Open Source Tools for Large Scale Visualization and Image Analysis

OME Users Meeting – Paris 2011

Julien Jomier, Kitware
julien.jomier@kitware.com
Kitware

- Founded in 1998
  - Support VTK (Visualization Toolkit) software
  - Revenue in 2011: $20M

- 95+ employees
  - 70+ PhD and Masters
  - 31% growth in 2010

- Offices
  - Clifton Park, NY (USA)
  - Chapel Hill, NC (USA)
  - Lyon (France)
  - Bangalore (India)
Business Model

- Open source software
  - Services and support
  - Consulting
  - Collaborative R&D

- Commercial products
  - Value-added products
  - Applications built on high quality, open source base
  - Custom (proprietary) software frameworks
Open Source Systems

- **VTK** – Visualization Toolkit
- **ParaView** – Large data visualization
- **ITK** – Insight image analysis toolkit
- **CMake** – Cross-Platform Build
- **Titan** – Informatics Toolkit
- **3D Slicer** – Medical research platform
- **IGSTK, CTK, VXL, Avogadro**, more…. 
Golevka asteroid vs. 10 megaton explosion

- CTH shock physics, over 1 billion cells
Polar vortex breakdown

- SEAM Climate Modeling, 1 billion cells (500 million cells visualized).
Objects-in-Crosswind fire

- Coupled SIERRA/Fuego/Syrinx/Calore, 10 million unstructured hexahedra
What’s Big Now: Case Study: Connectome Mapping Neural Circuitry
What’s Big Now (2008)

- Harvard Center for Brain Science Connectome Project
  - Jeff Lichtman (FAS/Molecular & Cellular Biology, Center for Brain Science, Harvard) and Clay Reid (HMS/Neurobiology, Center for Brain Science, Harvard)
  - Mapping connectivity of neural systems (e.g., mice)
  - Use electron microscopy to image tissue samples
  - ~25 μm resolution
  - 100,000 x 100,000 x 40,000 images
  - Each of the 20,000 images is 10 gigabytes
  - Total size is for one dataset: terabytes
Acquiring Data

- Embed tissue samples in cylindrical polymer
- Produce continuous ribbon of material at high data rates
- Image (SEM) ribbon as it streams off
This tissue ribbon is collected by a submerged conveyor belt.

Knife advances

Tissue rotates

These synchronized motions produce a spiral cut through the tissue block, yielding a continuous ribbon of tissue in the knife’s water boat.
40,000 of images like this per volume
Viewing Large Data

- Distant visualization
  - Leave data in place
  - Build Client / Server solutions
  - More efficient than transferring data

- Connectome Example
  - Interactive (>10 fps) through 100,000 x 100,000 x 40,000 volume
  - Oblique slice view through volumetric data
  - Enable tracing of neural circuitry
The Visualization Toolkit (VTK)

- www.vtk.org
- Started in 1993 at GE
- Visualization Library
  - Written in C++ (+5.5 million LOC)
  - Automatic binding for Java, TCL, Python
  - Portable by design: Linux, Windows, Mac OSX, Solaris…
- Very active community: 4000+ users
The Visualization Toolkit (VTK)
ParaView

- www.paraview.org
- An **application** and a **framework** for visualization and analysis of scientific datasets
- End-user visualization tool

1 billion cell asteroid detonation simulation

½ billion cell weather simulation

Fire simulation
ParaView

- OpenSource (BSD)
- Based on VTK
- C++/Qt
- Python support
- Very active community (HPC wire award)
- Multi-core support (MPI)
- Co-Processing (in-situ)
- More than 50 news readers
- Visit plugins are supported
- User’s guide online
ParaViewWeb

http://www.webviz.org
ParaView Web

Web Server

Interactive Flash
Java Applet
JavaScript Client
Tunnel (Adobe BlazeDS)
Visualization Servlet
Message Broker
Visualization Cluster
The Insight Toolkit (ITK)

- www.itk.org
- Started in 2000 from the NLM
- Image Processing Library
  - Written in C++ (+2.1 million LOC)
  - Automatic binding for Java, TCL, Python
  - Portable by design: Linux, Windows, Mac OS X, Solaris…
- Very active community: 2000+ users
Insight Toolkit

- Segmentation/Registration
- Filtering
- Image analysis
- Image-Guided Surgery
- Simulation: haptic devices
- No Visualization
- No GUI
Image Registration
Open-source Tools and Libraries

- **Implementation** of algorithms for dissemination
- **Prototyping** of new technologies
- **Dissemination** of research
- **Modularization** of applications
The Insight Toolkit v4

- Beta release this summer
- Simple ITK (no template)
- Better wrapping mechanism
- Support for video processing
- GPU accelerated algorithms
- Modularity
- Support for data management (MIDAS)
- Migration support
Improving Support for

- Large images (> 4Gb)
- Multi-Channel processing
- Multi-Resolution
- File formats
  - JPEG 2000
  - TIFF 4.0 / BigTiff
  - MRC
- Interfacing with Bio-Formats

Micro-calcifications - MicroCT
ITK v4 - Microscopy Features

- Deconvolution
- Noise Reduction
- Classification Algorithms
- Feature detection
- Colocalization
- Nuclei segmentation
- Color correction
- 3D registration (rigid and non-rigid)
Customers and Collaborators
Let’s work together!

• Bring ITK/VTK to the Microscopy community

• Collaboration
  - Research Grants

• Support on ITK, VTK, ParaView, CMake, MIDAS.

• Consulting
  - Software development
  - Infrastructure development

• Training
  - Courses off/on-site
  - Books (amazon.co.uk)