SUPERVISORY CONTROL WITH DUAL TASKING IN POST G-TRANSITION VEHICLE LANDINGS

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Background

- Crew control during exploration spaceflight consists of both planned automated supervisory control and unplanned manual override and control
- Adaptive changes that optimize sensorimotor function in microgravity can be maladaptive for transitions to other gravity states
- Crew override capability is critical to enable overall mission success during landing contingencies
- While training and landing aids can help overcome these adaptive changes, increases in cognitive demand need to be accounted for in our manual override strategy

Multi-Attribute Lunar Tablet Battery Task

The user will oversee a series of approaches through touchdown simulations on an iOS tablet with an external camera view of the Lunar surface.

Task Goals

1. Study a map of a planned landing site (Fig. 2) and memorizing the terrain and surface landmarks to inform potential divert maneuvers
2. Execute a divert if:
   a. Guidance recommended site is erroneous (e.g., the guidance projected landing target is not within 25 m of the planned landing site center)
   b. Projected landing site is no longer suitable due to surface obstacles (e.g., hazards)
3. A secondary operational monitoring task will challenge the user's cognitive reserve
   a. Maintain 4 gauges within acceptable limits
   b. Respond to visual indicators (COMM)

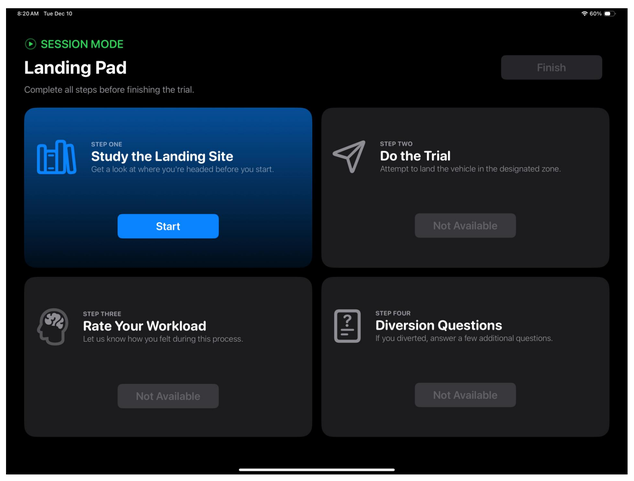

Figure 1. Lunar tablet task workflow

Multi-Attribute Lunar Tablet Battery Task

- Hazards (0 – 5 m)
- Landing sites (6; Connecting Ridge and Nobile Rim sites)
- Sun azimuth (0, 90, 180, 270 deg)
- Navigation downrange and cross range bias (0 or 25 m)
- Glide slope (45 deg)
- Altitude (1200 m) and downrange (1200 m)
- Camera modes (fixed and gimbal)
- Dual task difficulty (easy, hard)
- Various lighting conditions (dates and time of day)

Six scenario types (30 scenario combinations)

1. No divert required | fixed camera | no navigation bias | no hazards (2)
2. No divert required | gimbal camera | no navigation bias | no hazards (3)
3. Divert required | fixed camera | no navigation bias | varying hazards (8)
4. Divert required | gimbal camera | navigation bias | varying hazards (5)
5. Divert required | fixed camera | navigation bias | varying hazards (7)
6. Divert required | gimbal camera | navigation bias | varying hazards (5)

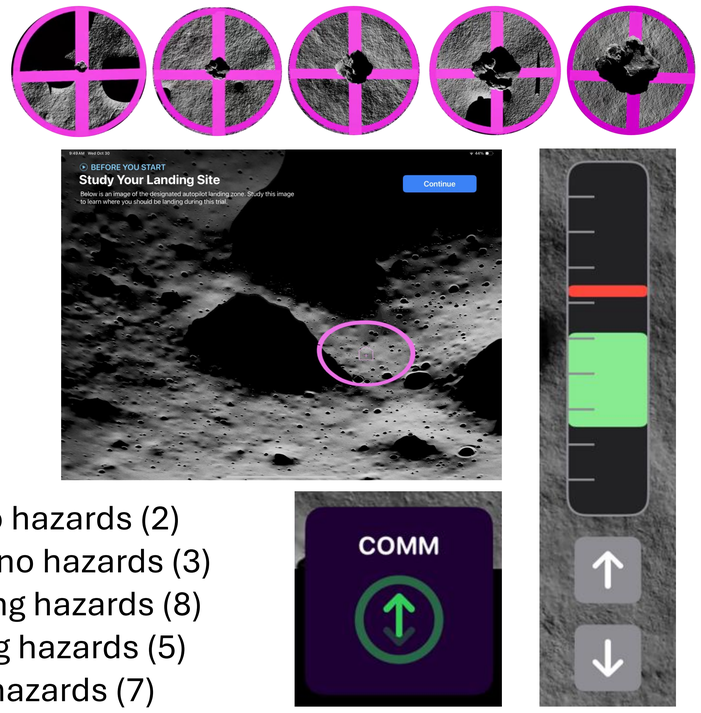

Figure 2. User interface elements

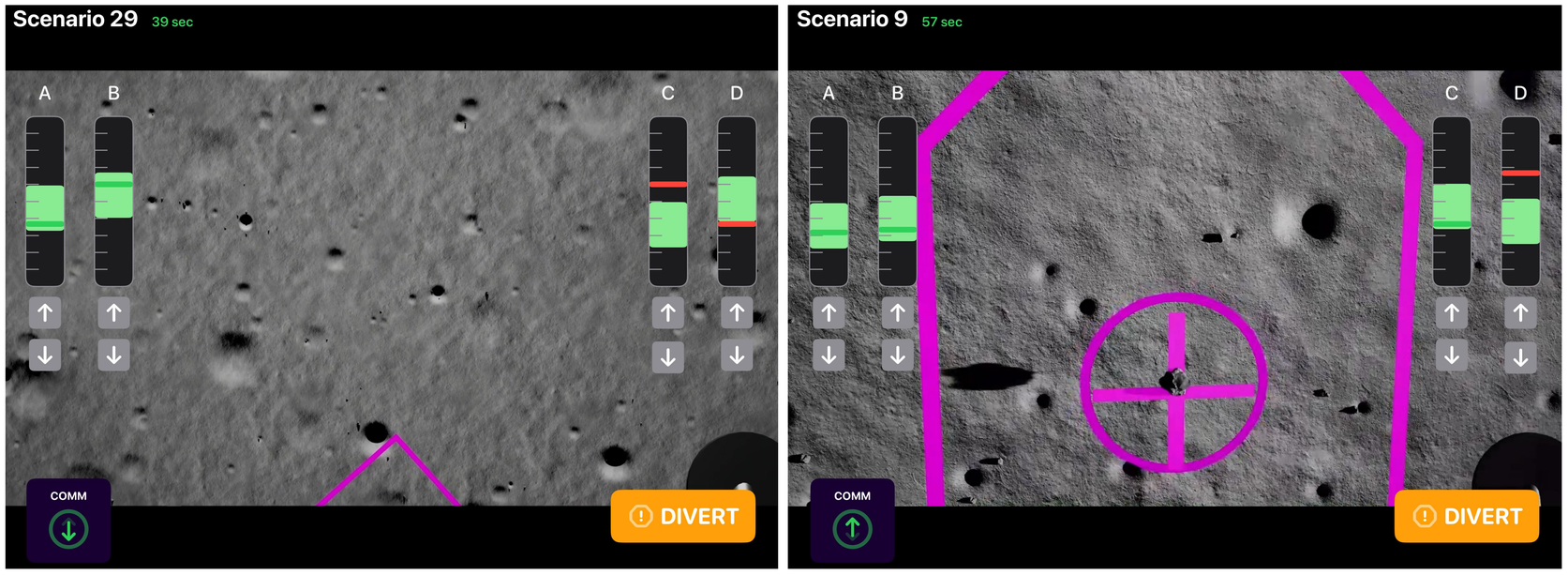

Figure 3. Fixed camera scenario (left), gimbal camera scenario (right). COMM indicator requiring swipe input (down/up) and gauges C and D in off-nominal configuration requiring arrow input (down/up).

Dependent Measures

- Divert performance considering potential hazards, navigation bias, landing site safety
- Number of missed indicators
- Incorrect input to gauges (e.g., up arrow selection for down arrow case)
- Temporal measures (e.g., reaction time for secondary tasks, time to view landing site image, time to initiate or complete diversion, total time gauges kept within nominal zones)
- Reason for diversion, if applicable (e.g., hazard at landing site, navigation bias, both, or none)
- Modified Bedford Scale

Relevance

This supervisory control task will be integrated into a flight study alongside manual control simulation tasks to demonstrate crew override capability across various control options following spaceflight and to identify any deficits that may require remediation.

Acknowledgements

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