High-Performance, High-Resolution, Large-Sized, Multi-User Interactive Visualization

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The fourth paradigm of science, data-intensive scientific discovery, is becoming more and more proliferated because of the rapidly increasing amount of data produced by the sciences. Huge data sets are also produced by other human activities. There is at least a doubling of the size of data every year. Interactive visualization is a necessary tool to aid humans in exploring these large data sets. Visualization-based analysis is also becoming increasingly collaborative with a need for both local and remote collaboration between individuals and groups of humans.

Visualizations at **high resolution** allows for making a lot of data visible simultaneously. A **large sized** visualization makes it easier to see both the finer details by physically walking up close to the visualization, and to watch the larger picture by walking away from the visualization. The size also makes it possible for several humans to simultaneously view the visualization. Finally, making the visualization support **multi-user interactivity** enhances the effectiveness and exploring of the data sets both for a single user and a collaborating group. The high resolution, large size and multi-user support expands significantly of the bandwidth between users and visualization vs. using a lower resolution, small sized visualization.

Several dimensions characterize how the data sets are handled and used. These dimensions include whether the data sets are stored locally or remotely, whether they are processed locally or remotely, on-demand or pre-processed, how much data each client is expected to need for every visualization action, and the number of clients. The Google Earth uses an approach where a pre-processed data set is stored remotely and transmitted on-demand in a few smaller pieces to potentially very many but light clients. The WallGlobe system uses an approach where one or more data sets are stored remotely, cached locally, processed on-demand, and transmitted on-demand in very many smaller pieces to a few heavy clients. Each approach has its advantages and drawbacks. The Google Earth approach is at advantage when serving many lighter clients with a primarily static data set. The WallGlobe approach is at advantage for large-sized high-resolution visualizations of more dynamic data sets with a need to do client specific processing of the data sets.

Displays with high-resolution and large size include wall-sized high-resolution tiled display walls built by tiling displays or projectors in a grid. The displays or projectors are driven by from one to a cluster of computers cooperating to produce a combined image. While a typical single high-end PC display have around 4Mpixels spread over 30 inches, large multi-display configurations have from 10's to many 100's of Mpixels spread over typically 200 inches or more.

This talk reports on lessons learned when developing approaches and systems for high performance interactive visualizations on a display wall with more than 28 computers connected to 7x4 projectors back-projecting onto a non-rigid canvas to create a 220-inch display with a pixel count of 22Mpixels. A set of applications are presented and discussed throughout the talk.