TRD #1: Image and Geometry Processing

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Overview

• Technical updates
  o Meshing
  o Shape analysis

• Software updates/demos
  o Seg3D
  o Cleaver (meshing)
  o Shapeworks
Multimaterial Meshing

• Goals:
  - Fast
  - Robust and easy to use
  - Quality (element and geometry)
  - Adaptive / efficient
  - Open-source
Meshing Activities

• Papers
  o IMR 2012
  o IEEE TVCG – To appear

• Software release
  o Cleaver, December 2012
  o API, command line
  o Simple GUI soon

• Adaptivity

• Geometric quality
Adaptivity

• Currently: grading away from surface
• Driven by “user” demand
• Surfaces has elements proportional to “need”
  o Curvature
  o Distance to other surfaces
Sizing Field

- Distance to medial axis
- New, robust set of tools for feature size (Shankar Sastry)
  1. PDE from boundary for distance transform
     - $C^1$ discontinuities -> medial axis
  2. PDE from MA to boundary gives feature size
  3. Gradient-limited field (PDE) from surface to volume
Adaptivity Example
Adaptivity Example
Adaptivity Up and Down
Adaptivity – Subgrid
Adaptivity Example
Topological Alaiiasing
Shape Analysis Applications

• Associated incremental technical advances
  o Orthopedics
    - Mouse knock-out model for osteochondromas (JOR 2012)
    - Hip displasia study (JOR 2013)
    - Mandibular joint (with Styner at UNC)
  o Pediatric head/brain growth models
  o Cardiac – LA afib study
Shape Analysis Technology

• More robust systems
• Geodesic distance as a feature for correspondence
  o MICCAI submission (to appear)
• Distances of points to manual detected features
Applications/Results

Mean shape
Applications and Results

• Left atrium pre and post ablation
  o Manual correspondences at pulminary arteries
Software Update: Seg3D

- Seg3D 2.1.5 release scheduled for first week of May
- Fixed 5 highest priority bugs, 9 bugs fixed in total
- New features added:
  - 4 user feature requests implemented
  - Matlab v7.3 file importer and MRC 2000 file importer and exporter added
  - Isosurface export to VTK added
  - Boost and Glew dependencies updated
  - Doxygen documentation added
  - Usage guide added (work in progress) and tutorial documentation extended
- Custom GUI and tools for Aribex (due May 15)
- Python interface used to build custom interface to Matlab-based machine learning segmentation algorithm
Seg3D Demo – Josh Cates
Software Update: Cleaver

• Cleaver was released fall 2012
  o API, command line
  o Documentation, example dataset
• Several updates with bug fixes
• Internal/DBP use
• Several outside downloads
• First instance of lightweight GUI
  o Not yet released
Cleaver Demo – Jonathan Bronson
ShapeWorks Viewer Demo – Josh Cates
Possible DBP: Allison Marsden

- UCSD, Assistant Prof, MAE
- Research
  - Cardiovascular fluid mechanics
  - Shape optimization for complex flows
- Possible applications
  - Segmentation/meshing
  - Shape analysis
  - Visualization of scalar/vector data
- Funding: unclear, actively seeking
- Status
  - Meeting, visit, exchange of data
Possible DBP: Kent Bachus

- U. of Utah, Research Professor, Dept of Orthopedics
- Research: biomechanics of prosthetic implants, prosthetic design and analysis of performance (laboratory)
- Funding: VA, US Army
- Status: meetings, discussions, student who is experimenting with tools
DBP Update

• Weiss (Bioeng) & Anderson (Orthopedics)
• Pathoanatomy of the hip
  o Displasia, impingment
• Successful analysis of hip population data with Shapeworks
  o J. of Orthopedics Research, to appear
• Recent R01 submission scored 10%
  o Recommended for funding (big cuts)