Paper ID: 83712
oral

35th IAA SYMPOSIUM ON SPACE AND SOCIETY (E5)
Interactive Presentations - 35th IAA SYMPOSIUM ON SPACE AND SOCIETY (IP)

Author: Dr. Zhelun Zhu
Xi'an Jiaotong - Liverpool University, China

Dr. Jingyang Liu
Xi'an Jiaotong - Liverpool University, China
Dr. Liu Yang
Tsinghua University, China

HOUSE – HABITATIONS ORGANISATION FOR HUMAN SETTLEMENT IN EXTRATERRESTRIAL ENVIRONMENT. AN AUTOMISED AND PERFORMANCE DRIVEN FRAMEWORK OF MODULAR UNITS LAYOUT GENERATION.

Abstract

Establishing permanent settlements in some astronomical bodies are raising increasing interest. During this process, one of the main challenges is to provide survival and living conditions in hostile environments where intervention and supplies from the Earth are highly complicated (Whitmore et al., 2013). In particular, it is essential the automation of the design and construction processes since prompt design solutions that meet the needs of unexpected situations are vital in unknown scenarios. For instance, tectonic activities or impact of Micrometeoroids and Orbital Debris (MMOD) could cause new slopes, bringing site variation and compromising the settlement normal activities (Kalapodis et al., 2020). This issue requires an expeditious response in adjusting the settlement's configuration to retrieve its functionalities, ensuring the mission's success and inhabitants' safety. The present research investigates an automatic design framework for a hypothetic extraterrestrial planetary settlement. It proposes an interactive design process for settlement's layout generation and relies on modular units realised with promising building techniques announced by Space agencies, using inflatable and preintegrated modules integrated with in-situ resources and 3D-print strategies. The resulting challenge consists of the settlement's organisation considering its functional relationships – which means reasonably distributing functions among the settlement – and pondering the path/distance between some vertices. On the other hand, the layout organisation depends on many aspects of its site, like its geometrical information and the presence of water or other resources. These data may be subjected to variations and therefore represent dynamical input to the framework, integrated in the framework by in orbit satellites monitoring by means of Neural Radiance Field strategy. These considerations bring to the need of an automatized and knowledge-based design process, where the crucial information can be integrated, leading to design outcomes with proper performances. The research of (near) optimal configuration will be achieved by the digitalisation of adjacent matrix and automated by the application of metaheuristic algorithm.

Connors, M. M., Harrison, A. A., Akins, F. R. (1985). LIVING ALOFT, Human Requirements for Extended Spaceflight. NASA. https://ntrs.nasa.gov/citations/19850024459

Kalapodis, N., Kampas, G., Ktenidou, O. J. (2020). A review towards the design of extraterrestrial structures: From regolith to human outposts. Acta Astronautica, 175(May), 540–569.

Whitmore, M., Mcguire, K., Margerum, S., Lockheed, M., Thompson, S., Allen, C., Bowen, C., Adelstein, B., Wong, D. (2013). Evidence Report: Risk of Incompatible Vehicle/Habitat Design Human Research Program Space Human Factors and Habitability Element.