Human-Robot Interaction

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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
• 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
  - 4 cameras and RoboRealm computer vision software