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Interactive Visual Analysis Tools – ParaView –

Tutorial: Interactive Visual Analysis of Scientific Data

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What Is ParaView?

- Open-source, cross-platform application for visualization and analysis of 2D/3D/4D datasets
- Developed by *Kitware*, based on *Visualization Toolkit (VTK)*
- Modular, scalable distributed-memory parallel architecture
- Client/Server visualization
- Pipeline-based data processing
- Extensive scripting and batch processing capabilities

- Tutorial part is based on ParaView's Version 4.0
- See <http://www.paraview.org/> for download, extensive documentation and application examples

Which Data Formats Can Be Handled?

Name	Description	Format	Description
LSDynaReader	Read LS-Dyna databases	NetCDF Reader	Reads regular array CF conventions.
PVD Reader	Load a dataset stored in PVD	BYU Reader	Reads Movie.BYU files
XML PolyData Reader	Reads serial VTK XML PolyData	Wavefront OBJ Reader	Reads Wavefront .OBJ files
XML Unstructured Grid Reader	Reads serial VTK XML Unstructured Grid	proSTAR (STARCD) Reader	Reads geometry in proSTAR (STARCD) format
XML Image Data Reader	Reads serial VTK XML Image Data	XDMF Reader	Reads XDMF (eXtensible Data Model Format)
XML Structured Grid Reader	Reads serial VTK XML Structured Grid	PDB Reader	Reads PDB molecule files
XML Rectilinear Grid Reader	Reads serial VTK XML Rectilinear Grid	XYZ Reader	Reads XYZ molecule files
XML Partitioned Polydata Reader	Reads the summary file of a partitioned PolyData	PLOT3D Reader	Reads ASCII or binary PLOT3D files
XML Partitioned Unstructured Grid Reader	Reads the summary file of a partitioned Unstructured Grid	Spy Plot Reader	Reads files in the Spy Plot format
XML Partitioned Image Data Reader	Reads the summary file of a partitioned Image Data	Restarted Sim Spy Plot Reader	Reads collections of Spy Plot files
XML Partitioned Structured Grid Reader	Reads the summary file of a partitioned Structured Grid	spc3d history reader	Reads an spc3d history file and properties.
XML Partitioned Rectilinear Grid Reader	Reads the summary file of a partitioned Rectilinear Grid	DEM Reader	Reads a DEM (Digital Elevation Model) file
XML MultiBlock Data Reader	Reads a VTK XML MultiBlock	VRML Reader	Load the geometry from a VRML file
XML Hierarchical Box Data reader	Reads a VTK XML-based Hierarchical Box Data	PLY Reader	Reads files stored in PLY format
Legacy VTK Reader	Reads files stored in VTK Legacy format	STL Reader	Reads ASCII or binary STL files
Partitioned Legacy VTK Reader	Reads files stored in VTK Legacy format (partitioned)	Gaussian Cube Reader	Produce polygonal data by reading a Gaussian Cube file.
EnSight Reader	Reads EnSight 6 and 6.2 files	Image Reader	Reads raw regular rectilinear grid data from a file. The dimensions and type of the data are specified in the file.
EnSight Master Server Reader	Reads files in EnSight's Master Server format	POP Reader	Reads data files from the Parallel Ocean Program (POP).
Tecplot Reader	Reads files in the Tecplot format	AVS UCD Reader	Reads binary or ASCII files stored in AVS UCD format.
NetCDF Reader	Reads regular arrays from NetCDF files using CF conventions.	Meta File Series Reader	Reads a series of meta images.
		Nrrd Reader	Reads raw image files with Nrrd meta data.
		FacetReader	Reads ASCII files stored in Facet format.
		PNG Series Reader	Reads a PNG file into an image data.
		JPEG Series Reader	Reads a series of JPEG files into an time sequence of image datas.
		TIFF Series Reader	Reads a series of TIFF files into an time sequence of image datas.
		Phasta Reader	Reads the parallel Phasta meta-file and the underlying Phasta files.
		Enzo Reader	Reads multi-block dataset from an Enzo file.
		Flash Reader	Reads multi-block dataset from a Flash file.
		SESAME Reader	Reads SESAME data files, producing rectilinear grids.
		CSV Reader	Reads a comma-separated value file.
		MFXReader	Reads a dataset in MFX file format.
		FLUENTReader	Reads a dataset in Fluent file format.
		OpenFOAMReader	Reads OpenFOAM data file format.
		COSMO Reader	Reads a cosmology file into a dataset.
		ExodusIIReader	Reads an Exodus II file to produce a dataset.
		Restarted Sim Exodus Reader	Reads collections of Exodus II files to produce a dataset.
		SLAC Data Reader	Reads SLAC data files.
		SLAC Particle Data Reader	Reads particle data.
		Particles Reader	Reads distributed VPIC files.
		VPIC Reader	Reads WindBlade/Firetec simulation files.
		WindBlade reader	Reads unstructured grid data and a cell connectivity file set as a dataset.
		NetCDF CAM reader	Reads rectilinear grid data from a NetCDF CAM file.
		NetCDF POP reader	Reads rectilinear grid data from a NetCDF POP file.
		Parallel NetCDF POP reader	Reads unstructured grid MPAS data from a Parallel NetCDF POP file.
		NetCDF MPAS reader	

User Interface

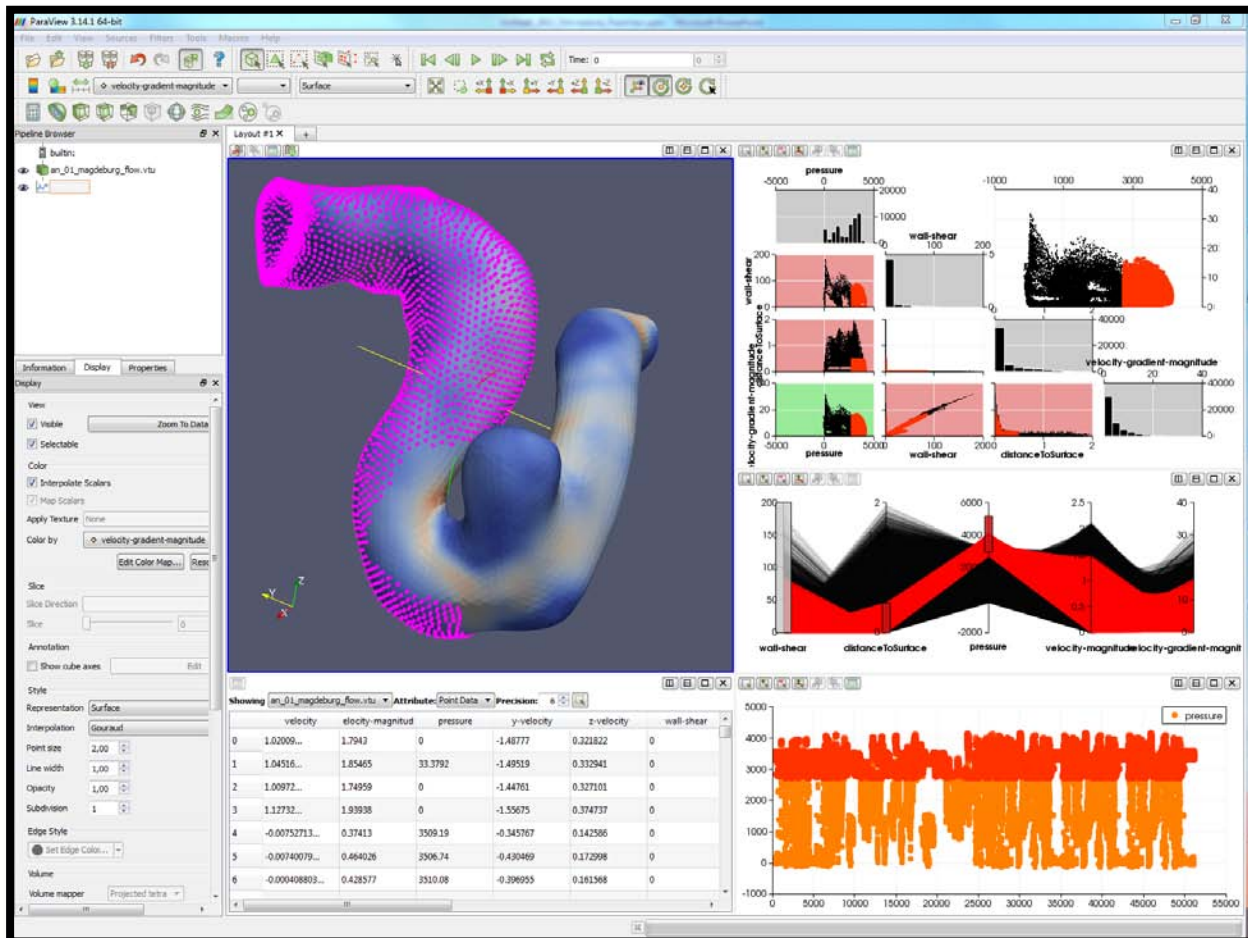
The screenshot displays a software interface with several key components:

- Top Menu and Toolbars:** Includes a menu bar (File, Edit, View, Sources, Filters, Animation, Tools, Help) and toolbars for Sources, Filters, Animation, and a common toolbar with icons for load/save, filters, and animation.
- Left Panel:** Contains a Pipeline Browser (listing objects like ExtractGrid2, Contour1, Clip1, StreamTracer1, TubeFilter1, ExtractSelections1, ExtractHistogram1, and ProbeLine1), an Object Inspector (showing properties for a selected object), and an Animation Inspector (controlling playback and keyframes).
- Central Views:**
 - Bar Chart View:** A histogram showing data distribution across a range from 0.21 to 0.64.
 - Spreadsheet View:** A table of data points with columns for Density, Momentum, StagnatorEnergy, Pressure, Temperature, and Enthalpy.
 - XY Plot View:** A line graph showing multiple variables (Density, StagnatorEnergy, Pressure, Temperature, Enthalpy, KineticEnergy, VelocityMagnitude, Swirl) over a time range from 0.00 to 100.00.
- Right Panel:** Features a 3D View of a complex mesh structure with a color scale for Density ranging from 0.203 to 0.655.
- Bottom Panel:** Includes View Configuration Buttons for switching between different visualization modes.

Live-Demo

IVA of a Cerebral Aneurysm

- Volume mesh composed of 181K tetrahedra
- 9 vertex attributes and 1 cell attribute



Summary

- ParaView facilitates brushing in physical and attribute space
- Views are linked with each other
- Integrated InfoVis views: table, histogram, scatter plot, scatter plot matrix, parallel coordinates
- Features may be extracted, stored and further investigated
- Analysis sessions may be stored and loaded or even applied to another dataset (works only partially)

- Integrating IVA is a big step in a promising direction
- Drawbacks of current implementation:
 - Workflow and plot GUIs not always intuitive
 - Some minor bugs hamper the workflow