Ultra-high-resolution wall-sized displays enable the visualisation of very large datasets

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Such displays feature a very high pixel density over a large physical surface, which makes them well-suited to the exploratory visualisation of large, heterogeneous datasets. Application areas include scientific data analysis and crisis management.

Our ability to acquire or generate, store, process, interlink and query data has increased spectacularly in recent years. This has had a profound impact in many application areas, including scientific disciplines such as Astronomy, Molecular Biology or Particle Physics. Challenges to address in these increasingly data-driven domains span numerous fields of computer science research: databases, data mining, communication networks, as well as human-computer interaction and more specifically interactive data visualisation. Indeed, scientists are faced with large-to-huge amounts of data that are difficult to understand and analyse in depth because of their sheer size and complexity. Users require effective tools to freely-yet-efficiently explore, make sense of, and interactively manipulate their data.

As part of our research in the field of data visualisation, we investigate the design, engineering and evaluation of ultra-high-resolution wall-sized displays[1]. This type of display features a very high pixel density over a large physical surface. For instance, WILD, the first wall display we set up in our laboratory, has a total resolution of 20,480 × 6,400 = 131 megapixels for a surface area of 5.5m×1.8m. Figure 1 shows part of the GLIMPSE360 image[2] displayed on our newer wall, WILDER, which has a somewhat lower resolution (14,400 × 4,800) but features a touch-sensitive frame and much narrower screen bezels.

Platforms such as WILD and WILDER can represent the data with a high level of detail while at the same time retaining context: users can transition from an overview of the data to a detailed view simply by physically moving in front of the wall display. Wall displays also offer good support for collaborative work, enabling multiple users to simultaneously visualise and interact with the data, provided that the right input devices and interaction techniques are made available.

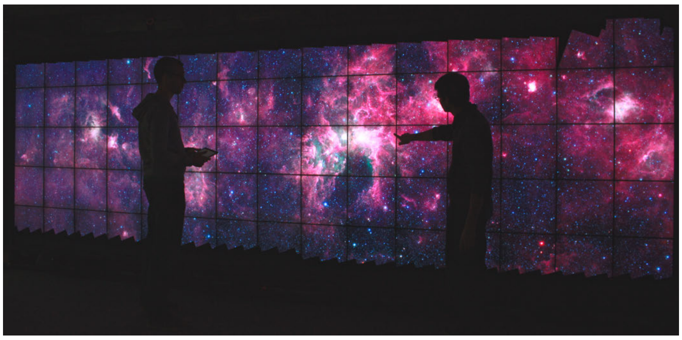

Figure 1. *Zooming in GLIMPSE360, Spitzer's Infrared Milky Way image* (540,000 × 15,000 *pixels*)*, on WILDER.*

1 Interacting with Wall Displays

Early work on ultra-high-resolution wall displays has mainly focused on the technical aspects of how to make such platforms: how to display complex graphics, how to stream data across the nodes of the computer clusters that drive them. They did not pay much attention to issues related to interacting with these display surfaces, often offering poor capabilities in that respect such as wireless mouse & keyboard on a stand, or in some cases gyroscopic mice.

To make them truly interactive, wall displays are increasingly coupled with input devices such as touch frames, motion-tracking systems and wireless multitouch devices, in order to enable multi-device and multi-user interaction with the dis-

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played data. Our research is about designing and empirically evaluating novel interaction techniques specifically designed for these environments, such as high-precision remote pointing techniques to enable users to interact when they are not within arm's reach of the display[3], or mid-air panning and zooming techniques for navigating maps, images and datasets that exceed the display capacity of wall displays[4].

Our research is also about the engineering of this specific type of interactive systems. As mentioned earlier, ultra-high-resolution wall displays are often driven by clusters of computers (the above-mentioned WILD platform uses $32+1$ graphics processing units in $16+1$ computers), which causes problems of data sharing and graphics rendering. The multiple input channels from the heterogeneous devices involved in user interaction with a wall display (motion tracker, tablets, smartphones, laptops) also add significant complexity to the process. We work on the design and development of software toolkits that ease the rapid prototyping and development of advanced interactive visualisations that can run on cluster-driven display surfaces[5,6].

2 Application to Astronomy

Application areas range from the monitoring of complex infrastructures and crisis management situations to tools for the exploratory visualisation of scientific data. Our latest application, called FITS-OW[7], enables astronomers to visualise and interact with very large FITS images and collections thereof (Figure 2). They can pan and zoom in images that are several hundred thousand pixels in width and height, overlay the results of data analyses, fetch and display additional images of a specific object or region in the sky, showing observations in different ranges of the electromagnetic spectrum or at different times. FITS-OW also lets astronomers query databases such as Simbad servers, and visualise the results of such queries in-place, right next to the corresponding source in the image. Detailed information can be shown for multiple sources simultaneously, including multiple measurements as well as documents.

Astronomers perform these operations using interaction techniques that were designed specifically for wall displays, using direct manipulation and gestures performed on the wall's surface or on handheld tablets[8]. Details about the specific challenges addressed in FITS-OW are discussed in our upcoming SPIE Astronomical Telescopes and Instrumentation conference paper[7]: generation of FITS tile pyramids and their multi-scale rendering; queries to sky catalogs; dynamic adjustment of scale, color mapping and graphics compositing settings, and the underlying input management framework.

Author Information

Figure 2. *FITS-OW on WILDER showing multiple FITS images, the result-set of a SIMBAD query restricted to observations about galaxies, basic measurements for galaxy M31, a page of a research paper discussing that particular galaxy, and the color map selector.*

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