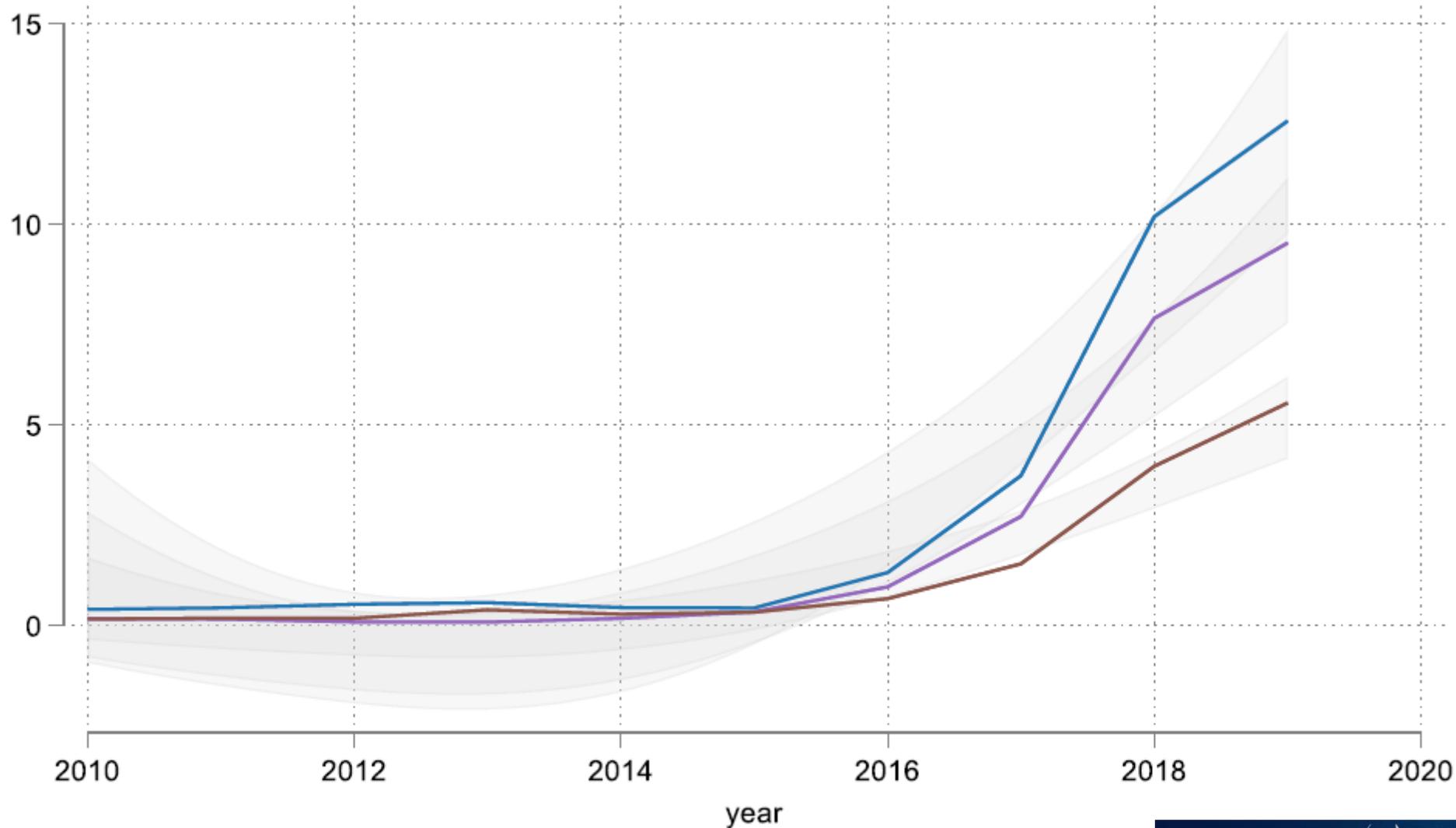


Modern Maintenance

Digitalization – robotics
and drones

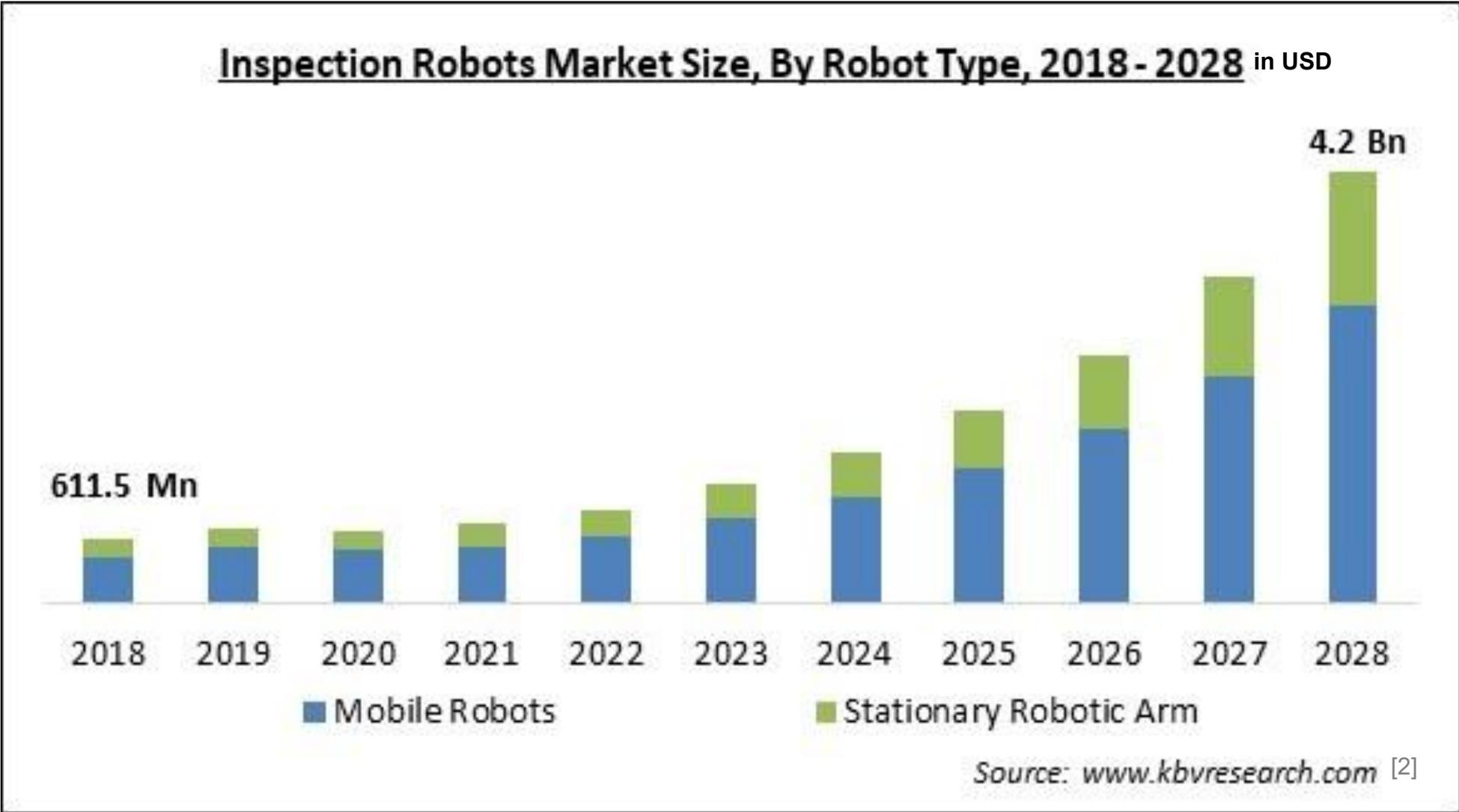


— EU-27 — USA
— Rest of the World



JRC TECHNICAL REPORT

AI Watch
 Evolution of the EU market share of
 Robotics: Database and Results



...and the inspection and maintenance market is expected to reach **US\$ 8.3 billion by 2030** [1]



[1] SNS Insider, <https://www.snsinsider.com/reports/inspection-and-maintenance-robot-market-1364>
 [2] kbv research, <https://www.kbvresearch.com/inspection-robots-market/>

Many applications, diverse requirements



Assets and equipment

Pressure vessels, ship hulls, hydro turbines, flare stacks, aquaculture net cages, generators, pipe bends, storage tanks, wind turbines, ...



Plants and areas

Electrical substations, solar parks, offshore/onshore O&G platforms, harbors, dams, nuclear facilities, power stations, buildings, airports, quay walls, ...



Long-distance / linear

Rail infrastructures, tunnels, bridges, waterways, drinking water networks and installations, power lines, ...



Credit: Stellaire.ai



Credit: Quantum Systems

Credit:
ScoutDI



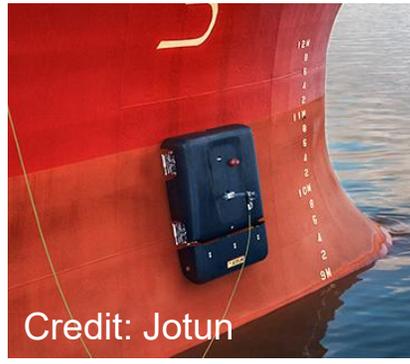
Credit: IKM



Credit: Eelume



Credit: Waygate



Credit: Jotun



Credit: Eddify



Credit: Railway Robotics

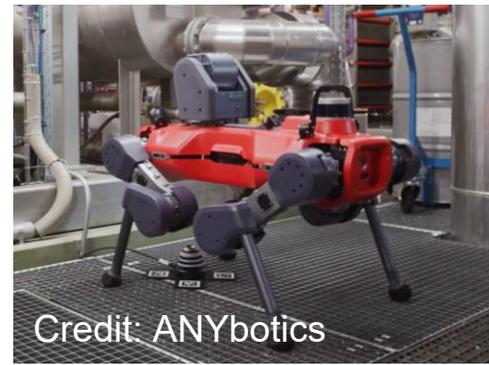
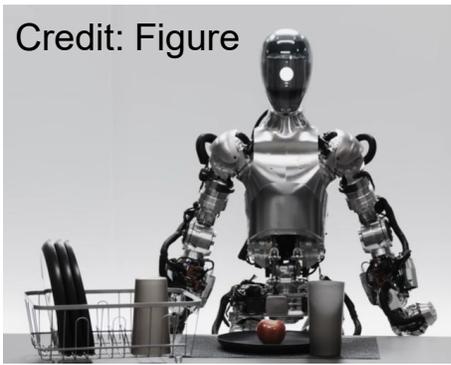


Credit: Infraspact



Credit: Surface

Credit: Figure

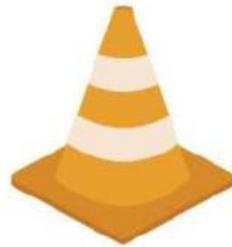


Credit: ANYbotics



Credit: Taurob

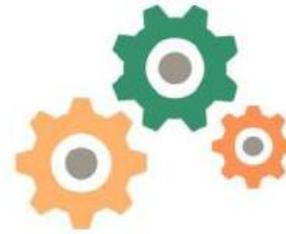
The most important common drivers for decision making in the petroleum and (petro)chemical industry



Improve Safety



Improve environmental performance



Increase operational efficiency



cost avoidance + cost reduction

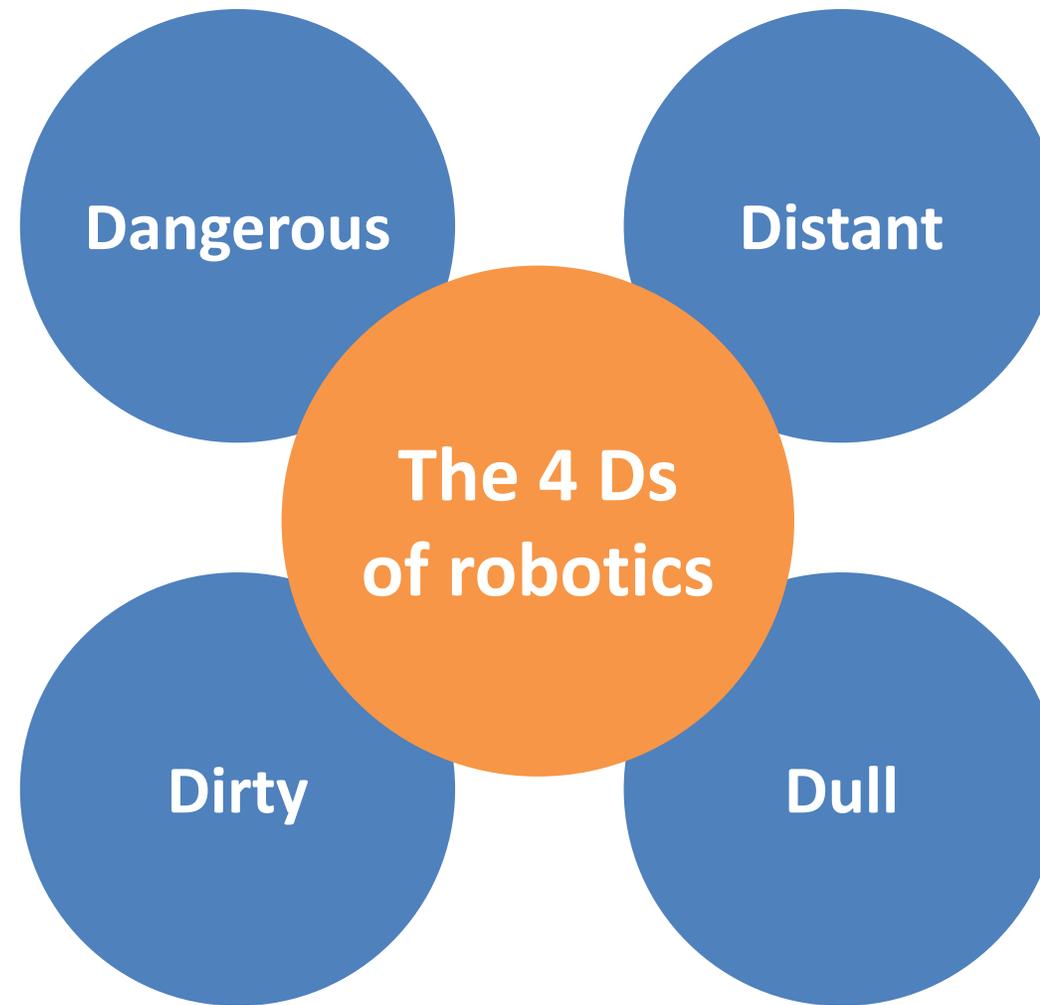


“There has to be a cost reduction to introduce new tech” Chevron, 2022

“Better quality is also a main driver” SPRINT WC, 2022



SPRINT Robotics Roadmap 2021



Do more – and do it better

Data collection

"Geo-reference" sensor data

Increase quality

Increase consistency

Sensors "on demand"

Continuous monitoring

Intervention

Improve data management

Data trending

Logistics

Multitasking

Durability

New work processes

Collaboration

Data collection

"Geo-reference" sensor data

Increase quality

Increase consistency

Improve data management

Data trending

Sensors "on demand"

Continuous monitoring

Robots4humans

Collaboration

Multitasking

Durability

New work processes

AI



Plants and areas



Assets and equipment



Long-distance / linear

ROBOTICS

DATA

Business / industry acceptance

Change management, new business models, business readiness level, understand the risk of ADR, cost of robot ownership, ...

Automatic data analysis

Interpretability and explainability, data quality and availability, model training automation, ownership of data, ...

Standardization

verification and validation, testing procedures to prove capabilities and set requirements to suppliers, ...

 World Class Maintenance

*“We’ve moved from a tech race to a **trust** race”
SPRINT WC, 2025*

Robustness and reliability

Robust long-term autonomy, bad weather, ATEX, GNSS-denied, ...

Sustainable deployments

Manage transition from one-off tests to ADR as standard tools in day-2-day operations

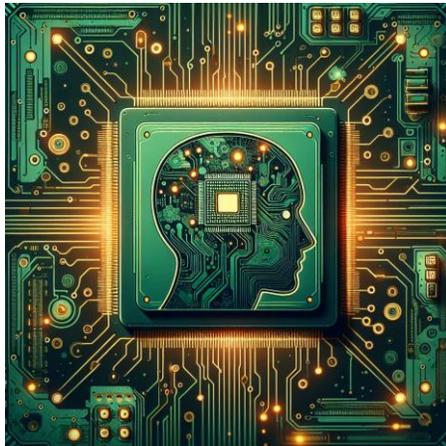
Integration

Integration into systems and operations, e.g., digital twins, plant management systems, work procedures, cyber security,...

Overall challenges for AI, Data and Robotics (ADR) technologies in I&M

Machine learning and AI

There are lots of definitions of Artificial Intelligence (AI)



“An AI system is a machine-based system that, [...], **infers**, from the **input it receives**, how to **generate outputs** such as **predictions, content, recommendations, or decisions** that can influence physical or virtual environments.

Different AI systems **vary in their levels of autonomy and adaptiveness** after deployment.”

OECD *publishing*

**EXPLANATORY
MEMORANDUM ON
THE UPDATED OECD
DEFINITION OF AN AI
SYSTEM**

OECD ARTIFICIAL
INTELLIGENCE PAPERS
March 2024 No. 8

 **Artificial Intelligence**

 **Machine Learning**

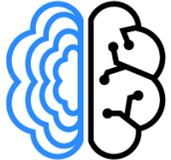
Predictive maintenance



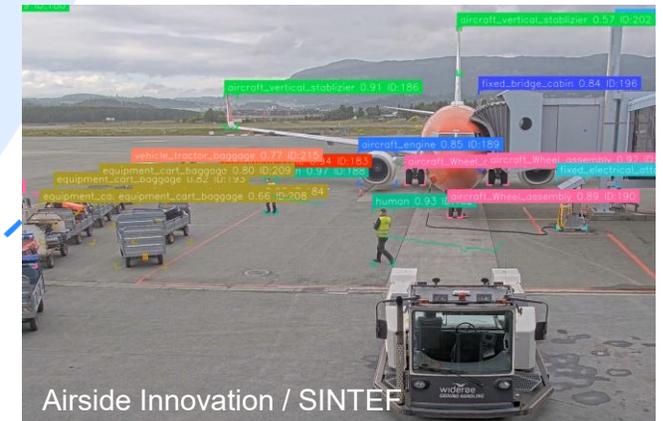
Source: MS Copilot.

Knowledge Management



 **Deep Learning**

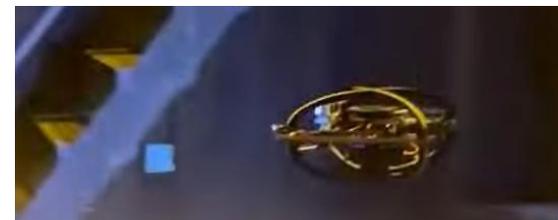
Object classification



Embodied AI

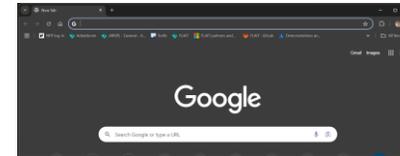


<https://www.figure.ai/news/helix>



<https://youtu.be/dFjsPwa9oIg>

drug discovery assistance
Johnson & Johnson



Agents



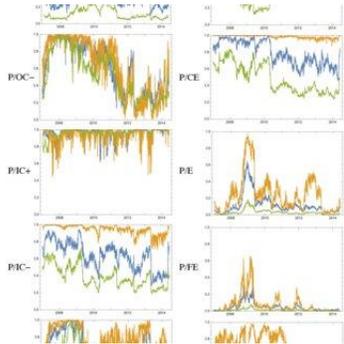
Podcast by Nick Youngson CC BY-SA 3.0 Alpha Stock Images

<https://dalle4ai.com/>

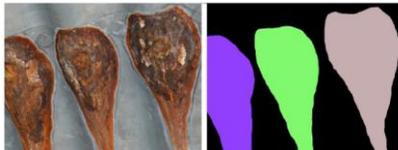
Generative AI



© Made by Nick Youngson CC BY-SA 3.0 Alpha Stock Images



https://www.researchgate.net/figure/Time-series-of-the-goodness-of-fit-test-to-the-log-normal-distribution-Blue_fig1_364932399



Fondevik et al, 2020, Image Segmentation of Corrosion Damages in Industrial Inspections

Deep learning

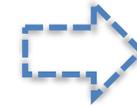
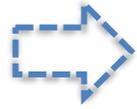


<https://youtu.be/dFjsPwa9oIg>

Generative AI

One-shot prompt

“Summarize the maintenance reports for this asset”



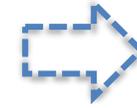
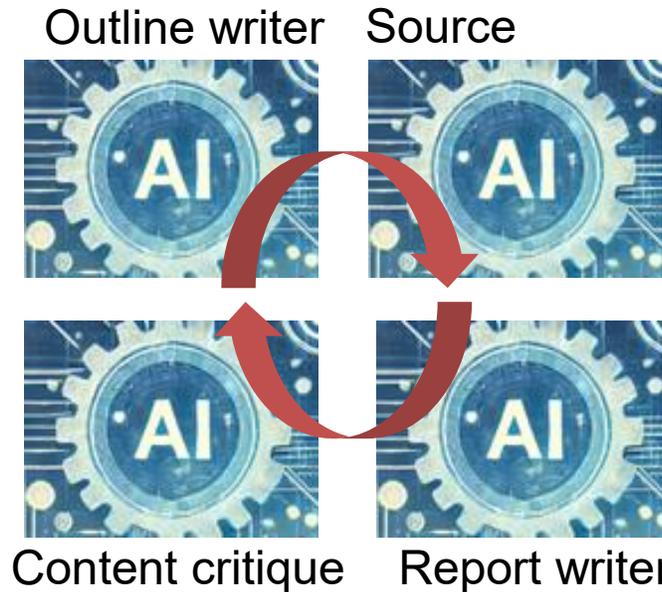
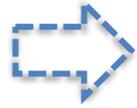
Fit for purpose?

Accurate?

Biased?

Agentic workflow

“Summarize the maintenance reports for this asset”



Use cases and technologies



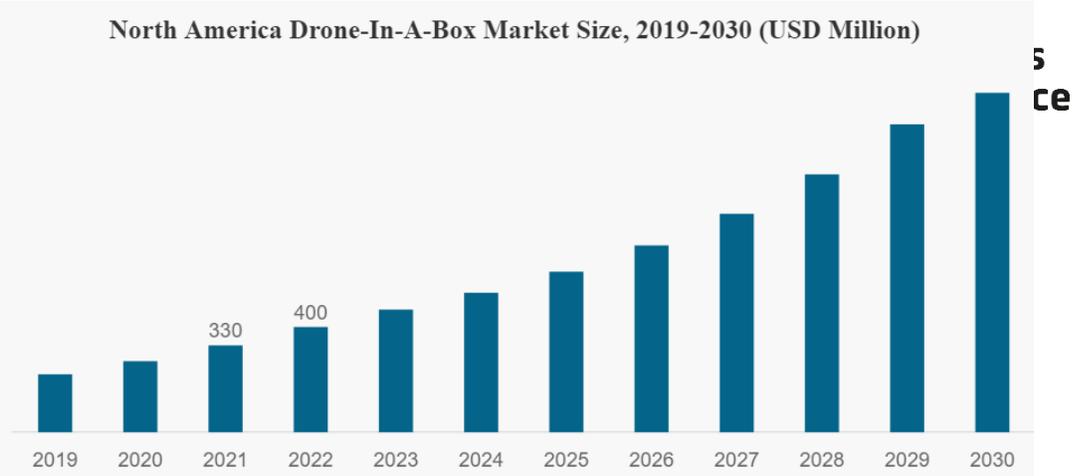
<https://www.youtube.com/watch?v=RwtNgUHU6ml>



<https://youtu.be/YMo3QNEov7U?si=aYIDVv5y2vxwDySz&t>

An aerial photograph of a long bridge spanning a wide body of water. The scene is captured during sunset or sunrise, with a warm orange and yellow glow on the horizon. The bridge's structure is silhouetted against the water and the sky. The text is overlaid in the center of the image.

**More than
617,000
bridges across the U.S.**



<https://www.fortunebusinessinsights.com/drone-in-a-box-market-108470>



2017



2023

SINTEF



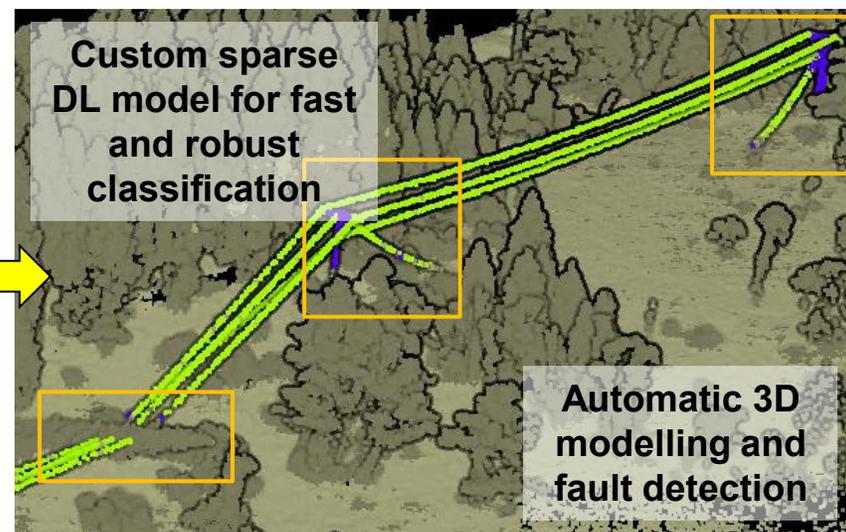
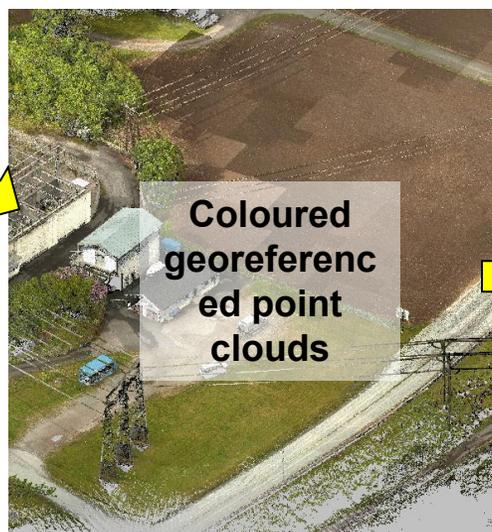
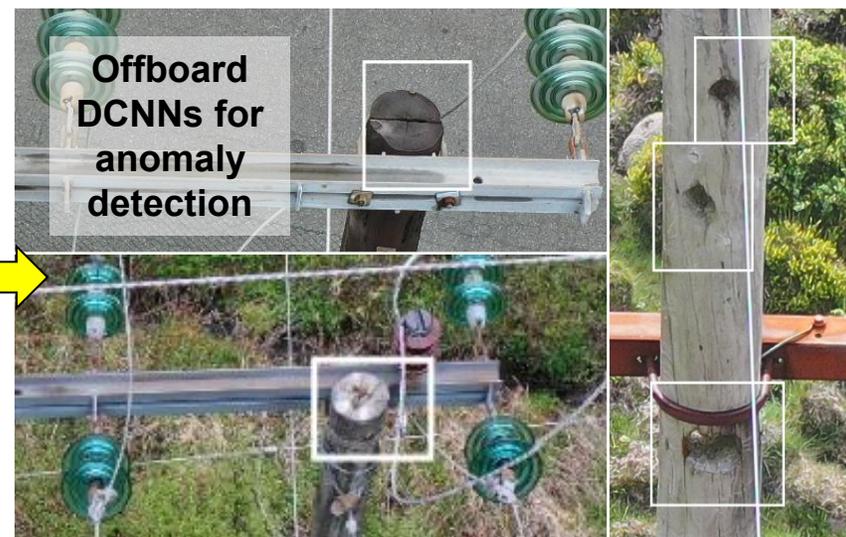
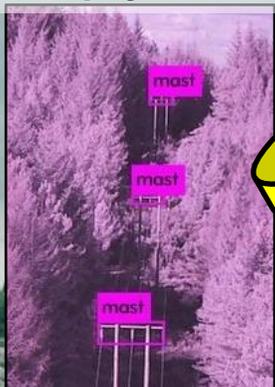
SINTEF

Visual/lidar fault detection of the electrical grid

World Class Maintenance

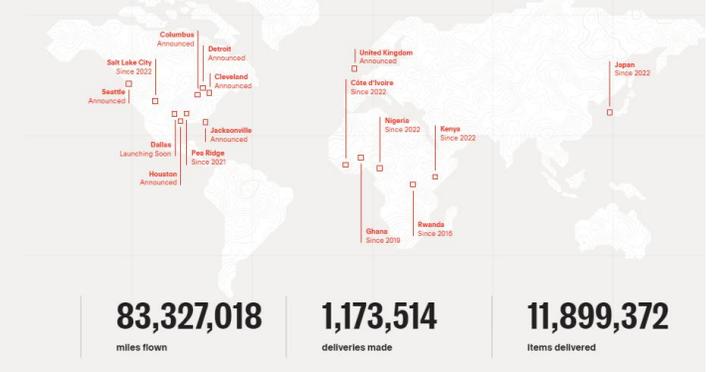


Onboard mast detection to steer inspection payload



Drone logistics

Zipline designs, manufactures, and operates the world's largest drone delivery service.



2024

<https://www.flyzipline.com/>

Airbus tests first shore-to-ship drone deliveries

By BEN SAMPSON — 27th March 2019 2 Mins Read

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2019

NRK Logg på

Vestland

Snakk med oss Vestlandsrevyen P1 SF P1 H Vestland i dag

Her flyr dei for første gong utstyr med drone til Nordsjøen

MONGSTAD (NRK): Minihelikopter skal i 150 km/t frakte kritisk utstyr til Nordsjøen – heilt utan menneskap.



2020

<https://youtu.be/hPv2FbaqIX8?si=RcdY02PkQOT1R3W9>

A photograph showing a large, modern drone operating center in Bergen, Norway. The center features a large, open-plan space with a grid floor and various equipment. An inset image shows a white drone in flight.

New drone operating center in Bergen

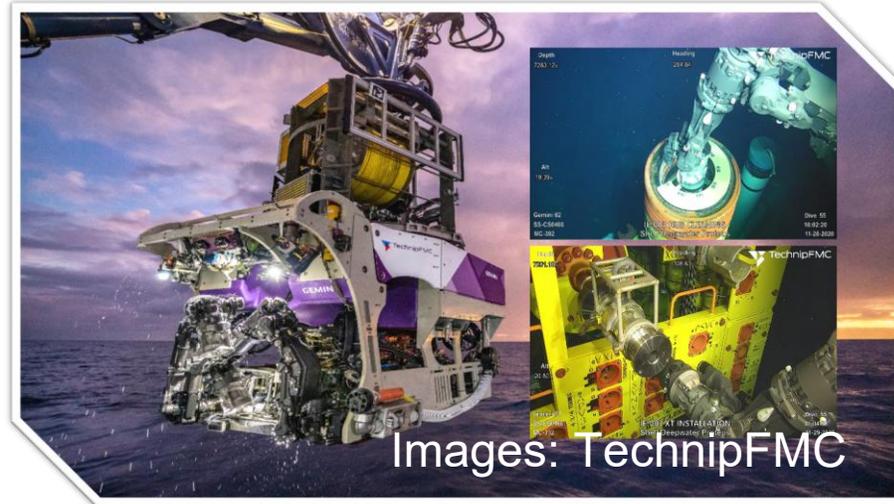
Equinor 16.4K subscribers [Subscribe](#) [36](#) [Share](#)

2023



2020 Up to 30-day diving.
Semi-autonomous.

Subsea I&M



Saipem's underwater drone hits milestone with six-month-long uninterrupted operations

World Class Maintenance

INNOVATION

May 6, 2024, by Nadja Skopljak

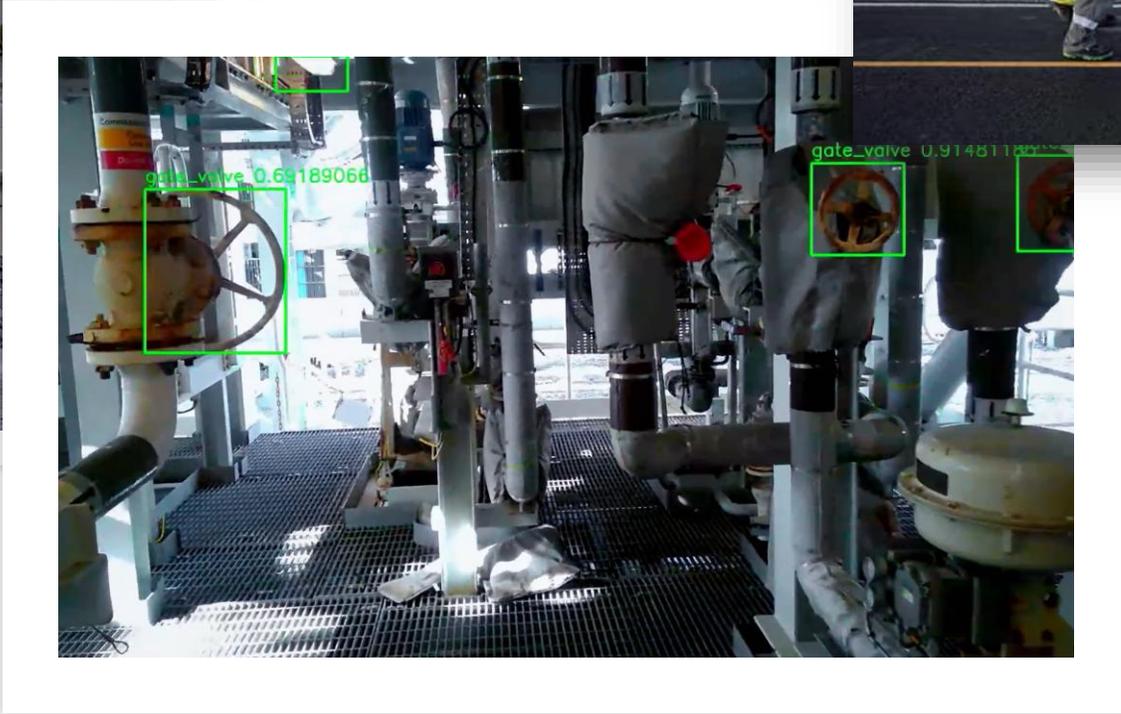
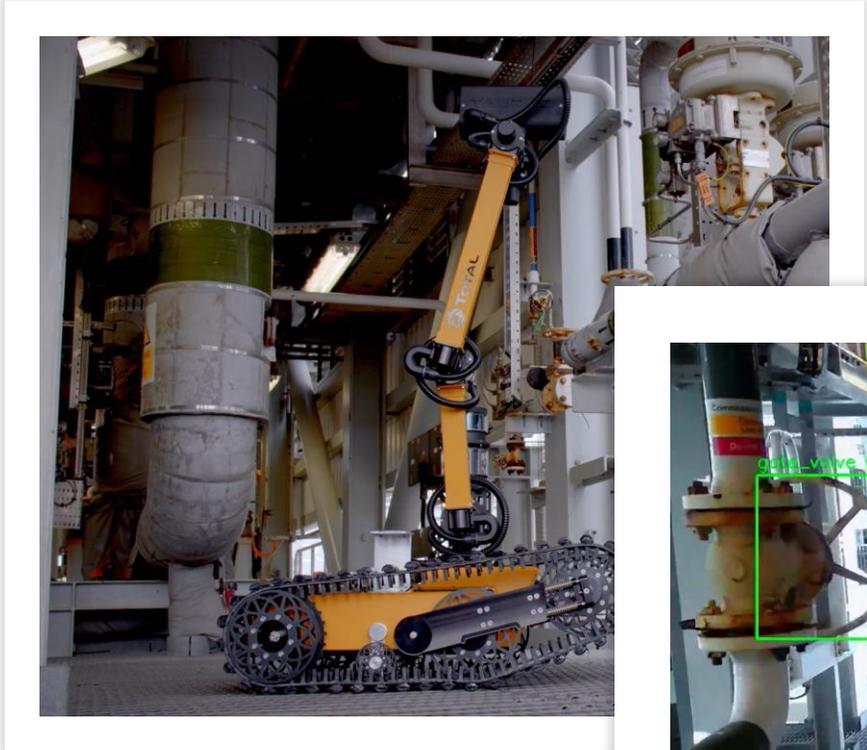


2023/2024 Resident. AUV+ROV.
Semi-autonomous.

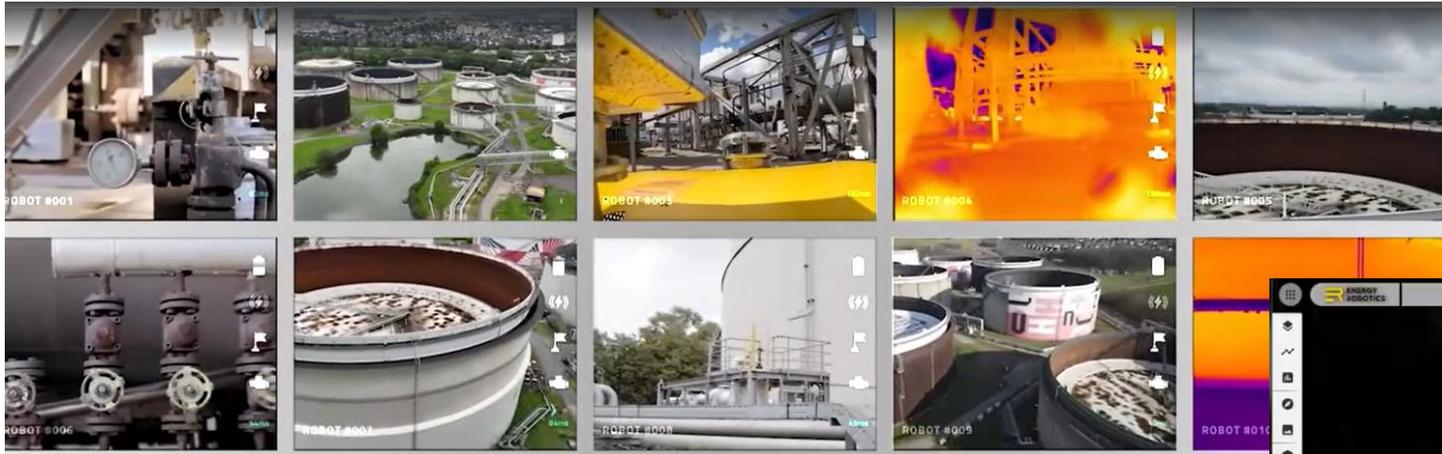


2017 Resident. Tethered Remote controlled

2025 ROV + Uncrewed Surface Vessel (USV)



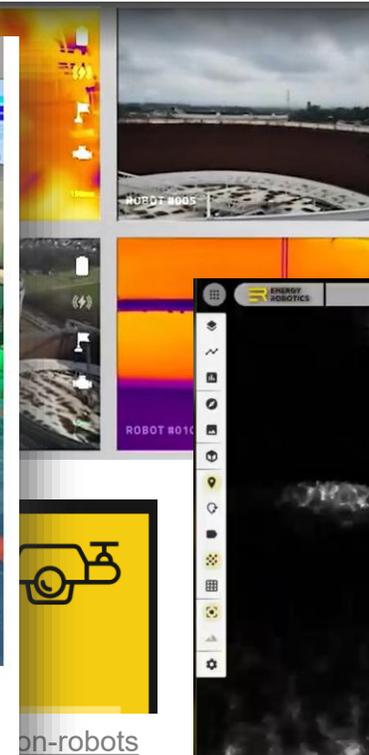
Robot fleet management



Screenshots from <https://www.energy-robotics.com/inspection-robots>



Robot fleet management



**Amazon makes ANYbotics part of its
AWS industrial cloud offering**

<https://roboticsandautomationnews.com/2024/09/11/amazon-makes-anybotics-part-of-its-aws-industrial-cloud-offering/85530/>

High pressure drone cleaning/spraying





System T

[Home](#) > [Products](#) > [System T](#)



SURFACE
DYNAMICS



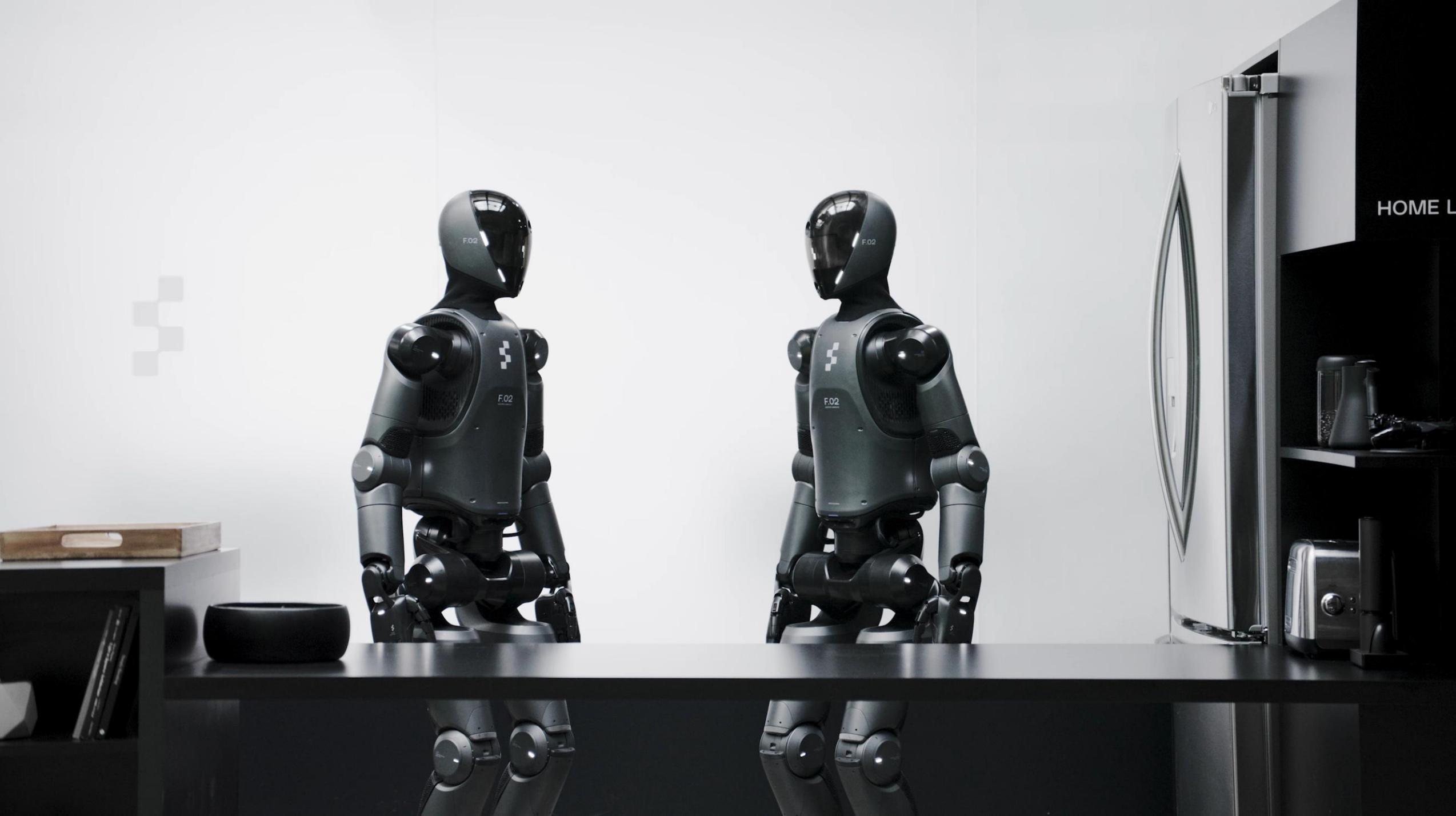
OceanTech

World Class
Maintenance



The Research
Council of Norway

SINTEF



HOME L

BMW
GROUP



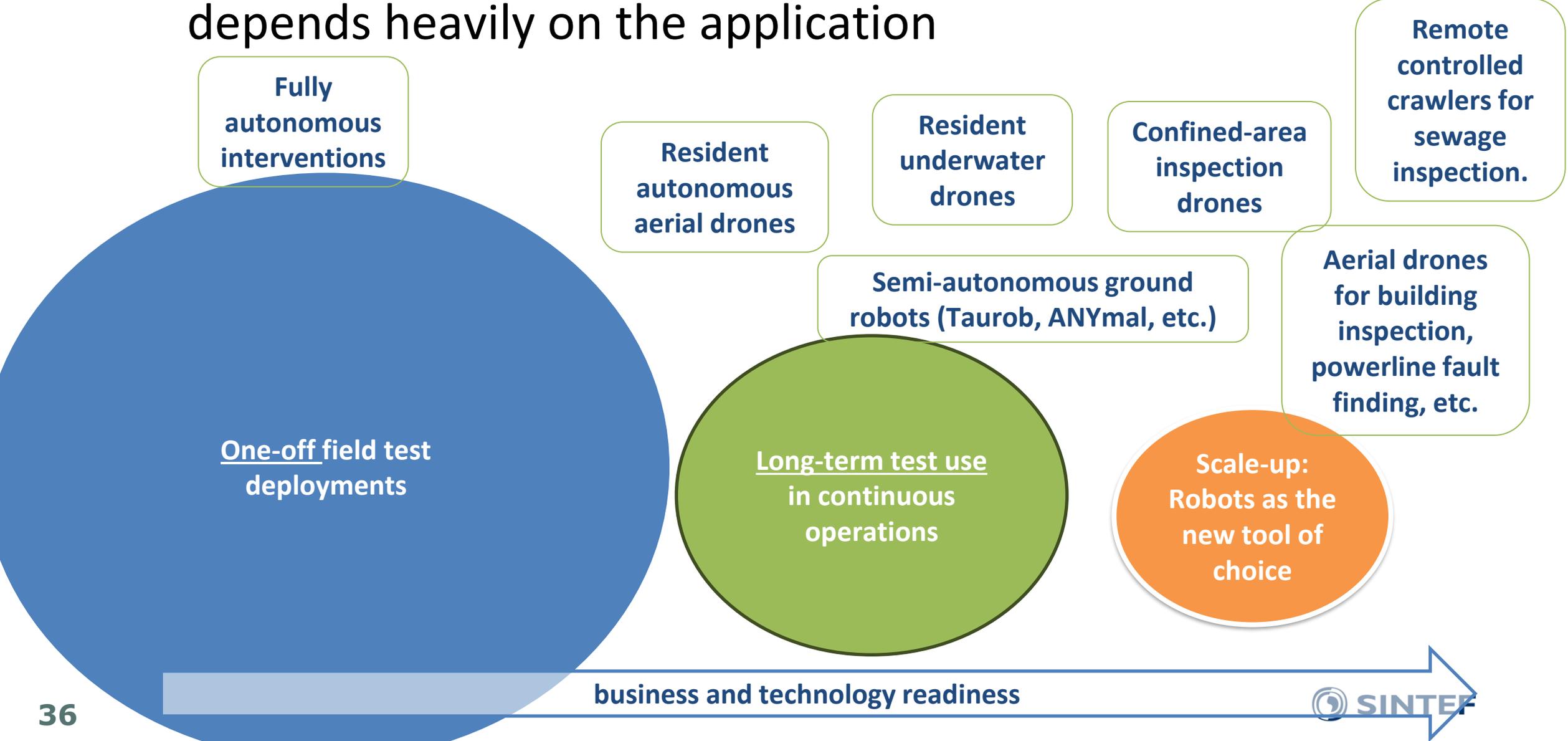
ROLLS-ROYCE
POWERTRAIN

PRODUCTION TESTS WITH HUMANOID ROBOTS

F.02

Ecosystems and business development

Commercial adoption of I&M robotics depends heavily on the application



Research and industry clusters on I&M robotics in Europe and Norway

I&M topic group

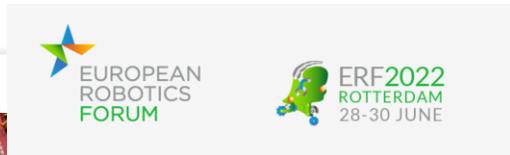


The AI Data Robotics Association

<https://adr-association.eu/>



I&M topic group



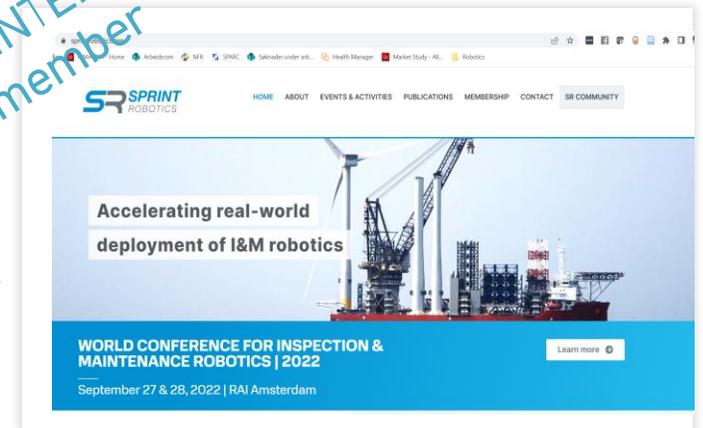
ERF2022 workshop: From one-off deployments to I&M robotics in continuous operation

In this workshop at the European Robotics Forum 2022, suppliers, end-users, and R&D personnel will present and discuss key factors to enable transitioning from "one-off" test deployments to inspection and maintenance (I&M)



<https://www.sintef.no/RINVE>

SINTEF is member



sprintrobotics.org



Norwegian industry network

Want more I&M robotics info?

Use of UAS for Overhead Powerline Inspection in Norway - Status and Challenges*

1st Mariann Merz
SINTEF Digital
Trondheim, Norway
0009-0003-5957-309X

2nd Tom Ivar Pedersen
SINTEF Energy Research
Trondheim, Norway
0000-0003-4206-7185

3rd Sture Holmstrøm
SINTEF Digital
Trondheim, Norway
sture.holmstrom@sintef.no

Abstract—Over the past decade, Unmanned Aerial Systems (UAS) have emerged as pivotal tools in fault localization inspections and scheduled assessments of overhead power lines. Driven by technology advancements and the promise of safer and more efficient inspections, the adoption of UAS among electrical grid operators has witnessed significant growth. This paper examines the associated operational aspects through structured interviews

[8], and large-scale infrastructure inspection and maintenance [1], [3] - [6]. These industries rely on aerial data collection, with early adopters seeing drones as a cost-effective, flexible, safe, and environmentally friendly alternative to manned aircraft or helicopters. However, as for most disruptive technologies, regulations have struggled to keep pace with technolo-

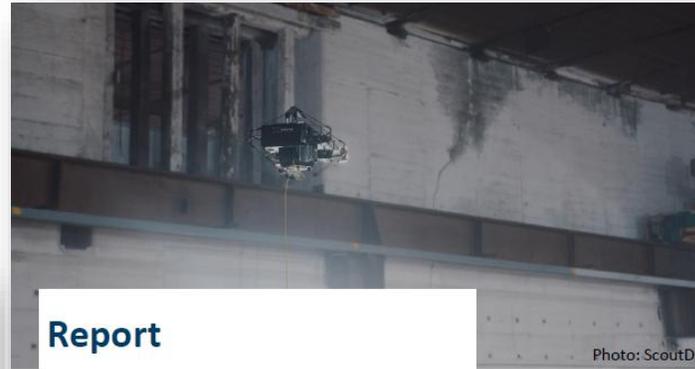
Research Article

An autonomous drone-based system for inspection of electrical substations

Helge-André Langåker¹, Håkon Kjerkreit¹,
Christoffer L Syversen¹, Richard JD Moore², Øystein H Holhjem³,
Irene Jensen⁴, Aiden Morrison⁴, Aksel A Transeth³,
Oddgeir Kvien⁵, Gunnar Berg⁵, Thomas A Olsen⁶,
Alexander Hatlestad⁶, Thomas Negård⁷, Rolf Broch⁷
and Jørn E Johnsen⁷

INTERNATIONAL JOURNAL OF
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International Journal of Advanced
Robotic Systems
March-April 2021: 1–15
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Report

Market Study on Inspection and Maintenance Robotics in Norway

Suppliers, Market Needs and Challenges

Author(s):

Mariann Merz, Aksel A. Transeth, Linn Danielsen Evjemo,
Eleni Kelasidi

Report No:

2023:00938 - Unrestricted

Photo: ScoutDI



Rapport

Undersøkelser av fordeler og ulemper ved landstyrt ROV-inspeksjoner og -operasjoner på undervannsanlegg

Forfattere:

Christoph Thieme, Esten I. Grotli, Tony Kråkenes, Stig Winge, Aksel A. Transeth

Rapportnummer:

2025:00725 - Åpen

Oppdragsgiver:

HavindustriTilsynet

World Class
Maintenance

SR SPRINT
ROBOTICS



Robotic Field Worker Solution:
Operational deployment best
practices and processes

SINTEF

Contact: Aksel.A.Transeth@sintef.no



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