Isomics, Inc.

**Service**
- Core PI: W. Schroeder
  - Kitware, Inc.

**Training**
- Core PI: R. Gollub
  - Martinsos Center, MGH

**Dissemination**
- Core Co-PI: T. Kapur, S. Pieper
  - SPL, BWH, Isomics Inc.
Free Open Source Software

• Open source is a development method for software, that promises better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in.

• Research should avoid proprietary software and hardware, because
  • Locks researchers to a single vendor
  • Prevents leveraging of the work of other scientists

• The Open Source Initiative (OSI) is a non-profit corporation formed to educate about and advocate for the benefits of FOSS.

http://www.opensource.org/
Updates

- Slicer4 – released November 2011
- Methodology:
  - Shape regression
  - SPHARM-PDM mean latitude axis
- Tools:
  - Dental Tools
  - Intensity Segmenter
- Future work
• Image analysis and data visualization
• FOSS for Windows, Linux, Solaris and Mac OS
• Updates
  • New lighter interface
  • Transition from Kwidgets to QT
  • Extension manager
  • Volume rendering
• Open Source: No restrictions on use, no license fees
• The source code could be used to develop a commercial package that could be sold. No need to ask for permission.
  • You are responsible to make sure that you comply with all regulations that apply to the way you use it. In any case, MUST acknowledge Slicer’s contribution
• Possible to contribute. One’s choice, is NA-MIC’s decision, if contributions will be accepted.
New interface

Main Menu

Toolbar

User Interface (UI) panel of the Slicer Welcome Module

3D viewer

Data Probe

2D anatomical viewers
Sample Data

Brain MRI

Chest CT

Cardiac CT

Diffusion Tensor Imaging (DTI) Dataset

... soon Dental CBCT
Volume rendering
Slicer extensions
More...

To learn more about Slicer and its different functionalities, please visit the Slicer4.0 compendium

http://www.slicer.org/slicerWiki/index.php/Documentation/4.0/Training
Methodology development
Shape Analysis

- Algorithms development, 3D structural shape analysis
  - Correspondence, SPHARM-PDM & particle based entropy systems
  - Statistical Analysis, MANCOVA.

- Experienced clinicians are able to evaluate and diagnose 3D anatomical structures by looking at 2D classical imaging techniques \( \rightarrow \) difficult to quantify
Shape regression

- Longitudinal Computational Anatomy, computer models of anatomical evolution
- Estimating growth trajectories for 4D atlas construction
- 4D growth models provide a tool to generate shapes at any instant in time (within the interval defined by the data), offering us the opportunity to continuously measure shape properties
Brain atlas superior view
Atlas regressed volume

\[ (\text{mm}^3) \]

\[ 1200000 \]

\[ 1000000 \]

\[ 800000 \]

\[ 600000 \]

\[ 400000 \]

\[ 200000 \]

\[ 0 \]

\[ 6 \]

\[ 39.08 \]

\[ 72.16 \]

\[ 105.24 \]

\[ 138.32 \]

\[ 171.4 \]

\[ 204.48 \]

\[ 237.56 \]

\[ 270.64 \]

\[ 303.72 \]

\[ 336.8 \]

\[ 369.98 \]

\[ 402.96 \]

\[ 436.04 \]

\[ 469.12 \]

\[ 502.2 \]

\[ 535.28 \]

\[ 568.36 \]

\[ 601.44 \]

\[ 634.52 \]

\[ 667.6 \]

\[ 700.68 \]

\[ 733.76 \]

\[ 766.84 \]

\[ 799.92 \]
Atlas correspondence

0 mm

29 mm
Mean latitude axis
Software development
Dental Tools

- Tools and utilities for bone, teeth, skin, airway morphological assessment
  - Scan Converter
  - Relax Polygons
  - Surface utilities: VTK2Meta, Meta2IV, ...
  - Intensity Segmenter
- Only few direct download binaries, mostly code
- Multi-institutional development effort
Dental research

• Neuro-Imaging Research and Analysis Lab (UNC):
  – PI, Martin Styner
  – Research on diverse brain morphometry studies.
  – Emphasis on shape analysis and structural research for neurodevelopmental diseases.

• Orthodontics Research Lab (UofM):
  – PI, Lucia Cevidanes.
  – Diverse 3D imaging studies related with dentistry applications, asymmetry, TMJ OA, orthognatic surgery.
Intensity Segmenter
Future work

- Slicer4 extensions
  - SPHARM-PDM
  - Dental Tools
  - TMJ tools
- Application of new methodology to Dental Projects
- Training events
Conclusions

- Interdisciplinary, multi-institutional software development benefits medical imaging research.
- FOSS = Free Open Source Software
  - 3DSlicer version 4
  - Advanced morphology analysis methods
  - Working on easily-interfaced tools in Slicer 4
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- UNC Dentistry: Abeer Alhadidi, David Walker, David Baranowski...
- UofM lab: Dion Taylor, Joao R. Goncalves, Cauby Chaves Jr
- CWRU: Mark Hans, Martin Palomo