Science Crew Operations and Utility Testbed

Frank Delgado, *Johnson Space Center*
Robert Hirsh, *Johnson Space Center*

To effectively explore the lunar or martian surfaces, humans will require a surface transport rover. Although a rover was designed and used on the Apollo lunar missions (1960s), the capabilities associated with a prolonged stay on the lunar/martian surfaces will require the development of a new vehicle with significantly greater performance capabilities. To address this need, the Engineering Directorate at Johnson Space Center (JSC) started the Science Crew Operations and Utility Testbed (SCOUT) project in 2003. The SCOUT project's primary object is to design, develop, test, and evaluate advanced technologies and operations concepts that may be applicable to future lunar rover development efforts.

EVA-suited subjects operating SCOUT at Meteor Crater, Arizona (September 2006).

Over the last 4 years, the SCOUT project has developed a testbed vehicle that can transport two fully suited crew members, traverse 15-degree slopes, drive at a maximum speed of 9.5 miles per hour (on level surface), go over 1-foot-high rocks, and provide a 6-mile drive range between battery recharge. The SCOUT vehicle has provided engineers, astronauts, scientists, and operations personnel with hands-on experience conducting rover-related operations in lunar analog environments.

The Apollo lunar rover vehicle could only be controlled by on-board operators, but the SCOUT vehicle can be controlled in three drive modes: on-board; tele-operation; and autonomous navigation. The first drive mode (on board) involves control of the vehicle by on-board operators using the open cockpit that includes two seats, a control stick (usable from either seat), and a display and control system (DCS). These three components are ergonomically designed for use by crew members wearing an extravehicular activity (EVA) suit. The DCS and control stick provides all of the necessary insight, commanding, and control of the SCOUT vehicle by the on-board operator. While the EVA-suited crew members ride on board to the location of interest (LOI), their Portable Life Support System (PLSS) can be connected to the consumables being carried on the rover. This allows them to arrive at their LOI with a fully charged PLSS. Additionally, the metabolic rate of the crew members is much lower while riding on the rover than while walking. These two advantages provided by using the rover will allow crew members to conduct activities at a higher performance level for longer periods of time. Additionally, since the vehicle can carry heavy and bulky scientific instruments/equipment, the crew members will be able to perform missions that would otherwise not be feasible.

The second drive mode (tele-operation) controls SCOUT remotely. This mode involves providing tele-operators with all the information, command, and control capabilities that would be available to on-board operators. The third drive mode involves operating the SCOUT vehicle autonomously using the On-board Autonomy System (OAS). The OAS includes an autonomous navigation capability that allows the SCOUT vehicle to drive between locations autonomously. The OAS can take advantage of various on-board sensors (cameras, light detection and ranging systems, etc.) to carry out its functions.

Science Crew Operations and Utility Testbed

continued

Some of the advanced capabilities investigated by the SCOUT project over the last 2 years include:

- an ergonomically designed cockpit that will accommodate EVA-suited subjects
- an on-board (and mobile) EVA suit recharge capability that increases the amount of time suited crew members can perform EVA-suited activities
- an intelligent path planning system that uses terrain information to optimize a path between waypoints. The path planner has the ability to use information from satellite maps and human-designated "keep out zones."
- an obstacle avoidance system that allows the vehicle to drive around obstacles during autonomous point-to-point navigation
- a "Solar Power System" that augments the vehicle battery power system and extends the distance/duration of a mission
- an "Intelligent Vehicle Health Management System" that monitors on-board resources and assures that the vehicle has enough battery power to safely return home
- a "Single-Button-Startup" capability that allows the vehicle to be started by a single switch and one command
- a "remote control" capability (the Astronaut Interface Device) that allows a crew member to monitor and command the vehicle while performing activities off the vehicle
- an automated active seismic sensor system that can be used to study subsurface ground composition
- an advanced tele-operation system that uses hybrid synthetic vision and panoramic video to significantly enhance a tele-operator's situation awareness
- a remote interface to the Experiment and Planning Operations Center at JSC. This capability allows SCOUT to be monitored and controlled from more than 1,000 miles away.
- a vision-based gesture recognition capability that allows crew members to command the vehicle using arm and body gestures
- a "natural language" speech recognition/synthesis system that allows operators to command the vehicle using a wide assortment of English words and sentences
- an "ultra-wide band system" that is capable of providing very accurate position information for objects without the need of a Global Positioning System

The SCOUT vehicle also provided various other exploration-related projects with a testbed to carry out test activities. Some of the projects include: the Advanced Cockpit Evaluation System (ACES) project; the Planetary Exploration Geophone System (PEGS); and the Lunar/Mars Drill project. The ACES project developed an advanced visualization cockpit that can be used to tele-operate an assortment of vehicles. The PEGS project is capable of mapping the subsurface with the use of a "thumper system" that projects a cylindrical mass at the surface to create contusion waves. The drill project developed a prototype drill that can be used for drilling in extraterrestrial locations.

The SCOUT vehicle has been involved in several very successful field tests at an analog site, the Arizona desert (Meteor Crater). These field tests provided an Earth-based simulation of some of the conditions that would be found on the lunar surface.