Virtual Reality and Immersive Collaborative Environments: the New Frontier for Big Data Visualisation



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IDaVIE

immersive Data Visualisation Interactive Explorer

Mouse cerebellum tissue

The aim of the **iDaVIE** software suite is to render datasets in a virtual room-scale 3D space where users can intuitively <u>view</u> and uniquely <u>interact</u> with their data in ways unafforded by conventional flatscreen and 2D solutions.

Interaction



• Loading datasets is currently done by selecting which file to load as well as various rendering parameters, such as applied colormap, and (in the case of iDaVIE-c) particle size, opacity and shape, which can be mapped to dataset parameters or set uniform. Rendering takes place in the <u>Unity game engine</u>



• Selection boxes drawn in the scene with the controller allow the user to focus on a region and make annotations, saving them in an exported text file for later loading.





- Voice commands in iDaVIE-v also allows the user to
- "Crop selection/reset" focus on a selected region and upscale to higher resolution or return to full view
- "Edit min/max" enter colormap edit mode where controller height adjusts bounds
- "Mask on/off/isolate/invert" apply/display or remove the loaded mask or its residua
- "Colormap *type*" change the applied colormap
- "Projection average, maximum" change the transfer function of the ray-marching schema

Pilot user with Oculus Rift S headset – other tested headsets include HTC Vive and Samsung Odyssey

Performance

Unlike 2D software, performance bottlenecks can lead to cases of dizziness and nausea for the user^I. Extra care must therefore be taken to set framerate targets.

We achieve these targets through down-sampling data cubes and decreasing ray-marching samples dependent on radial distance from the center of the VR display, effectively producing a fixed foveated rendering scheme.







Applications

iDaVIE is currently undergoing pilot use cases over a range of data types (see images above):

- Confirming galaxy-group finding algorithm results performed on extragalactic 2MRS surveys^E
- Evaluating SOFIA source-finding algorithm results in HI gas cubes^H
- Reviewing hydrodynamic cosmological simulation snapshots^C
- Comparing stellar atmosphere models^D
- Animating galaxy-galaxy interactions^B
- Investigating animal tissue from confocal laser scanning microscopy^G



Future

May 2020 will see the official release of iDaVIE-v 1.0, the beta version of the volumetric data software. This will include the following new iDaVIE-v features:

- Desktop GUI (developed in collaboration with INAF in Catania, Italy)
- Editing voxels of a mask
- Real-time histogram plotting
- State-saving feature

Long term features for the suite include:

- Cloud database interfacing
- Greater data format flexibility



Plot showing results from a benchmark test with a randomly-generated volume cube fixed to the VR display. The cube is rotated along the three axes with different levels of ray-marching path samples and the foveated approach. **Frame timing** is the amount of time allocated to a single frame, meaning lower is better for higher framerates. Note the drastic difference in frame timings in the figure depending on cube orientation, a consequence of the 3D textures in Unity using 1D data structures to store the voxel information.

References

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- Digital planetarium integration
- Hand interaction & gestures with Valve Index
- Dedicated motion and time-domain representation
- Collaboration tools for spectator VR & external users

Proof of concept for spectator view of of an animated galaxy-galaxy interaction^B

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iDaVIE forms just part of our vision to explore new ways of interacting with and analyzing big datasets.





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