

Selected!

**Progress on applications of robotics
on nuclear and radiological sites**

**IEEE RAS Nuclear Facilities TC
IEEE 40th ICRA London 2023**

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IEEE & RAS Member**

*Apologies to the
huge amount of
work I can't
mention in
10mins!*

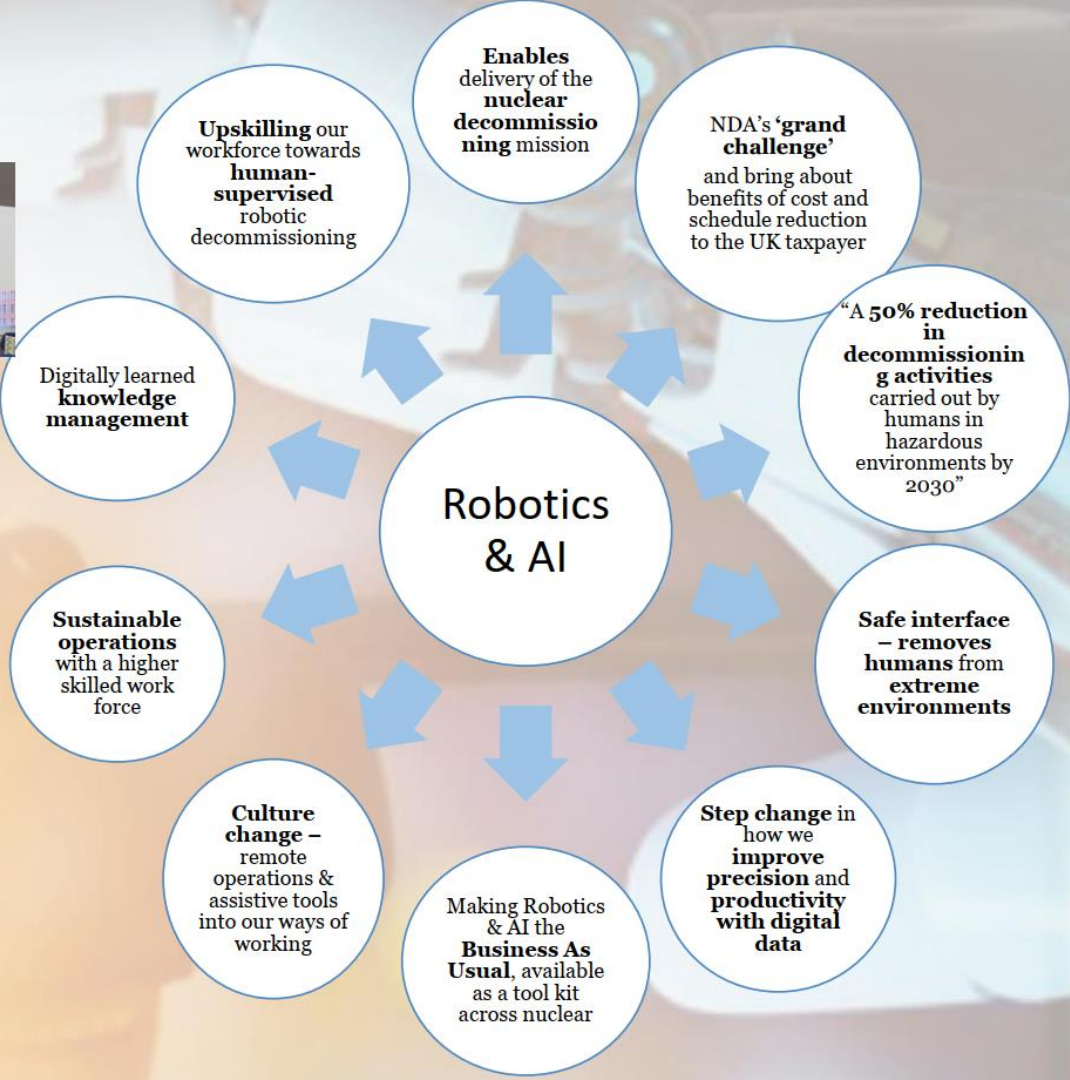
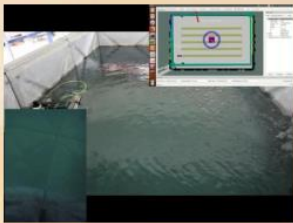
Why Robotics & AI...



Development of hands out of gloveboxes, UoM & UKAEA



Deployment into Magnox reprocess facility, Sellafield





LongOps

LongOps is a £12M UK-Japanese robotics project to develop robotic capability that will support delivery of faster and safer decommissioning at Fukushima Daiichi in Japan, and Sellafield and the JET fusion reactor in the UK.



CENTRAL ROBOTICS & ARTIFICIAL INTELLIGENCE TEAM



Academic Landscape

UKRI has invested significantly in academic robotics research



4 hubs established with £46M to support translation of academic research into industry

Partners and facilities

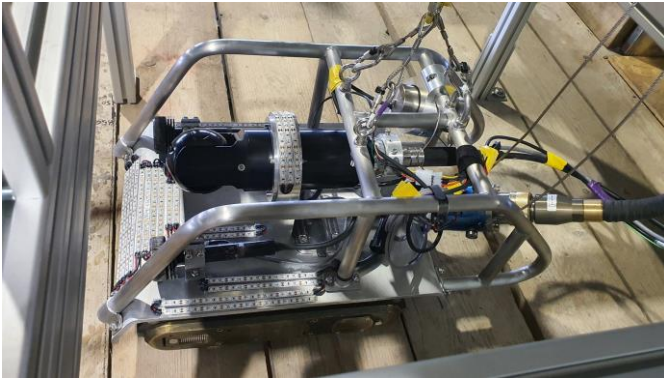
The National Nuclear User Facility for Hot Robotics (NNUF-HR) is an EPSRC funded facility to support UK academia and industry to deliver ground-breaking, impactful research in robotics and artificial intelligence for application in extreme and challenging nuclear environments.



Remotely Operated Vehicle Inspection in Vitrified Product Store (1)

Challenge

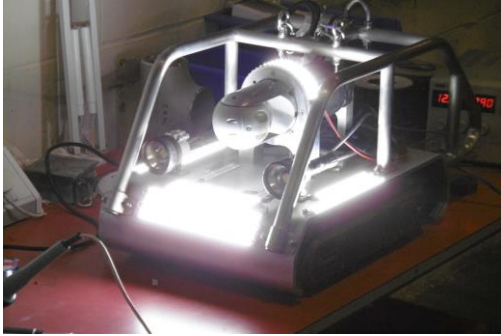
- Access was required to the Vitrified Product Store to check what was happening inside.
- However the store itself is difficult to get into, and inside has radiation levels that can cause even the toughest technology to fail.



Solution (1)

- Sellafield Ltd worked with the NNL Plant Inspection, Characterisation and Development & Remote Engineering, Design and Robotics teams to develop a new Remotely Operated Vehicle (ROV)
- The ROV had to be able to negotiate a 30m vertical drop, before travelling a 20m inspection route around obstacles; all this whilst in a gamma radiation field 10 times the highest radiation levels usually found in the hot cells at Sellafield.

Remotely Operated Vehicle Inspection in Vitrified Product Store (2)



Solution (2)

- Video footage was taken by a HD quality, radiation hardened Ahlberg camera.
- The end, fit-for-purpose solution also included temperature, humidity and radiometric sensors; lighting to improve the end image quality; and a rear facing camera to support the tricky navigation.

Benefit

- The ROV with extra tough components and extra radiation shielding has been successfully tested, giving a better understanding of the store condition and evidence to plan future stores.
- It is also fully reusable and can be sent back in to check on possible degradation over time.
- This solution combines Commercially Off The Shelf (COTS) components to create a bespoke umbilical controlled, highly manoeuvrable and reliable ROV with a custom array of inspection equipment, together with a unique deployment solution.



Case Study: Lyra, Active duct inspection, Dounreay



Dounreay



Challenge:

- Inaccessible ventilation duct
- Rad contaminated environment
- Confined space working
- Unknown materials & hazards

Current solution:

- Restricted air-fed suit entry
- 2,250 hrs air fed suited entries
- 450-500 individual entries @ £10k / entry

BENEFITS:

- Remote operation using Lyra
- Tetherless in confined spaces
- Digitally captures images, videos and 3D mapping
- Rad swabbing and monitoring

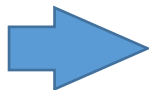


Added benefit:

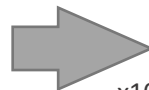
- + no air fed suit entries
- + Fewer health physics
- + No union issue
- + Fixable & replaceable
- + Improved working time
- + Resilient robots
- + Re-deployable elsewhere
- + R&D saving



12mths



9mths (idea -> trial -> demo -> deploy)



x100 deployments



£500M approx



x10's Years



Deployed Technology



Contamination control
suit



LiDAR Mapping



3 x Radiometrics



Wireless comms

createc

Boston Dynamics 

GOLD SOLUTION
PARTNER



2018

2019

Case Study: B203, Alpha contaminated cell

RAICo



Sellafield Ltd



Challenge:

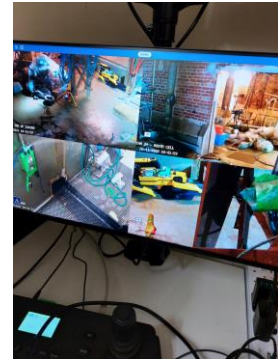
- Structurally unstable cell
- Alpha contaminated environment
- Restricted safe working zone
- Physical safety hazards
- Access to materials located outside of safe working zone

Current solution:

- Restricted air-fed suit entry (1.5 entries /team /shift)
- 17hrs /mth and 50 people
- Slow risk reduction decommissioning progress

BENEFITS:

- Remote operations using SPOT, robot dog (quadrupedal)
- Climbs stairs, picks up & carries items
- Relocate bags of waste (outside of safe working zone) down 2-storeys to a safe sorting area
- Digitally captures images, videos and 3D mapping
- Substantiation data for structure & assessments
- Existing operators undergone robotic training
- 3 SPOT entries /shift and 1 FTE operator
- Sellafield & UKAEA Collaboration under RAICo

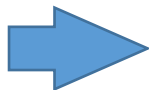


Added benefit:

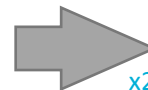
- + Reskilled operators
- + Fewer health physics
- + No union issue
- + Fixable & replaceable
- + Improved working time
- + Resilient robots
- + Re-deployable elsewhere
- + R&D saving



18mths



4mths (idea -> trial -> demo -> train -> deploy)



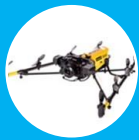
x200 deployments



>> £100M approx



>> Years



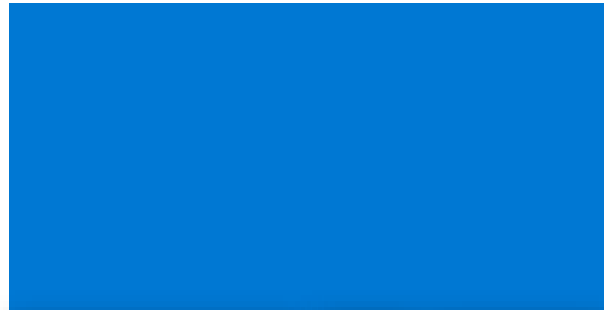
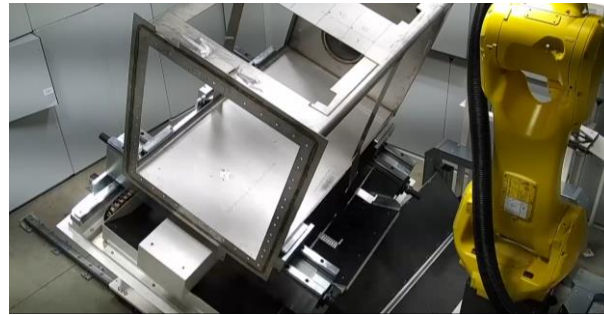
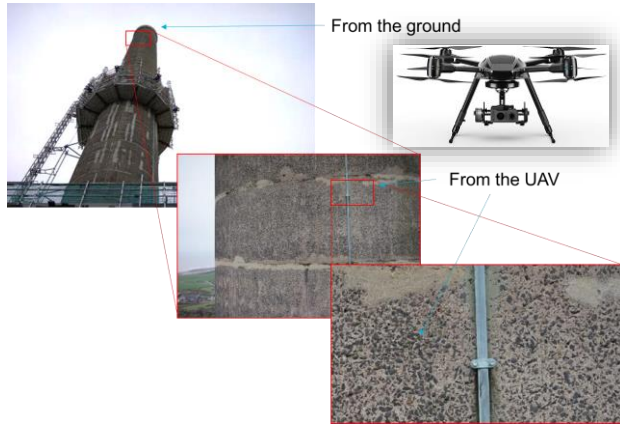
Air



Land



Water



- Beyond Visual Line of Sight (BVLOS)
- Conduct semi-autonomous inspection and survey missions in a routine manner whilst on the site.

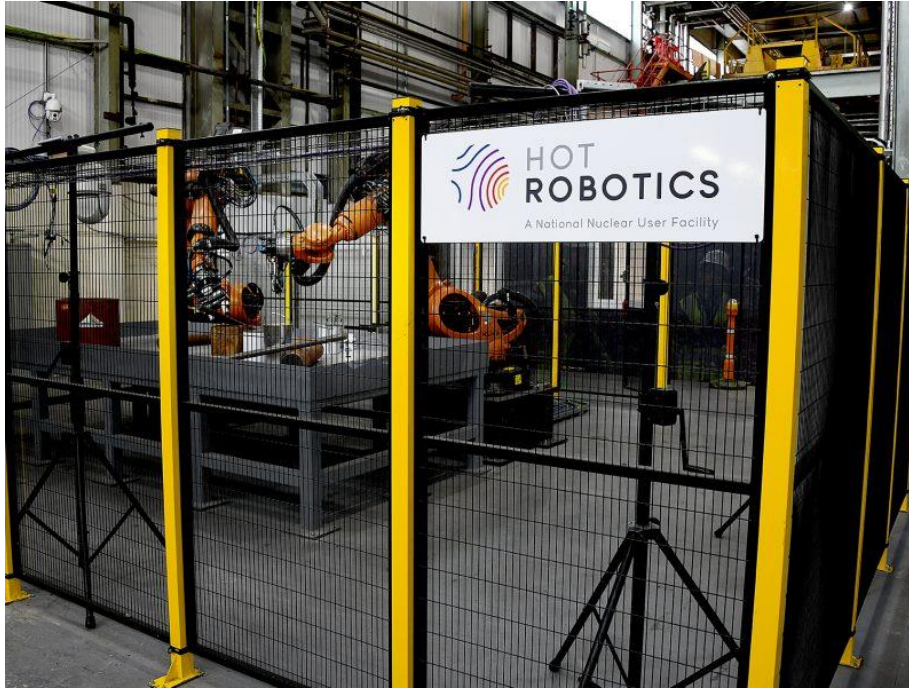
- **Detached** Beyond Visual Line of Sight (DBVLOS)
- Conduct semi-autonomous inspections and survey missions from a **detached location** (100s of miles between pilot and craft)



RAICo Principles

- End user led **Robotics and AI Collaboration** on research projects
- Step 1: RAICo1 – Close to end-user, but many have engaged
- Challenges from **fission** decommissioning and **fusion** engineering for mutual benefit (building on LongOps)
- Operationalise of 'this gen' robotics into the nuclear sector
- Develop & deploy remotely operated solutions for decommissioning
- Intelligent client and supply chain capability and capacity
- Socio-economic impact and skills development (Levelling Up)
- Start of a long-term collaboration
- 3 year investment aligned to the SR period [*short term*]
- Address NDA group challenges longer term





National Nuclear Laboratory, Workington Facility

NNL's Workington facility comprises of equipment and flexible floorspace to develop, test, and demonstrate robotic solutions for the nuclear industry.

The research test rigs available at the>NNL Workington Laboratory act as a link between low TRL robotics research and technology progression to TRL 6/7.

