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On-Orbit MSS Training Simulator

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Experimental tests and analysis have shown that the capture of free-flyers is the most complicated task to be performed by a robotic operator on board of the International Space Station (ISS). The understanding of Canadarm2 and free-flyer dynamics require highly qualified and well-trained operators. The dexterity and accuracy of the astronauts may decrease over time if they are not trained on-board. It was an obvious choice to have a simulator on-orbit to keep the skills of the astronauts at the required level. In order to support the training scenarios required by the on-orbit training, the SMP[1] simulator has been developed. The main objective of the simulator is to determine if an astronaut is ready to perform an operation with the real Canadarm2. The training scenario, implemented in the SMP, consists of capturing a free-flyer with the Canadarm2.

The on-orbit configuration includes a laptop, rotational and translational hand-controllers. To ensure power and communication between the laptop and the hand-controllers, CSA and Xiphos Technologies (Canadian company) developed a USB box interface based on Q4 card technology. Using this box, no external power is required for the hand-controllers. Furthermore, the box implements the HID standard interface (USB standard) and can be used with any HID compliant operating systems (Win2k, Linux etc) without requiring specific drivers installation.

The software architecture includes four modules, the Graphical User Interface (GUI), the Analysis Module, the Visual Renderer (VR) and the Dynamic Simulator (SIM) [Figures. 1,2]. It has the same architecture as the Basic Operations Robotic Instructional System (BORIS) simulator used to provide generic robotic training to the astronauts. The GUI has been developed with Java and runs on Windows operating systems. During a training session, the operator is firstly prompted to log into the system. Then, he has the choice to start a simulation session, a session analysis or a trend analysis. The session analysis provides information such as the hand-controller rates, the relative position and velocity between the end-effector and the free-flyer, and the capture status. Operational criteria and heuristics are used to provide a score, which allows the astronaut to have a good picture of his personal progress over time using trend analysis. The astronaut can then determine if he needs more training or not. The VR module has been developed with OpenGL toolboxes.

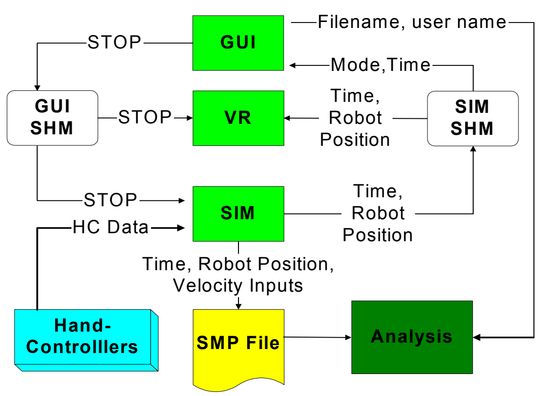

Figure 1: Software Architecture

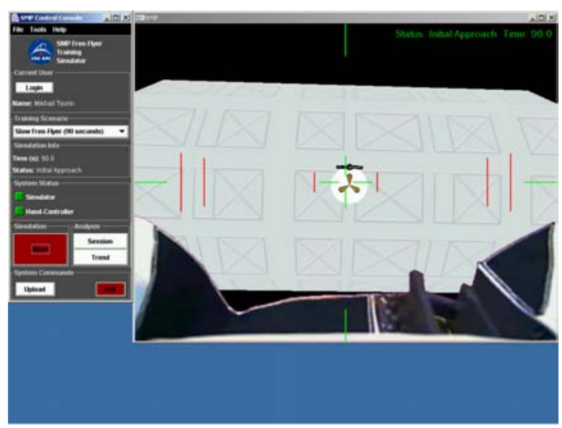

Figure 2: Software Graphical User Interface

Two Symofros models have been used to represent the Canadarm2 and the free-flyer. The Canadarm2 model has been configured and tuned using real flight data (data gathered during Canadarm2 operations) in order to obtain a realistic model. Generic parameters have been established to configure the dynamic behavior of the free-flyer. A Simulink diagram, using Symofros toolboxes, performs the simulation of the Canadarm2, models the attitude control system of the free-flyer, interprets the hand-controller input values, handles the capture sequence, and gathers session data. The SMP simulator running in soft real-time on Windows 2000 has been generated using Real-Time Workshop. The experimental system will be launched in January 2003 and will be used by several astronauts and cosmonauts. A functional system will be available for the participants during the poster session at Space Technologies Forum 2002.

[1] System for Maintaining, Monitoring MRO Performance on board the ISS