Paper ID: 105511
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IAF SPACE SYSTEMS SYMPOSIUM (D1)
Innovative Systems toward Future Architectures (1)

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SUPPORTING HUMAN LIFE ON THE MOON: DEVELOPMENT OF AN AUTONOMOUS SUB-REGOLITH GREENHOUSE SYSTEM

Abstract

Long duration crewed space missions risk failing to meet crew nutritional requirements if they rely solely on Earth supplied produce. Successful plant growth on the lunar surface has never been demonstrated, but if achieved could provide a continuous source of fresh food for a long-term crewed habitat. Designing, integrating and testing the Sproutnik greenhouse serve as a demonstration of a potential viable method for plant growth on the moon, overcoming radiation and temperature constraints that have previously made the task difficult to achieve. The Sproutnik greenhouse is capable of autonomously growing 20 Brassica Rapa plants for a 15 day period while buried below the lunar surface to protect from radiation. It uses a dual-walled cylindrical structure to provide structural strength and thermal insulation from the surrounding regolith. The greenhouse interior is pressurized and control loops are used to regulate interior temperature (using heating pads) and CO2 concentration (using a pressurized supply). Lighting and water are provided at levels needed for plant growth. Power is supplied by an internal battery as well as surface solar panels. Sensors collect atmospheric, growth medium moisture, and light data, which are processed and transmitted to a crewed lunar base every four hours using a surface ground station. Testing has shown that Sproutnik will be able to support the metabolic needs of the plants as they grow for the full 15-day period. Structural, thermal control, power supply, and link budget models have validated our approaches. A total of 18 further tests were completed, including continued sensor calibration, thermal control validation, growth medium testing and multiple integrated 15-day autonomous growth tests. Sproutnik demonstrates an autonomous approach to in-situ food production and provides a foundation for future food production systems for sustained lunar and deep-space exploration.