IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Life Support, habitats and EVA Systems (7)

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COMPUTATIONAL DESIGN FOR A DEPLOYABLE LUNAR HABITAT AND GREENHOUSE SYSTEM

Abstract

In the last years we have been witnessing a boost in space exploration, guaranteed by the constant progresses in engineering and space technologies, by the active participation of private aerospace companies determined to collaborate with international space agencies in order to promote human space exploration in LEO, the Moon and beyond. The plan is to undertake long-term expeditions to the Moon and Mars within the 4th decade of this century. In particular, the installation of a permanent base on our satellite would allow medium and long-term crewed to the Moon, overcoming the absence of an atmosphere, reduced gravity conditions, micrometeoroid impacts, high thermal differential, GCR radiation and solar flares. The possibility of building a lunar settlement is currently under study by NASA Artemis Program and others active subjects in the aerospace sector.

The purpose of this research is the design of an architectural concept, a Class II lunar habitat, to allow a mission of four astronauts for 180 days at the South Pole of the Moon.

Following the current space architecture concepts and technological lunar trends, this study investigates an easily compactable, transportable and deployable habitat system. By studying its behavior through different multi-physics simulations, this project presents a unique solution that combines In Situ Resources Utilization and technology with high TRL level technology from Earth, generating an innovative design. Since this project is focusing on medium and long term missions, in which food provisions would require significant number of resupply flights, a study has been developed in order provide the crew with continuous access to fresh products, specifically crops with high water content.

Therefore, the habitat concept has been integrated with an hydroponic greenhouse system, a strategic element for a sustainable lunar settlement. This study identified different plants suitable for this harsh environment that could grow inside a hydroponic greenhouse, to guarantee the supply of 50% of the daily astronauts' nutritional requirements.The work translates into a habitat system consisting of two interconnected environments, the living area and the greenhouse area. A sequence of separated floors according to the destination of use is concentrated in the central core of the habitat, while the surrounding external area is dedicated to the greenhouse system. The overall architecture is enclosed by an inflatable membrane and further protected by a lunar regolith shield. The deployable frame guarantees a modular expansion of the internal system.