Inchworm Robot (IN Series)

GITAI

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The GITAI Inchworm Robot is specifically engineered for use in In-Space Servicing, Assembly, and Manufacturing (ISAM). Packed with an array of features, this versatile robot serves as an indispensable tool for executing various tasks in microgravity environments.

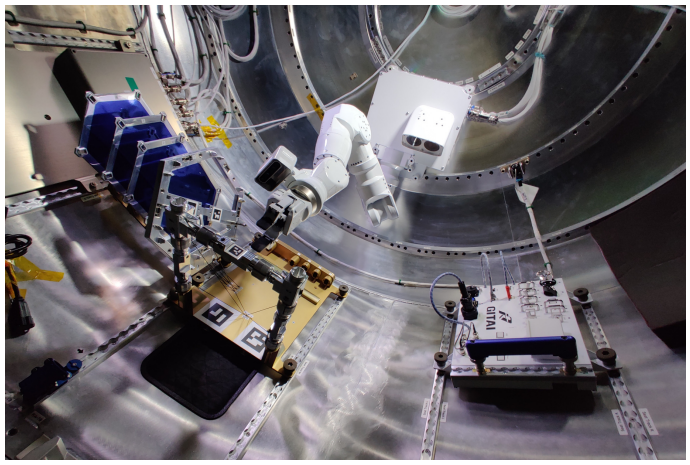
At its core, the Inchworm Robot is a sturdy and reliable solution for maintenance, repairs, and scientific experiments in space. Its unique modular design distinguishes it from other robotic solutions. The robot is equipped with a flexible tool-changing interface, allowing it to support a wide range of tools. By utilizing the Grapple Fixture, the Inchworm Robot can seamlessly move from one location to another.

Overview

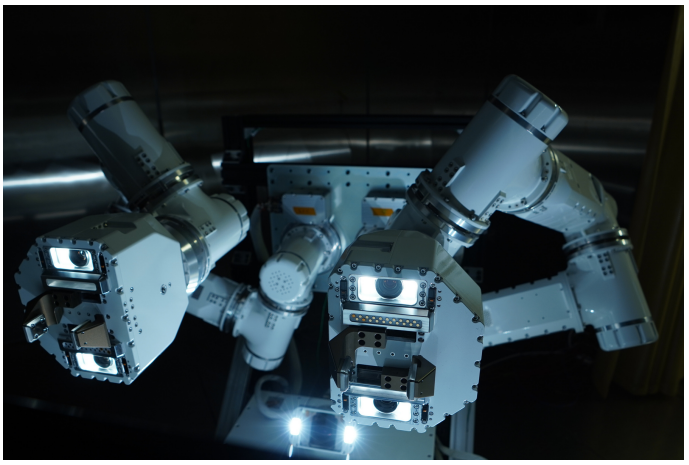
GITAI is a space robotics start up that aims to provide safe and affordable means of labor in space. Given the high cost to maintain a crew in space, or the high development/operational cost for robotic solutions, GITAI has launched a product that is applicable to various business domains to solve this issue. GITAI's "Inchworm Robot", with its high task capability through its autonomous software and customized hardware can fulfill customer's various requirements.

Founded in 2016, GITAI S1 has successfully finished its In Space Assembly and Manufacturing(ISAM) demo inside ISS in 2021, and GITAI S2 is planned to conduct additional tech demos outside ISS in unpressurized environment, achieving TRL7 in both inside and unpressurized environment in space. All the GITAI robotics technology is based on this technology and is achieved by vertically integrated inhouse design. All mechanical, avionics, and software development is made inhouse with the full capabilities of customization, and continuously improved through iterative agile style development.

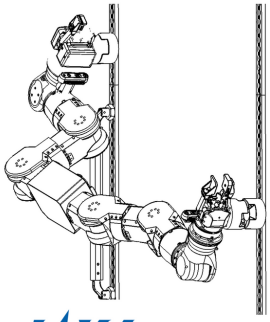
We support providing robotic arms from LEO to Lunar applications and track records include projects with major US aerospace companies, together with projects shown below.



GITAI S1@ISS IVA2021

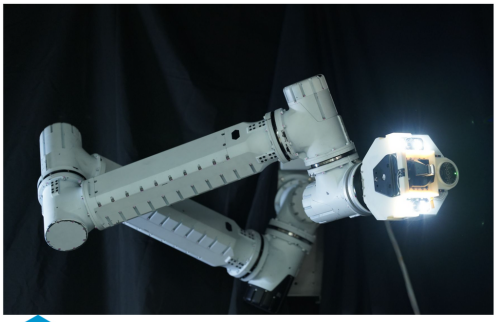


GITAI S2@ISS EVA2023



Guideline for applying Robotics, JAXA(2021)

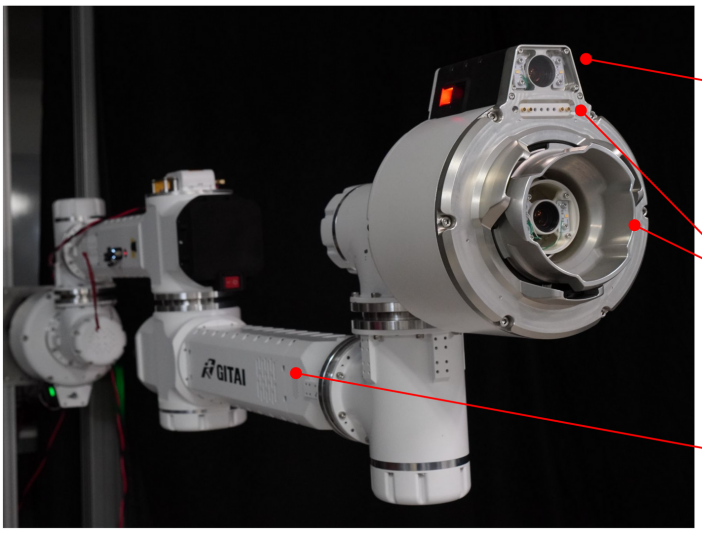
Robotic Arm for Lunar Pressurized Vehicle, TOYOTA(2022-)



Robotic hand and arm for OSAM, METI(2021-2022)

Capabilities

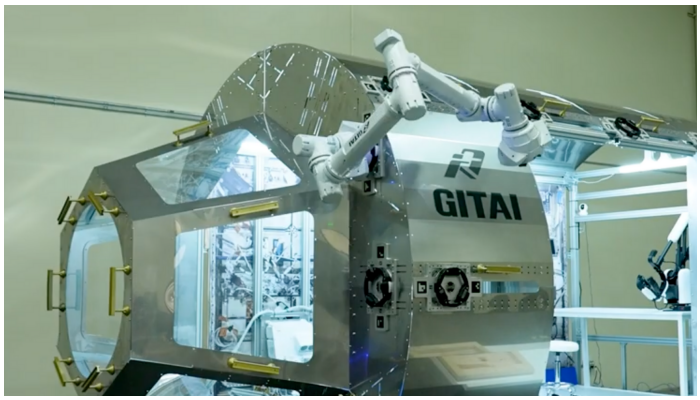
Here are some examples of task capabilities that the Inchworm Robot can support. GITAI will support developing tools/software to achieve customer needs under a 1G environment, as we believe that conducting repetitive experiments is the only way to increase the robustness and fidelity of the system to increase mission success.



Camera/LED for Autonomy:
Enables highly autonomous capabilities through Perception, Motion planning, and Verification

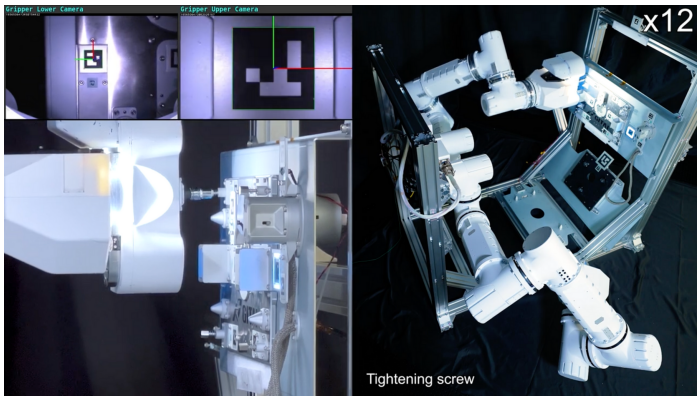
Interface Design to Expand Capability:
Extensive task capability through tool changer transferring Power & Data. The interface on both ends enables moving from one place to another. Payload capability 5.0[kg]

Computer, Batteries:
Stand-alone system continues operation independently.



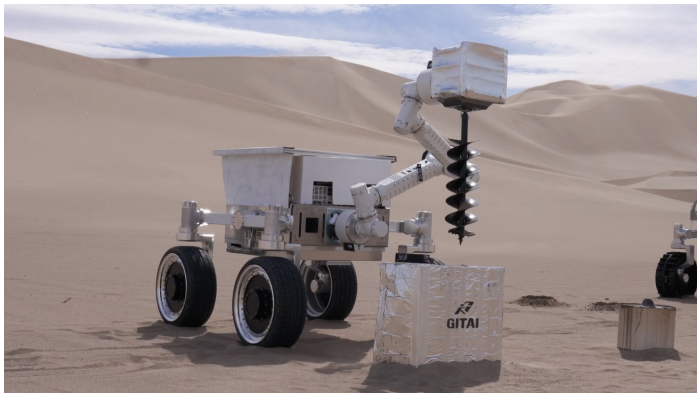
Autonomous walking capability

Video: https://youtu.be/rZr26qsLRqE



Inspections/Maintenance capability: Tightening screws

Video: https://youtu.be/ftK2w2l1dpI



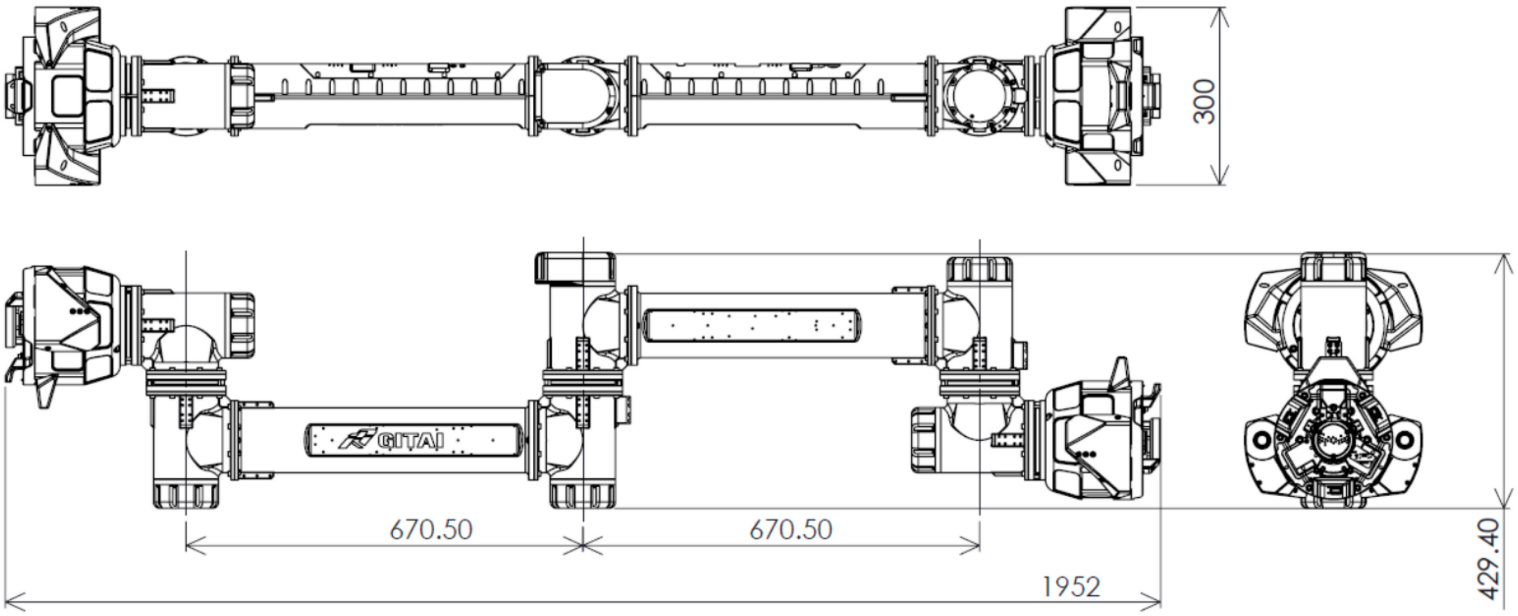
Scientific sampling capability: Drilling lunar surface

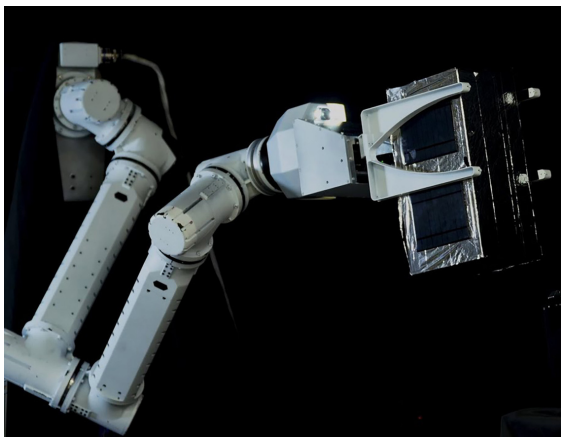
Video: https://youtu.be/4-hEH0dLMhI

In space assembly capability: Welding paneels

Video: https://youtu.be/4-hEH0dLMhI

Specifications





End effector example: Big claw for debris catching

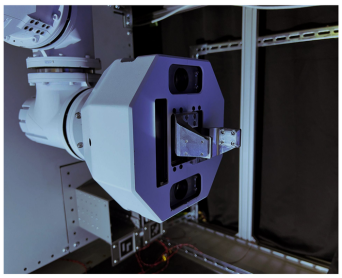
Combine two arms to create an extended, single long arm

	Spec	Unit
Degree of Freedom (End Effector)	7 (2)	
Dimensions	2	m
Weight	50	kg
Drive Power Supply	24-48	Vdc
Power Consumption	60 standby, 200 peak	W
Temperature	-20 to +60	℃
Rated Continuous Joint Torque @ Ta=25℃	368	Nm
Rated Maximum Angular Velocity	32.6 (@ 24V input)64.9 (@ 48V input)	deg/s
Actuation	Brushless DC Motor, Harmonic Drive	
Accuracy	±1.0	mm
Sensors	19bit Absolute Encoder on input/output Motor Current Sensor Temperature sensor on boards/motors, etc	
Internal Communication Bus	EtherCAT	
Options	Redundant avionics, including OBC	

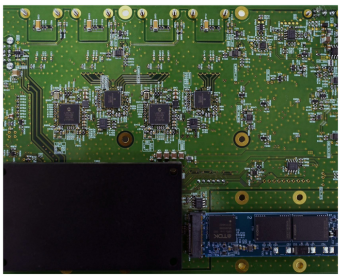
Environmental Spec

GITAI's vertically integrated in-house design key components are fully tested to support customer mission. They are currently at TRL6, and will be proven TRL7 at ISS(unpressurized) in 2023.

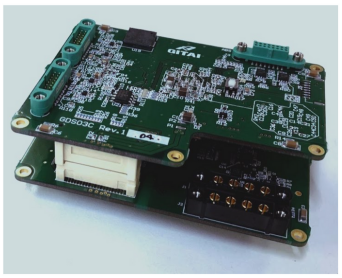
ACTUATOR



TOOL CHANGER

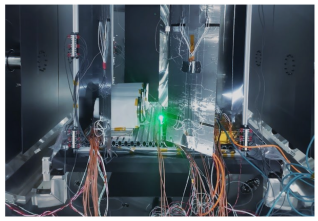


REDUNDANT OBC



MOTOR CONTROLLER

THERMAL VACUUM TESTING



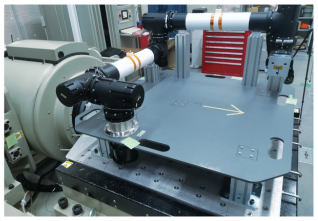
PRESSURE:
7.5x10^{-9}Torr[10^{-6}Pa]

TEMPERATURE:
-40 to 167°F [-40 to 75°C]

THERMAL VACUUM TESTING

TEMPERATURE:
-60 to +90[°C]

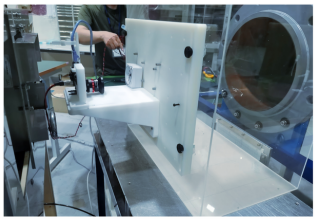
RANDOM VIBRATION TESTING



20 to 2000 [Hz]

OVERALL:
24.4 [Grms]

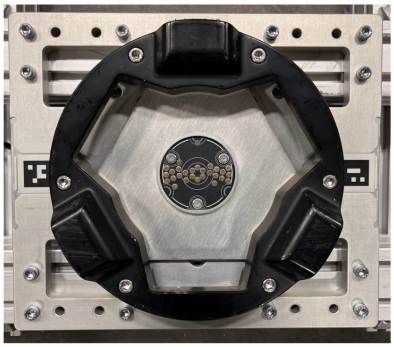
RADIATION TEST (SEE)

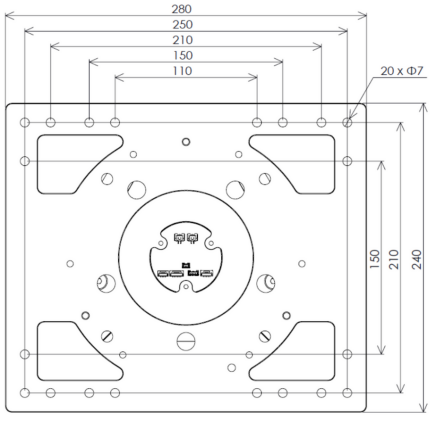


70 MeV
1×10^{11} p/cm^2 (min)

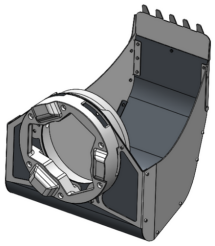
Interface Design

GRAPPLE FIXTURE





TOOL CHANGER



BACK HOE

TIPPING TOOL

GEOLOGICAL SURVEY TOOL

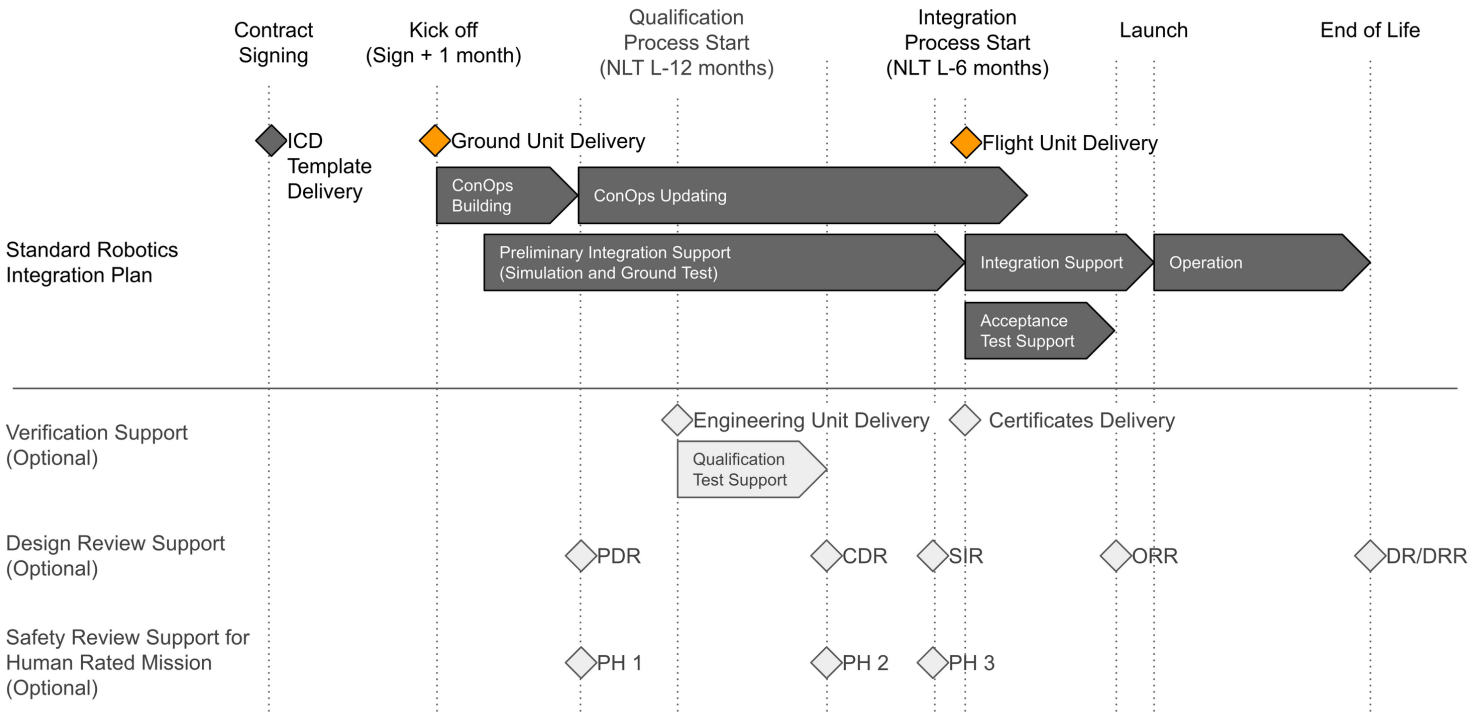
	Electrical Interface
①	USB communication
②	Reserve (free to use)
③	Power supply (12V, 1.5A)
④	Ethernet
⑤	PWM (ex: used for LED)

The Inchworm Robot supports various types of tools through the tool-changing interface. By applying Grapple Fixture, Inchworm Robot becomes possible to move from one place to another.

For 3D models, please contact us.

Services/LT

GITAI supports the delivery of the robotic hardware together with software implementation, and integration support. Our support includes experiments using Engineering Model under 1G, to manufacturing of the Flight Model.



Milestone	GITAI Deliverables	Customer Deliverables
Contract Signing Typically Launch - 12 to 24 months	- ICD Template	
Kickoff Signature + 1 month	- Ground Unit	- Customer Platform CAD Model - Preliminary Mission Plan
Qualification Process Start (Optional) No Later Than Launch - 12 months	- Engineering Unit	- Qualification Test Plan
Integration Process Start No Later Than Launch - 6 months	- Flight Unit - Completed ICD - Manufacturing Certificates (Optional)	- Integration Schedule - Mission and Launch Plan - Acceptance Test Plan
Launch	N/A	N/A
Initial Checkout	- Initial Checkout Operation	
Flight Operation	- Flight Operation	

Example of a Standard Project Processing Schedule