HUMAN-ROBOT INTERACTION DIRECTED RESEARCH PROJECT

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Human-robot interaction (HRI) is about understanding and shaping the interactions between humans and robots (Goodrich & Schultz, 2007). It is important to evaluate how the design of interfaces and command modalities affect the human's ability to perform tasks accurately, efficiently, and effectively (Crandall, Goodrich, Olsen Jr., & Nielsen, 2005) It is also critical to evaluate the effects of human-robot interfaces and command modalities on operator mental workload (Sheridan, 1992) and situation awareness (Endsley, Bolté, & Jones, 2003). By understanding the effects of interface design on human performance, workload, and situation awareness, interfaces can be developed that support the human in performing tasks with minimal errors and with appropriate interaction time and effort. Thus, the results of research on human-robot interfaces have direct implications for design.

Because the factors associated with interfaces and command modalities in HRI are too numerous to address in 3 years of research, the proposed research concentrates on three manageable areas applicable to National Aeronautics and Space Administration (NASA) robot systems. These topic areas emerged from the Fiscal Year (FY) 2011 work that included extensive literature reviews and observations of NASA systems. The three topic areas are: 1) video overlays, 2) camera views, and 3) command modalities. Each area is described in detail below, along with relevance to existing NASA human-robot systems. In addition to studies in these three topic areas, a workshop is proposed for FY12. The workshop will bring together experts in human-robot interaction and robotics to discuss the state of the practice as applicable to research in space robotics.

Studies proposed in the area of video overlays consider two factors in the implementation of augmented reality (AR) for operator displays during teleoperation. The first of these factors is the type of navigational guidance provided by AR symbology. In the proposed studies, participants' performance during teleoperation of a robot arm will be compared when they are provided with command-guidance symbology (that is, directing the operator what commands to make) or situation-guidance symbology (that is, providing natural cues so that the operator can infer what commands to make). The second factor for AR symbology is the effects of overlays that are either superimposed or integrated into the external view of the world. A study is proposed in which the effects of superimposed and integrated overlays on operator task performance during teleoperated driving tasks are compared.

Studies proposed in the area of camera views investigate inclusion/exclusion of a robot within the video feed and camera frame of reference. One study will investigate the effects of including and excluding the robot's chassis within the video feed presented to operators on path-following and maze traversal task performance. Another study will investigate the effects of the addition of an exocentric camera frame of reference to egocentric frames of reference on operator task performance for these same tasks.

Lastly, studies in the area of command modalities will systematically build and evaluate gesture and voice vocabularies for commanding a ground-based mobile robot. The first in this series of studies will have participants produce robot commands for a set of critical control functions. The characteristics of the commands will be analyzed. In a second phase of this study, the strength of association between command and voice/gesture inputs will be evaluated. The next two studies will test the learnability and memorability of the developed vocabularies in the context of a representative task.

The work will contribute to closure of Human Research Program (HRP) gaps by providing information on how display and control characteristics – those related to guidance, feedback, and command modalities – affect operator performance. The overarching goals are to improve interface usability, reduce operator error, and develop candidate guidelines to design effective human-robot interfaces.

REFERENCES

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