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IN-FLIGHT CREW TRAINING

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It is a well known fact that computer generated training videotapes can significantly enhance perception of procedures and sequences such as on-orbit assembly of structures. It is much easier to show a videotape of how something works then it is to try to describe it verbally or with text and 2-D drawings. One can carry this observation one step further – to actually project the trainee into a life-like computer generated 3-D training scenario with a Helmet Display System.

It is easier to relate to a videatape because it communicates thru graphical means – easy and natural for everybody to understand. Still the trainee is only playing a passive role of an observer – he can't reach out and interact with objects on a videotape, just as he can't change the viewing angle. Helmet Mounted Displays make it possible for someone to actually project himself into a virtual environment and take an active role in their training. Just like the video training films are stored on cassette tapes, life-like 3-D training scenarios can be stored in cassete modules. Instead of placing a videotape in a VCR, the trainee plugs in a scenario module into the computer and puts on a Helmet Mounted Display to find himself surrounded by that scenario. Here is one possible application for such system :

A system on board of Space Station Freedom developes a fault. A decision is made to repair the fault locally with minimum loss of time. None of the crew, however, has been trained to deal with this particular emergency. The selected Astronaut has to quickly absorb the maitenance procedures, make few practice runs to build up confidence and finally perform the actual repair.

The crewperson loads the simulated mission cartridge, dons the Helmet Mounted Display and is immiediately projected into a "3-D training manual". Unlike a conventional repair manual this one has no pages, instead it surrounds the trainee with a life-like 3-dimensional representation of the

faulty system and it's surroundings. On the first pass the trainee can simply sit back and watch the faulty system repair itself. If a different viewing angle is desired, all the trainee has to do is to move his head to a new viewing position. The view changes automatically just as it would in real life. In this part of the accelerated training the astronaut is assuming a passive role of essentially watching a 3-dimensional videotape of repair procedures. Following a few minutes of passive observation the astronaut can place his hand on, for example, a module being replaced in a chassis. He can now actively follow the repair sequence by interacting with moving objects in the scenario. This active participation in the simulation scenario has the feel and sound of hands-on training. After several active passes in the virtual (computer generated) environment the crew is now ready to repeat the repair on the real system with full confidence.

The in-flight crew trainer will provide more effective training simulations thru video or animated task descriptions and interactive training environments. The latter will include computer generated, synthetic 3-D training scenarios and active computer control of hand input peripherals for tactile training during scene playback. The system will provide accelerated in-flight training capability by refreshing crew skills and practicing unplanned contingency operations in a realistic environment. The in-flight crew trainer will also enhance crew preparedness and safety.

The in-flight crew trainer is a stand alone system consisting of up to five nodes (two helmets per node). Each node uses three digital signal processors (two DSP's to compute the graphics, the third acting as a simulation host) and four graphics processors on a single printed circuit board. The simulated environment comprises a series of wireframe and solid-shaded images. All system calculation are real-time, so as soon as the wearer moves his head, the image also moves.

The "Helmet Mounted Display System" and "Part Task Trainer" are two projects currently underway that are closely related to the in-flight crew training concept. The first project is a training simulator and an engineering analysis tool. The simulator's

unique helmet mounted display actually projects the wearer into the simulated environment of three–dimensional space. Miniature monitors are mounted in front of the wearers eyes. The images are slaved to a head tracking device which allows the system to sense that the wearer has turned 180 degrees for example, and projects the images which were previously behinnd the wearer. The system can simulate (in real time) the actions of astronauts in the Space Station Freedom cupola, Shuttle or Manned Maneuvering Unit (MMU) for coordinated training of up to ten crew members. Partial Task Trainer (PTT) is a kinematic simulator for the Shuttle Remote Manipulator System (RMS). The simulator consists of a high end graphics workstation with a high resolution color screen and a number of input peripherals (including the "Handcontroller Chair") that create a functional equivalent of the RMS control panel in the back of the Orbiter. PTT is being used in the training cycle for Shuttle crew members. It provides inexpensive hands–on training in an environment where mistakes can cause no damage to hardware. PTT has been designed to augument large scale simulators that are expensive to operate. It allows the crew members more time to work with the Shuttle RMS and learn different modes of operation. Activities are curently underway to expand the capability of the Helmet Display System and the Partial Task Trainer. Lower system complexity, higher fidelity graphics and improved processing speed are among many performance improvements that could benefit the respective projects as well as the in–flight crew trainer.

Researchers involved in these projects include Peter Galicki (NASA/JSC) and David Shores (Barrios Technology). Peter Galicki is conducting research in real–time computer hardware and interfacing. He is also involved in the development of Helmet Display technology and it's applications to JSC programs. David Shores is a computer graphics software engineer specializing in simulation development and synthesis for high end, color graphics workstations.

Most of the research for the in–flight crew trainer will be conducted at JSC's Integrated Graphics and Operations Analysis Laboratory (IGOAL). IGOAL's staff and high performance graphics workstations are dedicated to development of simulation and engineering analysis tools as well as graphics synthesis algorithms. IGOAL's man–in–the–loop simulators include Shuttle Remote Manipulator System (RMS) simulator and Space Station RMS simulator. Proximity operations simulators in the IGOAL support Shuttle, Shuttle–C, OMV and MMU. IGOAL is also involved in the development of Helmet Display technology with one Helmet System operational and an upgraded system under development. In addition a custom peripheral decelopment facility within IGOAL provides a capability to interface it's computer systems to the real world. Appart from IGOAL JSC Systems Engineering Simulator will also take part in the study of an in–flight crew trainer.

This proposed training system concept is based on many new technological breakthrus some of which are more mature then others. Third generation digital signal processors and highly integrated graphics chips dramatically improve data processing performance making it possible to shrink the entire processing system to a single board. After the graphical images are computed they require a high resolution color miniature monitor for display. Color miniature displays that can be mounted on a helmet are not currently readily available and could represent a potential "hole". On the other hand, real–time head trackers are in production and their operation and interfacing are well understood. Integration of the trainer with existing flight systems should be straight forward and could provide for the interaction of multiple trainees within a common simulated environment. Low weight, volume and power requirements should be met by high component integration. Local storage of "digital" training scenarios are being investigated as well as remote transmission of training sessions from the ground.

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