

Humans & Automation Qualifying Exam 2011

You are responsible for assessing two competing ground control stations for a robot equipped with a video camera designed to remotely explore the surface of an asteroid. The ground control station will be in the space station. The robot is expected to have communications with the space station via the deep space network, which has been criticized for latency issues. The robot will be equipped with LIDAR (Light Detection and Ranging) for local mapping and obstacle avoidance.

One subcontractor promises that an adapted gaming controller can remotely teleoperate the robot, as well as control a camera that can pan and zoom. For this system, the operator can also enable a gesture-based form of control where actual movement of the controller assumes the navigation functions. Another company states that their ground control station is PC-based and controls the robot locomotion through mouse point and clicks on a robot-generated 2.5D map (from the LIDAR). The pan and zoom features are also controlled by the mouse (mouse clicks on the image pan while the scroll wheel zooms).

In terms of display output, both systems display the camera view on a stand-alone display. The gamer system provides a small 2D LIDAR map and the current speed overlaid on the camera view (so it only has one display). For the PC-based system, the speed and map views of Figure 2 are on a second display.

1. Discuss which levels of automation (LOA) these two competing systems represent, and detail the pros and cons of these LOAs.
2. What insight does manual control theory give you in terms of controllability of the competing systems, particularly in terms of how much time delay in the relay to the ISS could there be before robot control stops being a closed loop continuous feedback manual control task and becomes a discrete “move and wait” exercise?
3. Compare and contrast the two different designs in terms of control/display compatibility issues. Be sure to address both the control of the vehicle as well as the camera control. Which do you think is better in terms of human performance and why?
4. Both vendors assure you that their systems maximize operator situation awareness. How would you test their claim? Be specific about your experimental test plan.



Figure 1: Gaming controller ground control interface

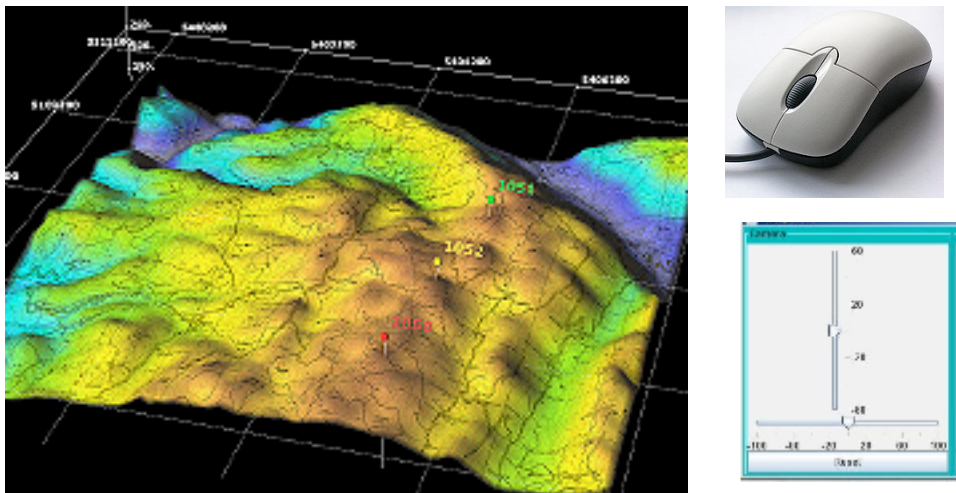


Figure 2: PC-Based control: Operator clicks on 2.5D map to navigate vehicle, changes speed through the slider, and pans with mouse movement and zooms with scroll wheel.