

## Self-Evolving AI Robot System for Lunar Exploration and Human Outpost Construction

### Project manager

## Kazuya Yoshida

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### leader's institution

Tohoku University

### R&D institutions

Osaka Institute of Technology

Tohoku University

Kyoto University

### Summary of the project

We develop a self-evolving AI robot system for lunar exploration and human outpost construction. The key technologies are:

1. The design of modular and reconfigurable robots.
2. Plug-and-play AI-based robot motion controllers.
3. Self-repairing capability using in-situ materials, such as lunar surface regolith.

These will facilitate exploration and resource utilization on the Moon by 2050 to realize a sustainable manned activity base.

In addition, developed technologies can be applicable to the earth such as natural disasters and etc.



Image of a lunar base with AI robots in 2050

### Milestone by year 2030

We develop a group of heterogenous AI robots with reconfigurable, self-repairing, and regenerative capabilities that adapt to harsh environments and changing mission tasks. The technologies are demonstrated in space-flight missions so that

they should be ready for actual activities on the Moon.

### Milestone by year 2025

We develop critical technologies for modular robots that can be assembled and reconfigured by themselves or by other robots. The robot modules are optimized to accomplish the mission tasks by selecting appropriate configurations and AI controllers depending on the environment. The function of the robots are demonstrated in a terrestrial lunar analog site.

### R&D theme structure of the project

#### Self-Evolving AI Robot System for Lunar Exploration and Human Outpost Construction

#### R&D Item 1: Modular Multi-Agent Robot Systems

(PI: Prof. Fumitoshi Matsuno at Osaka Inst. of Tech.

Prof. Kazuya Yoshida at Tohoku University)

1. Design, fabrication, and functional analysis of modular robots
2. Control of exploration and assembly tasks by multiple robots with different structures
3. Space demonstration of exploration and assembly tasks

#### R&D Item 2: Distributed, Plug and Play AI

(PI: Prof. Jun Morimoto at Kyoto University)

1. Implementation of Distributed AI system with Hierarchical Reinforcement Learning
2. Implementation of a Plug and Play AI system

#### R&D Item 3: Self-Repairable/Reproducible Hardware

(PI: Prof. Akihiko Chiba at Tohoku University)

1. On-demand robotic modeling method using powder materials
2. Development of 3D modeling method using lunar sand