

An Onboard ISS Virtual Reality Trainer

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Motivation:

Prior to the retirement of the Space Shuttle, many exterior repairs on the International Space Station (ISS) were carried out by shuttle astronauts, trained on the ground and flown to the station to perform these repairs. After the retirement of the shuttle, this is no longer an available option. As such, the need for the ISS crew members to review scenarios while on flight, either for tasks they already trained or for contingency operations has become a very critical subject. In many situations, the time between the last session of Neutral Buoyancy Laboratory (NBL) training and an Extravehicular Activity (EVA) task might be 6 to 8 months. In order to help with training for contingency repairs and to maintain EVA proficiency while on flight, the Johnson Space Center Virtual Reality Lab (VRLab) designed an onboard immersive ISS Virtual Reality Trainer (VRT), incorporating a unique optical system and making use of the already successful Dynamic Onboard Ubiquitous Graphical (DOUG) graphics software, to assist crew members with current procedures and contingency EVAs while on flight. The VRT provides an immersive environment similar to the one experienced at the VRLab crew training facility at NASA Johnson Space Center. EVA tasks are critical for a mission since as time passes the crew members may lose proficiency on previously trained tasks. In addition, there is an increased need for unplanned contingency repairs to fix problems arising as the ISS ages. The need to train and re-train crew members for EVAs and contingency scenarios is crucial and extremely demanding. ISS crew members are now asked to perform EVA tasks for which they have not been trained and potentially have never seen before.

Problem statement:

Even though the current 2D DOUG graphics software is available on flight, installed on ISS laptops, and used extensively for crew training prior to their flight, an immersive 3D environment onboard ISS is needed to provide the crew members with a better understanding of their tasks. An immersive 3D environment will allow them to get familiarized with the worksite efficiently and to better understand location, orientation, and operations when positioned outside the ISS during an EVA. The VRT is also needed to augment current ISS onboard trainers, such as the Simplified Aid for EVA Rescue (SAFER) trainer, currently available on flight, which continues training done on the ground but is currently very limited due to the reduced field of view and lack of a sense of immersion. A number of other virtual reality helmet systems have previously been

flown to the ISS, but their use has been limited to a few unique tasks due to their targeted capabilities and the certification time required to prepare individual scenarios for flight.

Approach:

One of the key considerations that drove designing and building the new unit in an efficient manner was to use components accessible on the ISS to the degree possible, to minimize the time and cost for certification for flight. Most of the components necessary for the VRT were already available onboard the ISS, such as: laptops, to run the visual graphic engine; a hand control module (HCM), to provide the inputs for flying and menu navigation; a webcam, to provide the tracking feedback needed for immersive head movement within the virtual environment; and an updated modified version of the DOUG graphic software, to support the new VRT mode capability. Additional components were needed to build the VRT, including: a new mounting adapter, for the unique optical hood; and a lens adapter capability, to incorporate vision correction as needed by individual ISS crew members. The VRT hood was manufactured from a non-flammable, space certified material that included shatter resistant optical lenses for safety.

Result:

The VRT system delivers an efficient way to help crew members to maintain proficiency in a previously trained EVA task. But most importantly the VRT allows crew members to prepare and train for contingency EVA scenarios when they occur. The smart design of the VRT uses basic components and incorporates parts already available on the ISS, creating a very useful, versatile, and unique training capability onboard ISS in a timely and cost effective manner.