

THE NATIONAL
ROBOTARIUM
PEOPLE CENTRED :: INTELLIGENCE DRIVEN

**REAPING
THE
REWARDS
OF
THE
ROBOTICS
REVOLUTION**

Making the UK an active player in the future global economy

INTRODUCTION



Stewart Miller
Chief Executive Officer
The National Robotarium

Robots will play a transformational role in the future of the world's economy and society.

They will **revolutionise manufacturing by supercharging industrial efficiency and productivity**, in a fast-changing global economy.

They will **address labour shortages and fulfil a range of repetitive tasks** that humans are increasingly reluctant to carry out - and **free up human talent to create and innovate**.

They will **make hazardous industries safer** by removing human beings from dangerous environments.

They will **re-shape the future of healthcare** as the world faces up to the significant challenges of a rapidly ageing population.

And they will be **increasingly used in domestic settings by ordinary citizens to carry out tasks** that become more difficult as people grow older.

The robotics revolution is inevitable, and it will be global. It will be an enormous economic driver for those countries that recognise its potential, and act upon it.

How will the UK embrace this change? Will it be an active producer of robots and grasp the opportunities of the robotics revolution - or remain a passive consumer, and miss out?

All the **evidence points to large-scale global adoption of robotics** in the coming years. A report published in August 2023¹ said the global robotics technology market was valued at \$72.17 billion in 2022 and is expected to reach around \$283.19 billion by 2032 - an increase of more than \$210 billion in just a decade. The industrial robotics market alone will be worth an estimated \$32.5 billion globally by 2028 according to another report².

The growth in the use of robotics and automation has been described as “breathtaking”, with continuing growth rate in global robotic installations, up 5% in 2022 compared to 2021.

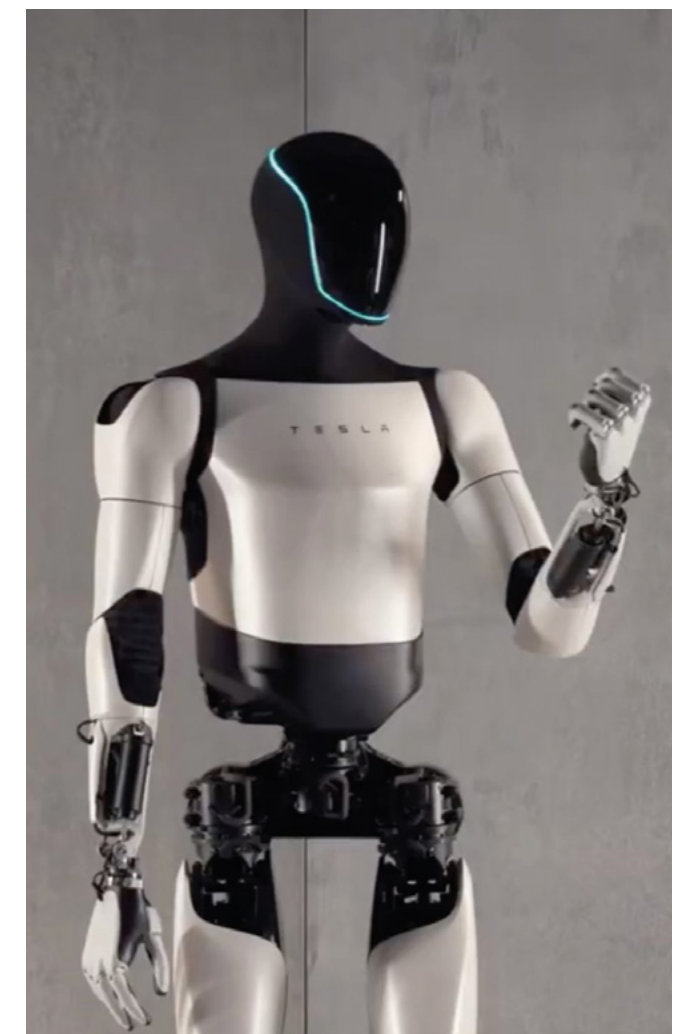
Asia remains the world's largest market for industrial robots, with 73% of all newly deployed robots in 2022 installed there. The dominant global player China saw 290,258 robot installations, marking a 5% growth from 2021. Japan, the second-largest market for industrial robots after China, experienced a 9% rise to 50,413 installations in 2022.

The European Union remains a major player with 70,781 installations in 2022, marking a 5% annual growth. Germany is one of the top five adopters worldwide, holding a significant market share of 36% within the EU (4% globally). Italy and France saw 8% and 13% growth in 2022, while the UK saw a modest 3% increase.

Although this is an improvement on the 2021 UK figure, which was down by 7% on 2020, **the UK is still lagging behind its European competitors, and way off the pace globally³**.

The UK needs to wake up - and fast. It can choose to become an active player in robotics, and identify areas to commercialise excellent academic research and to build robots and create robotic technology in the UK.

Or it can decide to be a passive consumer and import robots en masse from Asia, or elsewhere, at a huge cost to UK GDP, employment prospects and balance of payments.



Industrial giant TESLA are just one of 20+ companies developing humanoid robots, like the Tesla Optimus 2 (pictured), designed to be delivered in high volume and at low cost.

¹ Precedence Research report, August 2023

² Markets & Markets report, July 2023

³ International Federation of Robotics' World Robotics Report 2022 and World Robotics Report 2023

The **UK has an opportunity to be a producer of robots, and not just a consumer** - creating jobs and delivering economic growth. But we need to move fast, and build on what we have at The National Robotarium in Edinburgh.

Our vision, outlined in this document, is to build on the success of The National Robotarium to create a UK-wide network of robotic centres of excellence - linked closely to leading academic institutions and industry, across the nations and regions of the UK. These centres of excellence will form the hearts

of robotics clusters to create new products powered by robotics and AI - to help people in their places of work and their homes.

UK citizens will be buying and using domestic robots within the next few years on a scale never before imagined. Global shipments of domestic robots are forecast to grow to 29.6 million units by 2025, from just 9 million units in 2018⁴.

For all the reasons above, the UK must invest in its future - by investing in robotics. This document sets out how.

MARKET VALUE OF GLOBAL ROBOTICS TECHNOLOGY

2022 \$72.17b
BY 2032 \$283.19b

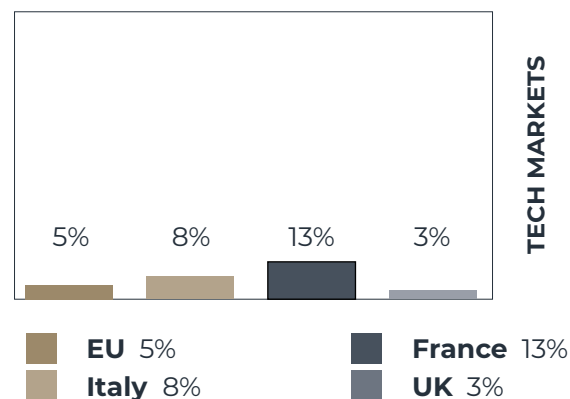
INDUSTRIAL ROBOTICS MARKET VALUE

BY 2028 \$32.5b

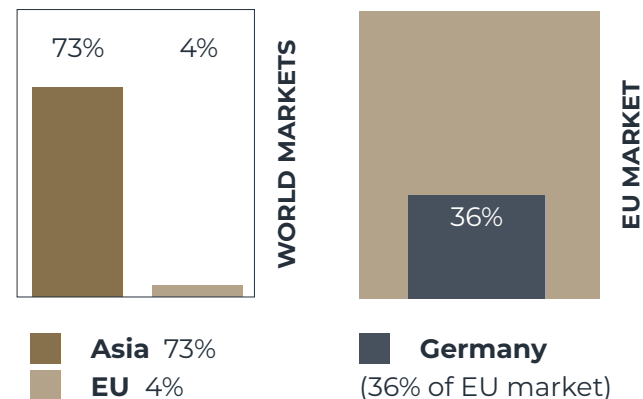
CONTINUING GROWTH RATE OF ROBOTICS AND AUTOMATION

2022-2023 5%

GROWTH OF GLOBAL ROBOTICS TECHNOLOGY MARKET

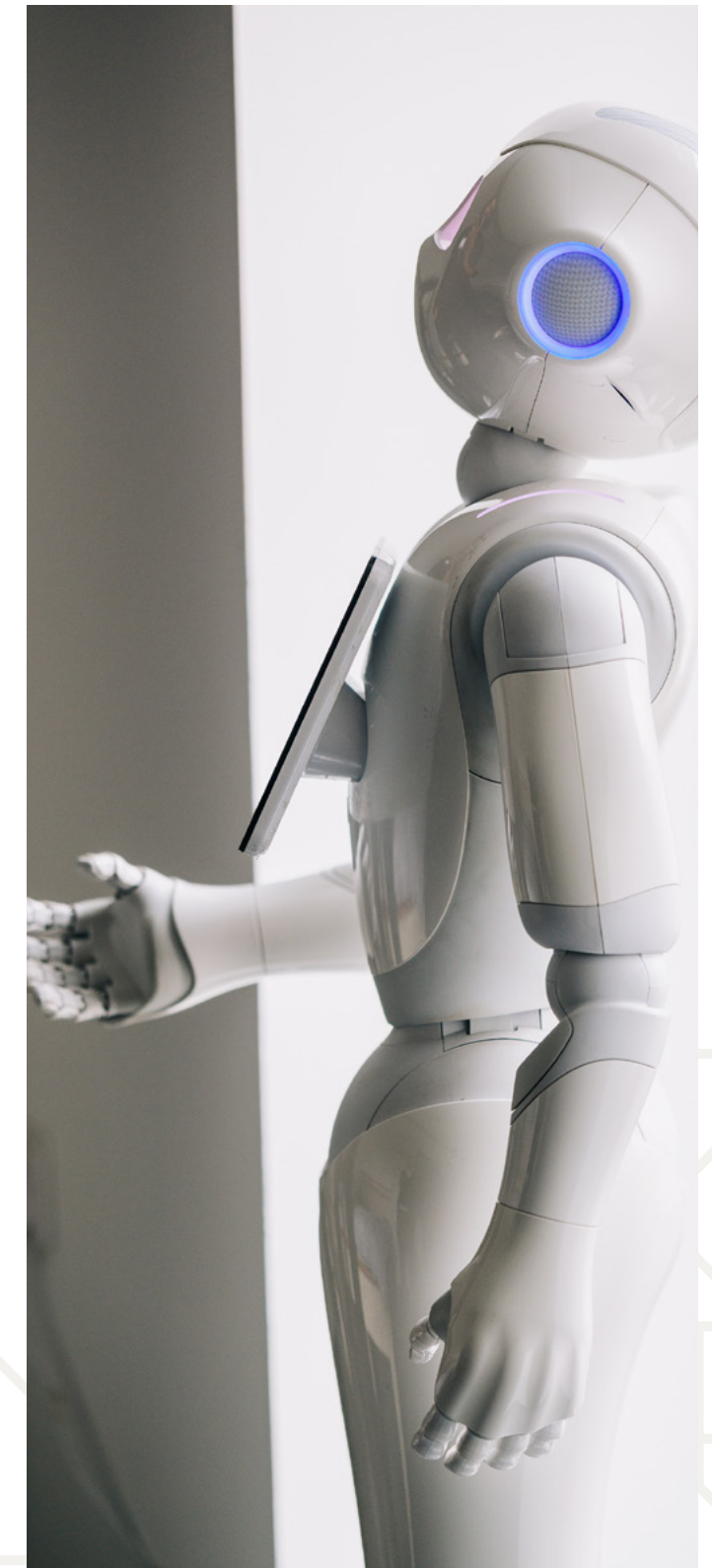


WORLD MARKETS FOR INDUSTRIAL ROBOTICS



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Continuous advancements in artificial intelligence, machine learning, and sensor technologies are driving the ongoing development of collaborative robots. These advancements enable cobots to become more intelligent, adaptable, and skilled in handling complex tasks. As industries increasingly seek flexible automation solutions, cobots are set to revolutionise work environments, shaping the future of work and enhancing overall productivity and efficiency".



⁴ Statista Research, August 2023

A BLUEPRINT FOR SUCCESS

The National Robotarium is a world-leading centre for robotics, artificial intelligence and autonomous systems, located on the Heriot-Watt University campus in Edinburgh.

Opened in September 2022, it acts as a hub to bring together research excellence, industry and creative young businesses to find, test and develop real-world applications for robotics, AI and autonomous systems. Its work aims to further the application of robotics for the benefit of society and the economy.

The National Robotarium is part of the Data-Driven Innovation initiative and received capital funding support of £22.4 million (£21 million from the UK Government and £1.4 million from the Scottish Government) through the £1.3 billion Edinburgh and South East Scotland City Region Deal.

Heriot-Watt University leads this national, and international, hub. The building has unrivalled, purpose-built facilities to support the development and testing of robotics and AI solutions.

The National Robotarium does not receive revenue funding. It is self-financing through renting space to businesses and charging companies and other organisations to design, develop, build and test robots in a range of lab settings, including the large Robotics and Autonomous Systems Laboratory (RAS Lab).

The National Robotarium is a catalyst for entrepreneurship and job creation, and a focal point for developing coordinated UK activities in the areas of investment, strategy, regulation, ethics and engagement to support the growth of robotics in the UK.

It is already making a hugely positive impact, accelerating growth and attracting investment. Within 12 months, it had become home to 100s of people working in and studying robotics and housed 4 exciting start-up businesses,

16 projects inspired and funded by industry, and 5 research projects. More than 150 events were held in that first year to promote and communicate the opportunities presented by robotics and the National Robotarium has already engaged with 1000s of young people.

This level of economic and social impact in a short period, with relatively limited public funding, can provide a blueprint for the UK to embrace the economic and social opportunities offered by the global robotics revolution. However, speed and ambition is crucial.

Currently, UK investment in robotics is very low. It tends to be subsumed under Artificial Intelligence and does not get the attention, or financial and human resources, necessary for a sector of such potential. For example, Innovate UK has just one person dedicated to robotics and there is just one robotics specialist at the UK Government's Department for Science, Technology and Innovation.

The commitment to robotics and level of investment needs to increase - rapidly. One way to do this is to replicate the National Robotarium model across the UK and create a network of centres to deliver on the potential of robotics to revolutionise the UK's society and economy.

These centres can sit at the heart of regional clusters to embed robotics at the heart of economies across the UK.

In Scotland, The National Robotarium is working with the Scottish Government to create a robotics cluster that expands the capabilities to include: manufacturing infrastructure; greater capacity to house and incubate robotic start-ups and help them scale up; more training and education targeted at

THE NATIONAL ROBOTARIUM'S MISSION IS TO:

**Help keep
us safe**

**Help keep
us healthy**

**Help us
be productive**

**Help us
develop talent**

the core skills needed by a robotics based economy (supplementing what already exists in Higher Education); testing and proving capability to allow cost-effective certification of new robots; and a convening space for discussion about big issues to ensure continuous future innovation in robotics.

We believe that replicating the National Robotarium model, and putting similar centres of excellence at the heart of robotics clusters across the UK, is a blueprint for future robotics success - making the UK an active participant and not a passive bystander in the global robotics revolution.



CASE STUDIES: MAKING ROBOTICS REAL

PUTTING A SPRING IN THE STEP OF OLDER PEOPLE

The SPRING project⁵ is developing an Ari robot from manufacturers PAL Robotics which can help older people in a variety of hospital and healthcare settings by engaging in simple conversations, offering reassurance, answering simple questions and ultimately improving mental well-being.

It is a 'conversational robot' which can detect that there are several people in a room and engage in appropriate conversations based on their different roles and queries. It could in the future identify patients who might have been waiting alone for a long time, or those who could be anxious, assessing who might need assistance and engaging in face-to-face conversation with patients, family members, staff members, and groups of people, as appropriate.

A robot with this ability to personalise its interactions would be a real asset in healthcare settings. The technology is touch-free and hands-free, so a robot like this would be particularly useful in lowering people's fears of spreading infection. Its ability to interact with individuals and groups means it could take on public-facing duties – such as providing directions, and answering simple questions in a waiting room – and help to take the pressure off professional staff.

The project is a collaboration between eight different European research institutions, including the National Robotarium. It has reached an important milestone with the first trial deployment of one of the robots in a hospital in Paris.



REVOLUTIONISING AGRICULTURE THROUGH 'SWIMMING' GRAIN ROBOTS

A robot which 'swims' through grain to ensure crops are stored efficiently and safely has been launched by agritech developer Crover - a tenant of the National Robotarium.

The T-shaped robot offers insights into the environmental conditions of grain crops, using in-built moisture and temperature sensors and two domed wheels to propel itself through grain or other material. It then feeds back data to a dashboard, giving users a more accurate understanding of the grain's condition.

Temperature and humidity have a profound impact on grain storage and can contribute

to the infestation of mould or insects which cause farmers to destroy significant quantities of stored crops. It is estimated that up to 30% of grain is lost from the global supply chain every year as a result.

The 'grain robot' also removes the need for manual sampling, which is time-consuming, labour-intensive and potentially hazardous.

Steve Maclaren, Chief Operating Officer at the National Robotarium, said: "Crover's work could help solve a massive global problem for the world's agriculture sector, by reducing waste significantly and increasing productivity. This is a great example of how the National Robotarium can provide a supportive environment for a robotics company with a creative product to make a real difference."



⁵ SPRING stands for Socially Pertinent Robots in Gerontological healthcare

REDUCING THE SPREAD OF INFECTION THROUGH ROBOTIC 'TOUCH'

A robot which gives clinicians the ability to 'feel' patients remotely has been launched as part of a hospital pilot - with the aim of reducing infection, and deaths, in hospitals.

Robotics company Touchlab, a tenant of the National Robotarium, has developed the technology, which aims to remove the potential dangers of human touch - and could also be deployed in nuclear decommissioning and handling toxic waste.

In hospitals, the Vålky telerobot is equipped with highly-advanced electronic skin (e-skin) technology - to transfer a sense of touch from its robotic hand to users.

E-skin is a material which is made up of single or multiple ultra-thin sensors to transmit sensations like pressure, vibration or motion from one source to another in real-time.

The pilot at a hospital in Helsinki, Finland will see a team of purpose-trained nurses explore how robotics systems can help deliver care, reduce workload and prevent the spread of infections or diseases - working with operators wearing an electronic haptic glove.

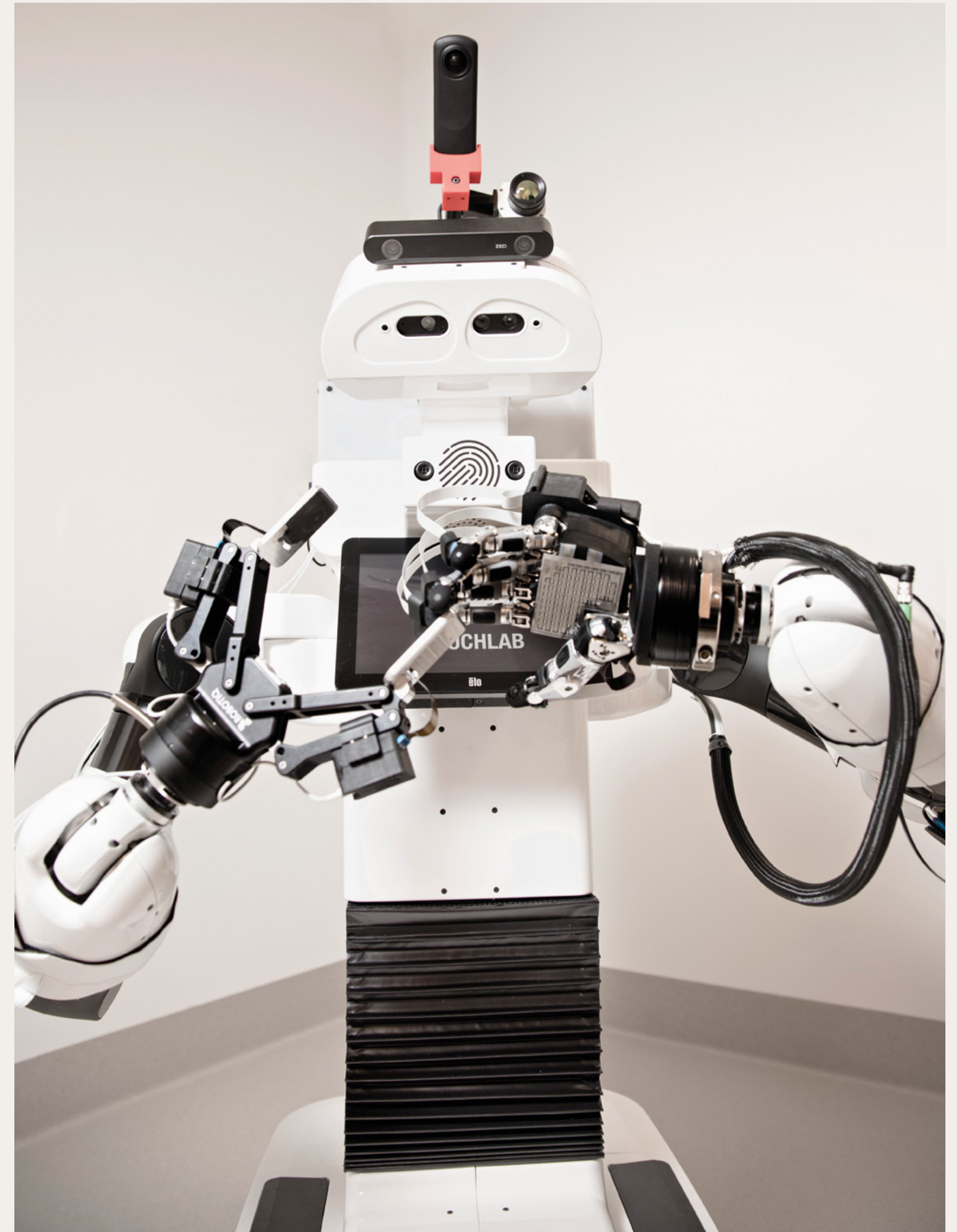
World Health Organisation research shows 15% of patients in low- and middle-income countries acquire at least one healthcare-associated infection (HAI) during their hospital stay. On average, 1 in every 10 affected patients die as a result of their infection.

With tens of thousands of registered nursing vacancies in the UK, it is hoped that Vålky will complement existing staff, freeing up people to focus on more complex nursing tasks while the robot carries out day-to-day clinical duties like measuring vital signs including pulse, temperature and oxygen saturation. It is also able to serve meals, move assistive devices and support patient care with tasks like brushing hair.

Additional applications for the technology could include nuclear decommissioning and the handling of toxic waste, helping reduce human exposure to jobs that are potentially hazardous to people's health and wellbeing.

Touchlab CEO, Dr Zaki Hussein said: "In the past, telerobots have been limited to being able to see, hear and speak on behalf of the people using them. Now, thanks to our innovative e-skin technology, robots like Vålky can 'feel' too."

Lisa Farrell, Business Development Manager at the National Robotarium, said: "Touchlab's technology, whether in hospitals or hazardous industrial environments, can reduce risks to human health and wellbeing. It's a great example of the National Robotarium bringing together academics and innovative businesses and acting as a catalyst to take their amazing work out into real-world situations that can help real people."



A SAFER, BETTER OFFSHORE WIND INDUSTRY

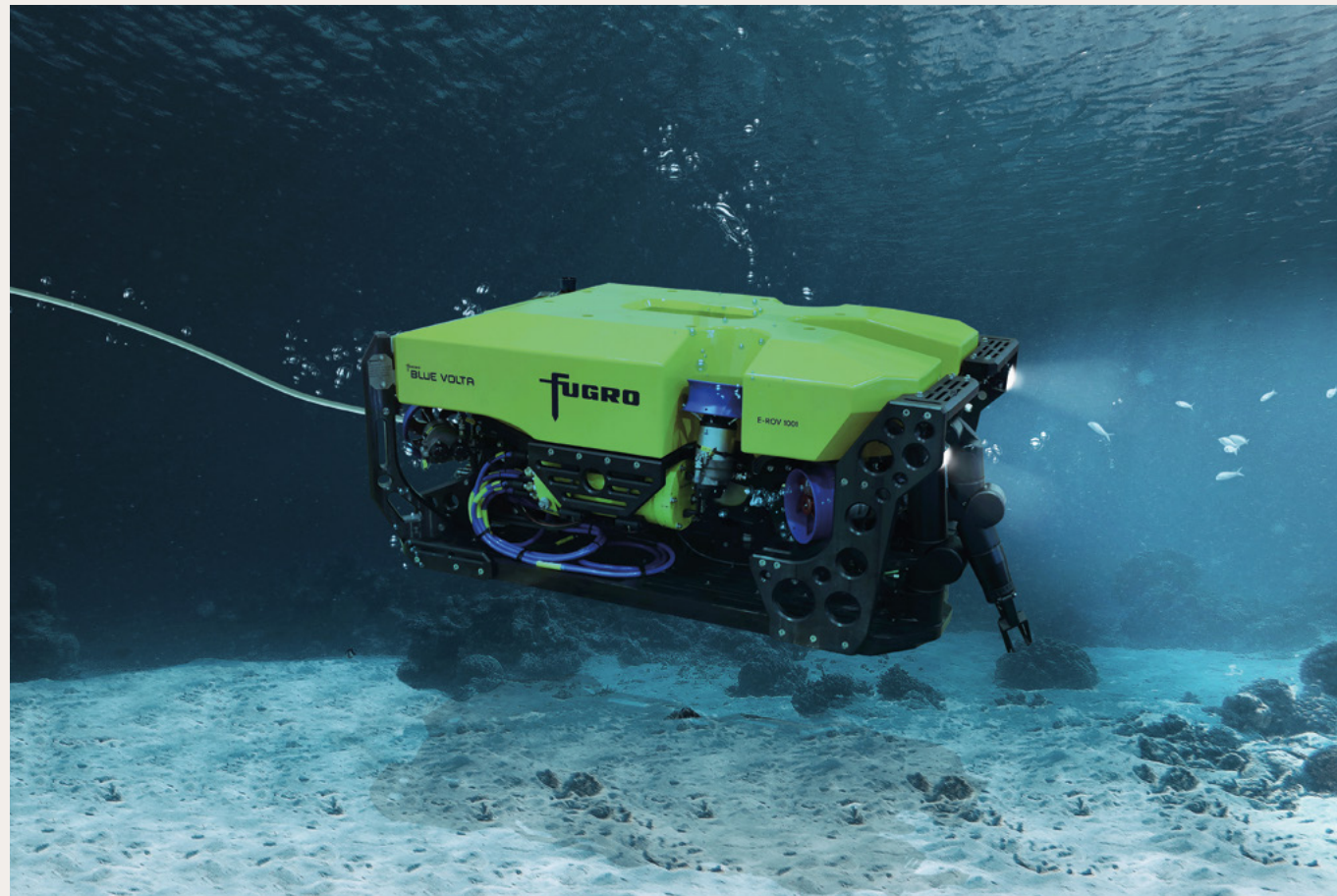
The repair and maintenance of wind turbines could be done more safely and efficiently thanks to a partnership involving the National Robotarium - benefiting the global environment and economy.

Remotely-operated robotic systems are being developed by the facility and Fugro, a global leader in the world's leading specialist in geographical location data (Geo-data).

The Underwater Intervention for Offshore Renewable Energies (UNITE) project aims to combine Fugro's uncrewed surface vessels with undersea robotic systems to support the rapidly growing offshore energy sector, which is vital in the pursuit of net zero.

It could make dramatic improvements in health and safety for workers by reducing the need for potentially hazardous offshore maintenance missions.

The robotic systems could also help improve the productivity of offshore turbines through reduced downtime, and make maintenance and repair exercises more cost-effective.



The UK has more than 11,000 offshore wind turbines and other offshore assets around its shores, with thousands more planned by 2050. On average, each turbine requires up to three maintenance checks per year, and more as turbines age.

Current maintenance methods involve vessels travelling into and working in areas of open ocean, where a mix of divers and ship-based crews manually inspect and or deploy tele-operated robots for inspection of individual wind turbines.

When applied to the whole of the UK's offshore wind sector, this translates into potentially hundreds of thousands of crewed maintenance missions every year which are costly, contribute emissions to the environment and present a safety risk for workers.

UNITE aims to increase the use of uncrewed vessels, working with underwater robotic vehicles, to conduct subsea inspection, maintenance and repair tasks which can be monitored onshore.

Researchers will focus on developing technologies which allow robots to build more accurate subsea maps to better navigate obstacles and targets. The project will also explore how robots interact with underwater structures, while dealing with external forces like changing currents or rough seas.

Professor Yvan Petillot, academic co-lead at the National Robotarium and principal investigator of the UNITE project, said: "Remote inspection and repair using robotic systems deployed in the field and controlled from shore is within our grasp. This partnership with Fugro presents an exciting opportunity to develop this next generation of underwater technologies as well as the skills and expertise needed to support the transition to net zero. UNITE has enormous potential to power the UK's offshore renewable sector and beyond, delivering worldwide economic and environmental impact.

A 5-POINT PLAN TO PUT THE UK AT THE HEART OF THE GLOBAL ROBOTICS REVOLUTION

The UK must build on the innovative work taking place at the National Robotarium and seize the enormous opportunities available to be a global player in emerging robotic technologies. It must act decisively and quickly to be an active player in the robotics revolution, and all the economic and societal benefits that will flow from it.



The UK CAN do this. Here's a blueprint to make it happen.

- 1 Create a Robotics UK agency to develop a strategy to build a robotics industry and ensure the UK does not miss out on multi-billion economic growth and tens of thousands of high-quality jobs from the robotics revolution;
- 2 Invest in 10 new Robotariums across the UK, based on the successful model of the National Robotarium in Edinburgh - a home for innovative young businesses to develop and commercialise great ideas, a crucible for turning world-leading academic research into practical uses for robots, and a place for industry to test robotics and autonomous systems;
- 3 Build industrial clusters around these new Robotariums, based on the 'Triple Helix' model between industry, academia and Government (and its agencies) - with a focus on the specific economic needs and academic specialisms of each region;
- 4 Create a robotics manufacturing base within these clusters by identifying sites for manufacturing plants, software labs, and design studios - as well as creating new companies;
- 5 Work with academia and industry to produce a report on the skills the UK needs to fill the growing number of roles in robotics: designing and building robots, writing the software that controls them; servicing and maintaining robots; and working alongside them to give them the right instructions to make them useful.



A network of new Robotariums to make the UK a centre of innovation in robotics and AI

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|----------------------------------|-------------------------------|
| 1 Belfast | 6 Birmingham, The Midlands |
| 2 Cardiff | 7 Bristol, South West England |
| 3 Newcastle, North East England | 8 Oxford |
| 4 Manchester, North West England | 9 Cambridge |
| 5 Sheffield, Yorkshire | 10 London |



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The National Robotarium is supported by £21 million from the UK Government and £1.4 million from the Scottish Government as part of the £1.3 billion Edinburgh and South East Scotland City Region Deal - a 15 year investment programme jointly funded by both governments and regional partners.

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