Large Displays: Will it ever be enough?

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Background

For the last several years PNNL has been exploring how to use large-screen, group interaction workspaces to complement our research into information visualization. A big part of that effort has focused on how to support new and innovative interactions with large screen systems. We have developed the Human Information Workspace (HI-Space) which uses video tracking to recognize multiple simultaneous hands and objects as inputs for a wide variety of applications using large displays. One of our ongoing projects is to develop applications for exploring biological data and to evaluate the effectiveness of these applications and environments. This work is being done in partnership with Brown University and the University College of London. To date, this project has been very successful as we try to understand both visualization and interaction factors that influence the scientists' ability to work on real world problems with large-screen, both immersive and non-immersive, environments.

HI-Space users interacting with 3D geometry data generated from 48 confocal microscope image slices at 512x512 resolution.

Previous work using the HI-Space includes video analysis, text analysis, geospatial applications, among others. Additional information on some of these projects can be found at www.pnl.gov/infoviz/hces. The emphasis of our work is to understand how to better allow individuals and groups to extract knowledge from complex and often incomplete large data sets. Publications and other workshop papers related to the topic of this work include the following.

Related publications, presentations, and demonstrations:

May, R. (2005) "Collaboration in Directly Mediated Interaction Environments," Workshop on Advanced Collaborative Environments, Redmond, WA,. September 9-10, 2005

May, R. and Baddeley, B., (2005) "Architecture and Performance of the HI-Space Projector-Camera Interface", IEEE International Workshop on Projector-Camera Systems in conjunction with Computer Vision and Pattern Recognition 2005. June 25, 2005, San Diego, California, USA.

May, R. (2004) "Merging Ubiquitous Displays and Interactions in the Electronic and Physical Spaces," Ubiquitous Computing 2004 workshop on Ubiquitous Display Environments. Nottingham, England. September 7, 2004

Cowell, A.J., Havre. S., May, R., Sanfilippo, A., (2005) “Scientific Discovery Within Data Streams” In Lecture Notes in Artificial Intelligence: 3345 - Ambient Intelligence for Scientific Discovery. February 2005, Springer Press Online Lecture notes series.

Cowell, A.J., May, R., Cramer, N. (2004) “The Human-Information Workspace (HI-Space): Ambient Table Top Entertainment” *In Proceedings of the 3rd International Conference on Entertainment Computing*, Eindhoven, The Netherlands, September 2004, pp. 101-107.

Kasik, D.J., Carpenter, L., Fisher, B., May, R., Streitz, N., “Graphics in the Large: Is Bigger Better?” SIGGRAPH 2002 Panel Session. July 25, 2002, San Antonio TX.

Invited technology demonstration at the SIGGRAPH 2000 Emerging Technologies Venue of the next generation interaction technology – Human Information Workspace.

Hardware:
The HI-Space research system consists of two separated displays each using a BarcoGraphics 6300. Tracking is performed by using an overhead camera to create an interaction volume over the table display surface (see the picture above). The video based tracking of multiple hands and objects is used in conjunction with traditional mouse and keyboard inputs. The horizontal table display is used for both visualization and interaction. Applications that use more complex visual control elements typically display them on the table surface. The separate vertical wall display is set up for both mono and active stereo projection. The wall is however primarily only a display surface with limited interaction support.

We are in the process of installing an additional large display wall. This new system will provide two side-by-side displays (5’h x 14.5’w total). Each of the fields of view will be driven by a Barco Galaxy 6 projector. This system will support mono, passive stereo, and active stereo viewing. It is also configured to be switchable between edge matched and edge blended modes. This system will provide a flexible environment for researching new large screen visualizations and interaction methodologies.

Position Statement and Interests

Large, high-resolution displays, whether they are displayed on walls, tables, floors, or wherever, provide opportunities to reevaluate how humans visualize and interact with electronic information. One critical challenge that the research community must face is how to represent a huge volume of dynamic information on large-screen multi-display environments. The representation has to make the information suitable for processing, analysis, sense-making and interaction between users and information, and between users and users, so that from data, collective knowledge can be achieved. Visualization tools have proven to help information analysts with discovery and confirmation tasks, but the tools are still inadequate for many complicated problems and are not keeping pace with advances in data generation.

Visualization tools have been optimized, in general, only for conventional desktop displays and interaction devices, which mostly support individual interaction. This focused optimization continues today even though visualization trends are towards display devices ranging in size from wristwatches and hand-held personal data assistants (PDAs) to high-resolution full-wall and theater-sized displays. For complex visualization problems, the larger displays are more likely to

have a direct impact, but smaller displays can still play an important support role in user interfaces and information understanding. One reason for integrating smaller personal displays in environments along with larger displays is to provide a balance between private and public spaces. The transition from individual workspaces to ones supporting group interactions requires that we expand our understanding of computer interaction to include social and behavioral sciences as well.

How many pixels are sufficient?

This brings us to an important and unresolved issue. What role do large, high-resolution displays play in providing an improved discourse and assist in understanding the information being presented? How many pixels does it take to display the 100 million FedEx transactions that occur per day? Will using the same display and visualization techniques work for the 9 billion messages the U.S. DoD deals with every day? How about for visualizing the 600 Billion IP packets on the DE-CIX back bone per day? The technology of displaying a greater number of pixels on a surface is only a small piece of the solution. To really address the problems of information overload we need to take advantage of the large format displays by understanding what advantages they offer over smaller displays. High resolution itself is probably not a distinguishing factor. Small high-resolution displays would also be able to approach human visual acuity limits just as easily and thus likely provide the same capability as a large screen when considering resolution alone. A large screen does however provide several other possibilities to investigate.

- A wider field of view is provided, so how do we perceptually take advantage of this at all resolutions? There are many lessons that we have learned and need to continue learning from the ambient display research community and human vision researchers.
- Large screens change the paradigm for organizing electronic information. It provides for spatially arranging information and having it carry a proprioceptive meaning. We need to develop both visual and interaction metaphors that take advantage of this.
- In general, interaction on large displays could be fundamentally different. How to design new interaction techniques for large displays and measuring the effectiveness of the interactions is a largely unexplored area.
- At best, group collaboration is difficult on small displays. Large displays in different orientations provide new opportunities for proximally located group collaboration. This is a topic CSCW and other communities have been looking into for several years.

Our interest in this workshop is to see what other attendees feel is the real potential of large displays and how to truely take advantage of them. We would look to learn from others in the workshop while also expressing what we have learned from our 10 years of research in the information visualization field.