01.SELF-REPAIRING LUNAR HABITAT

LOCATION

Conceptual Project

KEYWORDS

Biobased Materials, Robotic Fabrication, Modular Construction

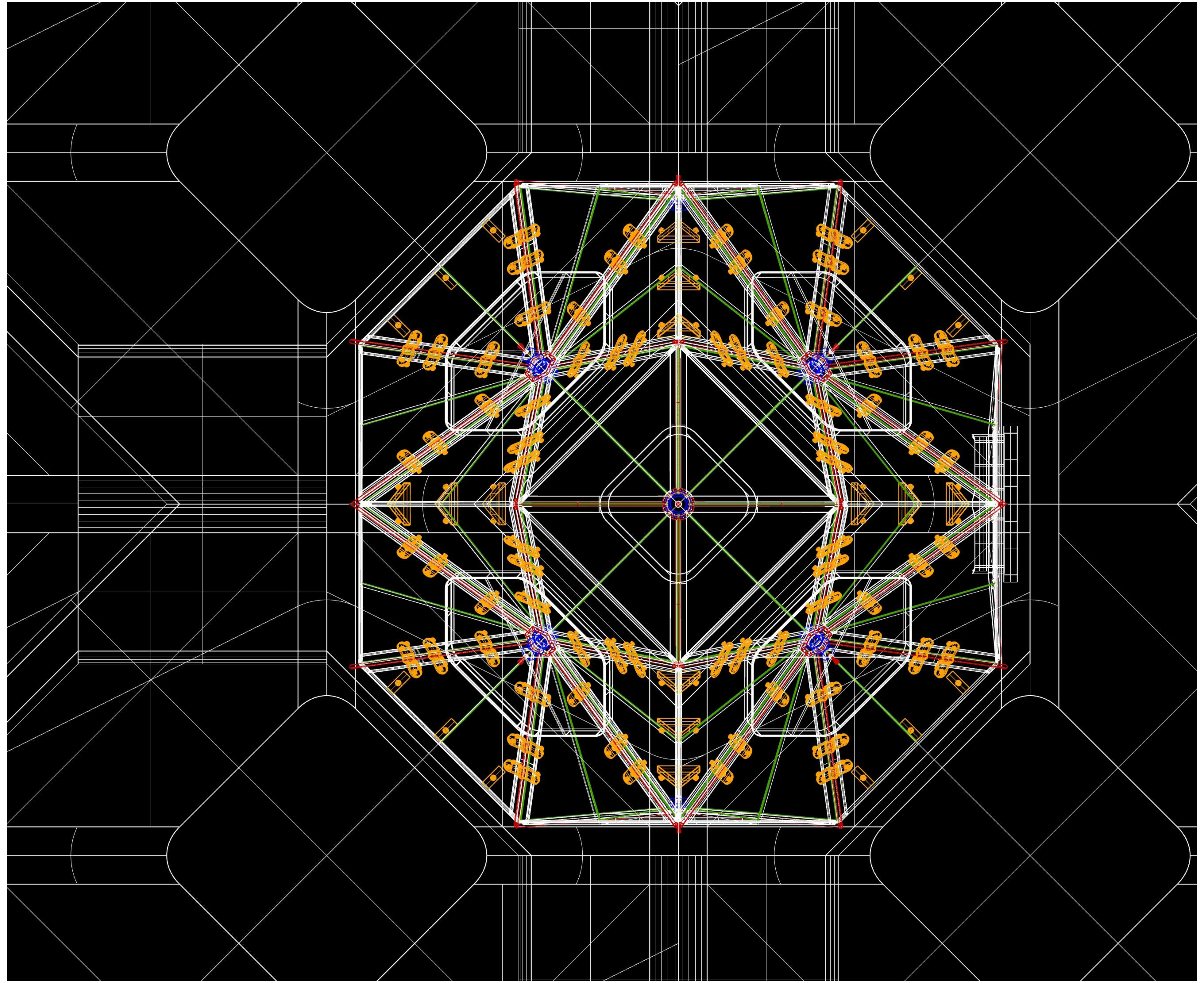
INVOLVEMENT

Individual Work

ABOUT

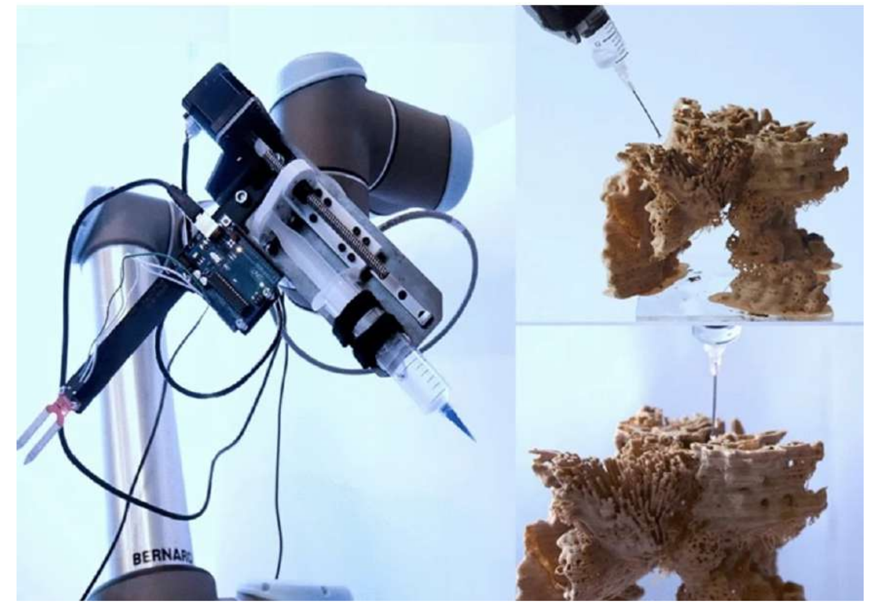
Mycelium-Based Adaptive Architecture.

With the increasing interest in long-term lunar missions, building sustainable, lightweight, and self-sufficient habitats on the Moon has become a critical architectural challenge. This speculative project proposes a modular habitat system using mycelium—a living material capable of growth, sensing, and repair—combined with autonomous robotic construction and material intelligence. Before crew arrival, robots deploy the structure and cultivate fungal growth on the inner shell. The mycelium acts as a self-monitoring layer: damage alters its electrical signals, detected by graphene nanosensors, triggering robotic self-repair.



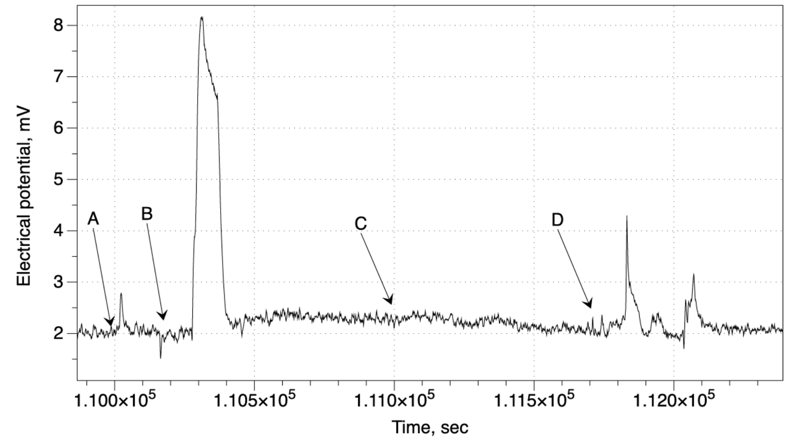
Background

[Computational and robotically fabricated lattice systems enhancing mycelia growth]. Reprinted from Alima, Snooks, & McCormack (2022), Bio Scaffolds: The orchestration of biological growth through robotic intervention, International Journal of Intelligent Robotics and Applications, 6(3), 522–529. https://doi.org/10.1007/s41315-021-00218-8.



[Robotic infusion of liquified Mycelia culture intro biodegradable scaffolds]. Reprinted from Alima, Snooks, & McCormack (2022), Bio Scaffolds: The orchestration of biological growth through robotic intervention, International Journal of Intelligent Robotics and Applications, 6(3), 522–529. https://doi.org/10.1007/s41315-021-00218-8.

In an experiment by Alima and colleagues, Bio Scaffolds, the focus is placed on the development of a dynamic interspecies feedback system. In this study, a robot equipped with humidity and color sensors monitors the growth of the fungi in real time. When it detects that the mycelium is drying out or not growing sufficiently, the robot autonomously injects nutrient solution to maintain its vitality and encourage further growth. This dynamic coordination process can last for several months—or even years—depending on the growth cycle of the mycelium.

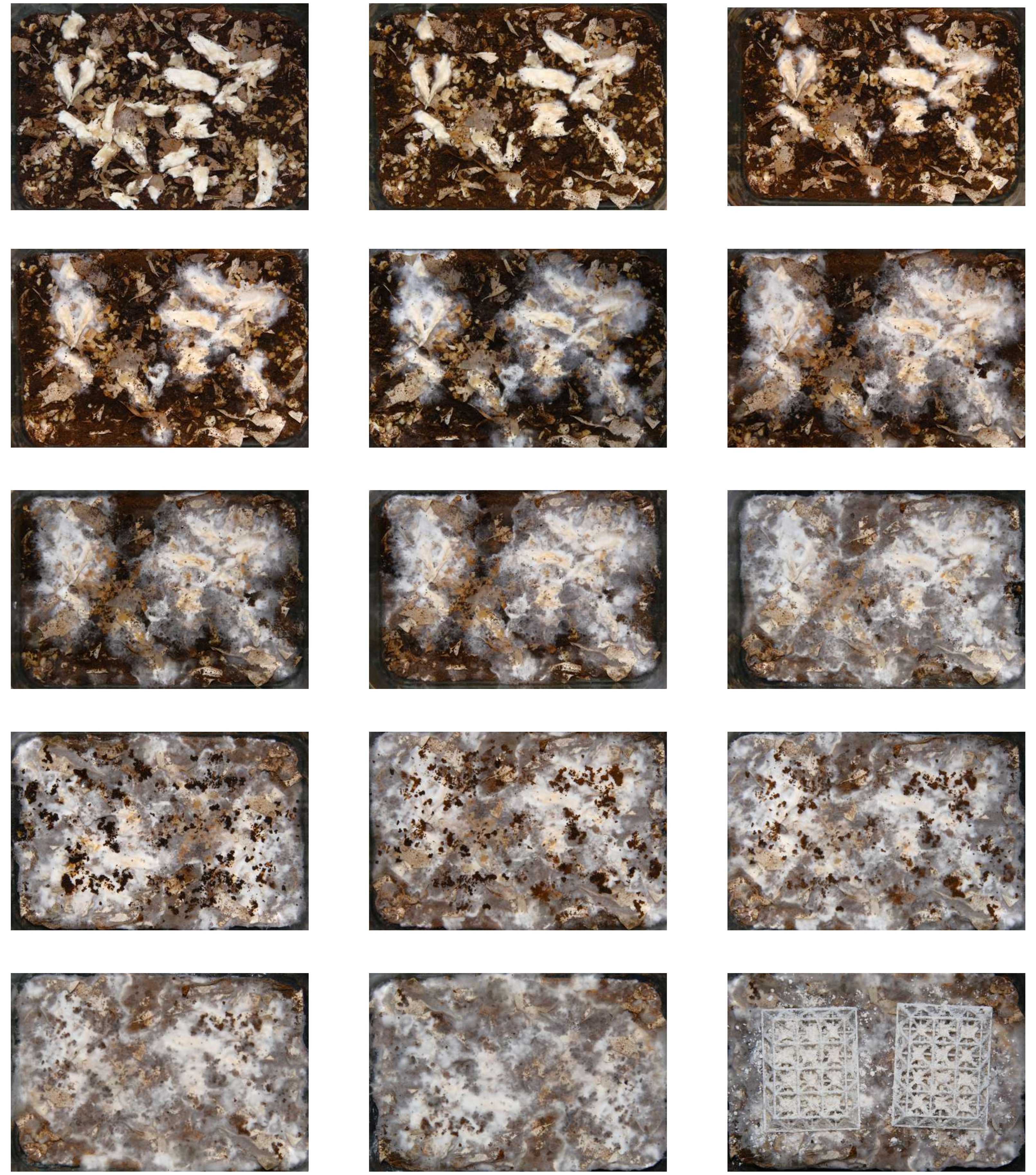


Reprinted from: Zhu, J., Sun, J., Li, H., Xu, P., Ma, L., Wang, Q., Chen, K., & Qu, S. (2025). Underlying the early signaling and gene expression of Pleurotus ostreatus mycelia during injury response. World Journal of Microbiology and Biotechnology, 41(3), Article 80. https://doi.org/10.1007/s11274-025-04296-9

The study "Underlying the early signaling and gene expression of Pleurotus ostreatus mycelia during injury response " (Zhu J et al., 2025) applied different stimuli to Pleurotus ostreatus, including arrow labelled (A), water(B), polydimethylsiloxane(PDMS) (C), and thermal stimulation with open flame for 5 seconds (D). All stimuli—except for PDMS—induced varying degrees of change in the amplitude of the fungal electrical pulses, with distinct response times observed for each.

If the robotic systems can be employed in space architecture to autonomously monitor and manage the growth and repair of mycelium-based structures, it would greatly enhancing efficiency and reducing maintenance. They could begin constructing habitat frameworks even before human arrival, enabling immediate occupancy and avoiding exposure to harsh conditions. This approach also conserves vital resources like oxygen, water, and human labor. After arrival, robots could continue expanding modules by directing mycelium growth within set frameworks—without human intervention.

Mycelium Growth Experiment



DAY 0-14

To explore the growth rate and climbing behavior of mycelium on a support structure, an ongoing experiment was initiated. The substrate—composed of shredded filter paper, spent coffee grounds, and oats—was inoculated with Pleurotus eryngii (King Oyster mushroom) fruiting body tissue. Mycelium will directly convert the substrate into biocomposite materials by imparting strength and cohesion to agricultural particles. Through the binding action of the mycelium, the substrate is consolidated into a dense mass, thereby forming a mycelium-based composite material.

By Day 2, visible mycelial growth had emerged. Over the following days, the mycelium progressively spread, gradually covering the substrate. By Day 13, it had fully colonized the surface, penetrated the bottom and side layers, and bound the entire substrate into a compact, cohesive mass.

On Day 14, a structural frame dusted with oat flour was placed on top of the colonized substrate to initiate the next phase: observing the form and speed of mycelium climbing onto the support. The experiment is still in progress, and final results are yet to be determined.