

Machine Vision for Glovebox sharp object recognition using 3D

Richard French, i3D Robotics

i3D Robotics – Quick Introduction



industrial 3D
robotics

**i3D Robotics are experts in 3D vision technology focused on stereo imaging.
3D machine vision, integration into autonomous systems and robotic platforms.**

Active markets to address customer challenges by providing vision in unmanned areas:

- Sector agnostic – difficult to access, hazardous environments
- Nuclear decommissioning, Fusion Energy R&D
- Production optimisation of metals, glass and ceramics.
- MRO in aerospace, nuclear and defence
- Telepresence, Telexistance & Digital Twinning



Our Technology Applications

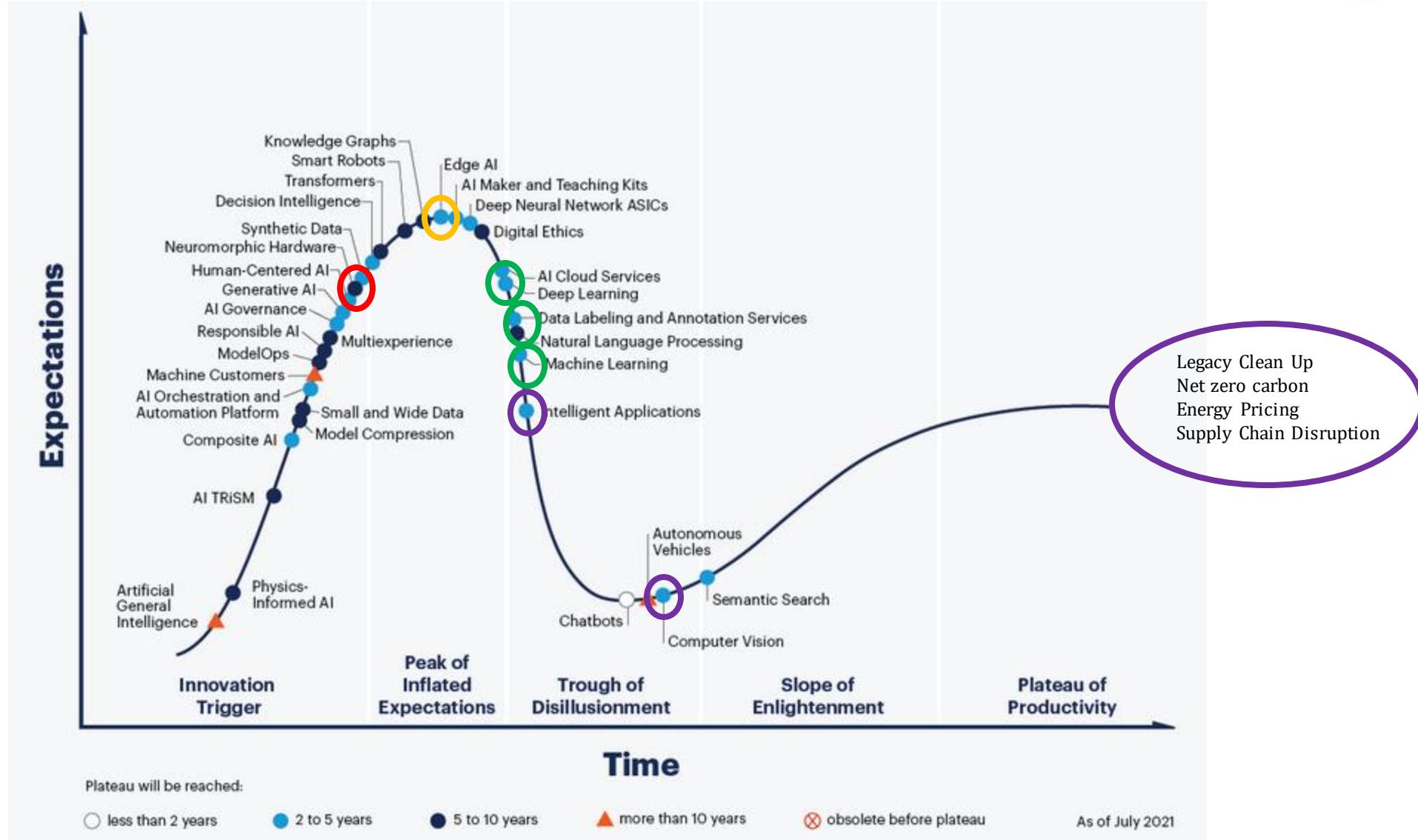


3D stereo vision systems, ML & AI being used to benefit:

- **Supporting zero carbon manufacturing**
- Reduce cost by improving processes in manufacturing, reducing material & energy consumption, thereby reducing costs, limiting waste through non-destructive fault detection
- **Delivering Industry 4.0 solutions**
- Remove danger to people - make nuclear decommissioning cheaper, faster & safer
- Health Physics applications - supports radiation detection & mapping
- Remove human error by in-process inspection & characterisation during manufacturing
- Improve safety & quality in arc welding inspection (in-process and post welding), Wire Arc Additive Manufacturing
- **Integrated Vision / Raman spectrometry package:**
- Characterise unknown substances from a distance - Real-time mapping of scene and of target substance location within a scene or area.



Reflecting back to 2021: Hype Cycle for AI



The SSL Challenge :

Identifying unknown sharps in gloveboxes

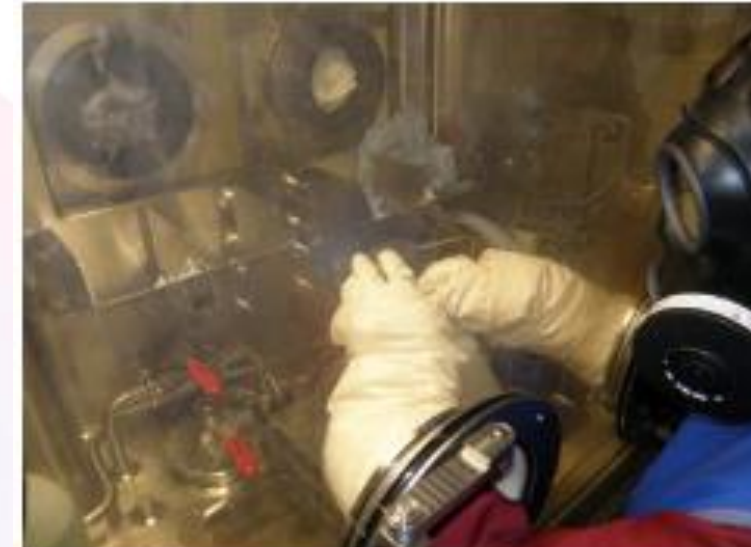
Launched June 2018

- Around 350 gloveboxes on site
- Up to 60 years old, degraded windows with little or no lighting, so poor visibility
- Contain clutter such as pipework & cabling
- Clutter might include sharp objects that present a dismantling hazard
- Need to analyse contents to identify location of any sharp objects



Variety of Gloveboxes: A challenge for vision

- SSL's Ultimate Goal = No hands in gloveboxes!



[Images Online] <https://i3drobotics.com/i3dr-changing-the-game-in-nuclear-decommissioning/> accessed 02/02/2023

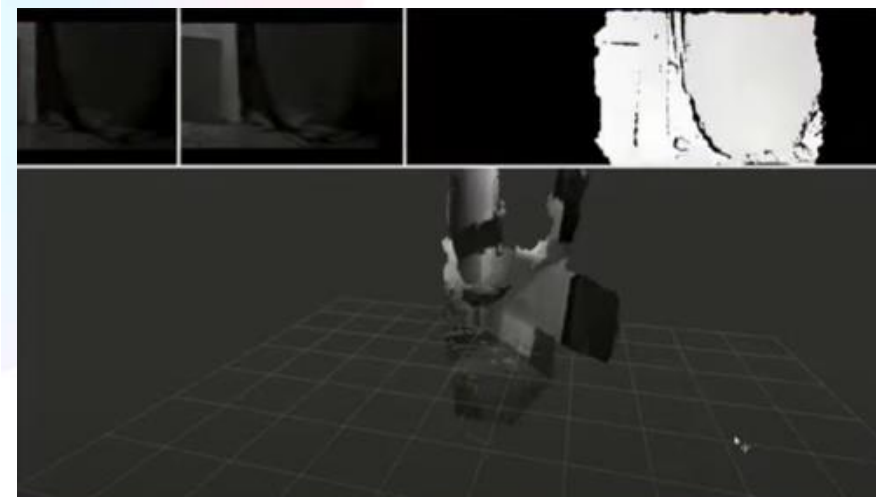
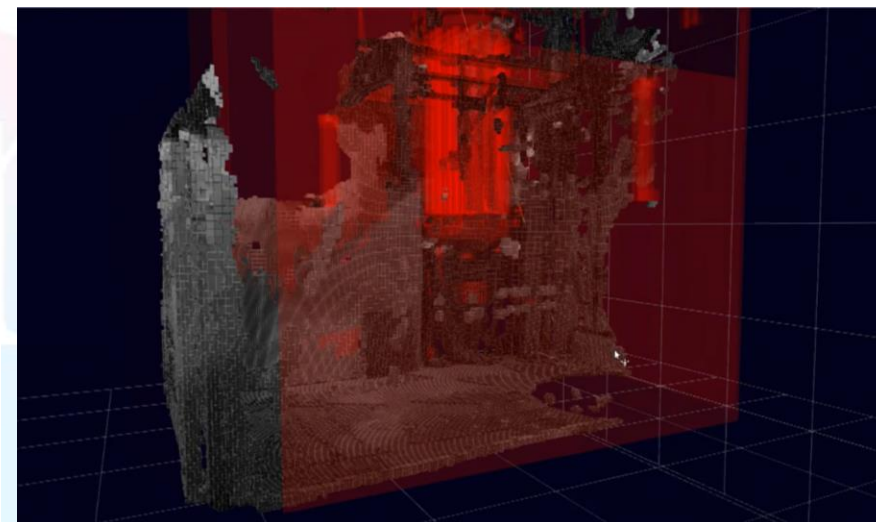
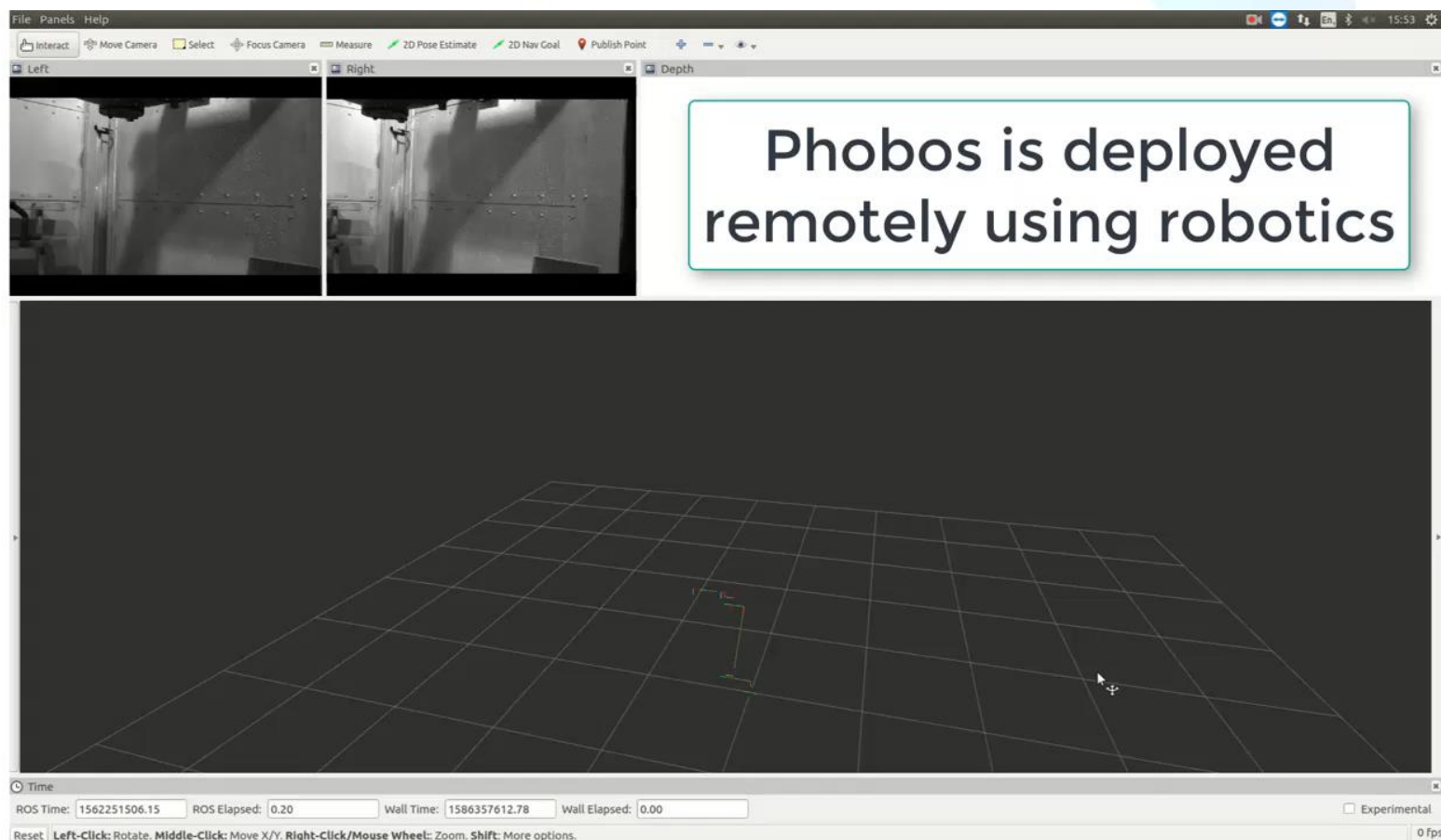
Older gloveboxes: Note the old gloves are 'posted' inside and blanking plugs fitted

Alford.R; Plant Dismantling & Decommissioning Challenges. [Online]. ED28. Government Document. [Accessed 02/02/2023]. Available from:
<https://cumbria.gov.uk/elibrary/Content/Internet/538/755/1929/1982/5066/42689153336.PDF>

- All share a common feature of a 150mm / 6" diameter glove port

3D Mapping Nuclear Environments

- Early trials with a Phobos 3D camera with a gantry mounted 6-axis UR-10 collaborative robot



Biologically Driven Design Challenge

PHOBOS: Quality 3D vision at distance

- High resolution stereo camera with using 5MP cameras
- Wide baseline for long range 3D vision (5 meters)
- Mounts for industrial / collaborative robotic arms available
- Metal housing for industrial environments (inc. IP65)



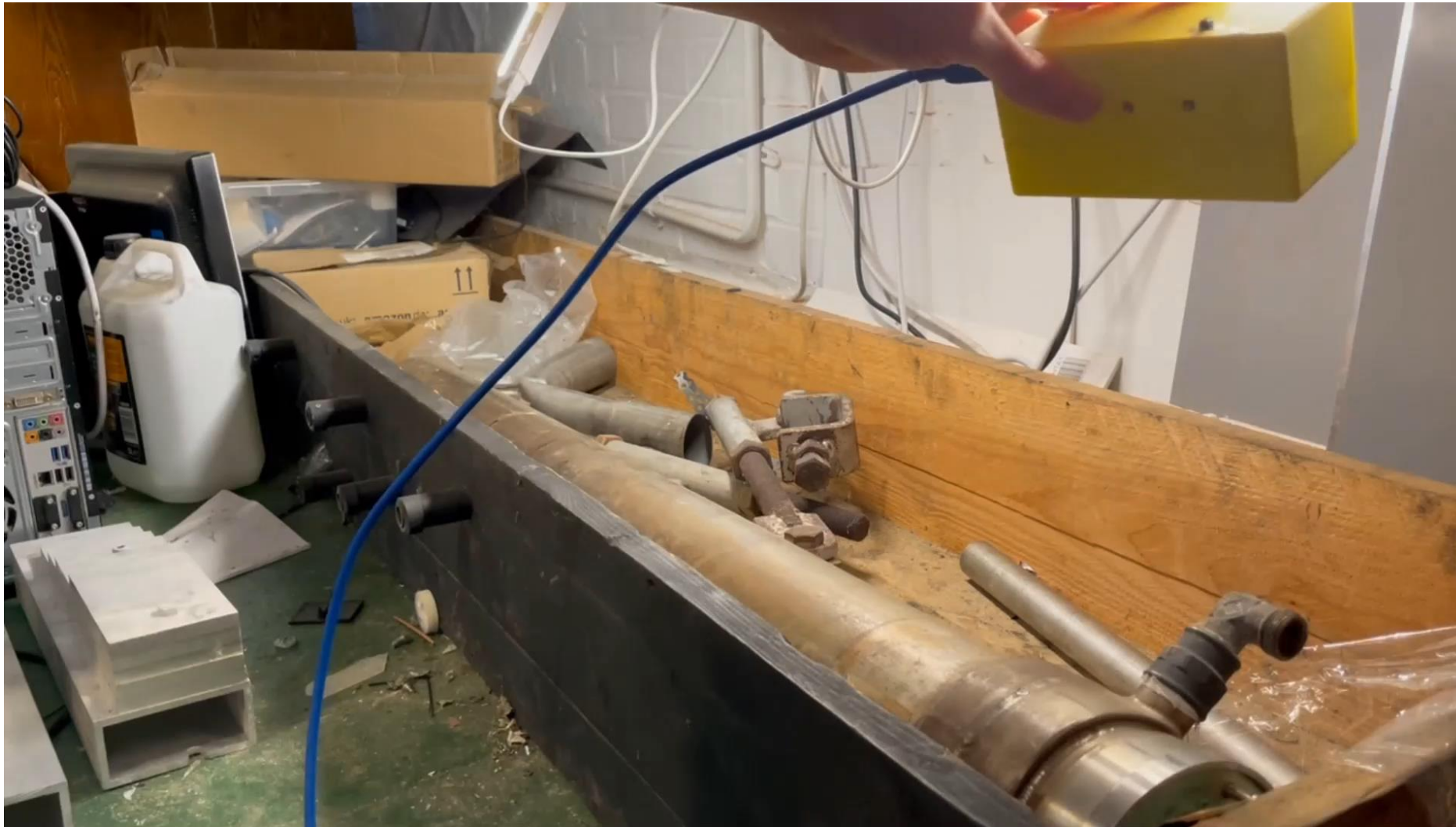
63mm

TITANIA: Detailed 3D vision in the palm of your hand

- Small form factor designed to fit through glovebox ports
- High resolution stereo camera with using 2MP cameras



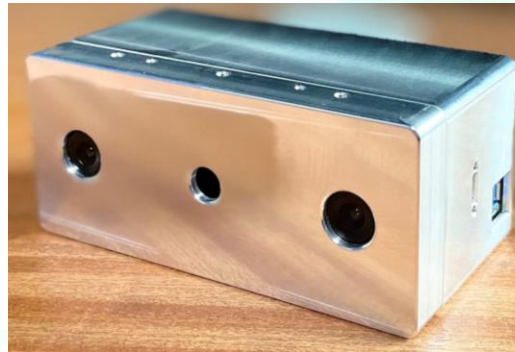
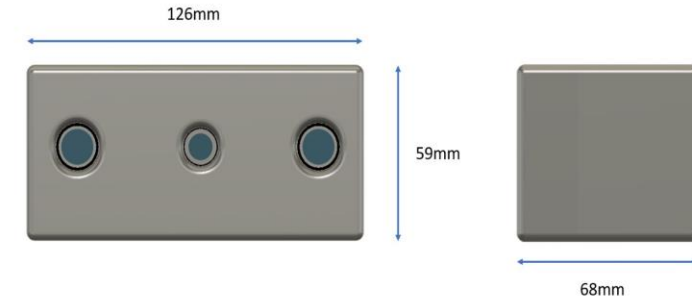
Glovebox mapping solution using 3D



Development of “Titania” for glovebox vision

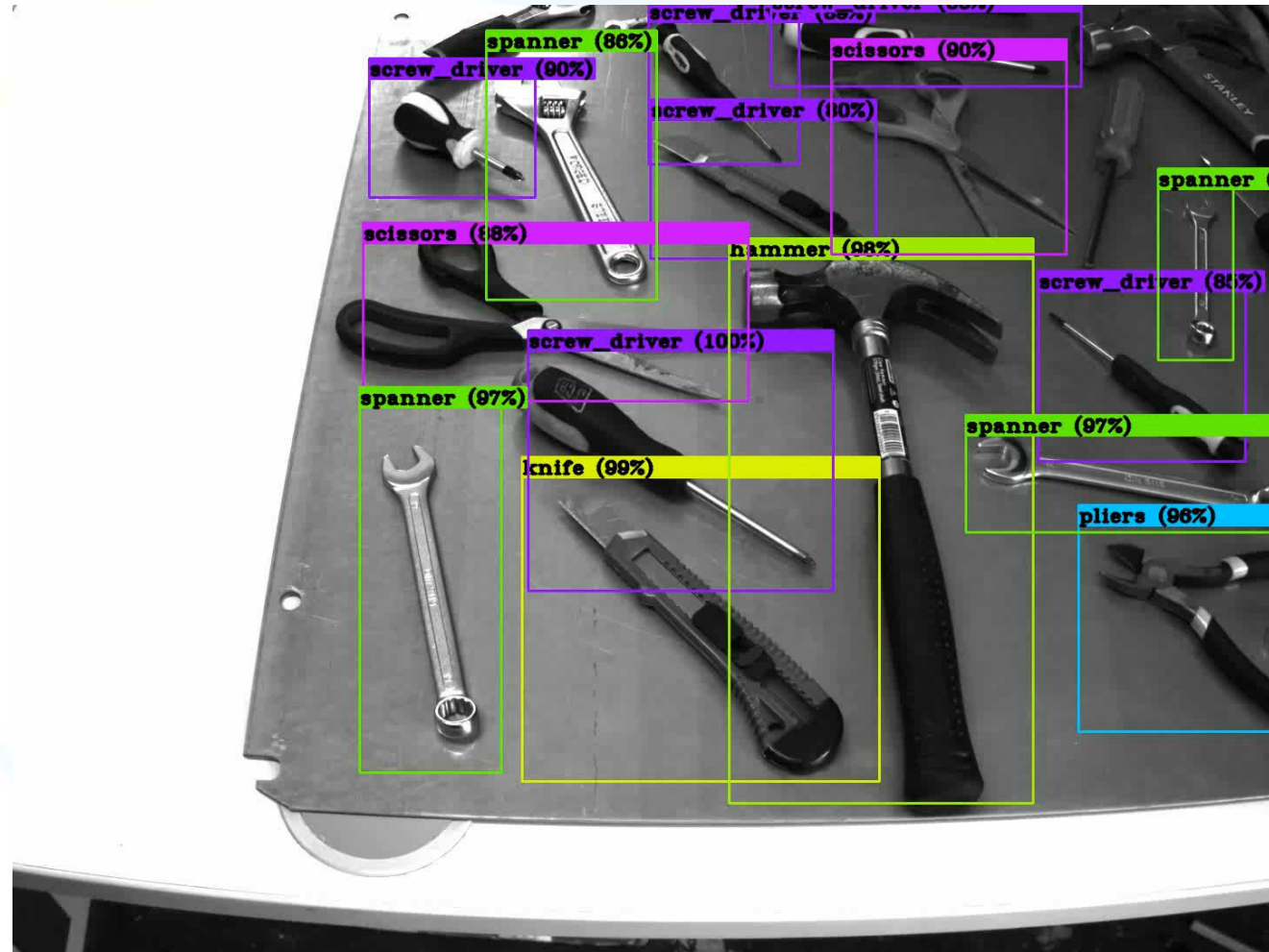
Titania: Detailed 3D vision in the palm of your hand

- Small form factor designed to fit through 150mm glovebox ports
- High resolution stereo camera with using 2MP cameras
- Bespoke mounts for co-bot arms including UR & Kinova
- Available with PA12 (350g) or aluminium (430g) housing for more extreme environments
- Long-term radiation tested [1.25MeV Gamma, TID 330 Gy : Dose 0.5Gy/h] (no shielding)
- UKCA / CE approval



Object Recognition using 3D

- Hand Tools
- Bolts & Fixings



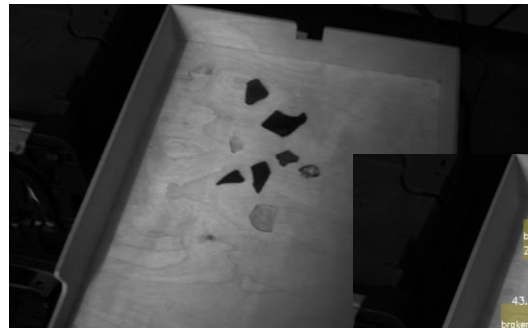
i3D's Complete Solution for Gloveboxes

i3DR has in-house skills in machine learning allowing for custom object detection systems

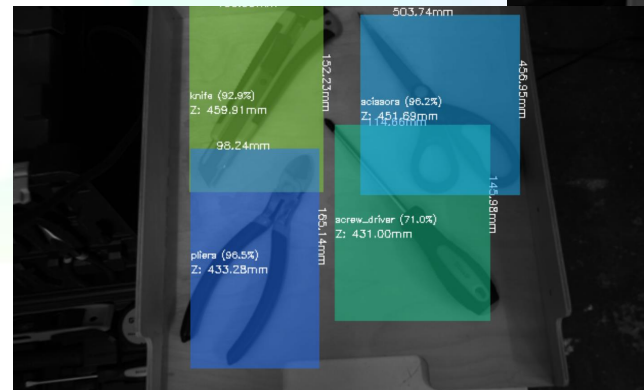
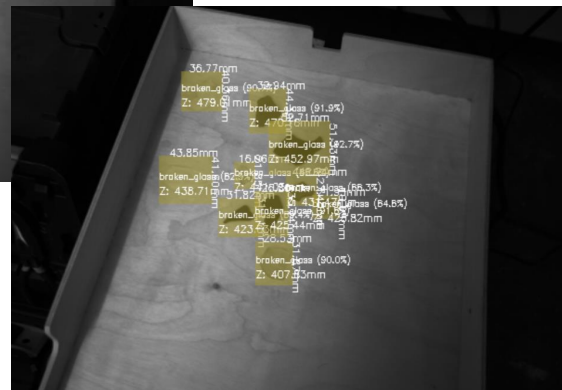
We have pre-trained models for the following objects

- Sharp objects
- Defects in steel, glass, bricks, tiles, aluminium automotive parts, welding (critical fabrications)

This is combined with our 3D generation capabilities to enable localisation of detected objects in 3D space

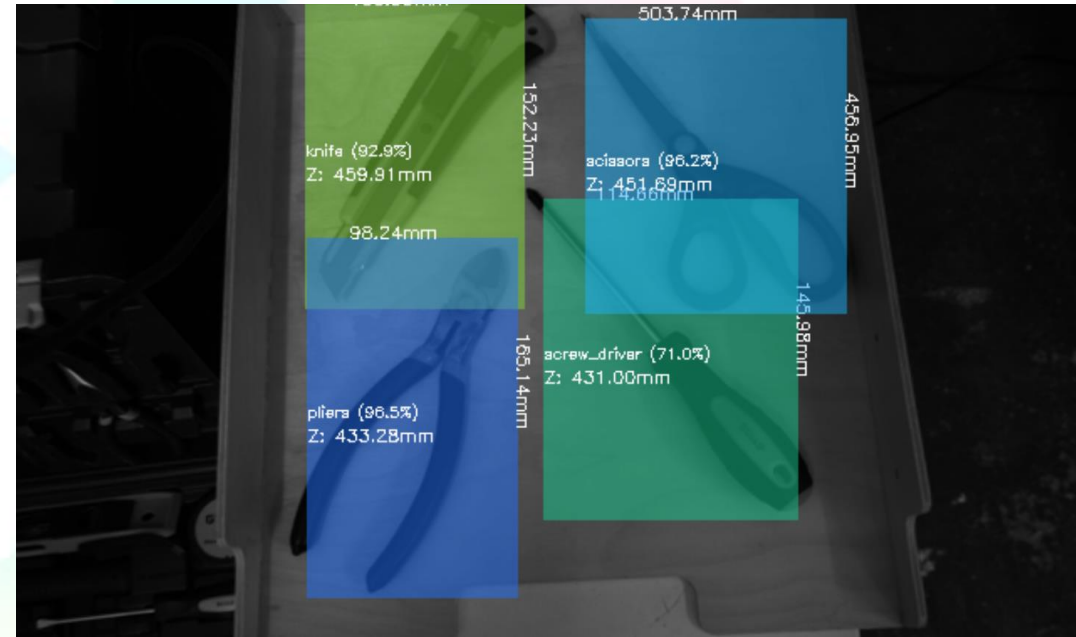
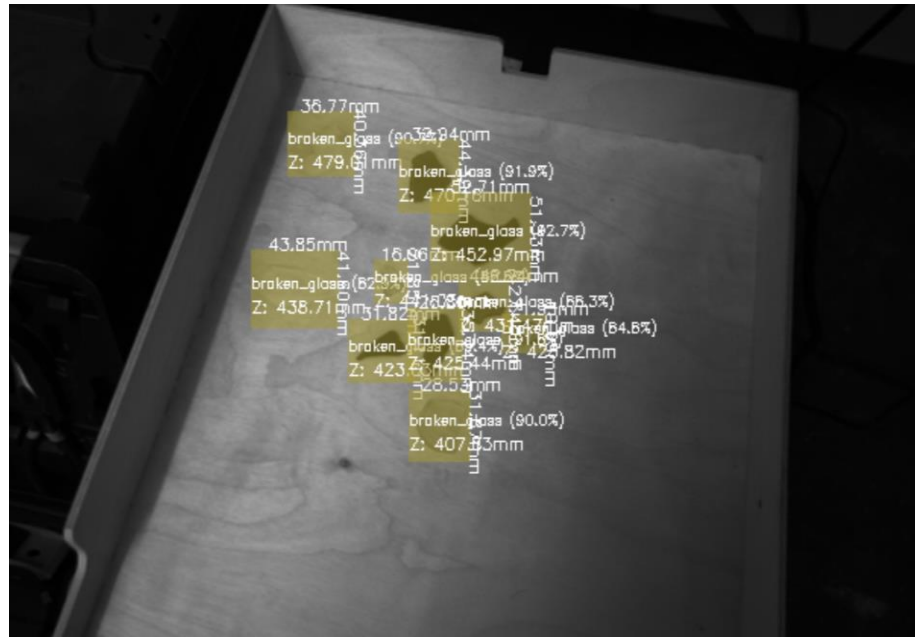


Identification and localisation of objects

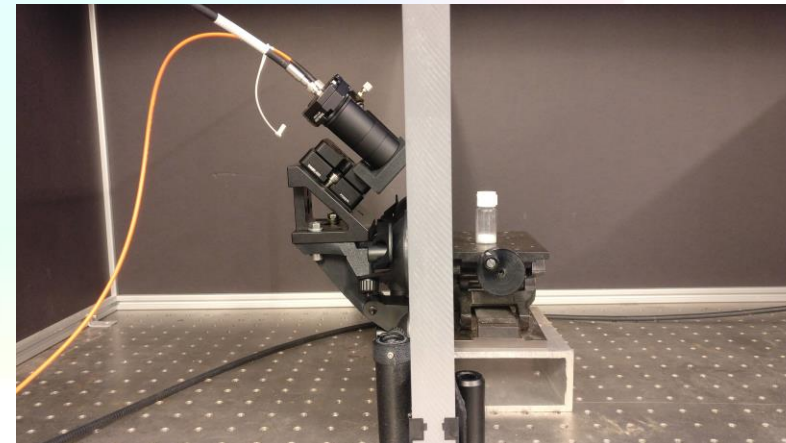


Size / weight estimation

- Underpinned by ML
- Using intelligent software to estimate size and weight
- Using accurate 3D to inform estimation



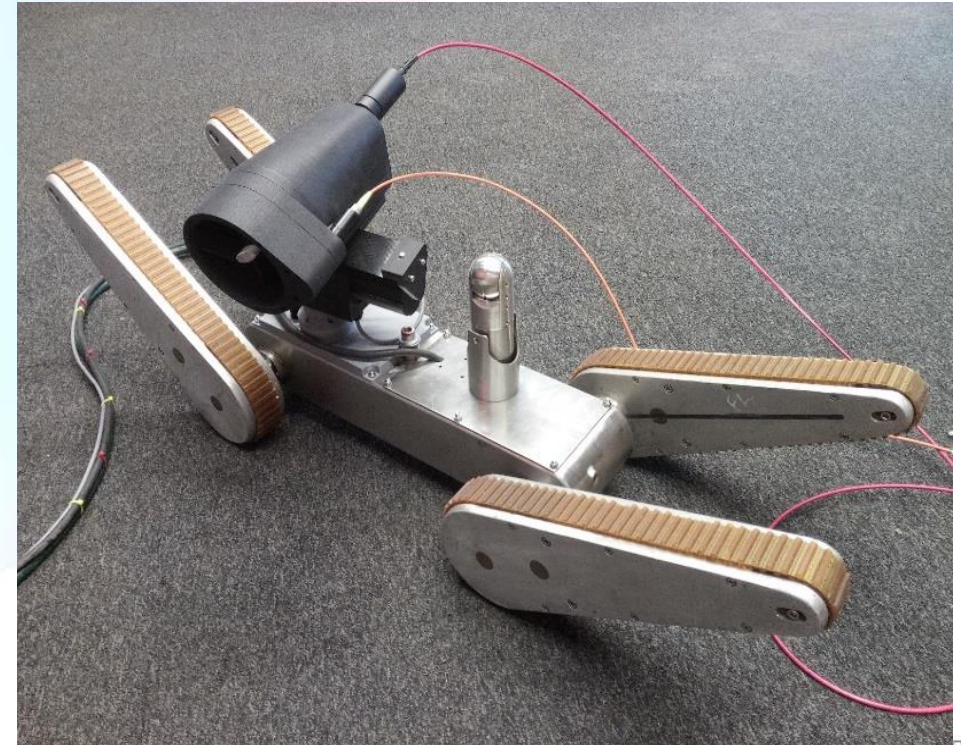
- Have worked with Sellafield and Jacobs to characterise toxic environments such as Cells and Gloveboxes.
- Worked closely with the Pharma industry to test and prove ODIN (A deep-UV system 229nm)
- Developing a new gas Raman analyser (Aura) to target hydrogen, gas blending etc (uses hollow core anti-resonant fibre)
- Have a range of probes
- Ideal for robotics platforms



System demonstrators

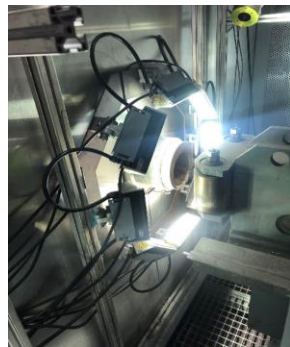
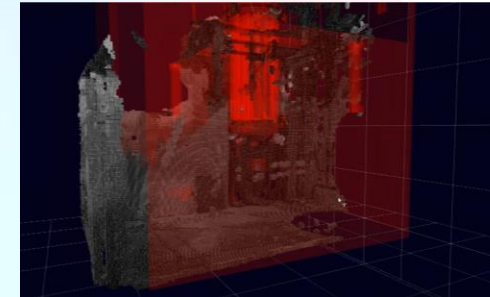
- **ISI specialise in optical metrology solutions for industrial applications**
- **Field deployable, portable Raman spectroscopy equipment for on-site materials and chemical analysis. Able to work in nuclear environments**
- **Modular fibre coupled systems allow for flexible deployment, including on robotic platforms**
- **Markets include nuclear, pharmaceuticals, homeland security, foundation industries, water contamination**
- Highly adaptable standoff Raman probes that can be used in situations ranging from pharmaceutical process monitoring to nuclear decommissioning environments
- Proprietary spectrometer technology ensures robust, stable, reliable and repeatable analysis
- Hydra- New Raman gas analyser based on fibre sensing.
- Applications include monitoring of gas-blending, hydrogen sensing, CO₂/ carbon dioxide/ carbon monoxide/ methane, etc.

<https://is-instruments.com/characterising-gases-using-hollow-core-micro-structured-optical-fibre/>



System demonstrators

- Customer challenges to achieve low risk, net-zero production:
Providing vision & sensing in unmanned areas
 - Sector agnostic
 - Difficult to access, hazardous environments
 - Test Data Management platform, software, AI routines, defect detection, long-term use
- Hydrogen Sensing with IS-Instruments
- New £4m industrial demonstrator project 2022: 12 site locations, multiple systems in use to enhance AI capabilities



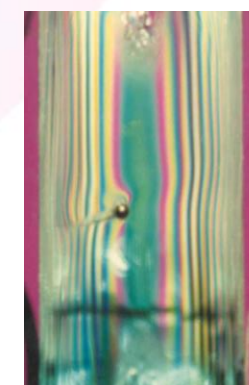
voestalpine



BRITISH
STEEL

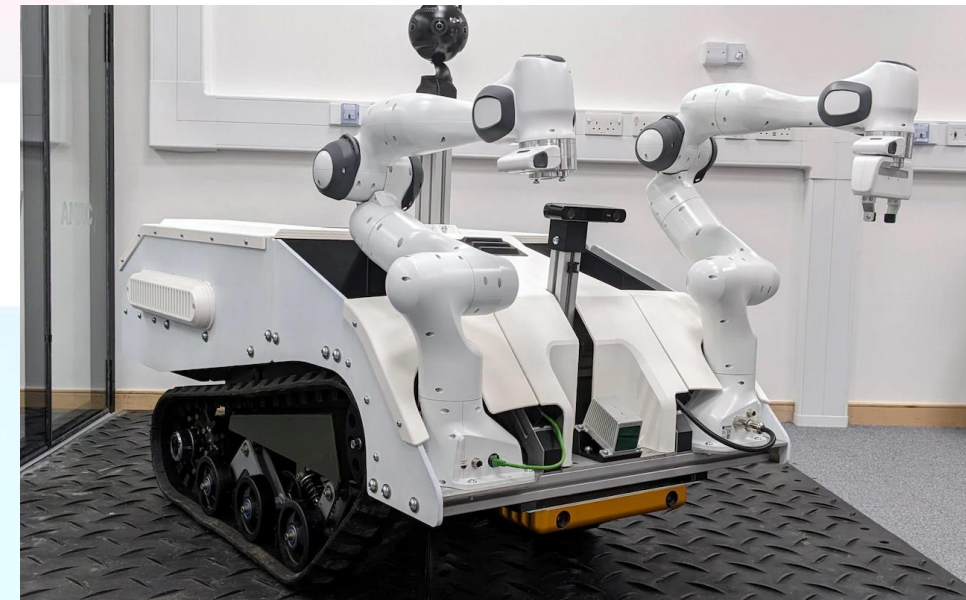
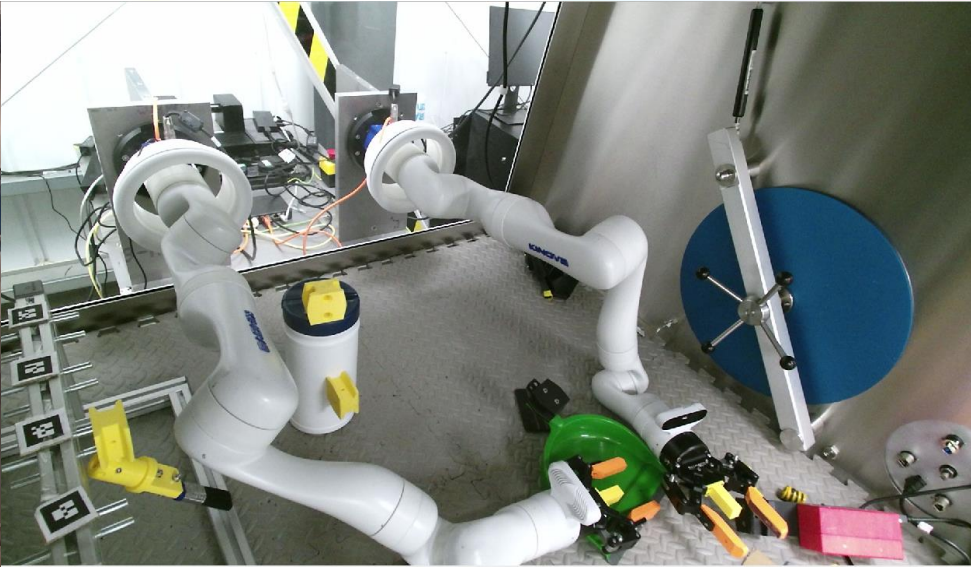


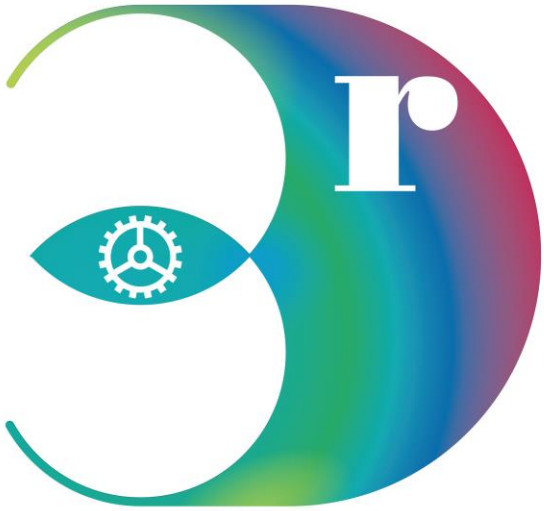
METINVEST



System demonstrators

Robotic Glovebox Decommissioning & Telexistance R&D





industrial 3D robotics

Dr Richard French

Senior Systems Scientist

+44 (0) 1732 373 043

rfrench@i3drobotics.com

www.i3drobotics.com

Expertise in 3D machine vision and robotics.

- High-Resolution Stereo- camera technology / 3D Vision
- Infrastructure Mapping Technology including SLAM
- Machine learning “ML” & Artificial intelligence “AI”
- Integration of complementary technologies
- Collaborative Robotics & Digital Twinning



https://twitter.com/i3D_robotics



<https://www.linkedin.com/company/i3d-robotics/>



<https://www.youtube.com/channel/UCpXAxJ-WQqjFTxmPBddLxvw/featured>

