Visualising Astronomy Data using VRML

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ABSTRACT
Visualisation is a powerful tool for understanding the large data sets typical of astronomical surveys and can reveal unsuspected relationships and anomalous regions of parameter space which may be difficult to find programmatically. Visualisation is a classic information technology for optimising scientific return. We are developing a number of generic on-line visualisation tools as a component of the Australian Virtual Observatory project. The tools will be deployed within the framework of the International Virtual Observatory Alliance (IVOA), and follow agreed-upon standards to make them accessible by other programs and people. We and our IVOA partners plan to utilise new information technologies (such as grid computing and web services) to advance the scientific return of existing and future instrumentation.

Context
Visualisation is a primary knowledge discovery tool in astronomy. Examples range from the iconic redshift map to the contemporaneous software, the unveiled visibilities of cosmic magnetic fields and neutrino telescopes, the Virtual Observatory, through to modeling astronomical data description and on-line publication protocols, is making possible new approaches to visualization. For example, the VOTable tool enables arbitrary elements from a VOTable to be plotted against one another and thereby provide rapid visual feedback to the user during the session. These renderings were done with points to improve rendering speed and provide rapid visual feedback to the user during the session.

Motivation
The best use case which motivates our development of VOlume is that a user has a VOTable which they wish to explore visually. The VOTable is available via a generic data stream, allowing the input to come from an application, a file or a network socket. The VOTable is parsed by VOlume and the user is presented with a simple interface to choose which columns of the table to visualise, and how to map values in the table to geometry. Once the user is satisfied with these mappings a visual representation is produced by VOlume. Each row in the input VOTable corresponds to a single point in the visualization which has been scaled or coloured, to convey information such as integrated flux or apparent diameter. The user should be able to interactively rotate the visualization to see obscured features and get a sense of the structure. They should be able to zoom to inspect more distant or finer-scale structure, and move into and through the data volumes. To aid navigation, visual documents might be added such as coordinate axes and planes.

Transformation and rendering performance
The conversion from VOTable format to VRML is fast in all but the most pathological cases, and is done at most a few times per second, and so the usefulness of VOlume as an exploratory tool depends almost entirely on the rendering of the constructed environment being accomplished at interactive speeds. This is true not only in the familiar VRML, but also in VOTable views that are available to render VOlume-created environments. We have undertaken some simple rendering performance tests of the FreeWRL VRML renderer compared to a native, OpenGL renderer written in C called Stereov. We have tested renderings of two environments, one containing 9000 points, and one containing 1000 spheres. For the point environment, we measured 1.3 fps for FreeWRL and 100 fps for Stereov. For spheres, we measured 1.7 fps for FreeWRL and 15 fps for Stereov.

Extensions
There are several possible extensions to VOlume which would increase its utility, performance and flexibility. We highlight a few of them here. VOlume could support additional columns in the input VOTable to size, orientation or colour. The 3d gaming technique of “billboarding” could be used to render spheres using a single texture and a variable map which animates a single texture. The pedagogic is already designed to change the camera, giving the impression of a modeled camera. VOlume could implement a stereoscopic version of the application using stereoscopic display techniques. It shouldn’t be a particularly difficult project to create a stereoscopic version of FreeWRL.

The 2dF Galaxy Redshift Survey catalogue
One of the main uses of VOlume will be to explore structure in redshift catalogues. Here we show VOlume representations of a brightness-limited sub-sample of the 2dF Galaxy Redshift Survey 100k data release (Colless et al., 2002). The wedge-shaped nature of the survey is clearly visible, but too is structure towards the bottom of this poster. These renderings were done with points to improve rendering speed and provide rapid visual feedback to the user during the session.