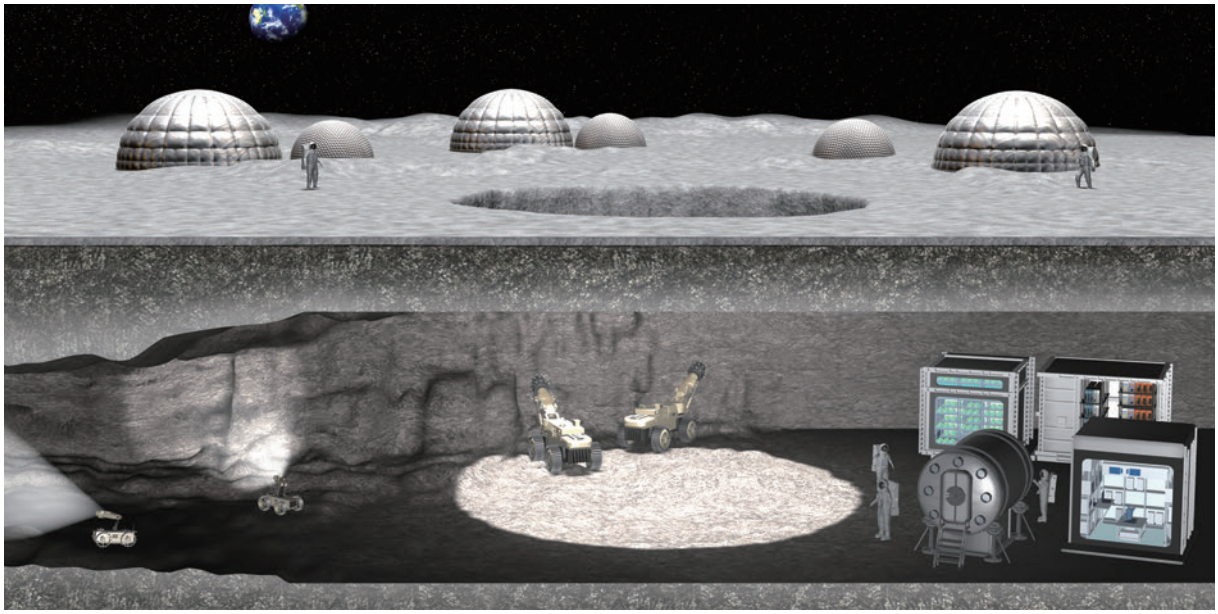
Space Development Vision
HAZAMA ANDO CORPORATION

Hazama Ando is applying its construction expertise to future lunar exploration, driven by growing opportunities through NASA's Artemis Program and JAXA's Moon to Mars Innovation.

Building Safe and Secure Environments in the Lunar Geofront.

Lunar Geofront Concept

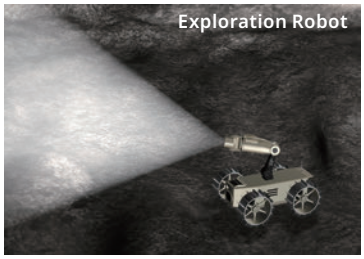
An integrated approach to exploring, constructing, and maintaining lunar underground spaces.



STEP 1 Exploration

Autonomy in Unknown Environments

- Enable continuous exploration of unknown environments with enhanced adaptability.
- Measure lava tube geometry and rock properties using autonomous, obstacle-surmounting robots.
- Assess structural stability and identify optimal locations for subsurface development.

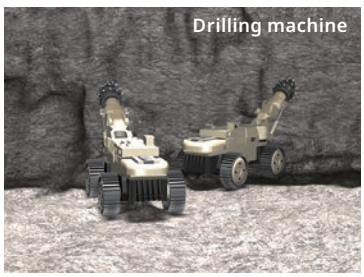


Robot that acquires subsurface data.

STEP 2 Construction

Shaping and Reinforcement Methods

- Apply terrestrial tunneling technologies to excavate and shape lunar underground spaces.
- Reinforce rock masses based on geological conditions to reduce collapse risk.
- Ensure structural stability and airtightness for human habitation.
- Maintain functionality under harsh lunar environmental conditions.
- Adapt geometry and scale to specific applications.

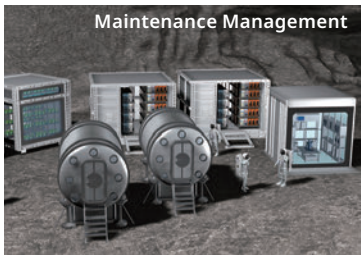


Method for Excavating.

STEP 3 Maintenance Management

Anomaly Prediction and Detection Methods

- Continuously monitor environmental and structural changes.
- Detect early signs of collapse, leakage, and other anomalies.
- Maintain functionality under harsh lunar environmental conditions.
- Ensure long-term safety through rapid response.
- Provide a safe and reliable environment for habitation, research, and storage.



Monitoring to detect early signs of abnormalities.

Lunar Lava Tube Stability Assessment

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Joint Research with Kyushu Univ.

Challenges Addressed

- Limited quantitative methods for assessing lunar lava tube stability.
- Uncertainty in low-gravity effects and rock mass variability.
- Lack of design guidelines for lunar subsurface infrastructure.

Overview

This study develops a stability assessment framework for safe and cost-effective utilization of lunar lava tubes.

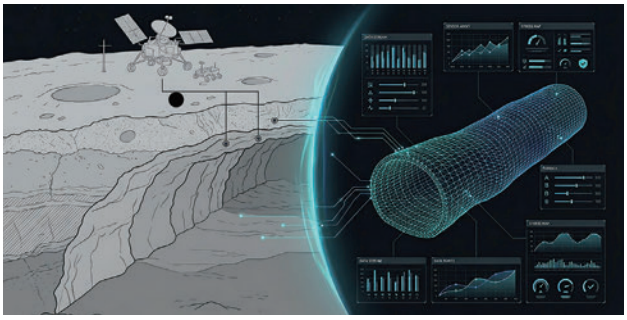
- Lava tube and rock mass modeling.
- Evaluation of low-gravity effects and rock massheterogeneity.
- Analysis of lunar exploration and analog data.
- Development of collapse criteria and safety factors.

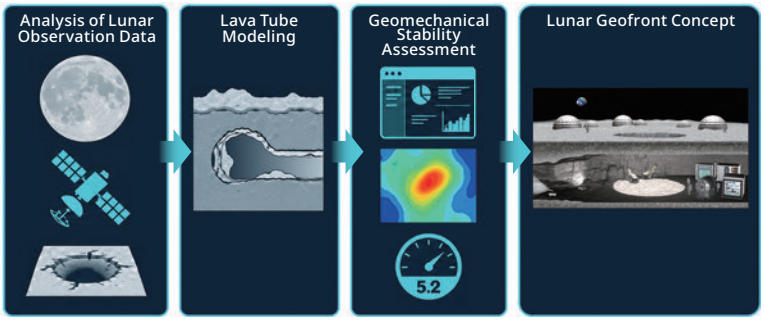
Future Work

- Improve assessment accuracy through expanded case studies.
- Develop a framework addressing lunar environmental uncertainties.
- Integrate knowledge from related fields through interdisciplinary collaboration.
- Investigate applications to lunar facility design and construction.

Expected Outcomes

- Systematic stability assessment and design guidelines.
- A common framework for risk assessment and decision-making.
- Technical guidelines for lunar facility design, construction, and utilization.





Self-Localization for Robotic Exploration in Lunar Environments

Challenges Addressed

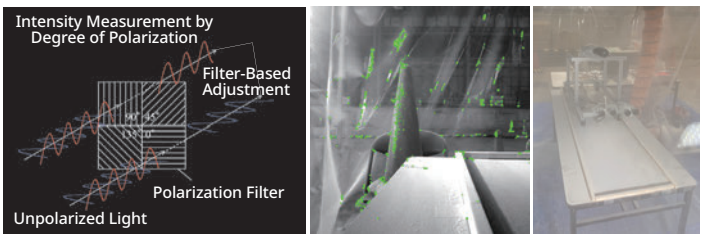
Autonomous lunar exploration requires robust self-localization under challenging environmental conditions :

- **No GNSS : No Earth-like positioning infrastructure.**
- **Regolith Dust : Dust can degrade visibility and sensing performance.**
- **Extreme Darkness : Lunar nights and permanently shadowed regions restrict optical sensing.**

Current Progress

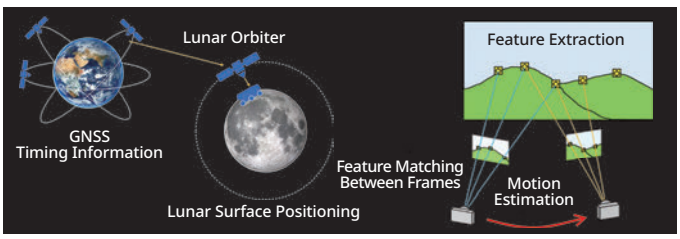
Polarization

Continuous image acquisition using polarization and optical cameras under varying dust concentrations in a 10m³ indoor test environment.



Infrared

A mobile robot equipped with three infrared cameras navigated 1.1km outdoors at night, achieving an average localization error of 0.132m, evaluated against GNSS-based ground truth.



Future Work

- Improve localization robustness through advanced polarization image analysis.
- Develop a prototype lunar rover integrating sensing and mobility technologies.
- Conduct field demonstrations in lava tubes and lunar analog terrains.

Expected Outcomes

- Autonomous lunar rover for diverse missions.
- Integrated sensing system combining cameras, LiDAR, and mission-specific sensors.
- Mobility system adapted to lunar environments.

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