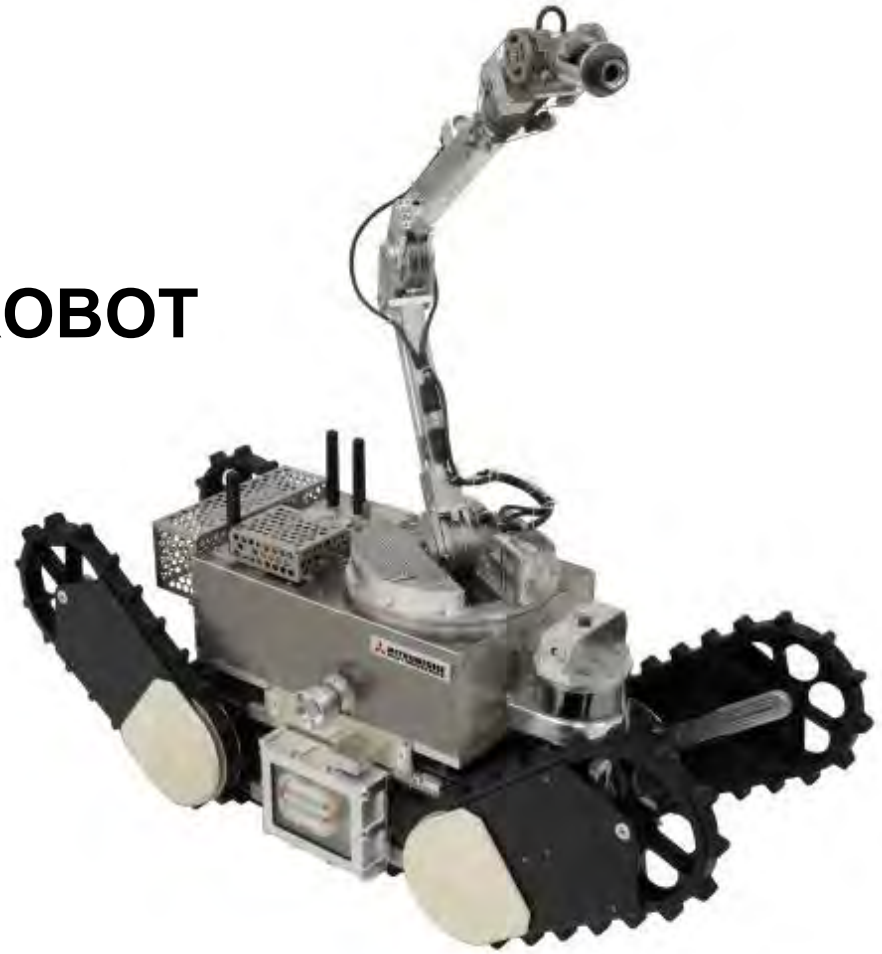
EX ROVR

MHI's Autonomous, Stair Climbing, Explosion-Proof Plant Inspection Robot



SPRINT ROBOTICS

World Conference for Inspection and Maintenance Robotics 2019

Mitsubishi Heavy Industries, LTD

Yuta Emura

October 23, 2019

MITSUBISHI HEAVY INDUSTRIES

MHI company profile – Snapshot of MHI group

Revenue	**34** billion Euro
Number of Employees	**80,744**
Group Companies	Domestic **74** Overseas **162**
Research and Development Expenses	**1.5** billion Euro
Number of Patents Held in Japan and Overseas	**24,487**

Fiscal Year 2018
(as of March 31, 2019)
1 Euro = 120 JPY

Value Proposition

Safer Operation

Removing human operators from potentially dangerous situations

Cost Efficiency

Avoidance of non-value add & highly repetitive tasks which frees human operator for more productive jobs

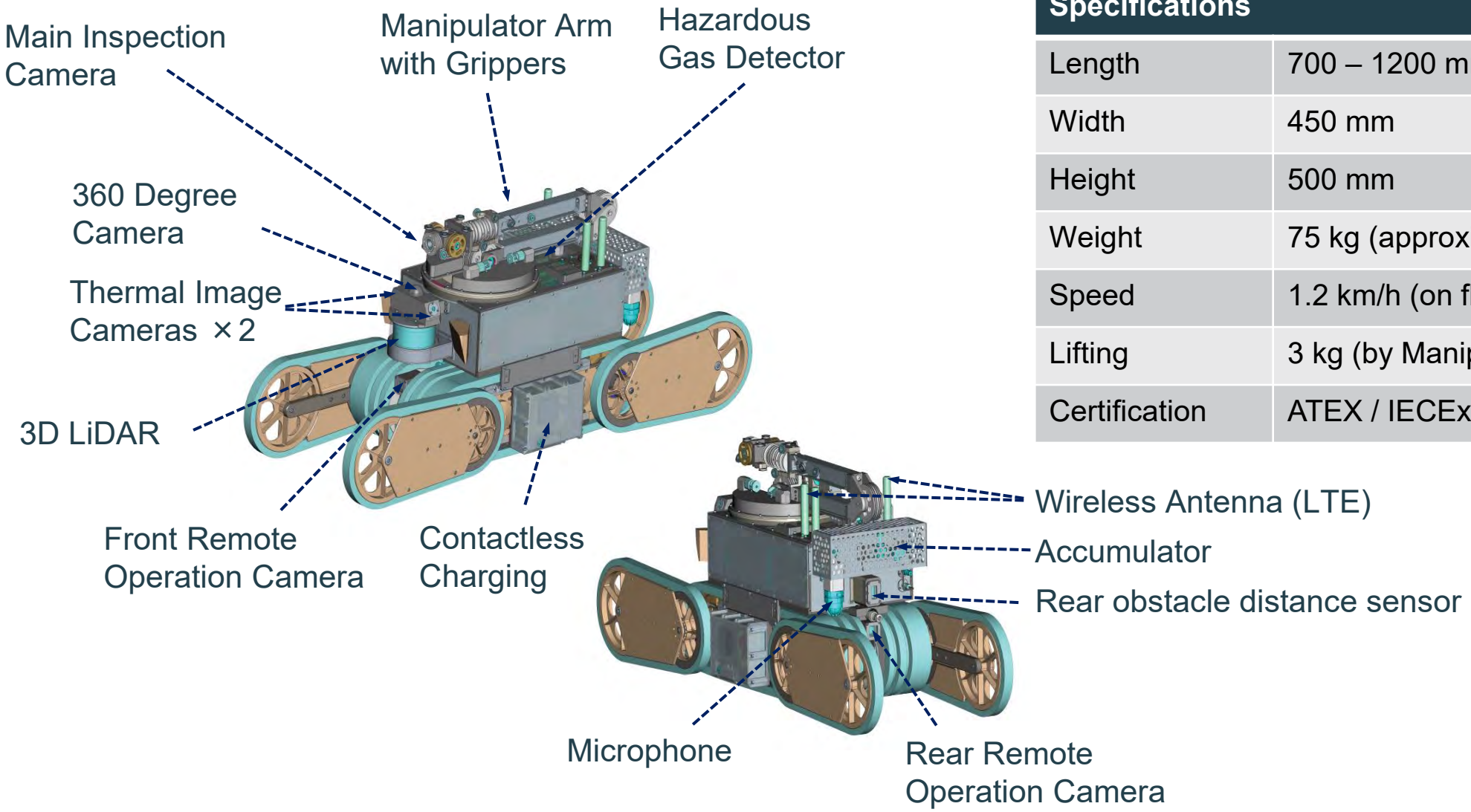
Highly Repeatable & More Frequent Inspections

Preventing unplanned shutdown by more frequent inspection

Enhanced Predictive Maintenance

Digital inspection data analytics; data is fully searchable & trendable (IoT, AI)

Main Specifications



Specifications	
Length	700 – 1200 mm
Width	450 mm
Height	500 mm
Weight	75 kg (approximate)
Speed	1.2 km/h (on flat terrain)
Lifting	3 kg (by Manipulator
Certification	ATEX / IECEx Zone 1 compliant

Key Features Part 1

Advanced Locomotion

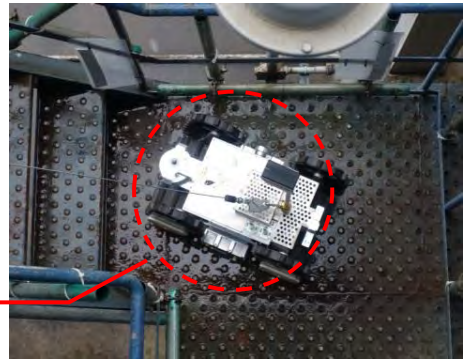
- ✓ Stair Ascent & Descent: -45 to 45°
- ✓ Scale Obstacles: Up to 15 cm tall

- **Covering multiple floors**

Small Footprint

- ✓ Highly Maneuverable: Easily turns a space of 900 mm width

- **Flexible operation**
- **Wider inspection coverage**



Contactless Charging

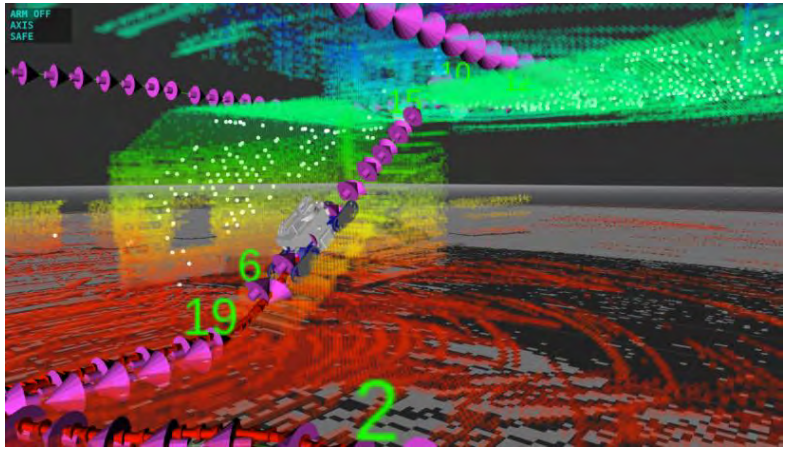
- ✓ 2 hour charging; 2 hour runtime
- ✓ Charging pad is explosion-proof

- **Reliable charging**
- **Flexible operation**

Autonomous Navigation

- ✓ 3D Map Creation: LiDAR
- ✓ Fully Autonomous Travel: Over obstacles and up & down stairs

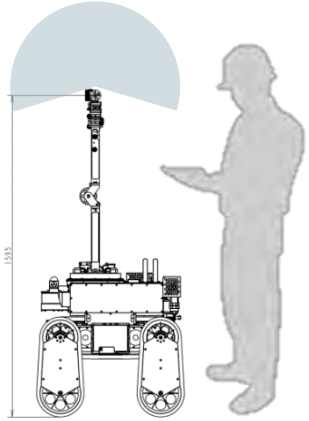
- **Easy to set scenarios**



Manipulator Arm

- ✓ Arm Camera: Enhanced image acquisition through reduced distance & angle
- ✓ Flexible: 6 degrees of freedom
- ✓ Lifting: Can pick up light objects (3 kg)

- **Enhanced data acquisition**



Latest Prototype in Action

4x Speed

Key Milestones

Jul. 2016 — MHI's first explosion proof certified mobile robot

Sakura No.2

Dec. 2018 — PoC at JXTG Nippon Oil & Energy #1

Mar. 2019 — PoC at JXTG Nippon Oil & Energy #2

Future

Oct. 2019 — Chevron on-shore site demo

Dec. 2019 — PoC at JXTG Nippon Oil & Energy #3

Feb. 2020 — PoC at JXTG Nippon Oil & Energy #4

2020 — ATEX/ IECEx Certification

2021～ — **Commercialization**

EX ROVR Preliminary Development Roadmap

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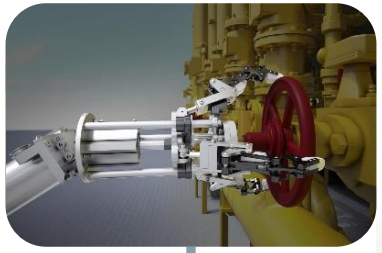
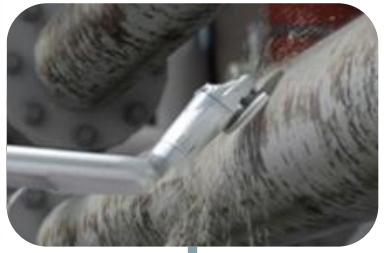
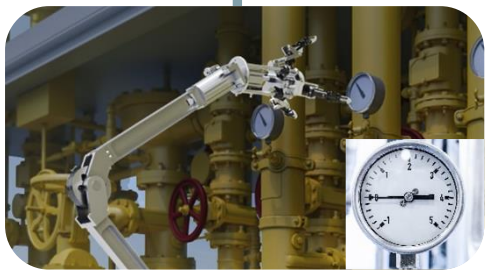
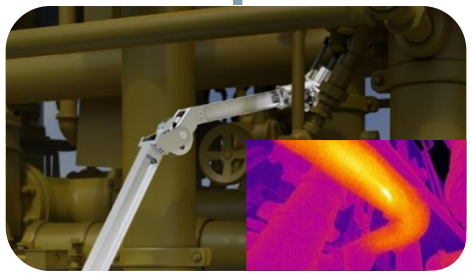
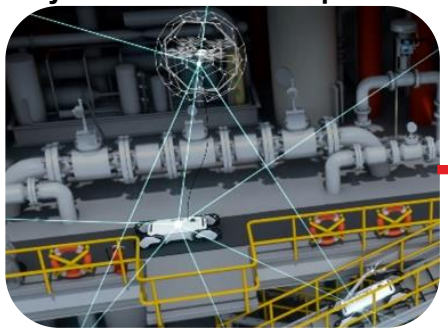
	2019	2020	2023	202X
Generation	1.0	2.0	2.X	Future Concept
Concept	Autonomous Monitoring (Data collection)	Light Manipulation / Advanced Autonomous Monitoring (Anomaly detection, Advanced analytics)	Complex & Autonomous Manipulation / Advanced Autonomous Monitoring (Anomaly detection, Advanced analytics)	Multiple-robot Collaborative Operation / Fully Unmanned Plant Operation
Major Functions	-ATEX/IECEx Zone1 certifiable design -Stair ascension/descension capable crawler system -Automatic navigation on multiple floors -Optical and thermal cameras -Gas and oxygen sensors -Microphone -Contactless charging by resonant inductive coupling -Wi-Fi and 4G-LTE	**In addition to the Gen 1.0 functions:** -ATEX/IECEx Zone1 certified -Manipulator arm -Camera and Gripper hand on manipulator arm	**In addition to the Gen 2.0 functions:** -Thermal camera and sensors on manipulator arm -Vibration sensor -Array microphones -End effector tool changer -5G--Communication	




How To Get Involved

If you would like to take a closer look at EX ROVR, please talk to us during or after the conference. Here are some ways we are working with our customers:

Business Case Study

In depth evaluation of the capabilities, limitations, and potential value EX ROVR could provide to a representative asset of your choice. Includes a detailed site walkdown, in depth operator interview sessions, and full report of potential value.

Field Demonstration / Proof of Concept

Short term deployment of EX ROVR to a representative facility to demonstrate capabilities in short run scenarios. Useful to see EX ROVR in action at your asset and to enhance organizational buy-in.

Pilot Program

Long term deployment of EX ROVR to begin realization of value. EX ROVR will collect and trend data at the asset and the organization can better understand how EX ROVR could fit in with daily inspection routines.

DeepStar Development

Join the project! Work with us to accelerate the development and deployment of future generations of EX ROVR.

MOVE THE WORLD FORWARD

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