IAF SPACE EXPLORATION SYMPOSIUM (A3)
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LOOPS-M PROJECT: STRUCTURAL AND BIOREGENERATIVE SYSTEMS FOR A SUSTAINABLE LUNAR GREENHOUSE

Abstract

In the forthcoming years mankind is at long last going to establish a lunar base for long-term presence of human beings on the moon with the Artemis program. Due to the necessity of an autonomous production of nutrients, the presence of a greenhouse will be an optimal solution, and this long-lasting vision will require extreme optimisation of all the processes regarding the settlement and its subsystems. The hereby proposed designs and prototypes are part of a long-term student project called LOOPS-M (Lunar Operative Outpost for the Production and Storage of Microgreens). The project was created by students of "Sapienza" University of Rome in partnership with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and MarsPlanet for IGLUNA 2021, an interdisciplinary student project coordinated by Space Innovation as part of the ESA_Lab@ initiative. The main designs consist of a shield for protection from the micrometeorite environment, an autonomous cultivation system called "HORT^3 MKII" to lower the astronauts' workload and a bioconversion system for waste management and recovery, all of which will be represented in a virtual reality environment to allow better insight. The micrometeorite shield is based on the stuffed Whipple layout, refined and adapted to the hypervelocity impacts typical on the lunar soil. A prototype 10x10 cm^2 will be created and it will undergo tests that recreate the lunar environment such as a thermal vacuum test and irradiation tests, to ensure its functionality in such a critical environment. The autonomous cultivation system is based on the previous version "HORT^3". This unit was developed for the HORTSPACE project, financed by ASI, during the AMADEE-18 analog mission held in the Oman desert in February 2018, and consisted in a highly efficient hydroponic system for the growth of microgreens. The new version is fully automated to make the cultivation autonomous from seeding to harvesting. To manage the waste a natural degradation process has been chosen. After the cultivation, the main waste consisting of roots, substrate and hypocotyl is introduced to the recovery system where larvae of Black Soldier Fly, use it as a food source. Once in the form of pupae, they could be used as a valuable protein source for crew members. In this work designs and prototypes of the autonomous cultivation unit, the bioconversion system and the micrometeorite shield will be presented, together with their layout in a virtual reality environment.