

Human Research Program Space Human Factors & Habitability Element Space Human Factors Engineering Project (SHFE)

Human-Robot Interaction

Jennifer Rochlis Zumbado, Ph.D., NASA JSC, jennifer.l.rochlis@nasa.gov Anikó Sándor, Ph.D., Lockheed Martin aniko.sandor-1@nasa.gov Neta Ezer, Ph.D., Futron Corporation neta.ezer@nasa.gov

> HRP Investigators Workshop 2012 Houston, TX

Background

- Risk of Inadequate Design of Human and Automation/Robotic Integration (HARI) is a new Human Research Program (HRP) risk
- HRI is a research area that seeks to understand the complex relationship among variables that affect the way humans and robots work together to accomplish goals
- The DRP addresses three major HRI study areas that will provide appropriate information for navigation guidance to a teleoperator of a robot system, and contribute to the closure of currently identified HRP gaps
 - Overlays
 - Use of overlays for teleoperation to augment the information available on the video feed
 - Camera views
 - Type and arrangement of camera views for better task performance and awareness of surroundings
 - Command modalities
 - Development of gesture and voice command vocabularies

Literature review of HRI methods and metrics

- Completed literature review of methods and metrics in HRI and related fields (e.g., human-computer interaction, aviation, automation, and teamwork)
 - Goals were to identify comprehensive, valid, replicable, and practical research tools to study space HRI and identify research needs
 - Concentration on taxonomies of HRI, task and performance metrics, testbeds, measures of interaction, teamwork, communication, workload, situation awareness, and interface variables
- Research areas applicable across space HRI
 - Compensations for poor or ambiguous video feedback
 - Match between command modality (e.g., gesture, voice, hand controller) and task
 - Communication issues (i.e., loss of signal, communication delay) and mitigations

Literature review of overlays

- Literature review on video overlays through augmented reality (AR)
 - Summarized research articles to understand the use of AR as guidance for operators during teleoperation and the effects of characteristics of AR on human task performance
 - Focused on navigation and robot arm alignment tasks
- Type of guidance (Foyle, Hooey, Wilson, & Johnson, 2002)
 - Command-guidance symbology gives operators direct information about the command inputs they need to make
 - Situation-guidance symbology gives operators cues to let them infer what command inputs are needed
- Type of overlay
 - Superimposed symbology is fixed on the operators' display and does not move with the video feed
 - Integrated symbology is linked to the scene in the video feed and moves with it

Review of NASA robotic systems SPDM observations

• Literature review

- Current NASA robotic systems including the Shuttle and Station robotic arms, Mars rovers, the Special Purpose Dexterous Manipulator (SPDM) and Robonaut 2 (R2)
- SPDM procedures and operator handbooks

Observations and interviews

- NASA robot system operations and interviews with NASA robotic operators and trainers
 - SPDM
 - Multi-mission Space Exploration Vehicle (MMSEV)
 - igoal laboratory gesture interface system
 - R2

HRI workshop

- Coordinated and held the Space HRI workshop November 14-17, 2011
 - Nineteen subject matter experts from NASA centers, academia, and industry discussed and documented research areas needed to address the HARI risk
 - Discussions framed by classes of robotic systems and In relation to the HRP gaps
- The research areas with the highest priority ratings:
 - Maintaining situation awareness
 - Applying research on human teams to human-robot teams
 - Knowledge of machine capabilities and states
 - Information sharing without overload
 - Variable time delay
 - Levels of automation
 - Changes in human performance over time

Research Robot

- CoroWare CoroBot for use in the FY12-FY14 studies
 - Programmable mobile robot, 12" x 13" x 16"
 - 4 degree-of-freedom robot arm
 - MS Kinect system for gesture interface

