Computational Anatomy Works (CAWorks): Enhancing Paraview for Medical Imaging

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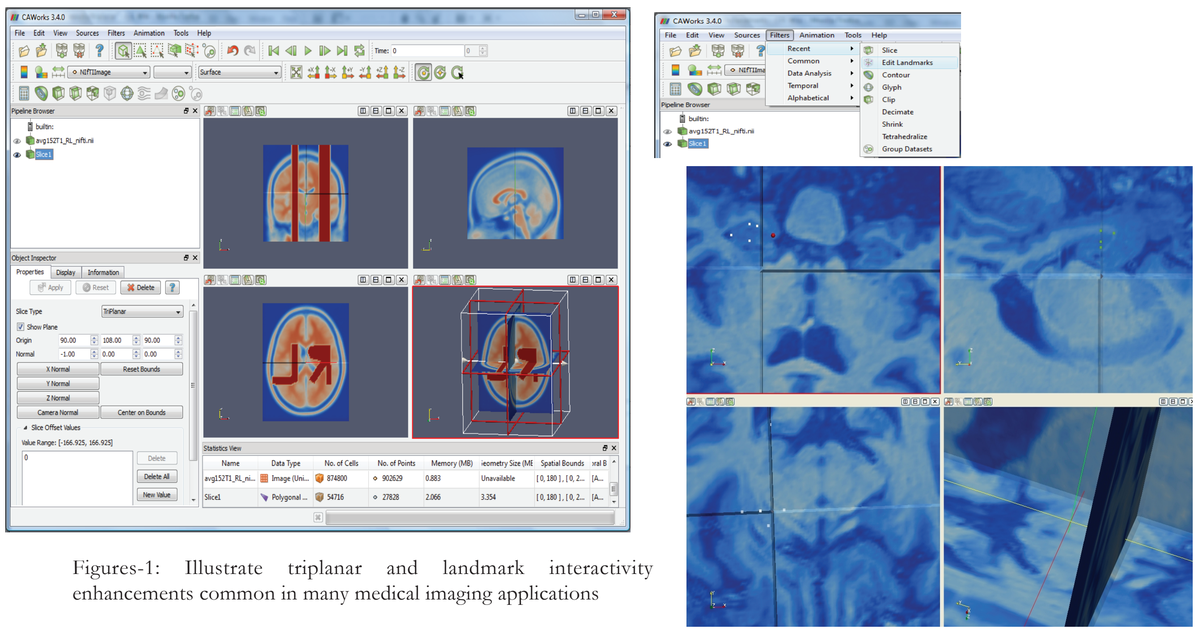
Introduction

Paraview is an open source, freely available program for parallel, interactive, scientific visualization. It has a client-server architecture to facilitate remote visualization of datasets, and generates level of detail (LOD) models to maintain interactive framerates for large datasets.[1] This software has become an important visualization tool for TeraGrid researchers.

The Center for Imaging Science at Johns Hopkins University has enhanced the Paraview application in order to support needs in Computational Anatomy and Shape Analysis. The application **Computational Anatomy Works (CAWorks)** provides:

1. Support for Medical Imaging data formats such as Nifti, Analyze, Freesurfer and landmark data.
2. Tri Planar view visualization
3. Interactive landmark placement
4. Shape Analysis plugin modules such as Large Deformation Diffeomorphic Metric Mapping (LDDMM)



Figures-1: Illustrate triplanar and landmark interactivity enhancements common in many medical imaging applications

Computational Anatomy

Computational Anatomy[2] is the mathematical and computational analysis of human shape and form. Computational anatomy has three components:

i. Anatomical manifold generation via segmentation of known structures
ii. anatomical manifold quantification via morphometric comparison
iii. disease detection and diagnosis.

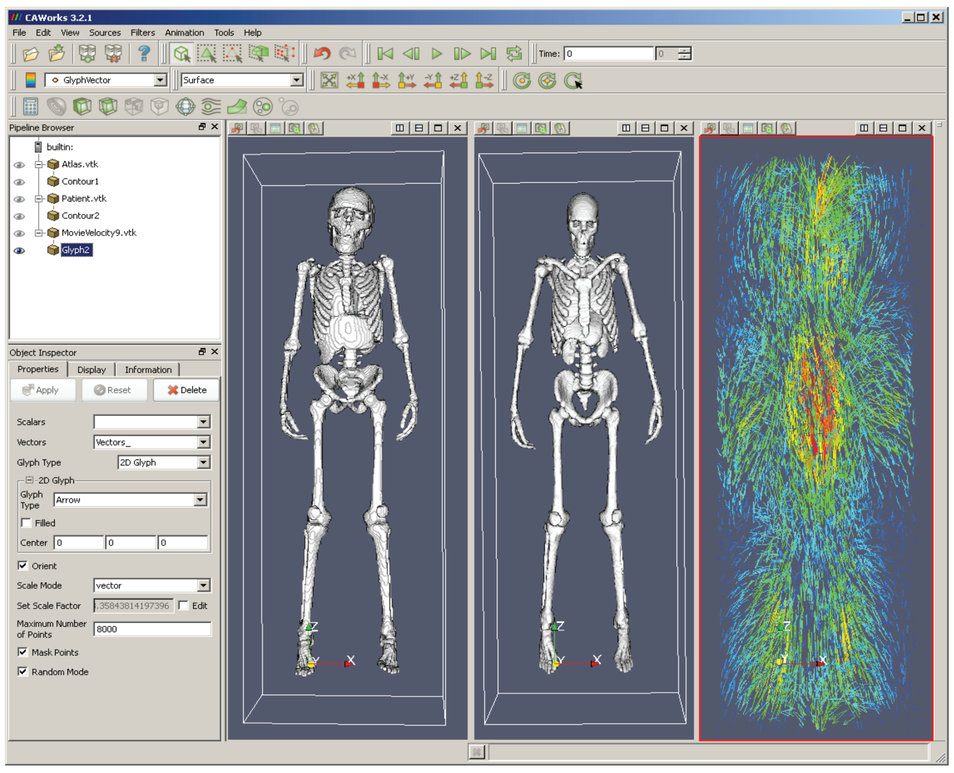
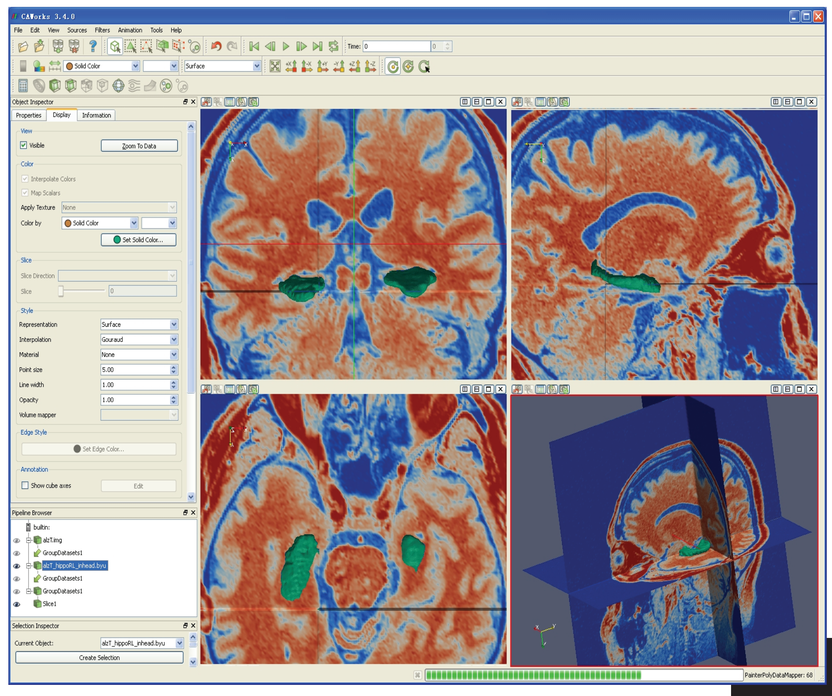


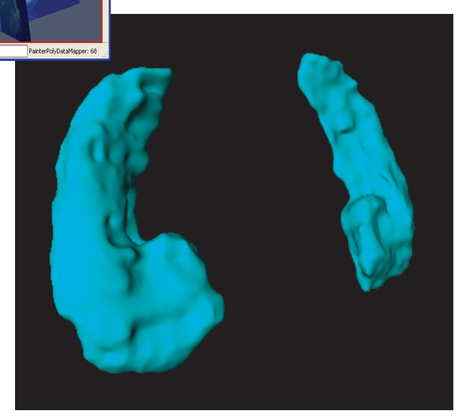
Figure-2: Utilizing Large Deformation Diffeomorphic Metric Mapping (LDDMM) on middle childhood whole body scans requires over 40GB of memory and 30 hrs of processing per computation in order to generate a deformable template. Utilizing TeraGrid resource is necessary for processing large data collections.

BIOCARD

The major research goal of the Biomarkers for Older Controls At Risk for Dementia[3] (BIOCARD) project is to identify areas of cognitive change with age, disease-related changes of cognition (with particular focus on Alzheimer's Disease) and the relationship of cognitive change to brain structure and function, as assessed through imaging. Utilization of CAWorks provides researchers a method of validating sub cortical segmentations.

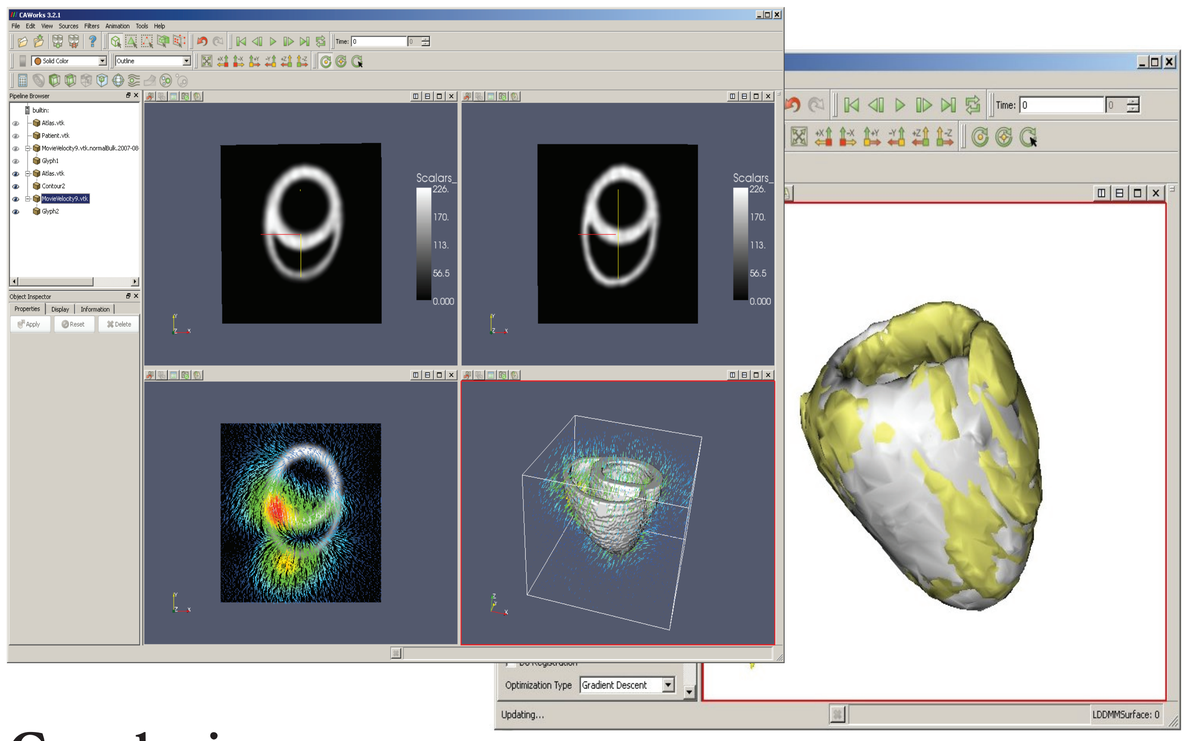


Figures-3: Magnetic Resonance Imaging (MRI) scans in Analyze format of an Alzheimer's patient shown in tiplanar view with the hippocampus surface displayed in byu format. Enhancing Paraview to support standard medical imaging Volume and Suface formats enable researchers to view and interact with regions of interest.



Cardiovasular Research Grid

The CardioVascular Research Grid[4] (CVRG) project aims to create an infrastructure for sharing cardiovascular data and data analysis tools. The CVRG will support national and international multi-institutional collaborations in cardiovascular science, and will build on and extend tools developed in the caBIG and BIRN projects. The CVRG project is supported by the National Heart Lung & Blood Institute at the NIH. The project is based at the Institute for Computational Medicine at Johns Hopkins University, in collaboration with the Center for Comprehensive Informatics at Emory University School of Medicine.



Conclusion

CAWorks has been a valuable tool in Computational Anatomy research. It has improved quality control and validation of imaging segmentation. The ability to support common medical imaging data formats, enhanced user interactivity and discovery. Utilizing the Paraview plugin framework, we added support for shape analysis modules which improve our research productivity and greater interaction with TeraGrid generated data.

References:

[1] Wikipedia: http://en.wikipedia.org/wiki/Paraview

[2] Miller, M.I., A. Trouve and L. Younes. "On the Metrics and Euler-Lagrange Equations of Computational Anatomy". Annual Review of Biomedical Engineering 4 (2002):375-405

[3] http://grants.nih.gov/grants/guide/rfa-files/RFA-AG-09-002.html

[4] http://www.cvrgrid.org/

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