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

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
  - 4 cameras and RoboRealm computer vision software