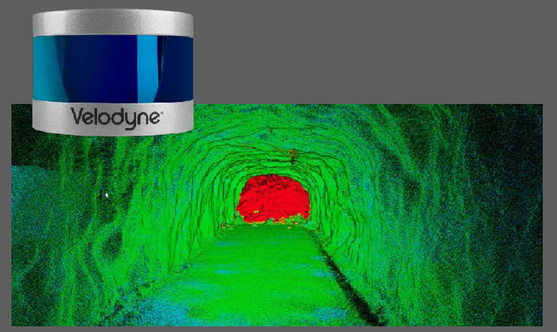
Indoor Navigation Technology

“ We provide location data in any situation. ”

Market Problem

In factories and industrial sites,

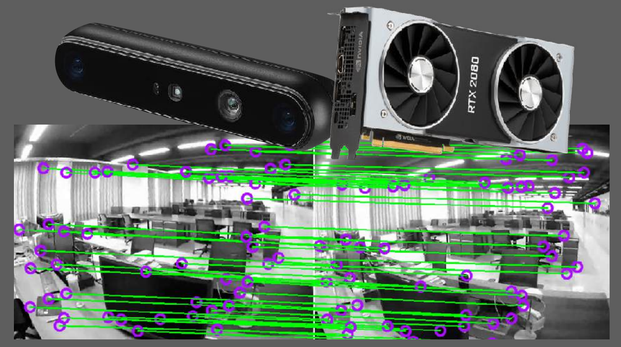
various robots are working in place of humans.



LiDAR requires

Mapping

for autonomous movement



Stereo Vision requires

Deep-Learning

for autonomous movement

However, they **cannot immediately navigate autonomously**

in environments where conditions frequently change

such as **construction sites,**

secure facilities with special purposes, or dark underground spaces.

Market Problem

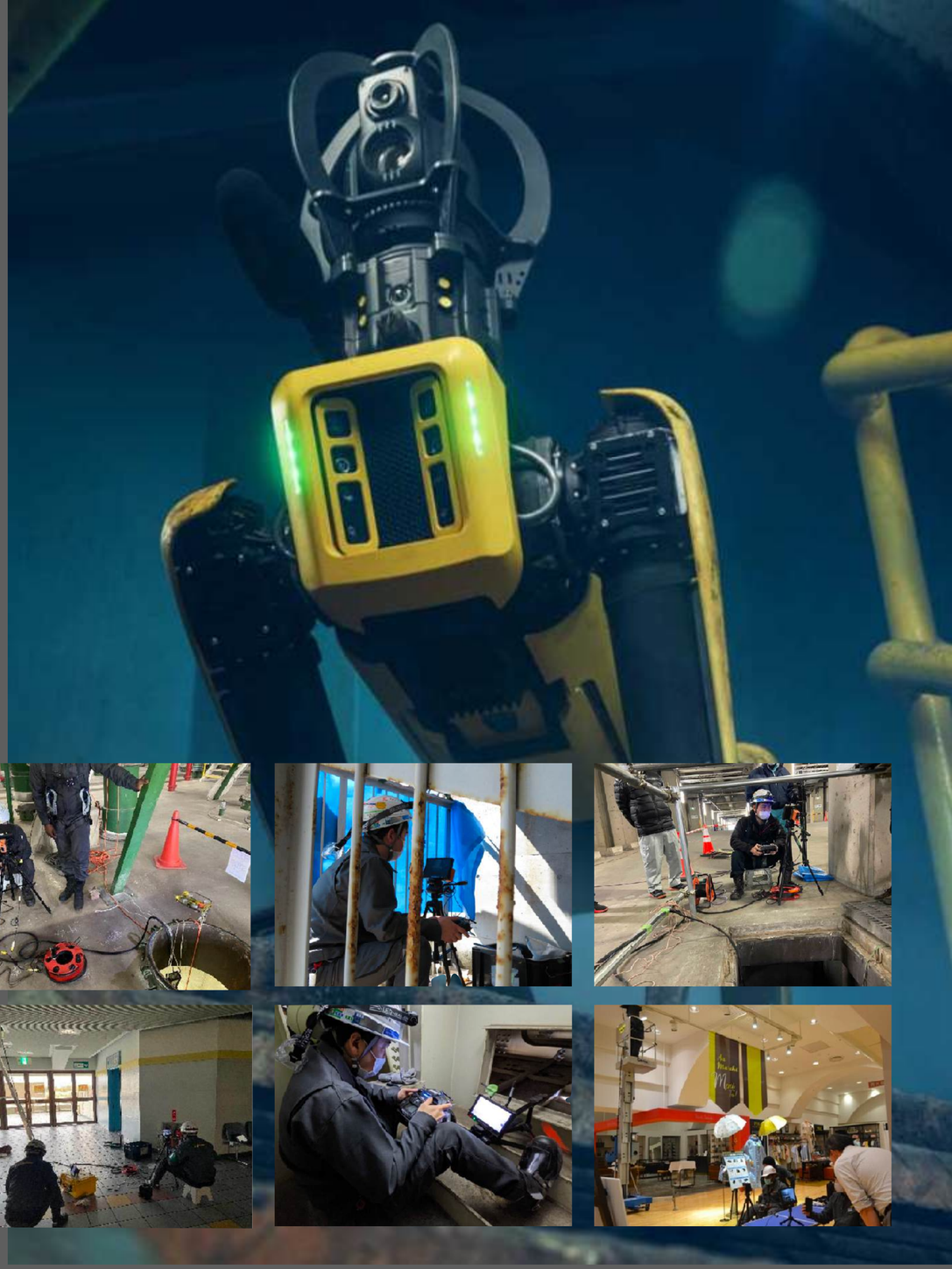
Customers have already purchased and customized robots and drones
require professional pilots for underground and indoor movement control.

The risk of the pilot's work

In order to control a robot
that has to do dangerous work on behalf of people,
People are exposed to dangerous situations again.

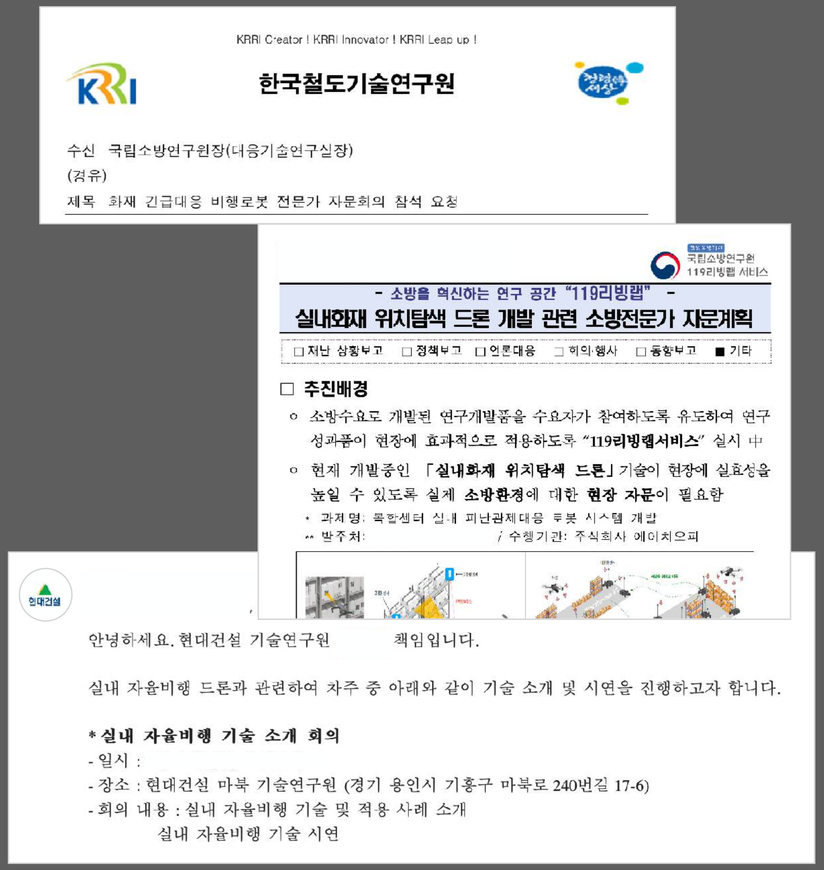
Application of delayed unmanned work

Robot utilization unmanned that is slowing down
due to **The high labor cost and inefficiency of professional pilots**



Market Problem

Korean government agencies and major construction companies are **requesting technologies to automate off-the-shelf robots.**



KRRI Creator ! KRRI Innovator ! KRRI Leap up !

한국철도기술연구원

수신 국립소방연구원장(대응기술연구실장)
(경유)
제목 화재 긴급대응 비행로봇 전문가 자문회의 참석 요청

국립소방연구원
119리빙랩 서비스

- 소방을 혁신하는 연구 공간 "119리빙랩" -

실내화재 위치탐색 드론 개발 관련 소방전문가 자문계획

□ 저난 상황보고 □ 정책보고 □ 언론대응 □ 회의·행사 □ 동향보고 ■ 기타

□ **추진배경**

○ 소방수요로 개발된 연구개발품을 수요자가 참여하도록 유도하여 연구 성과품이 현장에 효과적으로 적용하도록 "**119리빙랩서비스**" 실시 中

○ 현재 개발중인 「**실내화재 위치탐색 드론**」기술이 현장에 실효성을 높일 수 있도록 실제 **소방환경**에 대한 **현장 자문**이 필요함

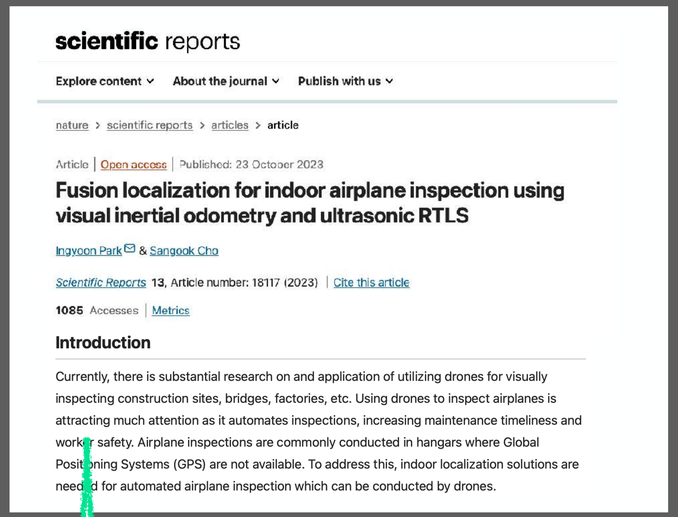
* 과제명: 복합센터 실내 피난관제대응 로봇 시스템 개발
** 발주처: / 수행기관: 주식회사 에이치오피

현대건설

안녕하세요. 현대건설 기술연구원 책임입니다.

실내 자율비행 드론과 관련하여 자주 중 아래와 같이 기술 소개 및 시연을 진행하고자 합니다.

*** 실내 자율비행 기술 소개 회의**
- 일시 :
- 장소 : 현대건설 마북 기술연구원 (경기 용인시 기흥구 마북로 240번길 17-6)
- 회의 내용 : 실내 자율비행 기술 및 적용 사례 소개
  실내 자율비행 기술 시연



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Article | Open access | Published: 23 October 2023

Fusion localization for indoor airplane inspection using visual inertial odometry and ultrasonic RTLS

Ingyoon Park & Sangook Cho

Scientific Reports 13, Article number: 18117 (2023) | Cite this article

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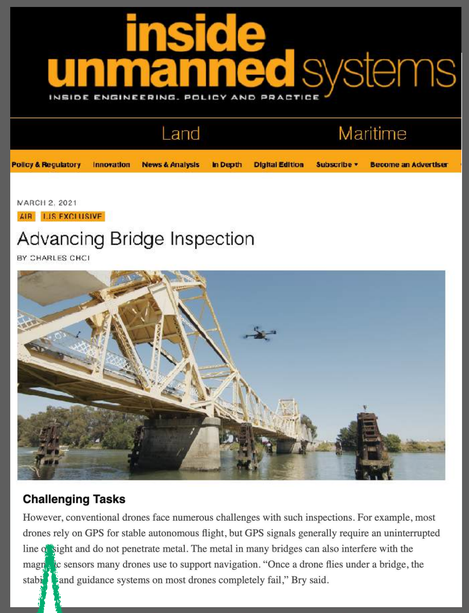
Introduction

Currently, there is substantial research on and application of utilizing drones for visually inspecting construction sites, bridges, factories, etc. Using drones to inspect airplanes is attracting much attention as it automates inspections, increasing maintenance timeliness and worker safety. Airplane inspections are commonly conducted in hangars where Global Positioning Systems (GPS) are not available. To address this, indoor localization solutions are needed for automated airplane inspection which can be conducted by drones.



inside unmanned systems

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AIR U.S. EXCLUSIVE

Advancing Bridge Inspection

BY CHARLES CHOI

Challenging Tasks

However, conventional drones face numerous challenges with such inspections. For example, most drones rely on GPS for stable autonomous flight, but GPS signals generally require an uninterrupted line of sight and do not penetrate metal. The metal in many bridges can also interfere with the magnetic sensors many drones use to support navigation. "Once a drone flies under a bridge, the stabilization and guidance systems on most drones completely fail," Bry said.

drones rely on GPS for stable autonomous flight, but GPS signals generally require an uninterrupted line of sight and do not penetrate metal. The metal in many bridges can also interfere with the

worker safety. Airplane inspections are commonly conducted in hangars where Global Positioning Systems (GPS) are not available. To address this, indoor localization solutions

International research papers and news articles have pointed out that **GPS-based drones often fail to navigate autonomously** depending on the environment, especially in GPS-denied or obstructed areas

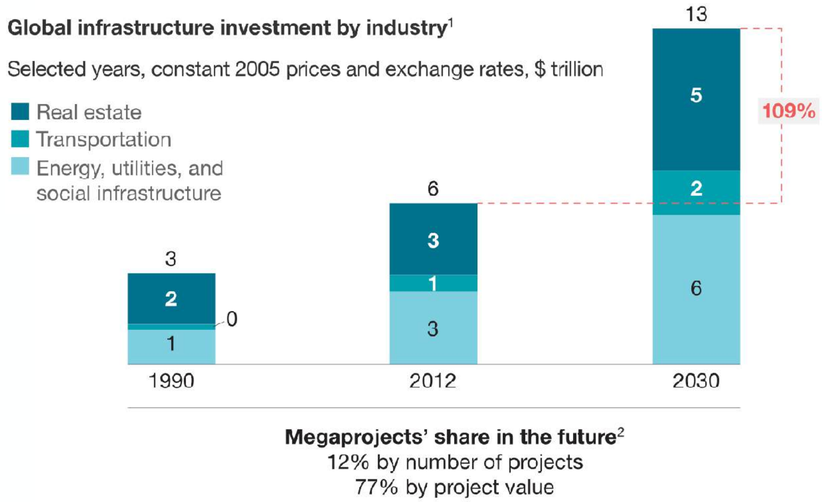
Market Problem

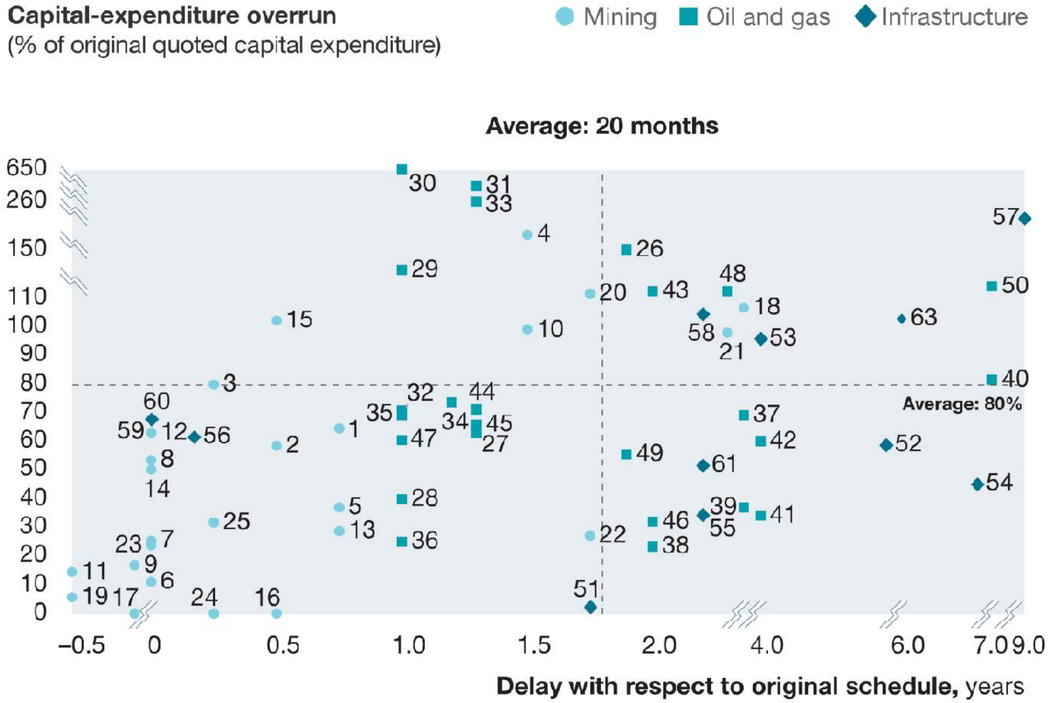
Source: Companies' public annual reports; IHS Herold Global Projects Database, November 19, 2013, McKinsey&Company

"Current limitations of digital twins:

Even if there is a smart construction technology,

it cannot be applied due to **the lack of professional manpower.** "



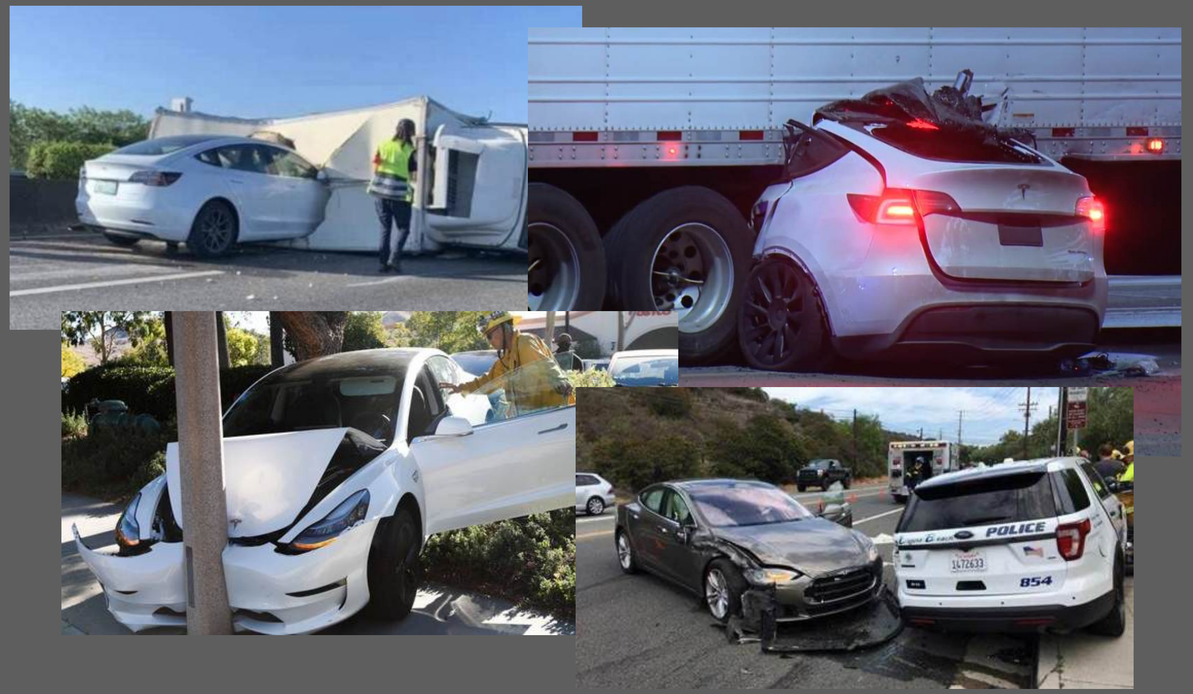


McKinsey&Company

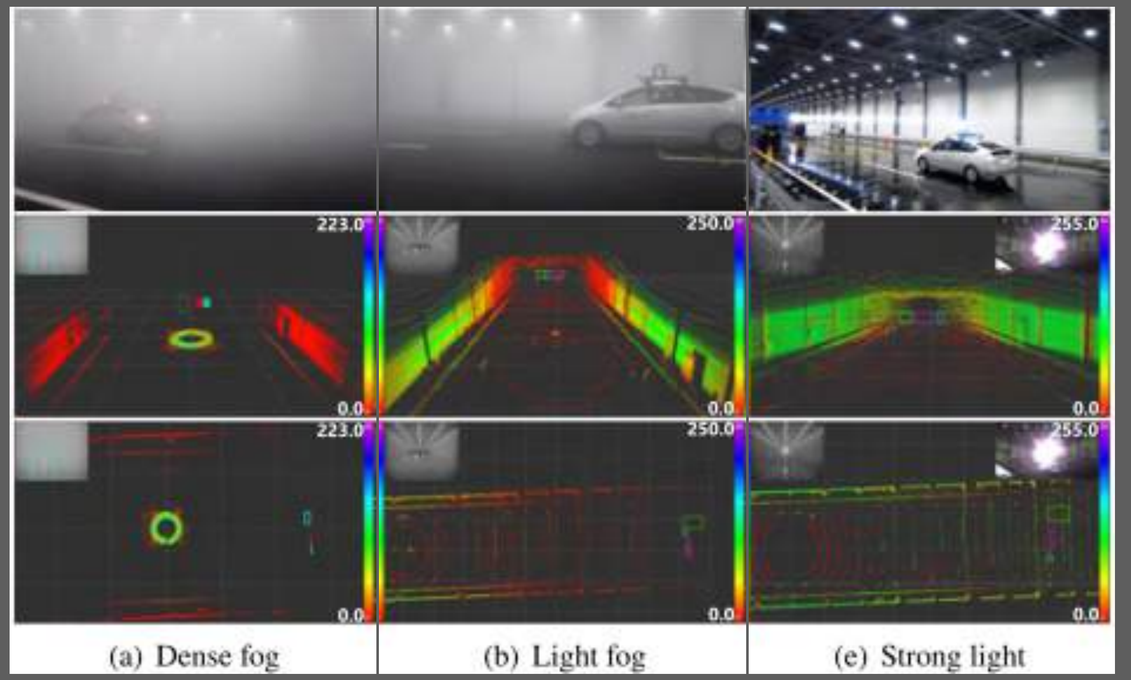
- 98% of the world's mega-projects are air-dulned or over-budget, and 77% are air-dulted by more than 40%.
- 35% of the time (14 hours per week) is used for unproductive activities (information search, rework)
- 60% of the main causes of productivity reduction are communication problems, schedule management, and design management problems.
- 35.2% of the limiting factor for the adoption of smart construction technology responded to 'lack of technical support manpower'

Technical Problem

Indoor and underground positioning technology has already developed a lot, It is not easily applied due to
environmental learning problems, high prices, and high-sifiration infrastructure needs.

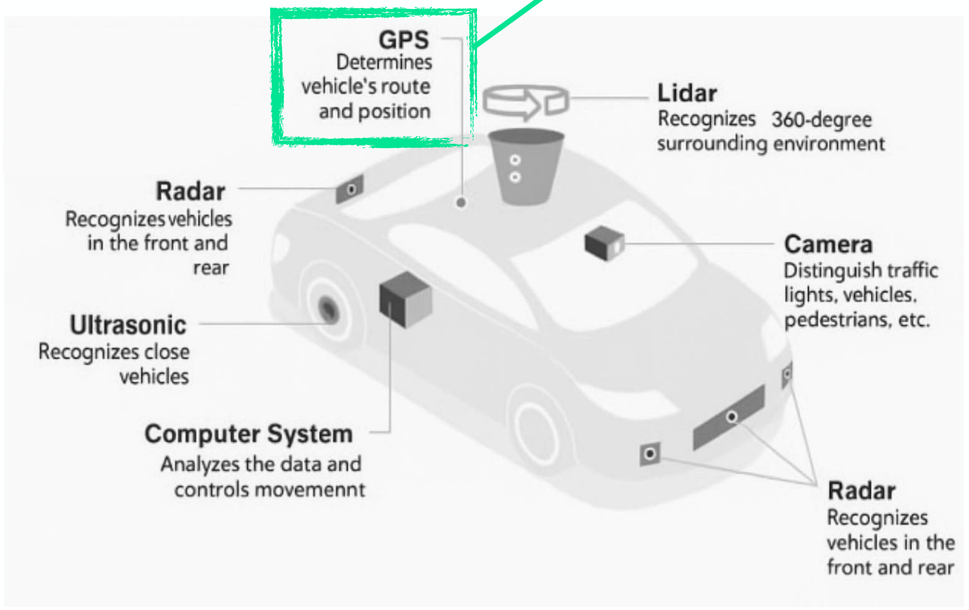


Stereovision technology uses only cameras,
but it is difficult to use in environments
where there is not much color difference.



LiDAR, which can be accurately detected using laser,
cannot detect obstacle distances
by reflections of smoke, rain, and mist.

Our Technology



The role of CereVellum System

It replaces the GPS module
to allow real-time acquisition of
GPS data indoors and underground.

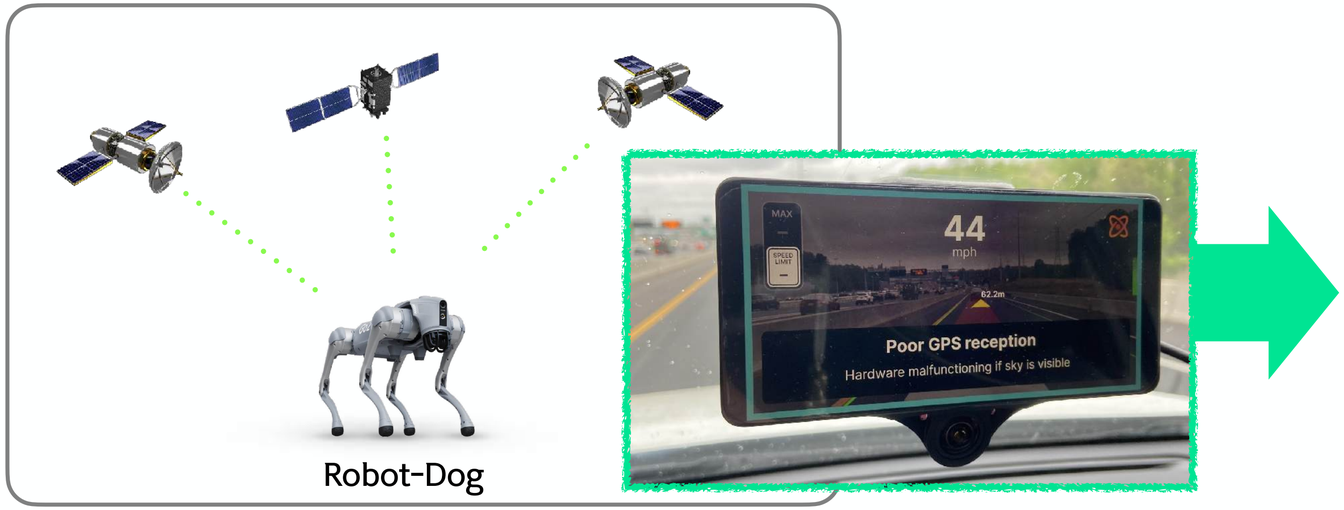
For stable autonomous driving, various data such as GPS data, Stereo Vision, LiDAR, SLAM, and IMU are required.

Among them, if there is no GPS data to determine the route and current location,
low-reliability location data will be generated, resulting in unstable autonomous movement.

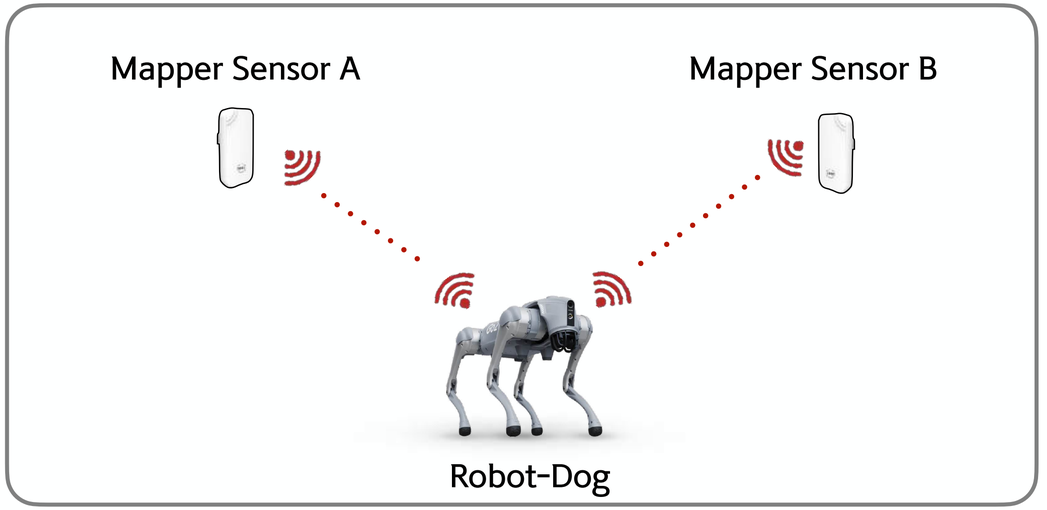
Real-time location data acquired through CereVellum is **mixed with SLAM and IMU data**
to generate reliable location data to support more stable autonomous movement.

Our Technology

GPS Principal



CereVellum System Principal



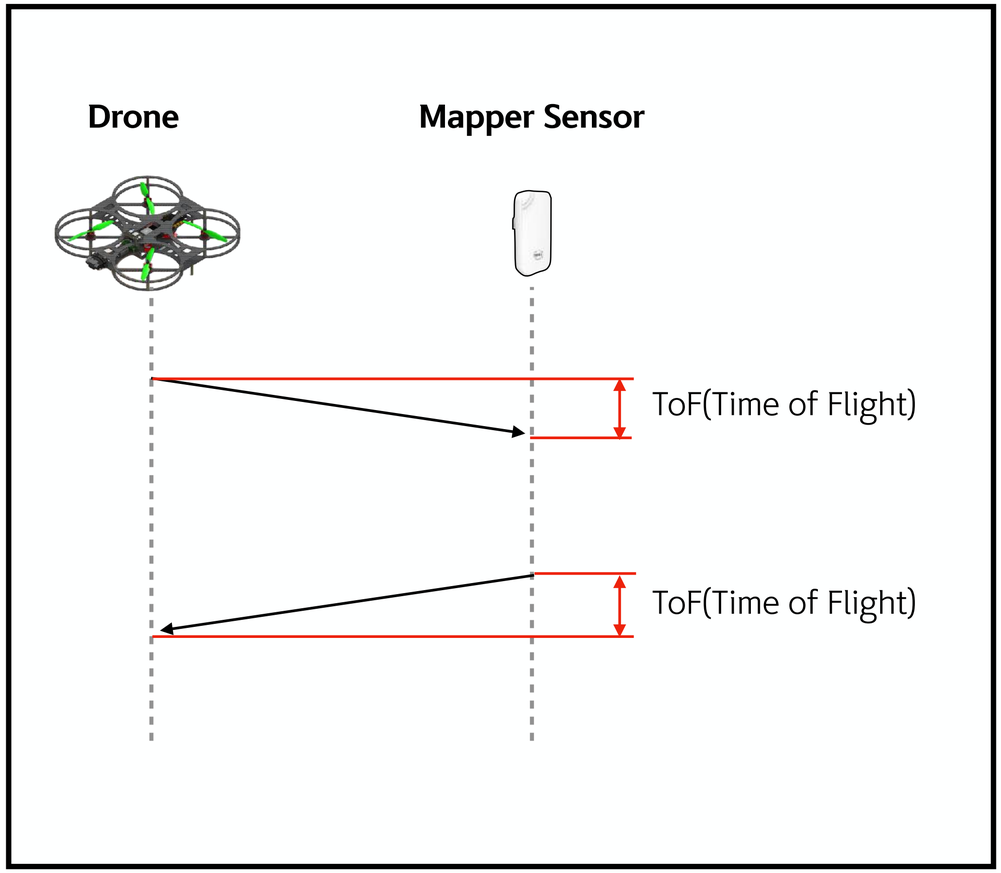
* GPS-based autonomous movement requires a connection with at least 17 satellites.

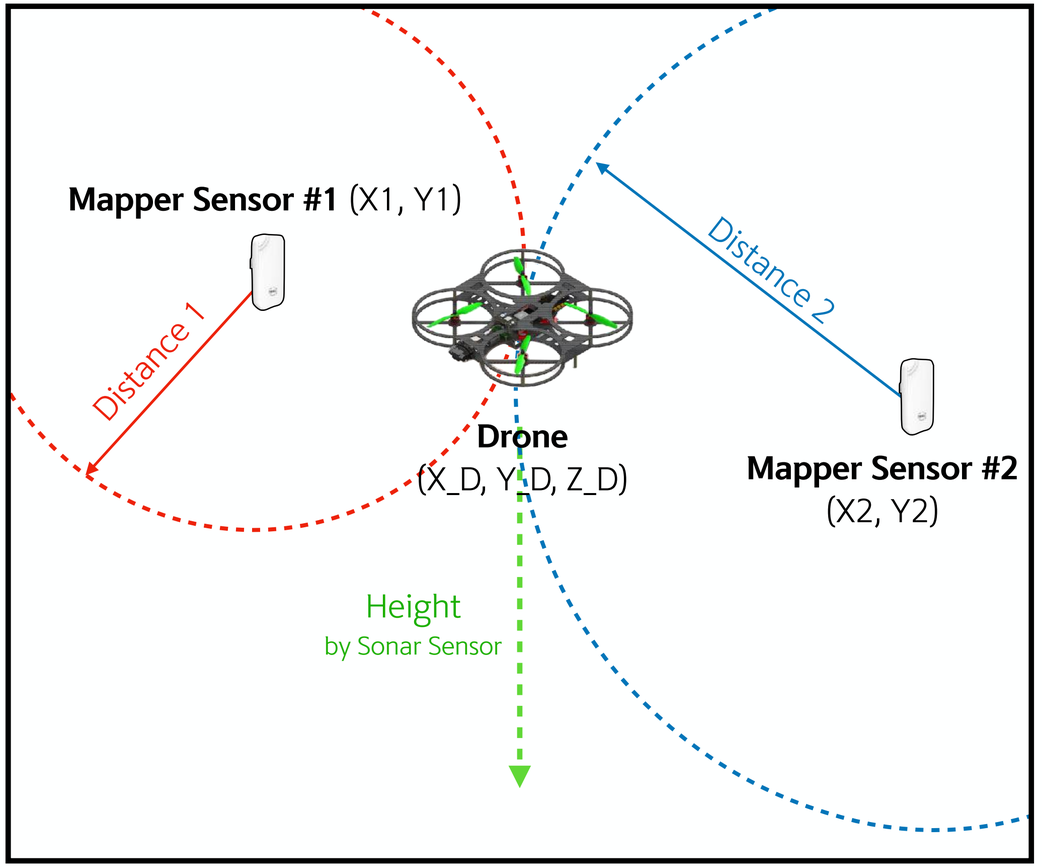
"The only & fastest to apply in the world"

GPS alternative Special Indoor Position Control Technology

Our Technology

CereVellum System Principal

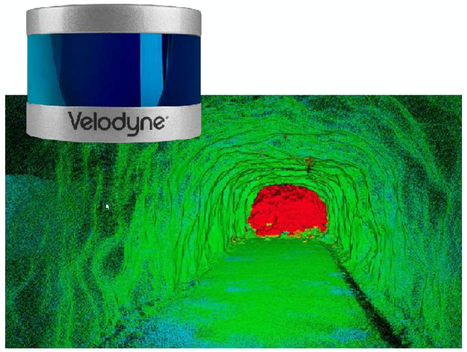




To measure the distance between Drone and Mapper Sensor, the distance is measured by a method called ToF (Time of Flight).
It is a method of calculating the distance between two objects using the time until the signal sent by Drone is reflected to the Mapper Sensor and returns.
It is a technology that determines the position of the drone at the point where the distance crosses within the radius from at least two Mapper Sensors.

Competition

More Cheaper,
More Autonomously.



	LiDAR	Stereo Vision	CereVellum
Pre-environment setting for Autonomous movement	Environmental mapping is required.	Deep Learning is required.	**Unnecessary**
Possibility of autonomous movement based on 2D indoor drawing	Possible after mapping	Impossible	**Possible**
Prices	$60,000 (Sensor + SLAM SW + Computing)	$107,000 (Dual Camera + High-Performance GPU Computing + AI Deep-learing)	**$27,000** (Sensor 10ea + Monitoring SW) *1650m^2

Solution

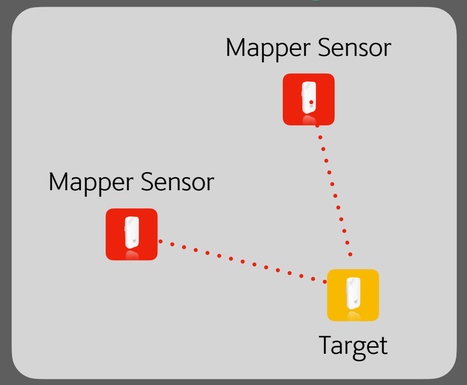
HOP's indoor positioning system **CereVellum** can be applied
not only to commercial robots and drones that move autonomously based on GPS, but also to humans.
Thanks to this technology, all location information can be **found without location restrictions.**

Example of installing
a commercial drone

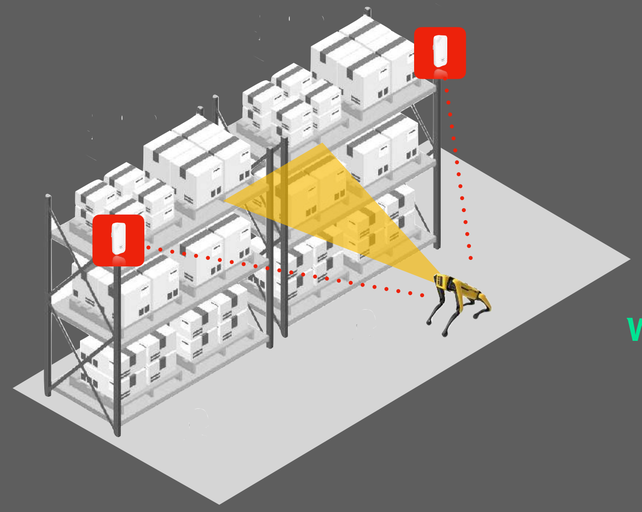
Location Accuracy	5 ~ 30cm
Operating Voltage	3.0 ~3.6 V
Operating Current	80mA
Operating Temperature	-20~ +45℃
Communication Distance	Max. 200m
Usage Frequency Range	3.1 ~ 4.8 GHz

Solution

CereVellum System

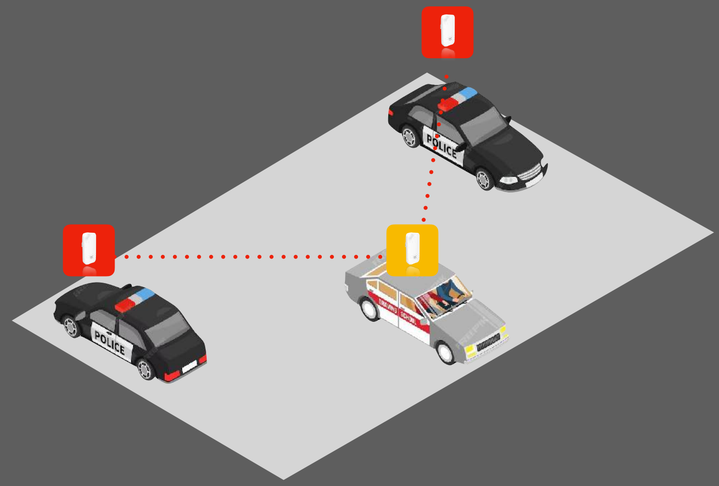


Warehouse



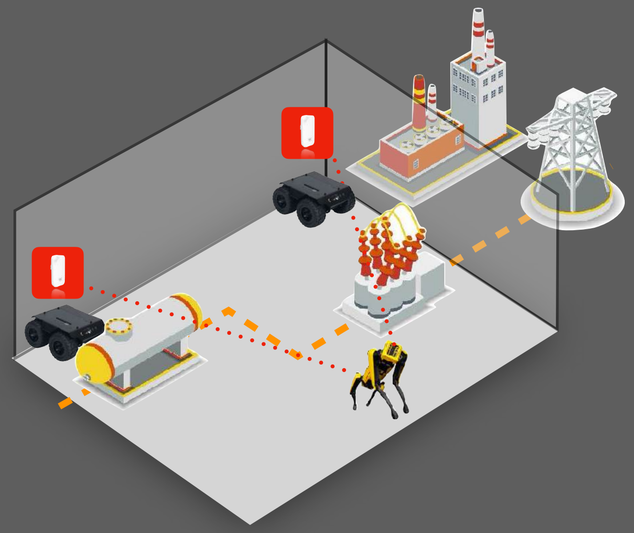
Inventory check of logistics warehouse using drones and robots

Police



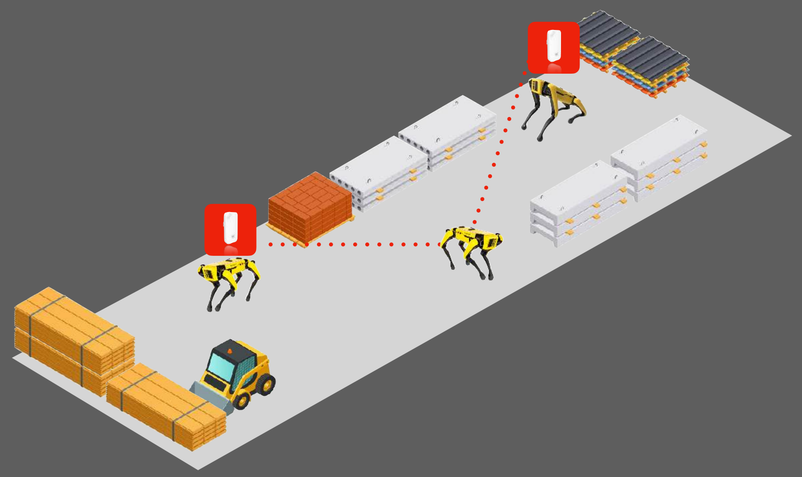
Search and arrest the location of underground escape vehicles (*Use attached position tracker)

Power plant



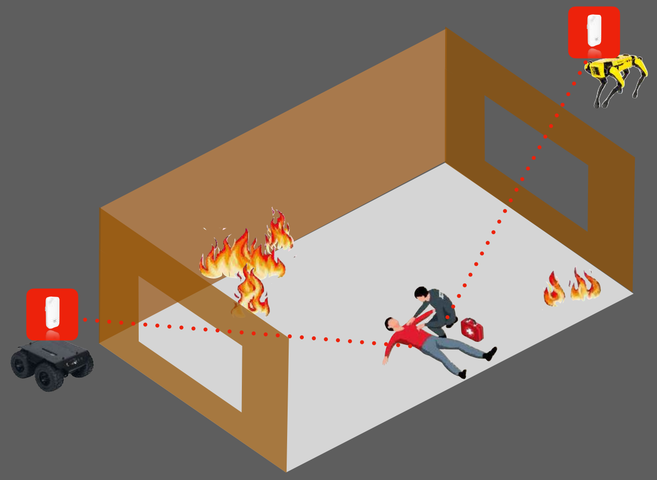
Unmanned robot inspection of power plant internal hazards and narrow space

Construction



Group robot mission for construction site inspection

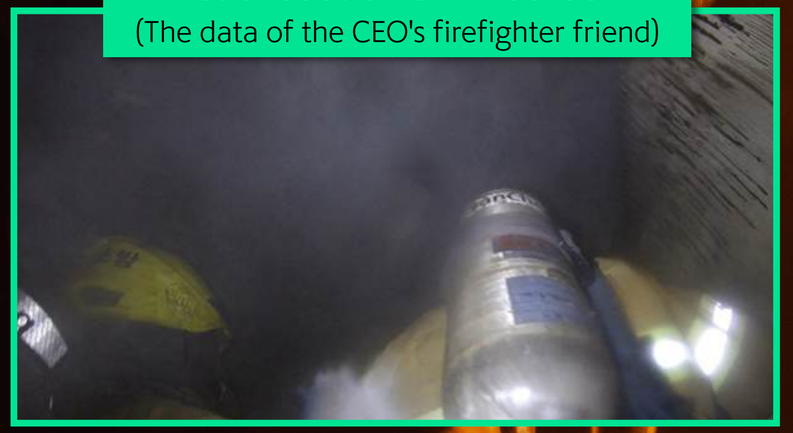
Firefighter



Building indoor rescuer location search

Entrepreneurship motivation

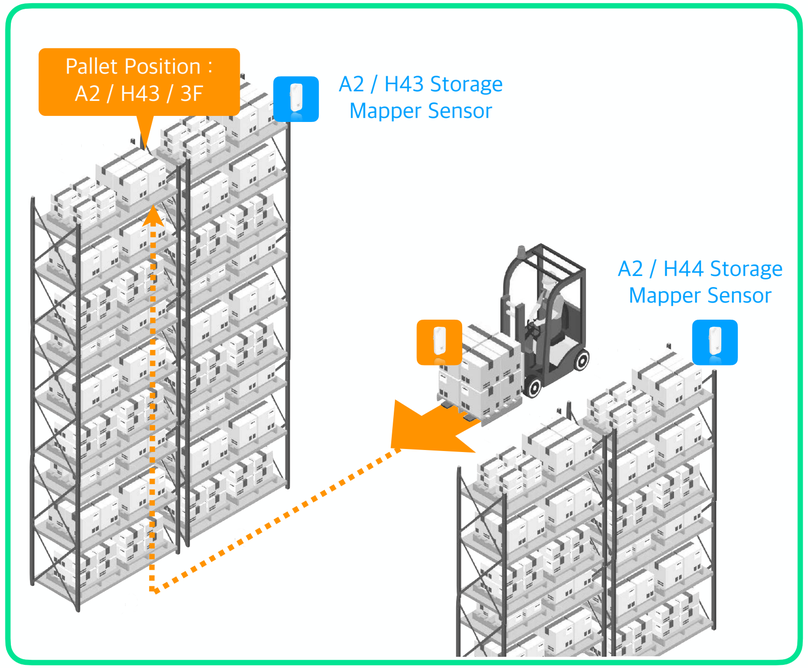
Real rescuer CAM screen
(The data of the CEO's firefighter friend)



Dangerous rescue work that requires
searching every corner of the indoor fire
to find **the location of the rescued person.**

Scenario

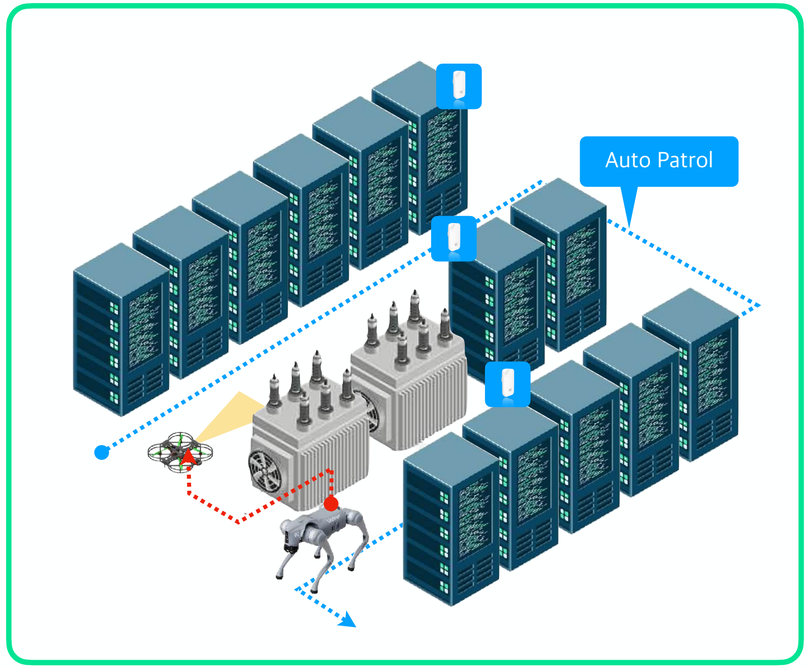
Scenario #1 : Warehouse



Real-time location monitoring :

If a Mapper Sensor is attached to the Storage rack of a high-floor battery factory, the exact location of the pallet can be grasped in real time. Our system allows to check the location of items within your warehouse in real time.

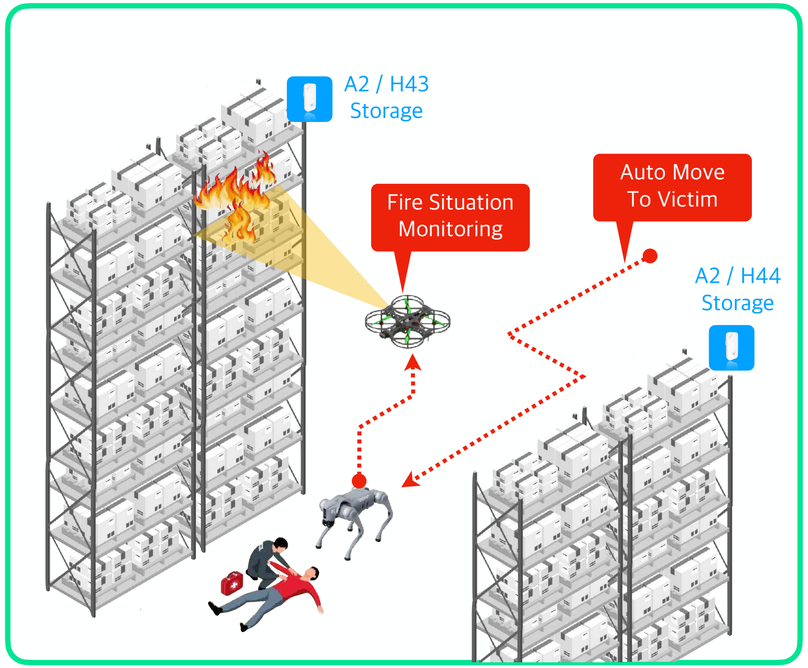
Scenario #2 : Power Plant for AI Server



Unmanned inspection & patrol for AI :

Unmanned patrols and inspection of power generation facilities for AI servers is possible. A team of various robots patrols and inspects according to the schedule unmanned.

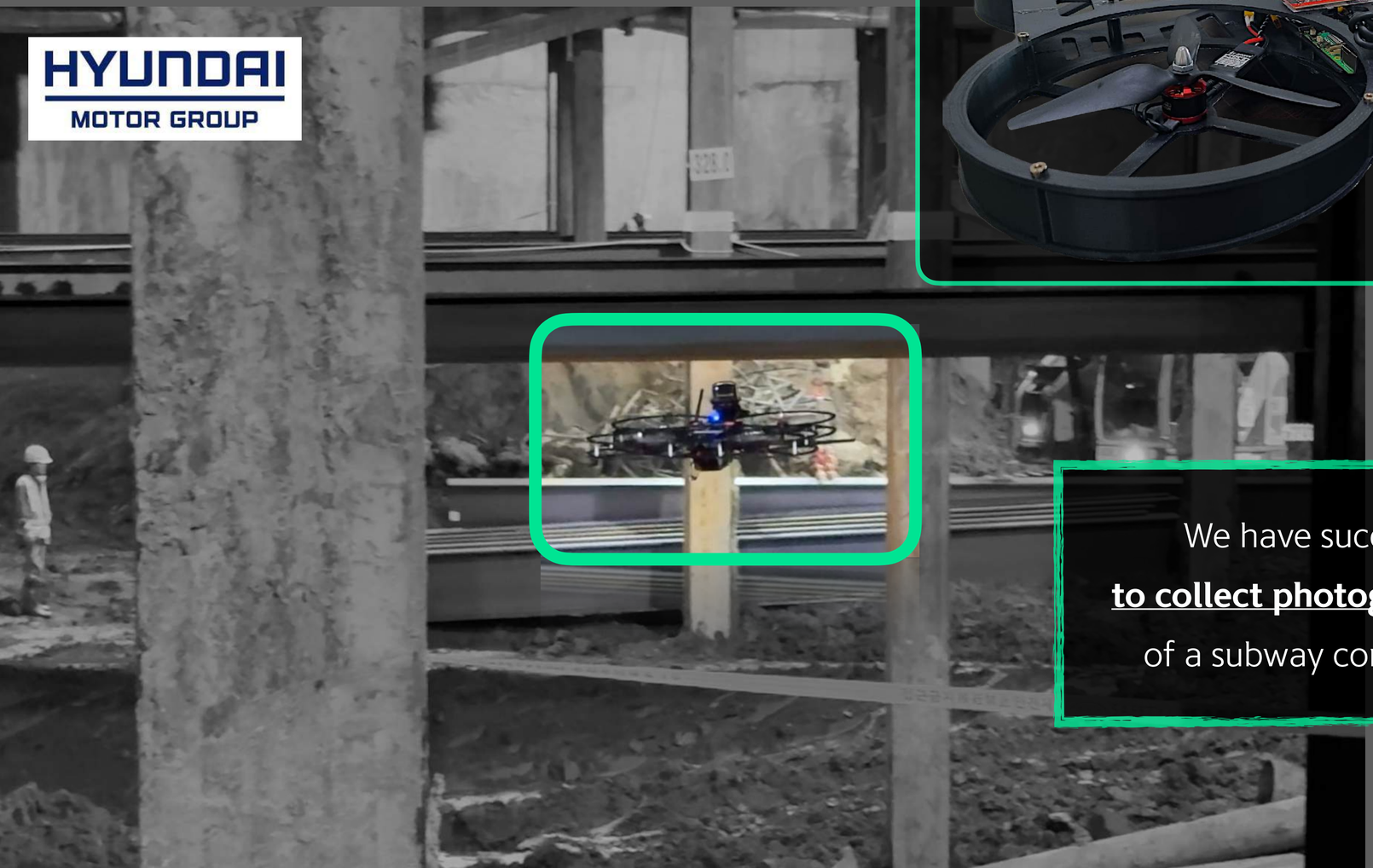
Scenario #3 : Indoor Fire Disaster



Unmanned fire detection :

In the event of a fire or accident, robots can be deployed autonomously to the scene to assess the situation. Additionally, in the case of casualties, the system can transmit the location of the victim to support fast and effective rescue operations.

Field Test



Self-developed drone for underground construction site inspection

We have successfully completed **an unmanned mission to collect photographic and location data for the digital twin** of a subway construction site with numerous steel structures.

Field Test

We have **completed the verification** of the construction company's Needs

"Unmanned system to secure inspection data containing location information"

Customer's requirements	Result of PoC
Stable movement in the steel structure environment	**PASS** (Passed the hovering test within 15cm for 50 times)
Resolution that allows to check the bolt/nut status	**PASS** (GSD 0.3cm or more)
Obstacle and worker avoidance flight	**PASS** (Passed the 50 times repeated test)
Real-time location information sharing	**PASS** (Passed the 50 times indoor communication test)
Autonomous movement to waypoint	**PASS** (Route flight accuracy within 15cm)

Feedback : In large construction sites where materials and vehicles frequently move and the environment is constantly changing,

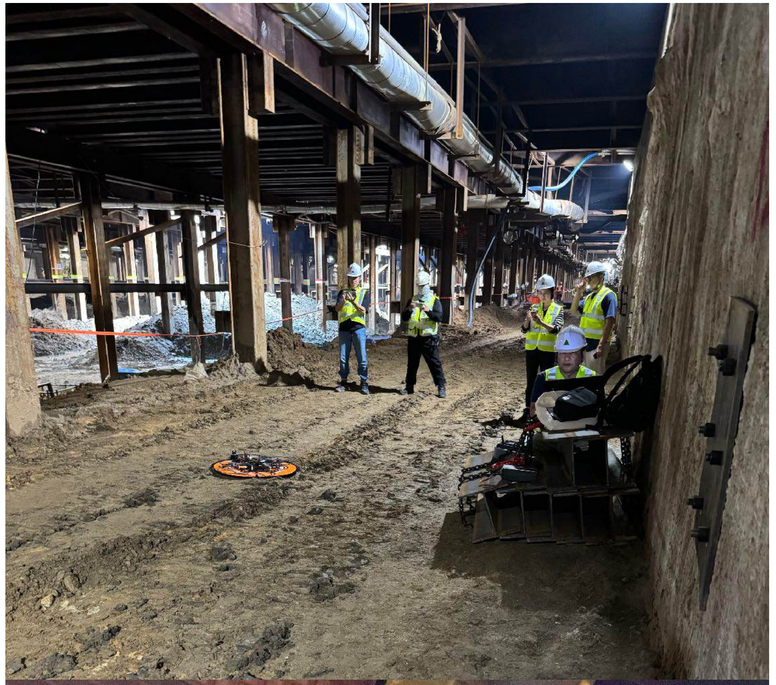
fixed-type Mapper Sensors can be inconvenient to operate.

↓

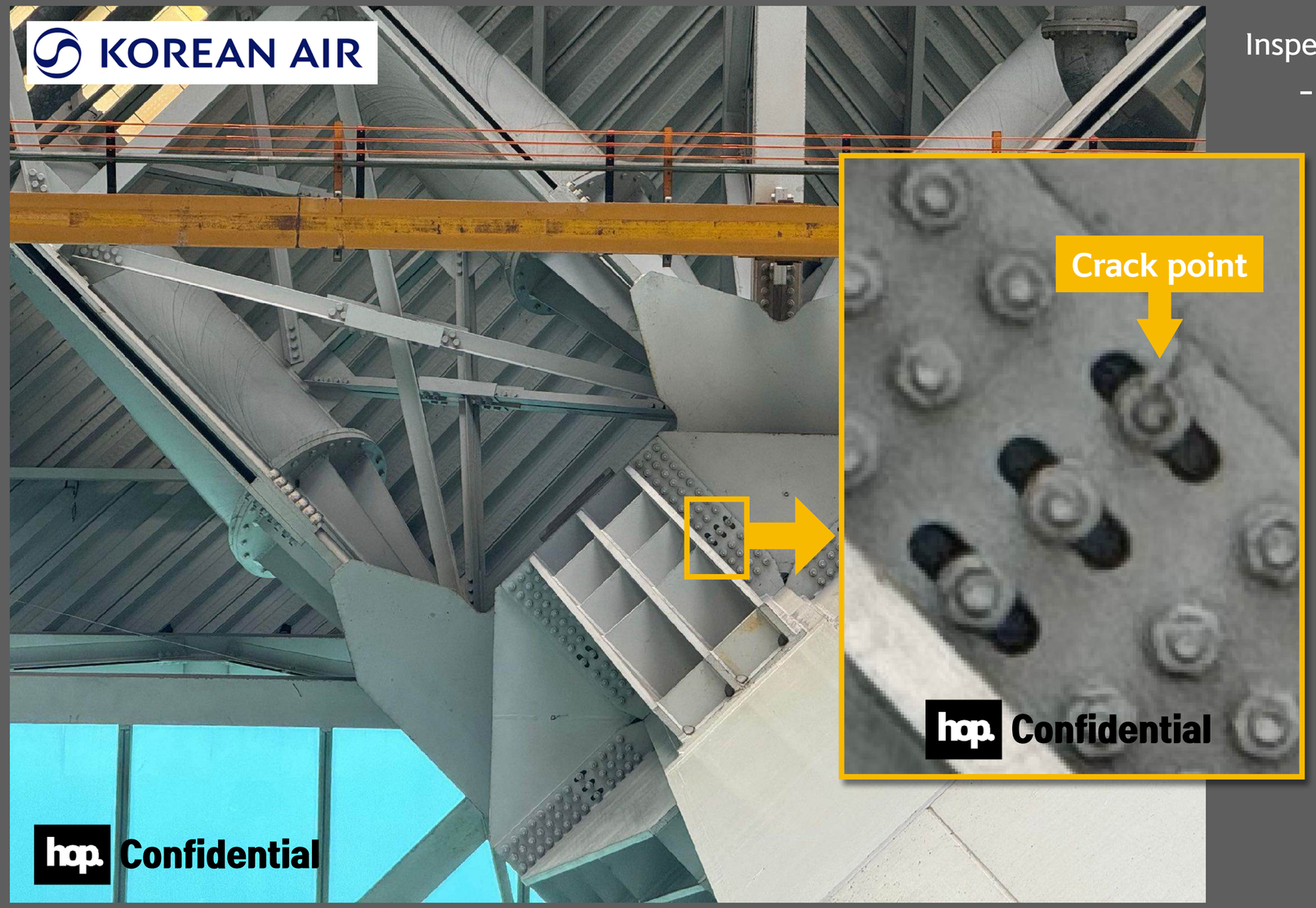
Solutions : Development of an indoor positioning system

for mobility without location restrictions

→ Development of Mapper Sensor for mounting robots



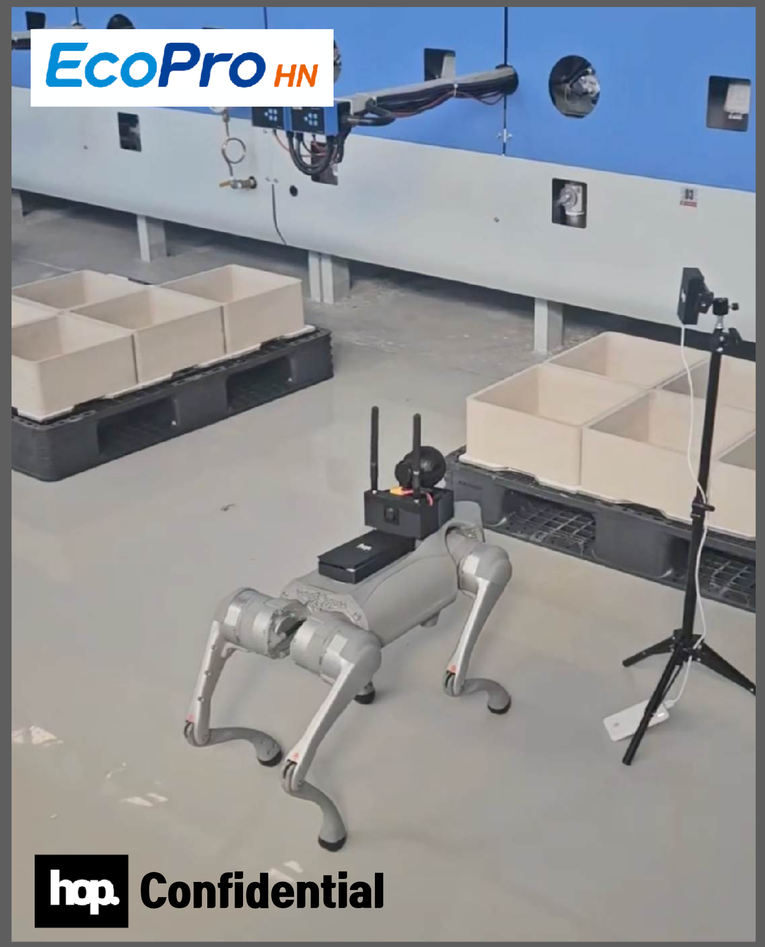
Field Test

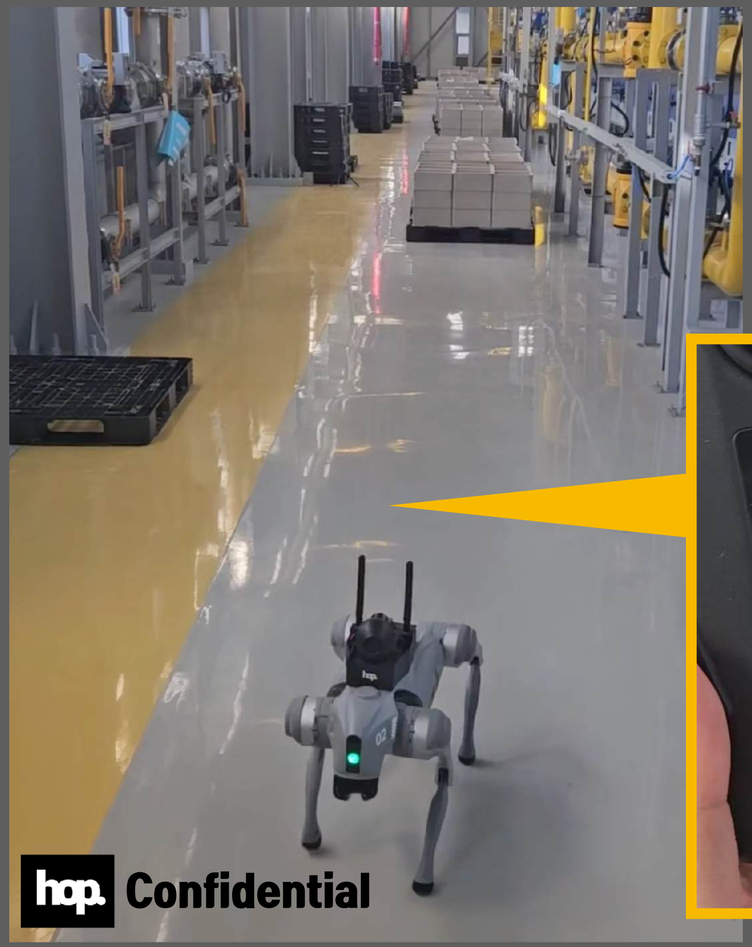


Inspection the ceiling structure in the airliner hangar

- **0.38mm** Crack Detection

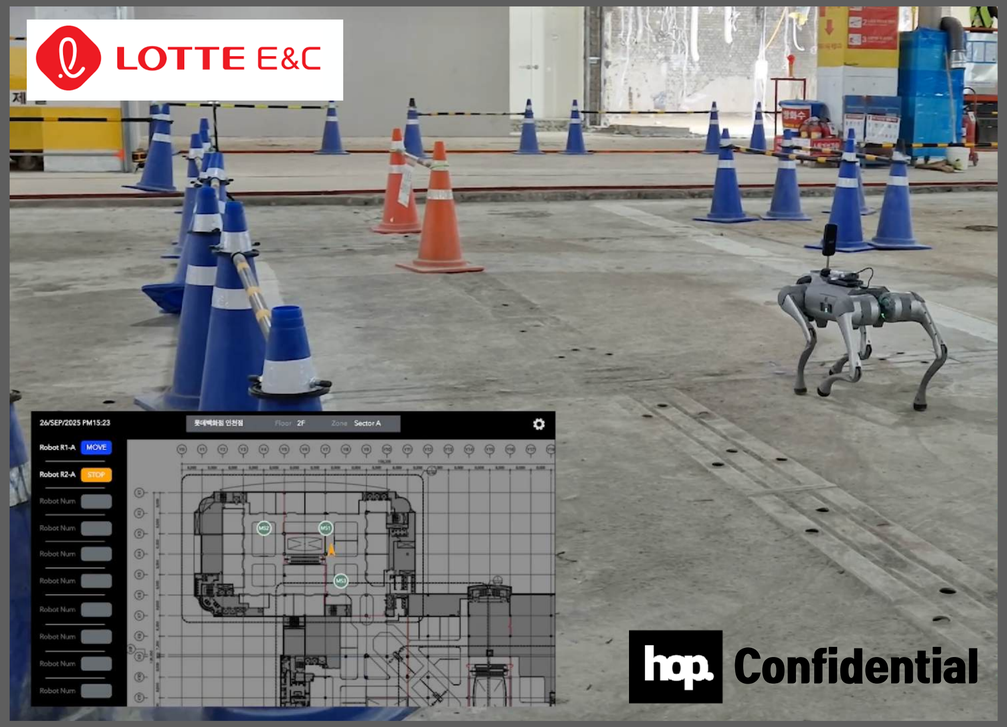
Field Test

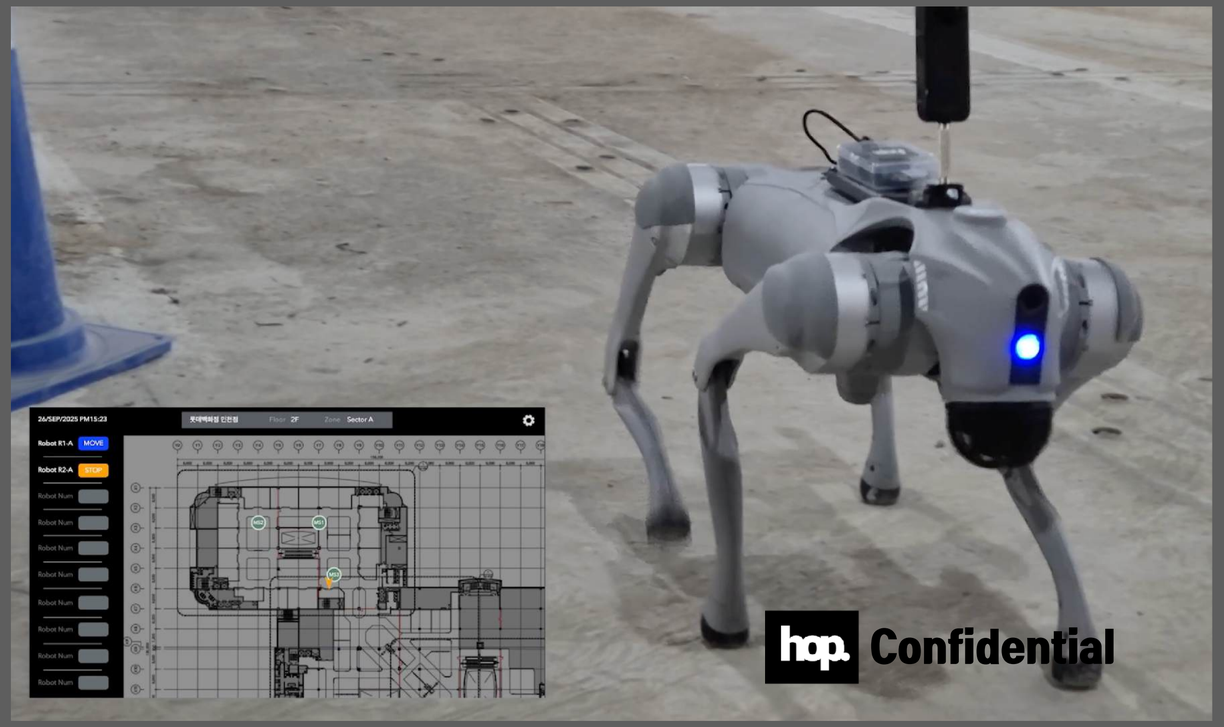




Performance Evaluation and Deployment of an Unmanned Patrol System for Battery Manufacturing Plants

- Aimed at minimizing casualties through pre-environment checks and patrols in battery manufacturing facilities where high temperatures and hazardous gases are present.
- Utilizing multiple quadruped robots equipped with various measurement sensors to patrol and inspect large-scale production areas.

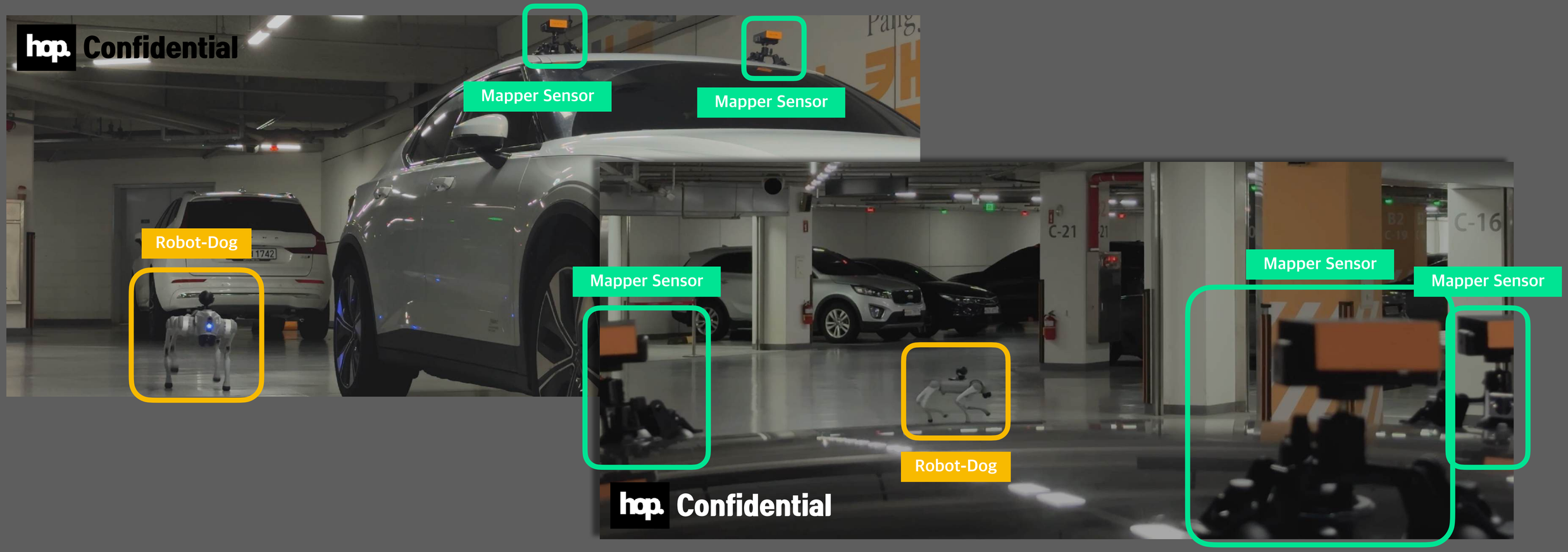




Performance Evaluation of a Nighttime Unmanned Patrol System for Indoor Construction Site

- Evaluating an unmanned patrol robot system capable of autonomously navigating and patrolling dark construction sites where no personnel are on duty at night to detect accidents or issues.
- Detecting collapses, falling objects, or other incidents and transmitting data in real time to the client’s server.
- In case of emergencies or major accidents, the AI automatically connects a phone call to the site supervisor.

Field Test



Performance Evaluation of an Unmanned Inspection System for Government Building Underground Parking Facilities

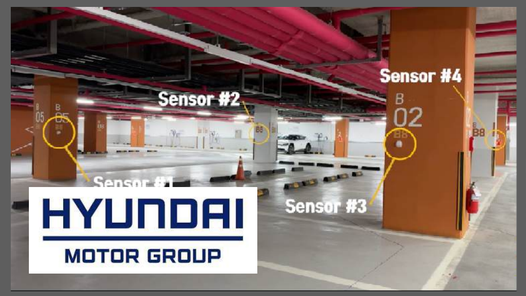
- Conducting performance evaluation for adopting an unmanned robotic system to detect potential risks in underground parking lots, where accidents can lead to major incidents.
- Instead of fixed environmental sensors, the system uses a vehicle-mounted type to minimize risks caused by environmental changes.
- The system can be installed on any vehicle type, allowing robot position control and data acquisition from inside the vehicle.

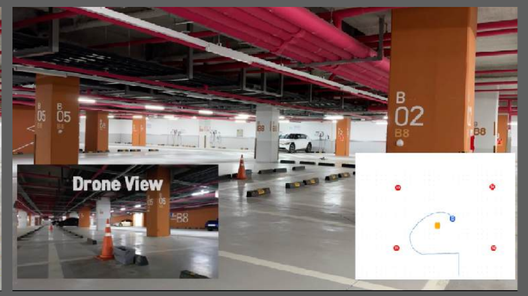
Performance Evaluation of an Unmanned Inspection System for Aircraft Engine Pallet Undersides

- Utilizing a small robot to inspect the underside of engine pallets within extremely narrow spaces of less than 60 mm.

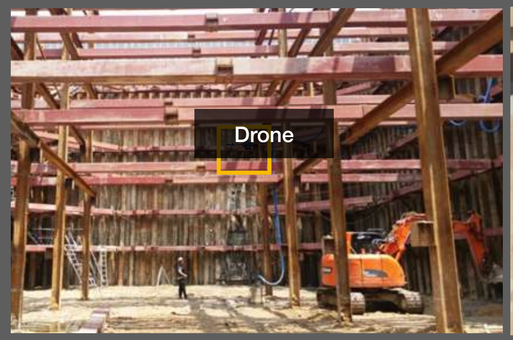
Field Test

Underground parking lot inspection

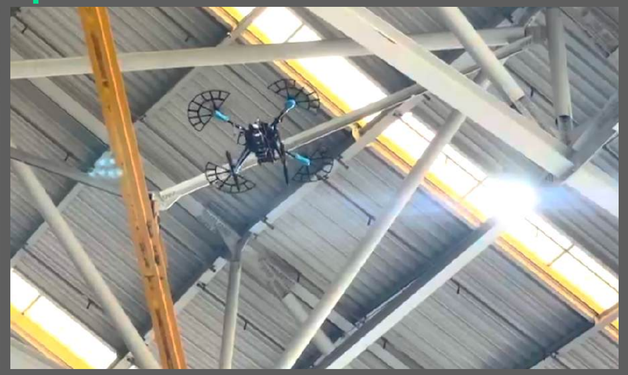




GTX-Line Construction Site Inspection



Aircraft hangar drone inspection



Customer company that completed PoC

LOTTE E&C · HYUNDAI MOTOR GROUP · KOREAN AIR · EcoPro HN · National Fire Agency 119 · KRRI 한국철도기술연구원 Korea Railroad Research Institute · liberaware CO.,LTD.

Customers under discussion on PoC

emart · SIEMENS · Honeywell · aramco · SUZUKI · HEWLETT PACKARD · TESLA · VARTA

Sales through PoC

$ 0.17B

(Based on 2025 estimates)

Customer profits

> The initial investment cost can be **recovered within 3 years** compared to the inspection cost of a high-cost specialist.

Annual manpower Patrol & Inspection cost
of Power facility for 7GW Ai server : $ 2.5B /year

VS

CereVellum System for Ai Server : $ 6.2B

Maintenance of power supply facilities
in AI data centers

OpenAI Stargate 7GW Ai Data Center
(Power supply facility at 988 Acres)

Market

TAM

Global Digital Twin of Building Inspection market

$1.3t

SAM

Safety inspection monitoring market

$520B

SOM

Korea / Middle East / US / Japan factory & special building inspection market

$30B

Revenue (2025)

Korea construction companies

$0.13m

Overseas construction companies & power generation companies

$0.07m

RaaS subscription
(Robot as a Service)

$0.01m

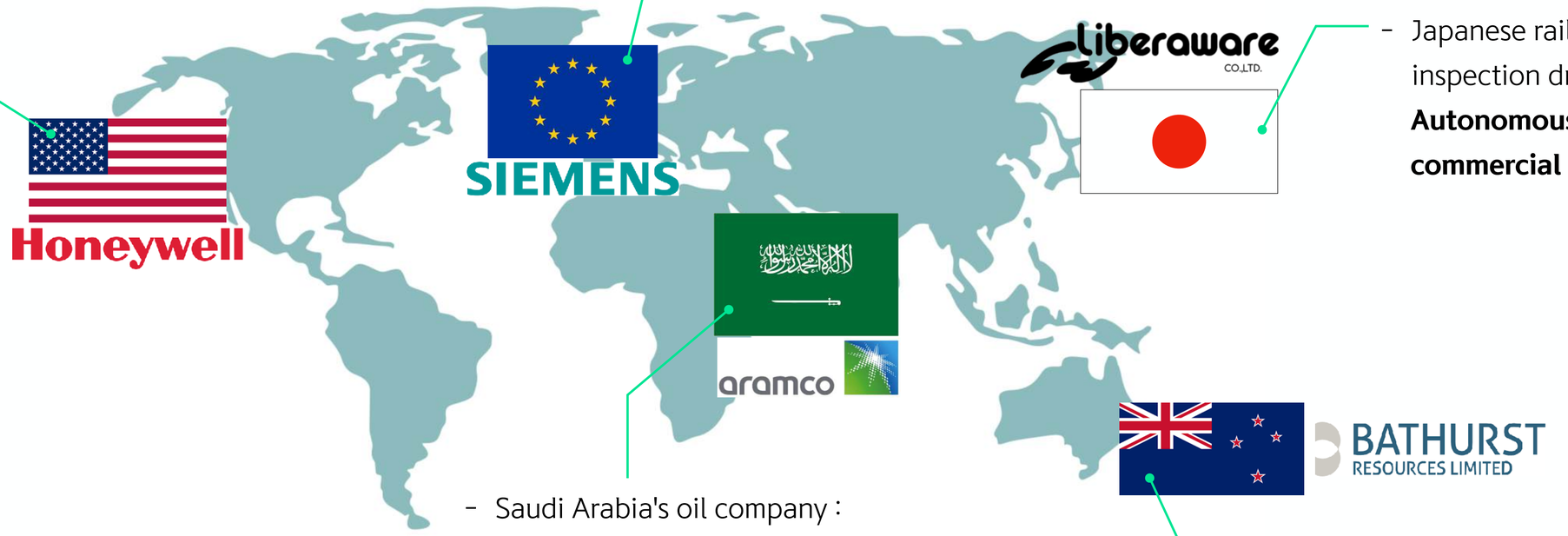
* Expected sales in 25 years: Hyundai E&C, Lotte E&C, Middle East DEWA, Japan Liberaware

Market

Based on PoC results, We are making **global entry a reality.**

- Factory & power generation facility operation management company : **Unmanned inspection system in the existing operation monitoring system**

- European railway/oil/logistics management conglomerate : **Unmanned safety management system for oil plants**



- Japanese railway and building safety inspection drone company : **Autonomous flight control of commercial drones**

- Saudi Arabia's oil company : **Unmanned safety & patrol system for oil plants**

- New Zealand coal mine company : **Unmanned inspection system for coal mine**

Projection

BEP

Category		2025	2026	2027
Revenue	CereVellum	$0.2m	$1.3m	$4.5
	RaaS	$0.01m	$0.15m	$1m
Total Revenue		**$0.21m**	**$1.45m**	**$5.5m**
Manufacturing Cost		$0.035m	$0.18	$0.55
Operating Expense		$0.1m	$0.25	$0.4
Operating Income		**$0.165m**	**$1.02m**	**$4.55m**

Members

CEO Enoch

- Early Graduation from Hansung Science High School
- B.S. in Mechanical Engineering, Yonsei University
- M.S. in Robotics, Yonsei University
- 12 years of experience in robotics system development (HILEBEN / Reset Company / NearthLAB)
- Collaborated with global enterprises including SIEMENS, GE, BP, ORIX
- CES Innovation Award for AI Autonomous Flight Technology

CTO Ki-Ryum

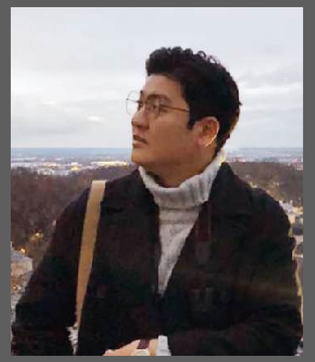
- B.A. in Economics, Yonsei University
- NHN NEXT (NAVER) Institute
- 10 years of experience in app and backend development (Developed server-based applications)

Senior Engineer Suik

- Lead developer for indoor autonomous control systems
- 3 years of experience in indoor autonomous flight drone development
- Award at the Korea Army Drone Combat Competition

CEO Staff So-Young

- B.A. in Public Administration, Korea University
- Experienced in China/U.S. international business strategy
- Financial and business operations support



Sales Young-Uk

- University College Dublin
- 7 years of sales experience in the U.S. and Singapore
- Project experience in commercial aircraft MRO

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Why wait when you can create
the future the fastest?