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DESIGN OF A MODULAR UTILITY VEHICLE FOR TELEOPERATED AND MANNED LUNAR SOUTH POLE EXPLORATION

Abstract

This paper presents a concept for an unpressurized Lunar Rover, called the Modular Utility Vehicle (MUV), as a feasible design for a modular, upgradeable, telerobotically operated and manned rover for navigating the Lunar South Pole. Designed for the NASA RASC-AL Competition, its capabilities include payload deployment, water-ice sample collection, geologic analysis, and terrain mapping. The defining aspect of this modular approach allows for future mission requirements and objectives to be met.

The modular aspects of the vehicle allow it to perform multiple tasks at once, either as a singular unified vehicle, or to be broken into smaller components and used singularly or as a swarm. This allows significant flexibility of vehicle management and the eventual deployment of habitation and scientific structures on the Lunar surface. Modularity also increases redundancy, and adds options for mitigating vehicle damage, failed components, or emergency return to the lander.

The basic vehicle design is made up of a single chassis. The chassis has an outfitted mass of approximately 150kg and can support 30x its own weight. Nominally operated in pairs of two, each chassis provides two payload bays, two utility bays, 1.6kWh of batteries, computers, keep alive functions, communications, and four external connections to mate-up with more chassis, drive mechanisms, or robotic manipulators.

Payload bays provide the vehicles' primary interface though the installation of human drive controls, science packages, or capability expansions such as extra batteries to help survive the 14-day long Lunar nights. The vehicle follows a 1.4 factor of safety to meet NASA's human safety requirements and has a minimum driving range of 28.5 km, assuming no solar power availability to recharge the batteries.

The general operational concept of the vehicle allows crews on Earth or the Lunar Gateway to perform tedious and potentially dangerous terrain mapping in preparation to receive a crew on the Lunar surface. The rover identifies areas of interest that human crews will later examine for samples and water-ice collection for eventual return to Earth. Once the crew arrives they will reconfigure the rover to operate as a human surface transportation system.

Crews, both on and off the Lunar surface, will be aided in Navigation by LIDAR, terrain mapping, auto-drive features, and augmented reality. Most technologies are at a readiness level 9, and many have a flight-proven history. No significant advancements in technology must be made for the feasibility of the design.