Innovate UK

Results of Competition: Electronics, Sensors and Photonics for Robotics in Extreme Environments

Competition Code: 1903_ISCF_ESPROB

Total available funding is £2,000,000

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
NEMEIN LTD	Environmentally Powered Integrated Thermoelectric Harsh Environment Robotic Magnetic Anomaly Locator (EPITHERMAL)	£99,496	£69,647

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Nemein is an award-winning small business based in South Wales, manufacturing downhole tools for the oil and gas industry. The proposed project targets the development of a magnetic anomaly sensing capability purpose-built for the extreme environment found at the bottom of kilometres-deep wells.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
CREATE TECHNOLOGIES LIMITED	Smart Radiation Sensor for Intelligent Nuclear Robots	£175,000	£122,500
University of Oxford		£75,000	£75,000

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Project description - provided by applicants
Createc and the Oxford Robotics Institute are collaborating to develop a modular 'Radiation Smart Sensor'. The Smart Sensor will combine not only the ability to sense radiation using a special imaging detector, but also comprises all of the physics knowledge, algorithms and computing power to understand the meaning fo the data and advise other system components on how to react to the data. The smart sensor will therefore make it easy for anyone to make their robot respond intelligently in radioactive environments, avoiding hazards and actively managing its own exposure to radiation.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
IS-INSTRUMENTS LIMITED	Optical Stimulated Luminescence Detection of Beryllium within Nuclear Fusion Facilities (OSLB)	£169,383	£118,568
United Kingdom Atomic Energy Authority		£72,319	£72,319

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Project description - provided by applicants
Nuclear fusion is a long term solution to the future energy supply of the planet. It is carbon free and highly efficient. However, the inside of a fusion reactor is an unforgiving environment: components are exposed to high temperatures, energetic hydrogen ions and electrons with high kinetic energies, and 14 MeV neutrons. Metallic surfaces are essential in a fusion reactor, with beryllium (Be) one of the candidates implemented in the Joint European Torus (JET). Its unique combination of low atomic mass, low fuel retention and favourable mechanical properties make it a good choice as a first wall (plasma facing) material within experimental and commercial fusion reactors. However, human exposure to Be and its compounds can cause berylliosis, a chronic allergic-type lung response and chronic lung disease. During a reactor's operational lifetime, sections will need to be periodically removed for refurbishment or replacement. These components will become radioactive and covered in Be/BeO deposits due to particle induced sputtering and re-deposition. These deposits can form Be/BeO dust. Therefore, the ability to handle Be dust and components contaminated with this dust is essential to safe and efficient operation of a fusion plant. At present, within the UK based JET facility, this issue is addressed by personal cleaning all the surfaces of the site. This is time consuming and potentially hazardous. No sensing solution currently exists to quickly and accurately identify the Be/ BeO deposits within a given facility. This proposal seeks to develop a new sensing system target BeO deposits. The focus of the development will the production of a new prototype sensor and a robotic platform that will be used to scan the instrument at the target within the environment. The system will take in account the challenges for working in this high radiation regime. The instrument will be tested against target samples, both in the laboratory and a representative test environment. The key objective is to demonstrate that the unit can detect deposits at the required levels of accuracy with minimal false positive returns, as well as examining the speed at which an sample area can be scanned. In addition, designs will be produce for radiation hardened options using both Rad hard detector and ultra low cost options where the camera can be considered disposable.

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I3D ROBOTICS LTD	Smart IMAging for Nuclear "SIMAN"	£132,608	£92,826
NATIONAL NUCLEAR LABORATORY LIMITED		£30,185	£15,092

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
This project will develop the use of 3D vision in alpha glovebox operations. It is led by SME i3D robotics with the National Nuclear Laboratory as a project partner. The team will develop a 3D stereo vision system that is capable of operation in alpha glovebox environments. This will allow glovebox operators to view the contents of a scene using 2D images or 3D models. Algorithms will also be produced to highlight objects which are deemed sharp or hazardous. A further aim of the project is to interface the systems with robotic and AI (RAI) technologies currently used in nuclear decommissioning. This will allow for autonomous cutting of gloveboxes as well as sorting and segregating nuclear waste. Through a combination of these aspects, the system will also be aimed at advancing the "no-arms-in-gloveboxes" where the contents of a glovebox will be displayed and controlled through robotic systems or teleoperations.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
CREATE TECHNOLOGIES LIMITED	Automated Nuclear Decontamination Cell (AND-C)	£68,361	£47,853
KUKA SYSTEMS UK LIMITED		£148,817	£89,290

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Project description - provided by applicants
In many nuclear decommissioning facilities, a decontamination cell is used to process transport containers on site so that they can be sentenced to low level waste. A dedicated cell can also be used for decontaminating components such as piping. This is labour intensive work that needs to be carried out using complex Personal Protective Equipment (PPE) and there may also be a requirement for air-fed suits. The work is difficult and strenuous resulting in limited time for 'on-the-job' shifts. This in turn leads to the requirement for multiple operational teams as well as support staff and radiation protection staff. The proposed solution is to remove nuclear workers from this type of hazardous environment by combining Createc's ESP technology for radiation mapping with KUKA's proven nuclear robotic arms. The innovation over manual decontamination or even robotic remote handling is that the 3D radiation contamination map will be transferred directly to the robotic system to guide the arm to the precise location and remove the contamination. A KUKA robotic arm will carry Createc's radiation mapping sensor pack. The sensor pack utilises a laser scanning system to build up a 3D point cloud of the container and then guide the robotic arm around the surfaces of the container. The 3D positional information of the contamination can then be translated to the positional system of the KUKA robotic arm. The arm can then carry suitable tooling for mechanically removing the contamination. The arm will also carry a method to extract any air borne secondary contamination. The main areas of focus for this project will be to enable the Createc sensor pack mounted on the KUKA arm to map the contamination on a container and produce a 3D model with the precise location of the contamination. A prototype cell with a KUKA arm will be developed that can demonstrate a Createc sensor pack producing the 3D contamination model that can be used by the robotic arm to remove the contamination. It is envisaged that a mock-up of a contaminated component will be used for the demonstration. The prototype will show how the arm can move to the contaminated area using the map, but there will be no tooling or demonstration of material removal as part of this project.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SPACECHIPS LTD	Assessing the feasibility of photonic transceivers for satellites and planetary robotics	£98,442	£68,909

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Project description - provided by applicants
We live in a satellite-enabled age: the spacecraft orbiting overhead are not abstract science, but part of a critical, life-support system that we all depend on every day. Satellites collect and distribute vast amounts of data giving us a detailed understanding of what is really happening in our world. They deliver live, awe-inspiring imagery in high resolution, broadband global communication, increased positional accuracy and observe the fragile eco-systems of our planet. Thousands of satellites will be launched over the next decade to provide global internet coverage, mobile telecommunication, Earth-Observation analytics, navigation and space-based IoT for real-time monitoring of assets. Morgan Stanley recently valued the global satellite industry at £0.75 Tn up to 2040\. Developing countries and emerging markets in Asia, South America, and Africa are seeking low-cost Earth-observation capability for national capacity building, and the desire to become self-sufficient for data collection to address local societal needs such as environmental monitoring, measuring climate change, global warming, disaster management, food sustainability, deforestation, imaging to locate natural resources like oil and gas, as well as observing geological formations. Operators of Earth-Observation satellites want to offer customers new imaging services such as live and intelligent geo-spatial and geo-tagging insights to target lucrative market opportunities. Agencies want to offer new space-exploration experiences and increase levels of public engagement. Traditional science payload suppliers are now under pressure from aspiring commercial start-ups looking to profit from robotic exploration. The project will investigate how to advance space-based imaging to address the market needs of Earth-Observation satellites and planetary robotics. De-risking the suitability of the latest photonic transceivers and the development of on-board electronics for use in the harsh environment of space are the key goals. The project aligns with the aspirations of the government's Industrial Strategy to raise productivity and earning power in the UK, and strengthen UK science and business. Spacechips existing on-board processing products are contributing solutions to address major societal needs such as environmental monitoring, measuring climate change, global warming, food sustainability and bridging the global Digital Divide by providing innovative and enabling satellite-based solutions. Linked to the government's Industrial Strategy, we plan to use the National Satellite Test Facility.

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MARYNSOL LIMITED	SeaWynd: Autonomous Inspection of Seabed and Splash Zone Structures for Offshore Wind Arrays	£121,842	£85,289
OFFSHORE RENEWABLE ENERGY CATAPULT		£23,861	£23,861
SAFEGUARD NAUTICA LTD		£104,181	£72,927

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Offshore wind turbines can become corroded by wave effects in the so called splash zone near the water surface. Visualising this damage is difficult due to the extreme environment. Currently, scheduling maintenance is based on rough approximations of structure lifetime rather than requirements, which is expensive. SeaWynd aims to provide a sensor payload to remotely survey this splash zone and provide high resolution datasets from which to detect any abnormal changes to the turbine structure. This would reduce operation and maintenance costs for managing offshore wind farms This project will involve both the development and hardening of the SeaWynd device with an evaluation of its performance during a sea-trial at an operational marine renewable energy site.

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INNOVATIVE TECHNOLOGY AND SCIENCE LIMITED	The development of an ATEX zone 0 encoder for explosive environments(ATEX Encoder)	£114,969	£80,478
GRANTA DESIGN LIMITED		£59,958	£29,979
TWI LIMITED		£74,668	£74,668

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Project description - provided by applicants
Vital to any NDT inspection is pinpointing the precise location of the defects found. Advanced inspections, such as phased array or full matrix capture, need the precise location of the sensor as it is moved during the inspection. This is to allow the data collected to be viewed as a map or 3D segment. The odometry of the robot or probe is handled by an encoder. An encoder is a transducer that sense the position or orientation for use as a reference or even as a feedback to control position. If these advanced techniques are to be used in potentially explosive environments, such as the oil and gas industry, then ATEX certification is a pre-requisite. ATEX certification demonstrates component/system suitability for use in an explosive environment. Current ATEX encoders are not suitable for NDT applications as they are bulky and have a very high torque that necessitates some force to enable the shaft to rotate and the encoder to record precise position. They can also be prone to slippage which may affect the position of the robot or probe, especially in an environment where hydrocarbons are present. ATEX environment: explosive atmospheres can be caused by flammable gases, mists or vapours or by combustible dusts. In these environments the smallest source of ignition such as a spark or a hot surface can cause an explosion resulting in significant damages, serious injuries and loss of life. Using the correct equipment can prevent this. In some circumstances, these environments must be entered to work or inspect. The equipment used in these environments must be ATEX certified -- designed and certified to prevent any explosions and not become a potential source of ignition. The goal of the project is to develop an ATEX-certified contactless magnetic encoder. Physically, the new encoder will much shorter than the conventional designs. Eliminating of the need for a mechanical coupling (via a shaft) further reduces overall package size and will considerably reduce the encoder torque. That means it will be much easier to integrate the new encoder into applications where space is an important factor, it will be appropriate to NDT applications, the potential for accidental damage to the encoder in challenging industrial environments will be significantly reduced.

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DEEP6 UK LTD	Compact and cost effective; submersible subsystems for inspection.	£72,213	£50,549

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Project description - provided by applicants
At **Deep6** we aim to lower the barrier to entry of submerged inspections; significantly reducing costs whilst also improving the success rate and quality of data captured by unmanned submersibles. To date we have developed a unique, cost effective unmanned submersible design to be launch from an autonomous surface vessel. Now our objective is to develop two new subsystems for our submersible; to enable it to realise its goals as a compact and low cost, yet powerful inspection tool.

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SPACE TALOS LTD	Feasibility study of active radiation shielding for electronics, sensors and photonics applications	£84,798	£59,359

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Project description - provided by applicants
Satellites provide us with many benefits from telecommunication, predicting the weather to protecting the environment. However, space is a harsh environment, and satellites are constantly bombarded by strong ionising radiation. The cosmic and solar radiation in space 'fry' electronics which means only very special and 'hardened' electronics can be used, that are heavy, require a lot of power and as a result, are quite simplistic compared to some electronics we enjoy on earth. We propose to analyse and evaluate the potential and compatibility of Space Talos Ltd. active radiation shielding solution with commercial off-the-shelf electronics, sensors, and photonics commonly used for robotics. Active radiation shielding traps plasma in an electromagnetic field, protecting the satellite. In particular, active radiation shielding will give easier access to orbits beyond low Earth orbits for small satellites where robotic applications such as satellites maintenance and mining are more significant.

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GMV INNOVATING SOLUTIONS LIMITED	Autonomous Robotic InSpEction (ARISE)	£79,943	£39,972
MDA SPACE AND ROBOTICS LIMITED		£29,728	£20,810
SUNDANCE MULTIPROCESSOR TECHNOLOGY LIMITED		£79,332	£55,532
University of Exeter		£58,340	£58,340

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Project description - provided by applicants
The modern world is dependent on the supply of mineral resources to provide the raw materials to meet, current and future needs for energy, manufacturing and construction industries and demands are increasing exponentially due to population growth, life expectancy and a more technologically-focused, digital world which requires sophisticated mineral products. The mining industry is committed to operating safely and reducing accident numbers, and it is increasingly migrating underground as surface deposits are exhausted. The underground environment is challenging due to: high rock stress, high temperatures, poor communications with surface, restricted access and lack of access to satellite positioning systems. The key risk in deep level mining is geotechnical because ground conditions are exacerbated by high stress at depth and the unpredictable nature of the blasting process on stress redistribution. It is essential to undertake disciplined geotechnical inspections of newly exposed rock after every blast, but it is well known that this process is dangerous, time-consuming and subject to human error. ARISE aims to implement autonomous surveys of geotechnical conditions during the normally unproductive period immediately after the blast when workers vacate the mine due to post-blasting fumes and seismic risk. The robotic platform will be used to: * Survey roof conditions in newly-blasted areas; * Monitor material flow in orepasses and extraction points, particularly mapping 'hangups' that can block orepasses. Mapping hangups from below is extremely dangerous for people; * Accurately map areas in 3D for reconciliation and design verification. ARISE will provide safety and financial benefits while not affecting the production cycle (operating in the shift change periods) and is therefore attractive for industrial roll-out. The project will develop the ARISE system as a commercial product. The ARISE system is an inspection robot for mining environment. Existing or COTS components are used where applicable and development within this project only focuses on electronics (on-board-computer) and sensors (vision, LIDAR). Sundance would develop the "ARISE-Kit" on-board computer and electronics to operate in harsh environments by using automotive graded parts. GMV will utilise its autonomy software but integrate a new set of visual sensing instruments using COTS cameras and develop an adjustable light array. MDA will loan an Obscurant-Penetrating (OPAL) LIDAR unit and aid in hardware and software integration activities. University of Exeter Camborne School of Mines will generate use cases and create risk assessment strategies that improve both safety and efficiency in underground production mining processes.