

Technical Demonstration Enhancement for “Robotics in Space” utilizing KIBO



**NASA-JAXA Joint Workshop
2019/02/14**

**Shinobu DOI/JAXA
JEM External Systems and Robotics
JEM Mission Operation and Integration Center**

JAXA's Vision in Robotics View Point

Expansion of Economic Activities on LEO (2020s~)

Technical
Demonstration

International Space Station

Cutting Edge
Robotics Technology
on the ground

*Applying Robotics, Automation
and Autonomization Technology,
Make Manned Space Activities*

- *Efficiently and Effectively*
- *Safely*

Feedback to the ground

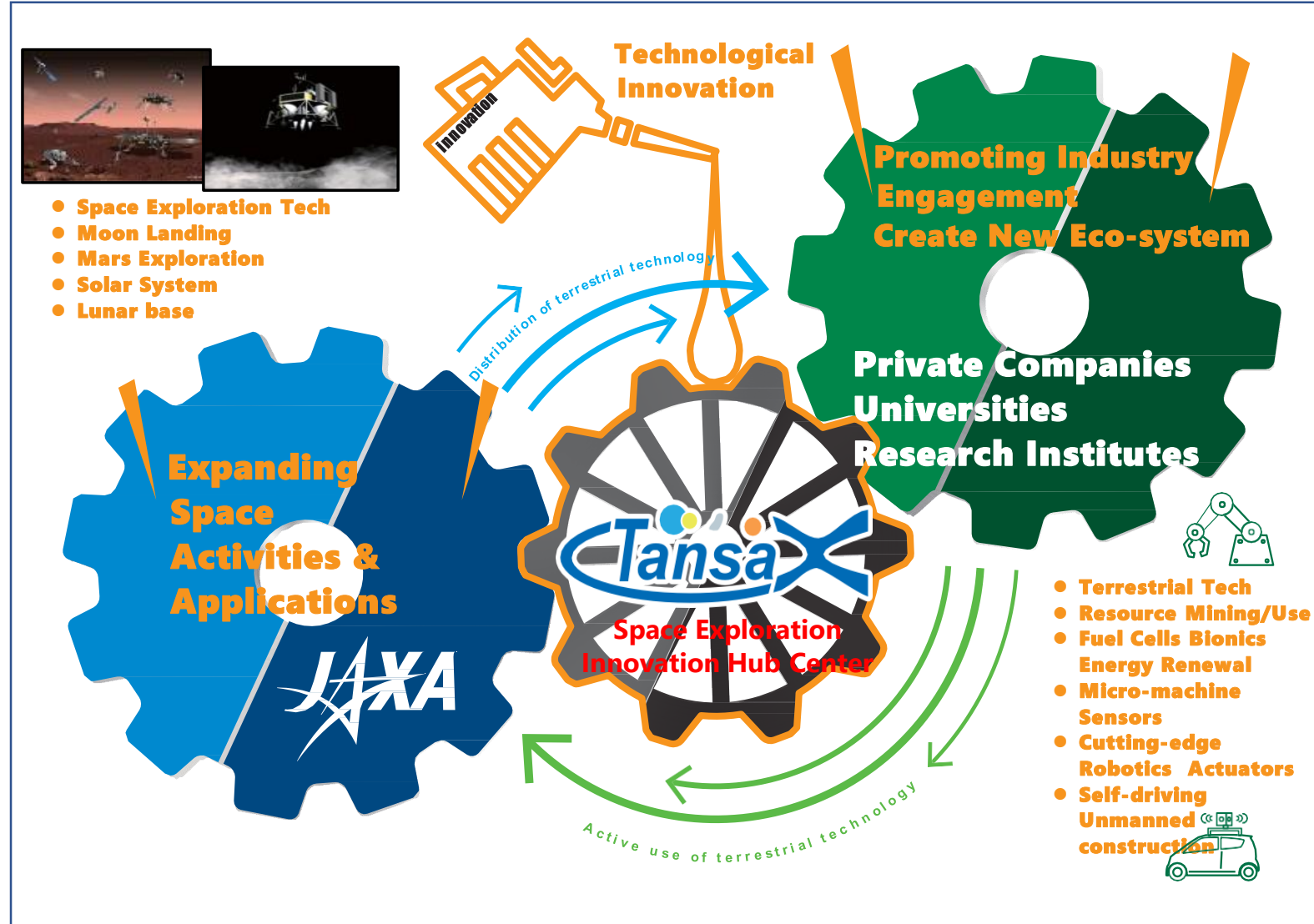
Expansion of Human Activities
Lunar Orbit (Gateway) (2020s~)
Lunar Surface (2030s~)



Joint Work with Space Exploration Innovation Hub Center



- Based on the Japanese government strategy issued in 2014, the public research institutions and agencies are expected to work as a bridge between the technological “seeds” and “needs” to create innovation.
- Per this strategy, JAXA was re-organized in April 2015 and the Space Exploration Innovation Hub Center was established in Sagami-hara Campus.
- Since then, 86 companies and 40 universities or research institutes have joined in the collaborative researches with JAXA.
- Recently one new theme, “Robotics for future manned space activities” was added for this hub research project.



Key areas for “Robotics for Manned Space Activities”

Localization and Mobility

- SLAM in closed and configurable environment
- Mobility in microgravity or low gravity
- Wireless Power Transmission

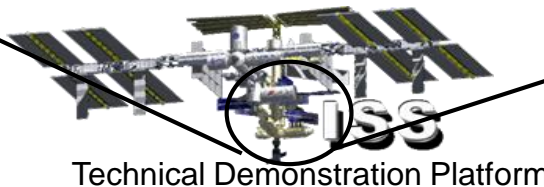
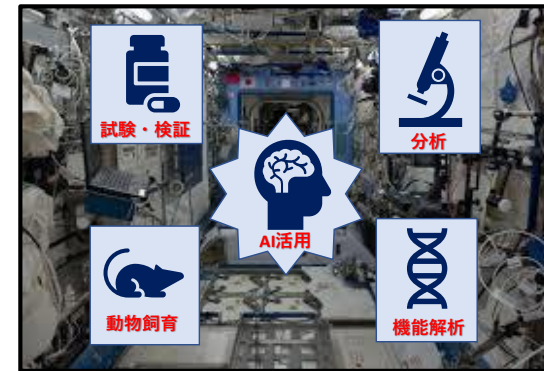


Equipment Automation/Autonomization

- Automation/Autonomization of equipment
- Less or no interaction with astronaut and/or IVA robot

Manipulation

- For combined task (Ex. Pull and turn)
- For soft item handling
- Dual arms
- Force feedback
- Haptics
- Multi-DOF, compact, and powerful hand



NASA's Relay Satellites

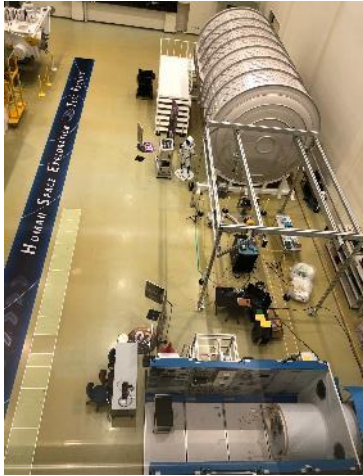
Significant
Communication Delay

Robot operation under latency

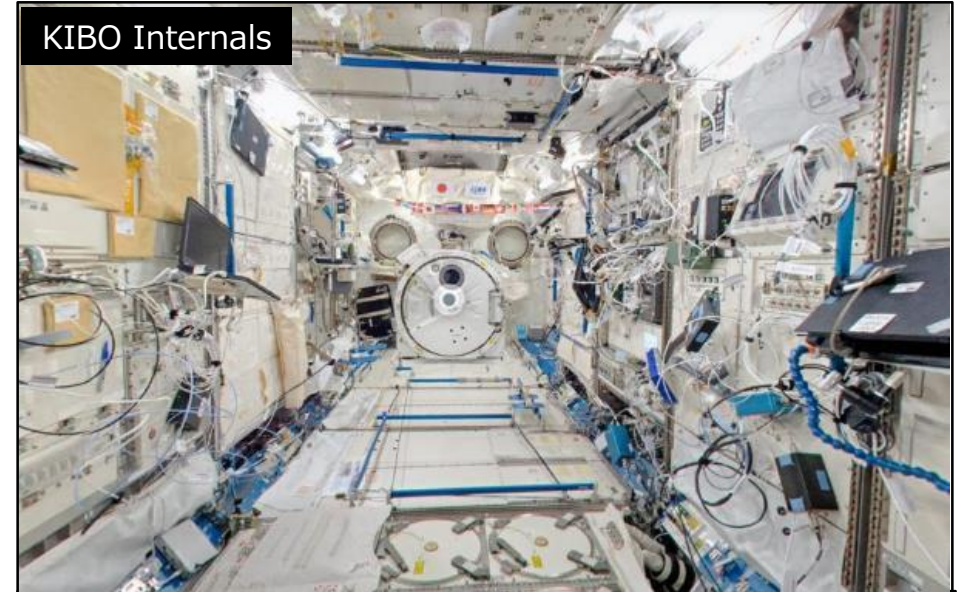
- Autonomization (Deep learning technology) in several seconds delay



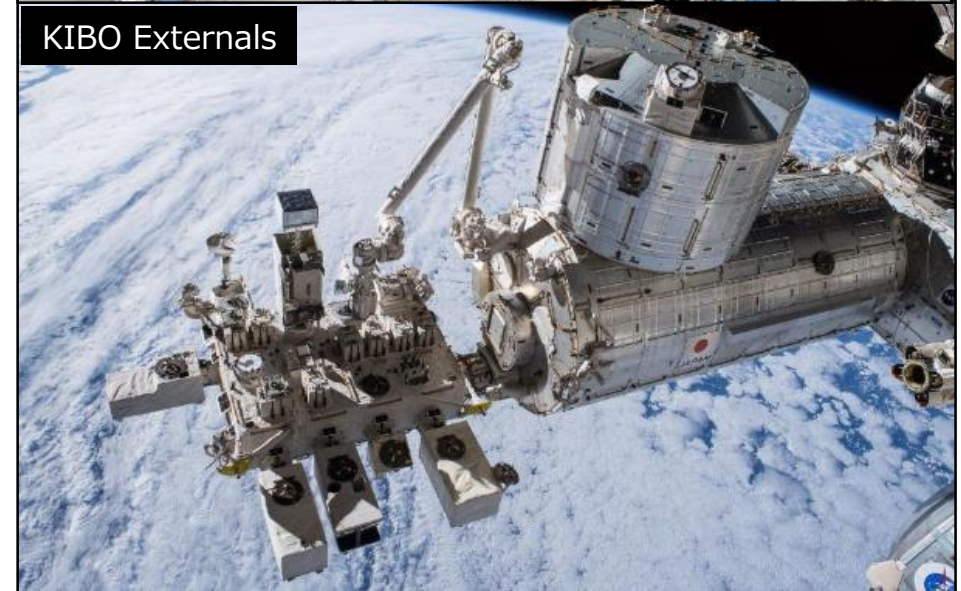
“KIBO” as Technical Demonstration Platform for Robotics



Intra-Vehicular Robot Test Field @ JAXA Tsukuba Space Center



KIBO Internals



KIBO Externals



Advanced Facility for Space Exploration @ JAXA Sagamiara Campus

Technical Demonstration from “on the ground” to “onboard in ISS”

Internal Robot Camera (Int-Ball)

- The main purpose of the Int-Ball is to reduce the crew time for video shooting onboard and finally to achieve crew time zero.
- The initial flight demonstration onboard in 2016 has been executed and acquired the flight performance data.
- Currently the next generation of the Int-Ball is under development to aim for the “crew time zero for video shooting”.
- Given the nature of this kind of “drone camera” in space, Int-Ball itself can be utilized as follows;
 - Technical demonstration platform
 - Tool for human resource development.



Astrobee/Int-Ball Collaboration for the Asia-Pacific Region under JP-US OP3



JP-US Open Platform Partnership Program (JP-US OP3)

- Increased cooperation with developing spacefaring countries in the Asia-Pacific region, possibly through the utilization of ISS resources.

The First KIBO Robot Programming Challenge by Astrobee/Int-Ball Collaboration in 2020

- ◆ The competition is performed by programming to Astrobee to move around inside KIBO module. Int-Ball serve as a camera robot in the game.
- ◆ Target participant are undergraduate and graduate students from the Asia-Pacific region, the United States, and Japan.

