Application of Medical Imaging to the 3D Visualization of Astronomy Data

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Summary

As part of the Astronomical Medicine (AM) project at the Initiative in Innovative Computing at Harvard, 3D visualization and analytical techniques developed for medical imaging have been applied to astronomy data. Most astronomy visualization applications and tools are only for two dimensional data, and the few available for three dimensional visualization lack sophisticated graphics and rendering capabilities. In applying programs like 3D Slicer, a medical imaging tool developed at the Surgical Planning Lab at Brigham and Women’s Hospital, to astronomy data we have demonstrated the usefulness of visualizing astronomy data in 3D. Using molecular line maps from the COMPLETE Survey of Star Forming Regions of the Perseus star-forming region, we have been able to identify new outflows and shells from young stars, and understand the gas’ hierarchical structure. The Astronomical Medicine project continues to apply new visualization and segmentation techniques to astronomy data, and integrate astronomy specific features into 3D Slicer paving the way for a general scientific visualization tool.

Visualization Tools

The primary tool being used for visualization and being adapted for astronomical visualization as part of the AM project is 3D Slicer. The application is built on top of the VTK and ITK toolkits, is cross platform, open source, and freely available. We have primarily utilized 3D Slicer’s isosurface rendering capabilities for visualization, and its segmentation modules. We also currently use OsiriX, another medical imaging program, for volume rendering. It is built on ITK and VTK, and is open sourced for Apple’s Mac OS X operating system.

Astronomy Research

One example where visualizing astronomy data in 3D has proven novel is in the search for outflows. Conventional methods are tedious and inefficient, especially for large surveys. When visualizing Perseus in ¹²CO and ¹³CO as a series of isosurfaces, the outflows were rapidly identified visually as “spikes” due to their extreme velocities observed along the line of sight. With this new outflow identification method, we have extended the known length of many outflows and discovered dozens of previously unknown outflows in the Perseus region while shortening the feature identification process from months to minutes. These new outflows greatly effect the cloud’s energy content. Future research includes development of segmentation algorithms to automatically identify outflows.

Dense Cores

Interactive exploration of RA-DEC-velocity data in 3D Slicer helps us intuitively understand the structure of a region. Dense cores, i.e., aggregations of gas at high densities (more than 10⁵ atoms per cm³), are usually expected to be associated with the smallest self-gravitating objects found. However, our research shows that this is not always the case, probably because of insufficient spatial resolution of some observations.

For more information, go to:
http://am.iic.harvard.edu

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