



## Multiple-Flat-Panel System Displays Multidimensional Data

Related images are displayed simultaneously to facilitate perception of trends in data.

Ames Research Center, Moffett Field, California

The NASA Ames hyperwall is a display system designed to facilitate the visualization of sets of multivariate and multidimensional data like those generated in complex engineering and scientific computations. The hyperwall includes a 77 matrix of computer-driven flat-panel video display units, each presenting an image of 1,280x1,024 pixels. The term “hyperwall” reflects the fact that this system is a more capable successor to prior computer-driven multiple-flat-panel display systems known by names that include the generic term “powerwall” and the trade names “PowerWall” and “Powerwall.”

Each of the 49 flat-panel displays is driven by a rack-mounted, dual-central-processing-unit, workstation-class personal computer equipped with a high-performance graphical-display circuit card and with a hard-disk drive having a storage capacity of 100 GB. Each such computer is a slave node in a master/slave computing/data-communication system (see Figure 1). The computer that acts as the master node is similar to the slave-node computers, except that it runs the master portion of the system software and is equipped with a keyboard and mouse for control by a human operator. The system utilizes commercially available master/slave software along with custom software that enables the human controller to interact simultaneously with any number of selected slave nodes.

In a powerwall, a single rendering task is spread across multiple processors and then the multiple outputs are tiled into one seamless superdisplay. It must be noted that the hyperwall concept subsumes the powerwall concept in that a single scene could be rendered as a mosaic image on the hyperwall. However, the hyperwall offers a wider set of capabilities to serve a different purpose: The hyperwall concept is one of (1) simultaneously displaying multiple different but related images, and (2) providing means for composing and controlling such sets of images. In place of elaborate software or hardware crossbar switches, the hy-

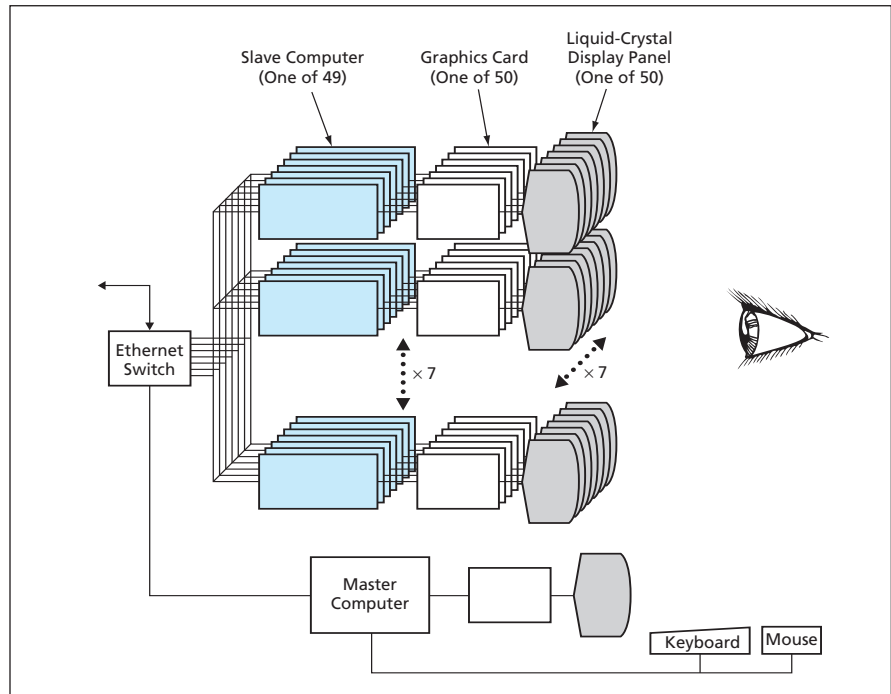


Figure 1. Master and Slave Nodes Communicate via a high-speed local-area network.



Figure 2. Each of 16 Images displayed on a hyperwall represents results of a computational simulation of airflow about an aerospacecraft (specifically, a proposed reusable launch vehicle) at one of 16 different combinations of Mach numbers and angles of attack.

perwall concept substitutes reliance on the human visual system for integration, synthesis, and discrimination of patterns in complex and high-dimensional data spaces represented by the multiple displayed images.

The variety of multidimensional data sets that can be displayed on the hyperwall is practically unlimited. For example, Figure 2 shows a hyperwall display of surface pressures and streamlines from a computational simulation of airflow

about an aerospacecraft at various Mach numbers and angles of attack. In this display, Mach numbers increase from left to right and angles of attack increase from bottom to top. That is, all images in the same column represent simulations at the same Mach number, while all images in the same row represent simulations at the same angle of attack. The same viewing transformations and the same mapping from surface pressure to colors were used in generating all the images.

*This work was done by Daniel Gundo and Creon Levit of Ames Research Center; Christopher Henze, Timothy Sandstrom, David Ellsworth, and Bryan Green of Advanced Management Technology, Inc.; and Arthur Joly of Computer Science Corporation. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-15037-1.*

## 3D X-Ray Luggage-Screening System

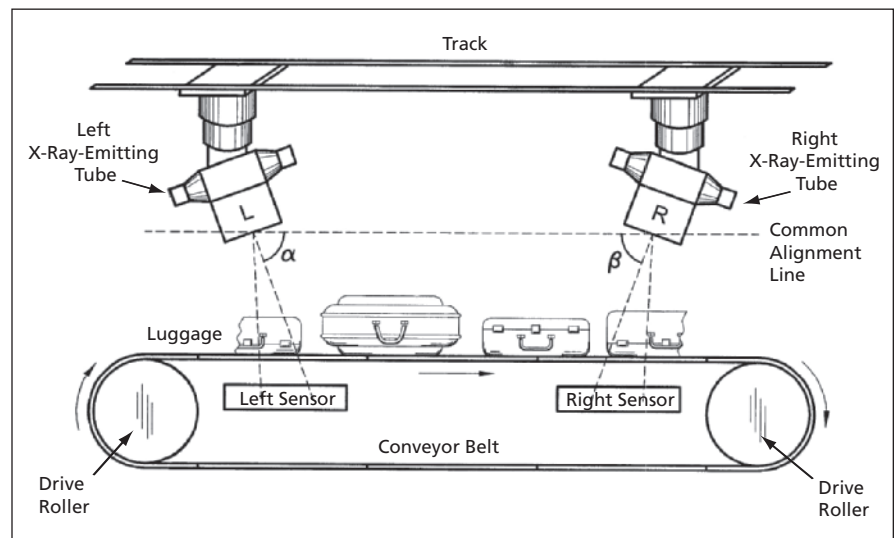
3D displays would help inspectors distinguish among objects at different depths.

Marshall Space Flight Center, Alabama

A three-dimensional (3D) x-ray luggage-screening system has been proposed to reduce the fatigue experienced by human inspectors and increase their ability to detect weapons and other contraband. The system and variants thereof could supplant thousands of x-ray scanners now in use at hundreds of airports in the United States and other countries. The device would be applicable to any security checkpoint application where current two-dimensional scanners are in use.

A conventional x-ray luggage scanner generates a single two-dimensional (2D) image that conveys no depth information. Therefore, a human inspector must scrutinize the image in an effort to understand ambiguous-appearing objects as they pass by at high speed on a conveyor belt. Such a high level of concentration can induce fatigue, causing the inspector to reduce concentration and vigilance. In addition, because of the lack of depth information, contraband objects could be made more difficult to detect by positioning them near other objects so as to create x-ray images that confuse inspectors.

The proposed system would make it unnecessary for a human inspector to interpret 2D images, which show objects at different depths as superimposed. Instead, the system would take advantage of the natural human ability to infer 3D information from stereographic or stereoscopic images. The inspector would be able to perceive two objects at different depths, in a more nearly natural manner, as distinct 3D objects lying at different depths. Hence, the inspector could recognize objects with greater accuracy and less effort.



Images From the Left- and Right-Eye X-Ray Sensors are captured at different locations and stored along with conveyor position data allowing the appropriate left- and right-eye images to be viewed by the human operator on a commercially available stereo display screen.

The major components of the proposed system would be similar to those of x-ray luggage scanners now in use. As in a conventional x-ray scanner, there would be an x-ray source. Unlike in a conventional scanner, there would be two x-ray image sensors, denoted the left and right sensors, located at positions along the conveyor that are upstream and downstream, respectively (see figure). X-ray illumination may be provided by a single source or by two sources. The position of the conveyor would be detected to provide a means of matching the appropriate left- and right-eye images of an item under inspection.

The appropriate right- and left-eye images of an item would be displayed simultaneously to the right and left eyes, respectively, of the human inspector, using

commercially available stereo display screens. The human operator could adjust viewing parameters for maximum viewing comfort. The stereographic images thus generated would differ from true stereoscopic images by small distortions that are characteristic of radiographic images in general, but these distortions would not diminish the value of the images for identifying distinct objects at different depths.

*This work was done by Kenneth Fernandez of Marshall Space Flight Center. Further information is contained in a TSP (see page 1).*

*This invention has been patented by NASA (U.S. Patent No. 6,763,083 B2). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31783.*