Distance Visualization of Ultrascale Data with Explorable Images

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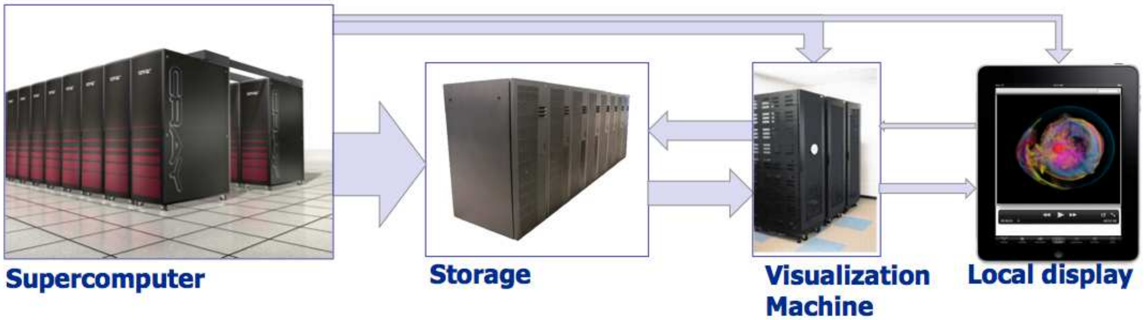

Figure 1: *Distance visualization of large-scale data anywhere anytime based on the concept of Explorable Images, which may be thought as a video that can be explored in multiple dimensions.*

This talk presents a new approach to distance visualization of very large data sets output from scientific supercomputing. The processing power of massively parallel supercomputers increases at a rather fast rate, about an order of magnitude faster every three years, enabling scientists to model complex physical phenomena and chemical processes at unprecedented fidelity. Several petascale computers are already in operation (http://www.top500.org) and exascale computing is around the corner. Each run of a petascale simulation typically outputs several hundred terabytes of data to disk. Transferring data at this scale over wide-area networks to the scientist's laboratory for post-processing analysis is not an option. Even the data files may be transferred, existing desktop data analysis and visualization tools cannot effectively handle such large-scale data. If the scientists may use the same supercomputing facility for data analysis and visualization, there are three viable solutions:

- in situ visualization, where visualization is computed during the simulation on the same supercomputer,
- co-processing visualization, where visualization is computed during the simulation on a separate computer, and
- post-processing visualization, where visualization is computed after simulation is over.

Here, the word *visualization* has a broader meaning, which may include any pre-processing, data reduction, feature extraction, and rendering. No matter which solution is adopted, scientists still need a way to see the resulting visualization on their desktop display. That is, distance visualization must be effectively supported.

There are three ways to do distance visualization: move data, move extracts, or move images. Moving raw data is not feasible for obvious reasons. Moving extracts, a small fraction of the the data characterizing some features of interest in the data, significantly reduces the amount of data that must be transferred over networks, but rendering the extracts at interactive rates could demand a powerful computer and a sophisticated user interface. Moving images can support two different modes of visualization: image-based rendering, which could require a large number of images, and video viewing, which is browsing images in sequential order.

We aim to enable scientists to visualize their data anywhere anytime on any display device, which may not have a powerful processor nor a large memory space, like an iPad, as depicted in Fig. 1. While videos can meet this need, videos only allow very limited exploration, i.e., playing forward and backward. We have been developing a technology which we call Explorable Images to enhance explorability. Our preliminary work [Tikhonova et al. 2010a] demonstrates both view exploration and the possibility to adjust color and opacity mapping. Our refined design [Tikhonova et al. 2010b] lets users also do relighting and visualize time-varying data. Overall, Explorable Images allows users to explore in the

- spatial domain of the data,
- temporal domain of the data,
- transfer function space, and
- rendering parameter space

without re-rendering and access to the original data. The storage requirement of Explorable Images without compression is 4X a normal image size, much smaller than the original data. The degree of explorability has a limit, but it already proves useful. As portable display devices and wireless Internet are commonplace, the concept of Explorable Images becomes very powerful, suggesting scientists to rethink how they do their routine data analysis and visualization.

Acknowledgements

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References

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