

SUPERBOTS ON THE LUNAR SURFACE: A HABITAT OPERATIONS AND MAINTENANCE SYSTEM (HOMS). S. J. Lawrence¹, G. J. Taylor¹, R. C. F. Lentz¹, L. M. Martel¹, W.-M. Shen², P. M. Will², M. H. Sims³, S. Colombano³, D. Kortenkamp⁴, B. Damer⁵, W. Chun⁶; ¹HIGP, University of Hawaii at Manoa, Honolulu, HI 96822; slawrenc@hawaii.edu; ²ISI, University of Southern California, LA, CA; ³NASA Ames Research Center, Mountain View, CA; ⁴Metrica, Houston, TX; ⁵DigitalSpace, Santa Cruz, CA; ⁶Lockheed Martin, Denver, CO.

Introduction: SuperBots represent a departure from the paradigm of single purpose robots for single missions to a more mature and evolved philosophy that emphasizes multifunctionality, modularity, and reconfigurability [1]. The SuperBot system consists of a set of interlocking autonomous robotic modules that can *self*-reconfigure into different systems for different tasks. This design philosophy reduces cost and payload mass while enhancing mission performance, reliability, and safety through the SuperBot system's ability to change shape and function as needed. SuperBots can work independently or in concert to perform a wide range of tasks [e.g. 2 and 3].

For the foreseeable future, astronaut extravehicular activity (EVA) time will be at a premium on the lunar surface. It is neither practical nor desirable to expect astronauts to perform all extravehicular functions during the course of a lunar mission. However, many of the expected tasks at a lunar facility will require extensive EVA time. Therefore, a need exists for a robust robotic system that can accomplish an assortment of EVA tasks while controlled by either the crew or from the ground [4].

The HOMS Concept: Our vision of a SuperBot teleoperated habitat inspection and repair system is called the Habitat Operations and Maintenance System, or HOMS. This concept involves the use of ~150 SuperBot modules in concert with each other and a few specialized tools (such as cameras and scoops). These modules, similar in all respects to the modules described in [2] and [3], are then used and reconfigured to accomplish a range of tasks on the lunar surface. For example, the same 10 SuperBot modules can be reconfigured to make an excavation arm for ISRU purposes or a small instrumented walker for habitat inspection. This use of specialized components with common docking interfaces, such as patch kits or cameras, transforms groups of identical SuperBot modules into versatile tools. We highlight here some of the tasks envisioned for HOMS in the initial stages of the second age of lunar exploration.

Logistics: The HOMS system could configure as a set of legs to move supply pallets from landed cargo elements to the outpost. HOMS could also

handle possibly dangerous tasks in the resupply of spacecraft consumables, such as connecting and disconnecting external fuel lines.

Operations and Maintenance: The HOMS system is ideally suited for (1) dust mitigation, such as microwave sintering of areas (using SuperBot walkers equipped with specialized microwave modules) surrounding the habitat, (2) in-situ solar panel production (3) solar panel cleaning (using SuperBot walkers equipped with brushes), (4) real-time monitoring and inspection of habitats and landed spacecraft (using walkers equipped with cameras), (5) outpost navigational beacons (6) nuclear reactor operations and (7) repair of habitats and spacecraft. For example, HOMS could be used to inspect and refuel surface nuclear reactors, minimizing the danger to human life.

Construction: At early lunar outposts, the HOMS system in the form of multiple SuperBot walkers with scoops could be used to provide a significant regolith mass excavation capability. This would be useful for the construction of foundations, grading roadbeds, running power lines, and creating emergency radiation storm shelters for the crew.

ISRU: The HOMS system could be used to provide regolith feedstock to ISRU pilot plants on the early missions, either through a system of scoops or as legs to allow active reconfiguration of a larger modular conveyor belt system.

Conclusion: The HOMS concept has countless applications at lunar outposts. The high degree of hardware commonality between the HOMS system and the Mini-MIS, and MULE SuperBot variants [2, 3], as well as any SuperBot variants designed for orbital and cislunar operations, leverages technology development costs across a wide array of mission types while promoting ease of repair and lowering costs. The SuperBot HOMS system offers a pathway towards flexible and robust human lunar surface operations and economical lunar surface development.

References: [1] Shen et al., this volume [2] Taylor et al, this volume [3] Lentz et al, this volume [4] Duke et al. (2003) *Lunar Surface Reference Mission: A Description of Human and Robotic Surface Activities*, NASA, TP-2003-212053