Advanced Cockpit Evaluation System Van

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How do you increase the view that a crew sees out the window aboard a spacecraft without raising the cost? How do you improve the images of what they can see in diminished-visibility environments? Are there any applications for this technology outside of spacecraft design?

The Exploration Systems Engineering Office in the Engineering Directorate at Johnson Space Center is experimenting with emerging technologies to answer these questions. Using a standard van, inexpensive off-the-shelf displays, and computer hardware, engineers created a mobile Advanced Cockpit Evaluation System (ACES). ACES is a personal computer-based mobile cockpit/command station with the capability to display, in real time, a full 360-deg view of the outside world by way of video cameras and synthetic imagery (satellite photos, heads-up displays, etc). This information can be displayed onto a five flat-panels arrangement or a helmet-mounted display (HMD) system. The video and synthetic images can be overlaid at different blending levels. If the live video were to fail, the synthetic scene would be immediately

The ACES van.

available to maintain situational awareness. A global positioning system/inertial navigation system feeds the synthetic imagery to keep the scene lined up with the video views. The van also carries a 4-kW generator, internal communications, and an ultra-high frequency/very high frequency radio system.

The ACES van was originally created by a small team of engineers to simulate a cockpit for the X-38 vehicles. Upon conclusion of the X-38 program, the ACES project received funds to continue work on next-generation display concepts.

The van allows NASA to explore new technologies that will provide astronauts "out the window" views in vehicles with or without windows or in conditions of limited visibility through the use of Visual Immersion technologies at a fraction of the cost of conventional development systems.

The Virtual Eye Sight of the van is created by a bank of eight video cameras arranged in a circle on a horizontal plane. It

feeds live video into a computer equipped with digitizer cards to collect the live visual input. The digitized video images are then matched according to a common time-stamp and are stitched together to form a panorama of the scene. Synthetic images such as heads-up displays, runway outlines, three-dimensional terrain models, or satellite photo images can be overlaid onto the video images. The camera setup is mounted on top of the ACES van so that the panorama changes as the vehicle moves.

The Virtual Cockpit Window view is created by five flat-panel displays mounted in a semicircular pattern in the back of the ACES van. These displays are tied to the vehicle heading and update accordingly. Just as when looking out the windows of a car, the roof and sides of the car determine the glass viewing portion available, on the ACES van the five flat-panel displays are achieved with one centered in front, two to each side at a 45-deg angle, and the final two mounted on each side to create the user's view.

An HMD view can be created when the user puts on a helmet that contains stereo-vision displays inside the helmet itself. The user is only limited by the field of view of the visual input feeding the HMD. The user can thus look anywhere the visual gathering device can see. The slice of the panorama seen by the user matches exactly that portion of the scene that the user would have seen with his or her eyes and refreshes depending on the orientation of the head of the operator.

The ACES van can be operated as a mobile platform to image any area that is in its view as it moves along the roadway providing, for example, enhanced viewing of fixed obstacles for marine navigation in ports and rivers, border surveillance, etc. The van can also be used in a stationary mode where real-time data and video, etc., are fed into the van to create a cockpit of any crewed or crewless space vehicle, aircraft, or rover.

In November 2004, the ACES van concept was demonstrated for the Air Force Predator Unmanned Aerial Vehicle pilots, management, and accident investigation board members at the Indian Springs Air Force Auxiliary Field in Indian Springs, Nev. Real-time data and video from a Predator flight were fed into the van to drive the five flat-panel configuration. The demonstration was well received, confirming future design concepts to improve the Predator cockpit. An additional demonstration was performed for Texas A&M University, which operates "Buckeye," a parafoil powered by remote control. The ACES van went to Texas A&M University and successfully tied into the Buckeye video and data downlink.

The application of this technology can best be summed up as a command station that can display a unique, real-time view of the outside world. It could be built in a fixed platform in a building or, as in our case, on a mobile vehicle platform. Any land, sea, or air vehicle, crewed or crewless, may find an application for this technology.