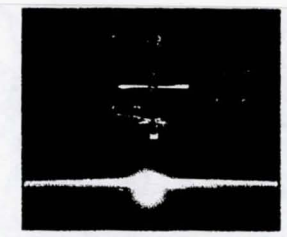
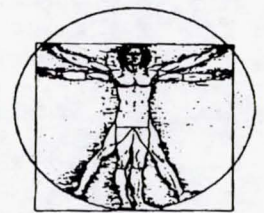


Source of Acquisition  
NASA Johnson Space Center



## **Habitat 2004**

# **Utilization of the Space Vision System As An Augmented Reality System For Mission Operations**

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## Summary

Previous research has shown that augmented reality can be an effective improvement for video based operations. However, the problem is whether such a technology can be used with existing flight hardware. To answer this question, the Canadian Space Vision System (SVS) will be tested as a 3D augmented reality system capable of improving human performance where the operation requires indirect viewing. This system has already been certified for flight and is currently flown on each shuttle mission for station assembly. Successful development and utilization of this system in a ground-based experiment will expand its utilization for on-orbit mission operations using the Space Station's robotic arm.



## Product

The proposed project when completed will have a subject tested set of symbology operating on flight certified hardware. This will be the foundation for performing on-orbit experimentation of the use of augmented reality techniques and technology.

## Status

Phase 1: Modification of SVS software to perform 3D overlays using camera positioning and attitude information received from a camera positioning device. This has been completed successfully.

Phase 2: Compare a proposed overlay scheme for the Automatic Transfer Vehicle to a tested overlay scheme from a previous experiment. 36 subjects were tested. Each person performed the task with each overlay, as well as, without an overlay. Data collected was time to completion, accuracy and reversals.

## Schedule

Data collection has been completed. Most data reduction and analyses have been completed. Final report will be completed by the end of the calendar. A presentation will be given at the Habitat 2004 Conference in January.



## Results

Analysis of variance (ANOVA) and post hoc testing of means for final alignment error and time for trial completion have been completed. Analyses of subject surveys and hand controller motion data (reversals and overshoots) are underway.

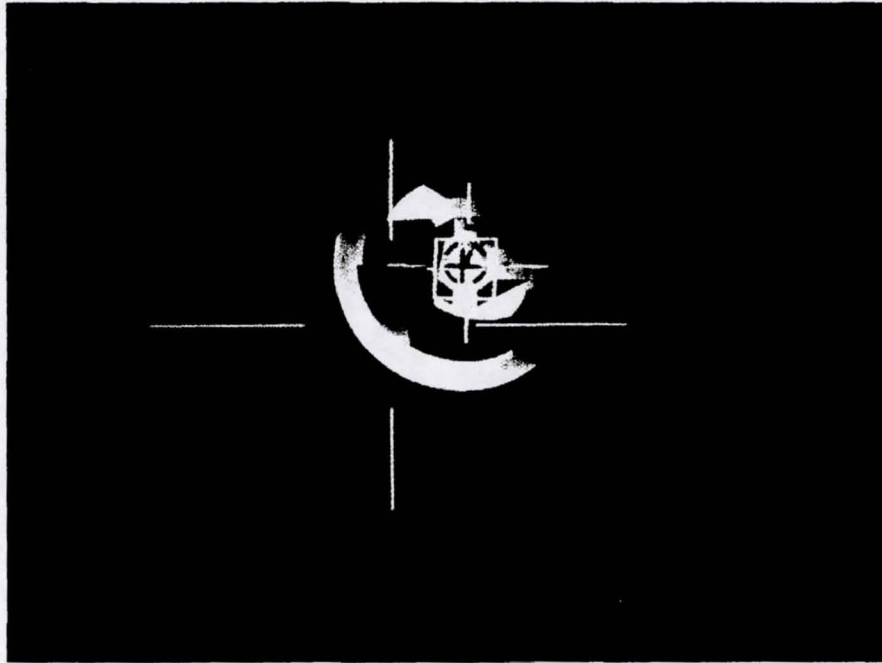
## Significant Findings ( $\alpha = 0.05$ ) – Alignment Error

- All augmented treatments (overlays) decreased final alignment error compared with control condition (no overlay).
- There were no differences in performance among the three augmented treatments (overlays).
- No gender-related differences were found for alignment error.

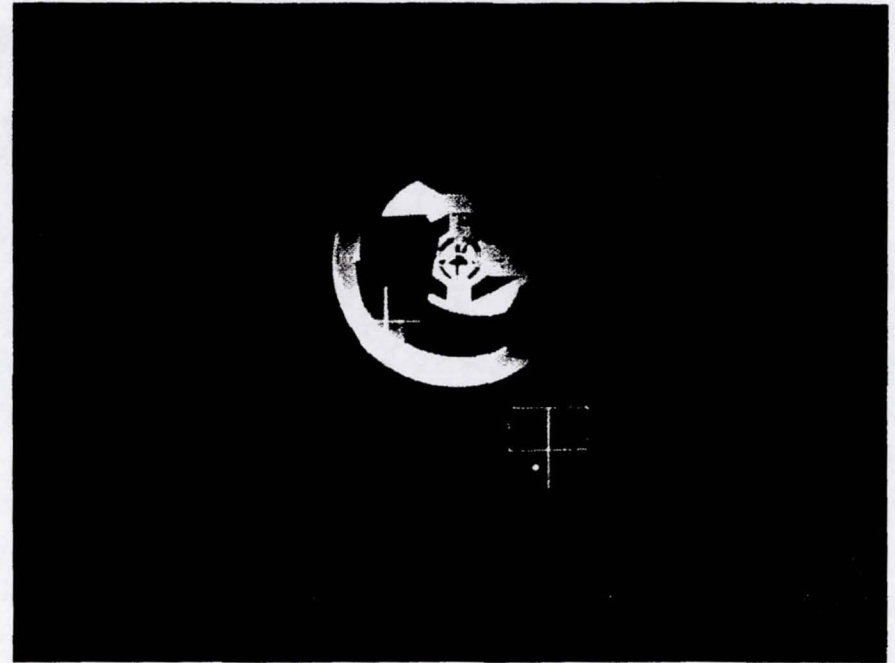
## Significant Findings ( $\alpha = 0.05$ ) – Completion Time

- Completion times with Overlay A were not significantly different from those with no overlay.
- Times to completion with overlays B and C were not significantly different from one another, but were significantly less than those with Overlay A or no overlays.
- Completion times were longer for female subjects.





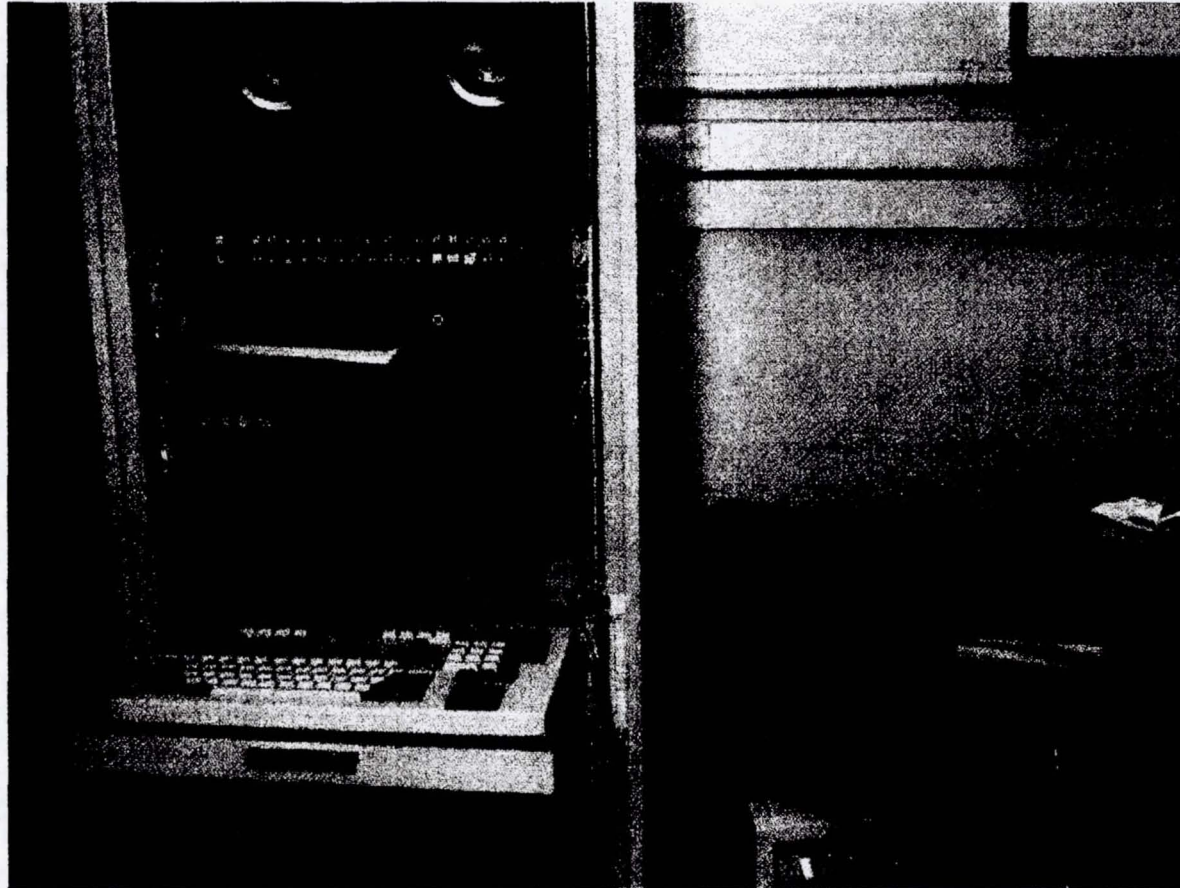
Overlay A – previously tested  
overlay in NRA project  
(dynamic overlay aka  
augmented reality)



Overlay B – proposed ATV  
overlay (graphics only)  
(dynamic overlay aka  
augmented reality)



Overlay C. Static Text.



SVS system modified and supplied by Neptec



## Expected Products, etc.

- HTV symbology objectively tested
- Flight like SVS system with 3D overlay capability
- Additional Metrics on the effectiveness of augment reality technology for training simulators
- The SVS system will be available for use in the robotics mockup trainers and potentially be an additional resource for an NRA project currently underway.

## Customers

Regular communication have been underway between MV robotics, current users of the SVS system. They anticipate the 3D overlay capability to be an enhancement for use with SSRMS and with potential use for vehicle docking.

Communication with robotics group ER has been underway. The SVS may be useful for augmented reality technology research in the robotics training community.



## Benefits

Certain robotic operations are very time consuming because of the need for situational awareness. Results show augmented reality technology improves this awareness and saves time.

Flight hardware can be upgraded successfully to take advantage. This might be especially true for robotic operations where geometric information may have more utility, i.e. alignment guides, trajectories, etc.



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<b>subjectManual</b>	
<b>abstract</b>	<p>Abstract Augmented reality is a technique whereby computer generated images are superimposed on live images for visual enhancement. 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 an NRA funded project entitled, "Improving Human Task Performance with Luminance Images and Dynamic Overlays". Future research is already being planned to also utilize a laboratory-based system where 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 capable of improving human performance where the operation requires indirect viewing. This system has already been certified for flight and is currently flown on each shuttle mission for station assembly. Successful development and utilization of this system in a ground-based experiment will expand its utilization 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 development of symbology (graphics and annotation) optimal for human performance and for development of optimal image registration techniques. It is anticipated that this technology will become more pervasive as it matures. Because we know what and where almost everything is on ISS, this reduces the registration problem and improves the computer model of that reality, making augmented reality an attractive tool, provided we know how to use it. This is the basis for current research in this area. However, there is a missing element to this process. It is the link from this research to the current ISS video system and to flight hardware capable of utilizing this technology. This is the basis for this proposed Space Human Factors Engineering project, the determination of the display symbology within the performance limits of the Space Vision System that will objectively improve human performance. This utilization of existing flight hardware will greatly reduce the costs of implementation for flight. Besides being used onboard 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.</p>
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