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FACTORS AFFECTING HUMAN PERFORMANCE AS ROVER TELEOPERATORS

Abstract

During the initial exploratory phases of human presence on other planetary bodies, robots (particularly rovers) will likely play a key role. They will undertake scouting missions prior to human EVAs, and conduct operations where they are unsafe for astronauts. Due to the data latencies involved, terrestrial mission control centres will not be able to command and control the rovers, and fully autonomous operations are currently too slow. Therefore, astronauts will likely control the rovers from the safety of surface habitats or spacecraft.

The astronaut operators of these rovers will have many tasks to perform, some of these in real-time. These are likely to include:

- Obstacle detection and avoidance
- Route planning
- Hazard identification and characterization
- Features-of-interest identification and characterization
- Conducting geological and scientific research
- Habitat construction, assembly, and repair
- Transportation of materials

While humans may very effectively conduct these operations, there are many factors affecting their performance. The effects of these are characterized, quantified, and mitigated, yielding design specifications for Surface Exploration Vehicles (SEVs) and their remote operation by astronauts. The following factors are among those considered:

- Operations in various lighting conditions
- Various look-angles with respect to the sun
- The number and configuration of cameras and sensors on the rover
- Camera and sensor positioning (egocentric versus exocentric, different placements)
- Effects of latency, frame rate and video quality
- Field of view
- Various techniques for creation of depth perception
- Integration of multiple sensor data, including range data
- Data display for astronaut operator, including Heads-up Displays (HUDs)
- Integration of camera and sensor data in to a Virtual Reality interface

The effects of these parameters and others have been tested under the auspices of the ERAS project (**E**uropean Ma**R**s **A**nalog **S**tation for Advanced Technology Integration), where analog astronauts in Europe conducted remote operations on a rover in Canada. The studies found that variations in the aforementioned parameters have important impacts on astronaut performance. The following paper details the results and presents recommendations.