Use of the Space Vision System as an Augmented Reality System For Mission Operations

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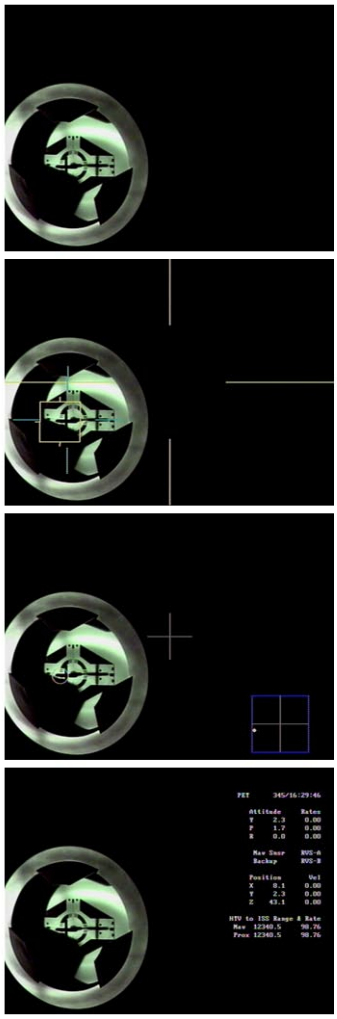
Augmented reality is a technique used to superimpose computer-generated images for visual enhancement of live images. Augmented reality can also be characterized as dynamic overlays when computer -generated images are registered with moving objects in a live image. This technique has been successfully implemented, with low to medium levels of registration precision, in the NASA Research Announcement (NRA)-funded project "Improving Human Task Performance with Luminance Images and Dynamic Overlays." Future research is being planned to also employ a laboratory-based system in which more extensive subject testing can be performed. However successful this might be, the problem will still be whether such a technology can be used with flight hardware. To answer this question, the Canadian Space Vision System (SVS) will be tested as an augmented reality system that is capable of improving human performance when the operation requires indirect viewing. This system has already been certified for flight and is currently flown on each Space Shuttle mission for Space Station assembly. Successful development and operation of this system in a ground-based experiment will expand its use for on-orbit mission operations. Current research and development regarding the use of augmented reality technology is being simulated using ground-based equipment. This is an appropriate approach for the development of the symbology (graphics and annotation) that is optimal for human performance as well as for the development of optimal image registration techniques. We anticipate the use of this technology becoming more widespread as it matures. Because we know what and where almost everything is on the Space Station, this technology reduces the registration problem and improves the computer model, making augmented reality an attractive tool—provided we know how to use it. Although this is the basis for current research in this area, there is a missing element to this process: the links from research to the current Space Station video system to flight hardware that are capable



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of employing this technology. Creating those links is the basis for our proposed Space Human Factors Engineering project: developing the display symbology within the performance limits of the SVS with the goal of improving human performance. This use of existing flight hardware will greatly reduce the costs of flight implementation. Besides being used onboard the Space Shuttle and Space Station and as a ground-based system for mission operational support, it also has great potential for science and medical training and diagnostics, remote learning, team learning, video/media conferencing, and educational outreach.

The primary sources of control feedback for robotic manipulation tasks on the Space Shuttle and Space Station are the video monitor views used by the operators. Monitor views include superimposed alphanumeric information to increase the safety, efficiency, and situational awareness during the manipulation task. AR features are constructed of geometric elements that are superimposed on the camera's field of view. These lines, arcs, dots, etc. are referenced to objects or positions in the three-dimensional (3D) space viewed by the camera. As the camera position changes, the positions of the geometric elements marking the spatial reference points change accordingly, providing what might be described as dynamic overlays.

Thirty-six participants (18 males, 18 females) were recruited from the Johnson Space Center Test Subject Facility. One of the 36 participants preferred to operate the hand controller with his left hand. The age range of the participants was between 20 to 40 years. All participants possessed vision correctable to 20/20 and were in generally good health.