66th International Astronautical Congress 2015

HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Human and Robotic Partnerships in Exploration - Joint session of the Human Spaceflight and Exploration Symposia (3-B3.6)

Author: Ms. Sherrie Hall
Massachusetts Institute of Technology (MIT), United States, shall6@mit.edu

Ms. Clementine Mitchell
Massachusetts Institute of Technology (MIT), United States, cmitchell@mit.edu
Dr. Christopher Assad
Jet Propulsion Laboratory, United States, christopher.assad@jpl.nasa.gov
Dr. Michael Wolf
Jet Propulsion Laboratory, United States, wolf@jpl.nasa.gov
Prof. Jeffrey Hoffman
Massachusetts Institute of Technology (MIT), United States, jhoffma1@MIT.EDU
Prof. Leia Stirling
Massachusetts Institute of Technology (MIT), United States, leia@mit.edu

INTUITIVE GESTURE CONTROL FOR THE ISS SPACE STATION REMOTE MANIPULATOR ARM

Abstract

One of the most essential tools on the International Space Station (ISS) is the Canadarm2 robotic arm, or Space Station Remote Manipulator System (SSRMS), used for all manner of external station operations such as grappling of incoming spacecraft, moving astronauts on Extra Vehicular Activities (EVAs), and station servicing tasks. Unfortunately, its operation is notoriously difficult. The current human-machine control interface uses two independent three-dimensional joysticks, with one controlling translational motion and the other rotational. Astronauts must coordinate separate inputs with each hand to use the joysticks, while visually tracking the robotic arm's position using three display monitors showing different viewpoints from cameras placed around the ISS. This study focuses on the extension of the BioSleeve, a self-contained surface electromyography (sEMG) static gesture control system worn on the forearm, for controlling the SSRMS. This study implements a new version that also incorporates inertial measurement unit sensors (IMUs), which can record linear acceleration and angular velocity. It is being used to explore how the combination of EMG and IMU data can enhance the BioSleeve's usability as a control interface. The goal of the present study is to develop a more intuitive system for SSRMS operations by comparing different gesture control methods. Each method maps a different set of hand/arm gestures to SSRMS commands. Specifically, mappings evaluated will include one of discrete, separate direction commands, and one of commands the user may couple to move the arm in multiple directions at once. These mappings are designed by considering correspondence between gesture, intended command, and the user's mental model, as well as the capabilities of the system and the comfort of gestures to the user. The mappings are compared through preliminary experiments conducted at the Massachusetts Institute of Technology's Man Vehicle Laboratory, with an SSRMS operations simulator. After training on the simulator with each mapping, participants are asked to perform a series of tasks with the SSRMS, such as approach and capture of a vehicle outside of the ISS. Participants complete these tasks using the different mappings with the BioSleeve interface, and with the traditional joystick interface. These experiments

guide determination of which mappings, and thus, which types of gestures, would be most natural and intuitive for SSRMS operators.