Innovate UK

Results of Competition: **Research and Development Competition for RAI in Extreme and Challenging Environments**

Competition Code: **1706_EE_CRD_RFHE**

Total available funding is £10m

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
FORTH ENGINEERING (CUMBRIA) LIMITED	Friction Stir Welding Crawler for Internal Repair and Refurbishment of Pipelines - FSWBot	£706,866	£494,806
INNVOTEK LTD		£205,252	£143,676
Lancaster University		£199,987	£199,987
London South Bank University		£219,676	£219,676
PROSERV UK LIMITED		£508,115	£254,058
TWI LIMITED		£160,019	£160,019

Project description - provided by applicants
Steel pipelines corrode due to of the nature of the liquids they contain. Also, cracks can form over time leading to failure and leakage of the contents, resulting in severe economic losses and environmental pollution. To avoid this, inspection, evaluation, and repair activities are performed periodically. Internal cracks and areas of corrosion and metal loss are monitored by the use of intelligent inspection devices (PIGs) which carry special sensors. Sections of pipeline that are found to be likely to fail are reinforced using an externally applied bolt-on clamp which is both costly and is difficult and dangerous to install. The FSWBot project will see the development of a radical new solution to internal corrosion and cracks that form inside pipelines. Meeting the objective will result in a much cheaper, safer repair process that will enable pipeline asset owners and their service providers to produce very high-quality welds in steel pipelines without shutting down and purging petroleum pipelines and without the use of divers and surface vessels. This is of enormous importance especially in respect to inaccessible pipelines and those which are installed in parallel groups where space around pipes is restricted. The objective of the project is to develop a robotic platform with a payload consisting of unique hydraulic friction stir welding equipment which produces no sparks. Data obtained by prior high-resolution mapping of anomalies that are produced by metal loss and corrosion will be used to provide information for mission planning. Repair will be carried out in-situ using no external power and no welding consumables. The robot will generate electricity from the liquid flow in the pipeline via a variable pitch turbine diving a generator, which will supply power to a hydraulic pump and a battery which drives the magnetic tracks. FSWBot will bring about a step change in the competitiveness and growth for 3 UK business -- namely Forth Engineering, Proserv and Innvotek.

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BAE SYSTEMS (OPERATIONS) LIMITED	SMARTER - Space Manufacturing, Assembly and Repair Technology Exploration and Realisation	£250,037	£125,019
LENA SPACE LIMITED		£49,947	£34,963
MAGNA PARVA LIMITED		£99,885	£69,920
Manufacturing Technology Centre		£79,944	£79,944
PRINTED ELECTRONICS LIMITED		£100,272	£70,190
REACTION ENGINES LIMITED		£20,000	£12,000
SATELLITE APPLICATIONS CATAPULT LIMITED		£59,990	£59,990
University of Nottingham		£63,999	£63,999

Project description - provided by applicants
Manufacturing in space has the potential to positively affect human spaceflight operations by enabling the in-orbit manufacture of replacement parts and tools, which could reduce existing logistics requirements for the International Space Station (ISS) and future long-duration human space missions. In-space manufacturing could enable space-based construction of large structures and, perhaps someday, in the future, entire spacecraft. In-space manufacturing can also help to reimagine a new space architecture that is not constrained by the design and manufacturing confines of gravity, current manufacturing processes, and launch-related structural stresses. The Space Manufacturing, Assembly and Repair Technology Exploration and Realisation (SMARTER) project will investigate the technical feasibility of manufacturing in space. The project will focus on how reconfigurable autonomous robotic technologies can be used to automatically manufacture components, assemble large structures, and service or repair existing space assets. The SMARTER concept, i.e. a manufacturing factory in space, could ultimately lower launch costs, the exploration of space and improve mission sustainability i.e. extend the useful life of assets launched into space. The need for a reconfigurable, autonomous manufacturing space port or factory stems from the market changing the paradigm of space operations and the development of enabling new capabilities that will put mankind's ambition to the test. These changes include: cost reduction of payload launch and sustainable space exploration, creating satellite constellations, exploration further into space and habitation on other planets and carrying out preventative maintenance or servicing of assets in space. This vision has also been recognised by NASAs On-Orbit Satellite Servicing Study, October 2010\. Realistically speaking, this described use of outer space may only truly materialise in 10 -- 20 year timeframe; nonetheless the UK has the prime opportunity to position itself suitably for this opportunity by investing now.

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PLANET OCEAN LIMITED	Enabling low cost AUV technology: Development of smart networks & AI based navigation for dynamic underwater environments	£568,966	£398,276
National Oceanography Centre		£144,111	£144,111
Newcastle University		£60,203	£60,203

Project description - provided by applicants
Small, low cost Autonomous Underwater Vehicles (AUVs) are providing a step-change in the accessibility, adoption and use of autonomous systems in the harsh and challenging marine environment. ecoSUB AUVs have been developed in collaboration between Planet Ocean and the National Oceanography Centre (NOC) and provide users with low cost, small, easy to operate, launch and recover, AUV platforms with up to 2,500m depth rating and long range/endurance capability. Applications for these vehicles are extensive, however, they have inherent limitations related to their size and design price point, as such, they are unable to rely on incumbent technologies for navigation, such as expensive Inertial Navigation Systems (INS), large Doppler Velocity Logs (DVLs) and traditional Long Baseline positioning (LBL), and due to their small size, low power/long range capability have limited resistance to tides and currents and the navigational challenge they present. This project seeks to develop an end-user requirements led innovative solution enabling accurate underwater positioning and smart AI for navigating in dynamic environments, it translates fundamental research in underwater positioning and delivers a Smart Network Positioning system for fleets of AUVs and an enhanced AI pilot feature. Innovative acoustic nano-modem technology developed within Newcastle University's ComS2IP group is an integral component in delivering success in this project. The project outputs will be tested in an offshore oil and gas environment, kindly provided by our end-user partner, BP International, who have provided extensive support to the ecoSUB AUV product development since 2015 and look forward to embedding this technology into their operations. The project team have a successful history of collaboration; Planet Ocean and the National Oceanography Centre (NOC) have previously completed a successful Innovate UK / Dstl project, and developed the ecoSUB AUV technology in partnership. Newcastle University have been well engaged with both Planet Ocean and NOC in the development of their nano-underwater modem technology and other systems previously commercialised under IP licencing arrangements.

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Q-BOT LIMITED	WormBot	£554,441	£388,109
Queen Mary University of London		£149,984	£149,984

Project description - provided by applicants

Q-Bot specialises in robotic services in the built environment, that allow easier, cheaper, safer and more effective repair, maintenance and upgrade of buildings and infrastructure. Q-Bot will be the end user of the WormBot system providing robot enabled services, initially in the application of the underfloor insulation to buildings (at a fraction of the current cost, and with none of the disadvantages of traditional methods) using a robot to apply insulation in an environment which is currently inaccessible for human operatives without prohibitive disruption and expense. The service is already being commercialised (with the help of a much more cumbersome hardware) with a number of clients including Local Authorities and Housing Associations with over 100 sites successfully insulated and over 300 committed to by our clients.
This project builds on ground-breaking robotics innovation in the area of soft and flexible robotic manipulators by the Centre for Advanced Robotics @ Queen Mary (ARQ), Queen Mary University of London (QMUL) initially developed for surgical applications. It will develop the technology further, with a view of utilising it in extreme and challenging environments of inaccessible areas of buildings (initially), infrastructure networks (including sewers) as well as nuclear site inspection. The project will deliver a proof of concept prototype that will be validated in demanding environments as well as developing further the service robotics business model (and validating it in various industrial segments using the Lean Start-up principles).

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THURN GROUP LTD. CAMBRIDGE POLAR CONSULTANTS LIMITED	Robots Under Ice: Gathering Ice Hazard Data from Below	£153,689 £55,689	£107,582 £38,982
Project description - provided by applicants			
THURN Group Ltd and Cambridge Polar Consultants Ltd are working on the use of Autonomous Underwater Vehicles (AUVs -- robot submarines) for determining ice hazard risk to shipping and energy installations in the Arctic. As the global climate changes, the polar ice is melting, opening up new shipping routes and easier access to offshore oil and gas vital to the UK and global economies, in seas which are still seasonally ice-bound. This project will investigate the feasibility of using robots to do the work. If the project confirms the feasibility of using robots commercially in the extreme and hazardous environment of the high Arctic, THURN and CPC will provide a service to determine ice risk, to help protect people, goods and vital infrastructure in the Arctic.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
QINETIQ LIMITED	Collaborative Technology Hardened for Underwater and Littoral Hazardous Environments	£511,912	£255,956
BRISTOL MARITIME ROBOTICS LIMITED		£97,804	£68,463
FORTIS MECHANICAL DESIGN LTD		£243,099	£170,169
Lancaster University		£390,827	£390,827
NUVIA LIMITED		£126,720	£63,360

Project description - provided by applicants

QinetiQ, a UK multinational defence technology company based in Farnborough, Hampshire, has teamed up with a number of the UK's top innovative technology providers in response to Innovate UK's Research and Developments competition for Robotics and Artificial Intelligence in extreme and challenging Environments. The title of the project is "Cthulhu" named after the cosmic entity created by writer H. P. Lovecraft, a gigantic entity worshipped by cultists. Cthulhu's appearance is described as looking like an octopus, a dragon and a caricature of human form.

QinetiQ have assembled a comprehensive team suited for the complex and wide ranging challenges associated with the decommissioning of the active process plants on the Sellafield site. The team includes expertise from both industry and academia, and the fields of expertise include: QinetiQ (lead), Nuvia UK Ltd, University of Lancaster, Bristol Maritime Robotics and FORTIS Remote Technology ; all the partners have in the past or are currently already working with Sellafield Limited and also across the Nuclear Decommissioning Authority (NDA) estate on an number of diverse decommissioning related projects, bringing together complimentary technologies, systems, understanding and skills to deliver solutions for extreme environments that have application, some cross-cutting, Nationally and Internationally.

This project undertakes research and the development of autonomous systems that exploit state of the art machine learning technologies in order to facilitate Autonomous Inspection and Maintenance of Hazardous (nuclear) Spaces.

The proposed solution will deliver the following innovative components:

* A robust robotic platform that is amphibious, with higher level of autonomy for extreme environment operations with 24/7 availability.
* Simultaneous Localisation And Mapping (SLAM) based on sonar, tactile and passive Electro-optical (EO) sensors enabling underwater operations; able to recognise objects of interest using new fast transparent deep learning image classifiers, make decisions in the context of the task (inspect and move) including collision detection and avoidance
* Tactile sensing for visually obscure environments to enable detailed local situational awareness to be achieved in support of the sonar sensing.
* The platform will be compatible with a range of intelligent tooling modules and hence adaptable for a range of operational scenarios.

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PROCESS VISION LTD University of Reading	Piglet – a new robotic solution to lower maintenance costs and improve safety in high pressure gas systems	£651,545 £199,329	£443,051 £199,329

Project description - provided by applicants

Within oil & gas processing, the challenges of high pressure and or temperature, safety and certification has, until now, meant that the benefits of robotic viewing of online infrastructure has not been available. This results in many processes across the world under-performing, running under optimum flow rates - and therefore below optimum revenues for the operator. At a time when oil & gas profits are under pressure key players are looking for innovative ways to improve performance and revenues from existing plant.

Glycol dehydration is the most common and economical means of removing water from natural gas and their interiors present an extreme and challenging environment, operating with natural gas at a pressure of around 50-200bar. There is currently no robotic system capable of inspecting the columns during operation. Any blockages should be identified and quickly removed in order to maintain performance. Blocked ports and other problems can occur that degrade performance, reduce process throughput and plant profitability. Our concept is Piglet (Pigging for un-piggable lines), which will provide a live video feeds to an operator, to give a true picture of the internal condition of the facility. This will provide early warning of plugging, scale, wax or corrosion, which may result in system dangerous failure and/or costly downtime involving potentially hazardous human intervention.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
MAGNA PARVA LIMITED Schlumberger	Enhanced Performance of Robotic Drilling Tools using High Frequency Vibration	£94,230 £0	£65,961
Project description - provided by applicants			
Drilling for oil and gas is a costly activity (around Â£1M/day). The drills are complex robotic machines, capable of autonomously controlling their steering using attitude sensors while working in some of the most extreme and challenging environments (up to 3000psi - 200 atmospheres - and 120C, and operating in drilling "mud" - heavy liquid designed to prevent well blowouts). Any enhancement to the performance of the drill has potentially large economic benefits, and that is the objective of this project. Magna Parva will investigate the feasibility of enhancing the performance of these drills (especially in hard rock such as granite or marble) by applying high frequency vibrations ahead of the cutting teeth. Such vibrations have two potential effects: (a) generating microcracks in the rock and (b) reducing friction. This latter is particularly interesting, because it may assist the autonomous steering of the robotic drill, so we will make "wet" tribometer measurements under drilling mud.			

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AUTONAUT LIMITED	AutoNaut for extreme environments	£350,009	£245,006
University of East Anglia		£74,999	£74,999
University of Exeter		£74,997	£74,997

Project description - provided by applicants

The aim of this project is to develop a wave propelled unmanned surface vessel (USV) capable of working autonomously, in winter, in the notoriously hazardous Antarctic and Arctic seas, such as the Roaring Forties and Furious Fifties. It is a partnership project led by AutoNaut Ltd, with the Universities of East Anglia and Exeter.

The collaborative project will need to solve novel issues such as icing on a small USV, and autonomous ice avoidance, as well as harvesting energy on the move when it is too dark for PV panels to charge batteries. It will adopt advances in the use of neural networking and artificial intelligence to manage and summarise data gathered so that vital data sets can be transmitted in real time via satellite to shore.

At present, there is a dearth of data from the Southern Ocean and Arctic, especially in winter. Very few ships pass through these enormous oceans. Not only do we have old and limited data on krill and fish stocks which may be threatened by a globally important fishery (legal and illegal), but climate scientists monitoring CO2 absorption at the surface have contradictory readings. Is the Southern Ocean giving off CO2, or absorbing it? This is a big question in climate science, and therefore for the global economy.

From a commercial perspective, the development of a very robust AutoNaut USV, with the capability to operate in the dark, and near ice, has great potential around the world. Some of the most difficult areas for offshore renewables and oil and gas industries are in extremely hazardous environments, such as the North Sea, Barents Sea, and the Arctic, as well of off South Georgia and the Falklands.

AutoNaut's wave propulsions system is elegant, and simple, with just four moving parts harnessing the pitching and rolling of a simple monohull to propel it forward. This system is inherently robust and is storm proven in the Atlantic, capsizing and self-righting in large breaking waves. It is seen as the only USV concept that has a chance of surviving such extreme environments. Solutions for icing and energy harnessing will give AutoNaut the capability for vital high latitude work of considerable importance both commercially and scientifically.

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HYBIRD LTD COSTAIN LIMITED	Autonomous Confined Space Inspection using Drones	£328,939 £19,999	£230,257 £10,000
Project description - provided by applicants			
Confined spaces currently account for around 15 deaths per year in the UK alone -- a loss rate which can and should be diminished to zero, through the use of technology in large infrastructure projects. HyBird is developing technology to meet this target through autonomous confined space UAV solutions, comprising a small, lightweight, collision-tolerant smart drone, an autonomous deployment docking station, and an AI-based in-situ material characterisation and threat detection and inspection software. Theses capabilities will minimise the need to send personnel into potentially hazardous environments -- and will analyse and assess the environment for threats/dangers in case it is required for one to enter. In addition to the human safety cost, extreme environments cost infrastructure projects billions of pounds each year due to defects, site down-time, and labour costs. Deployment of such a system can reduce the cost of inspection by in excess of 80%, whilst drastically improving productivity -- through early defect detection, and reduced down-time. HyBird's autonomous UAV solution will directly benefit asset owners, as well as service providers in the infrastructure/construction space; for a relatively small investment, the return on investment is realised through reduced project costs, lower health and safety risk, greater quality analytics, service transparency, and ultimately more business opportunities.			

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ROLLS-ROYCE PLC	COBRA: COntinuum roBot for Remote Applications	£940,544	£470,272
OPTEK LIMITED		£427,918	£299,543
United Kingdom Atomic Energy Authority		£279,996	£279,996
University of Nottingham		£304,928	£304,928

Project description - provided by applicants
Imagine if an engineer could inspect and repair a pipe deep within a nuclear reactor without having to get changed into a HAZMAT suit, or even perform an inspection and then repair a jet engine still attached to the wing of an aircraft, but from the comfort of their own home. COBRA (Continuum Robot for Remote Applications) aims to do just that. A consortium of industrial companies and academic institutions aims to design, develop and build a novel solution for remotely controlled specialist robots that will enable maintenance & repair tasks to be undertaken in extreme environments by teleoperation without compromising the health and safety of the operators. COBRA will reduce lifecycle costs, provide rapid worldwide operational response to issues, and improve the safety and quality of high value installed infrastructures. The continuum robot (a.k.a. snake robot), will be long enough to be deployed in a range of pipe based nuclear fission and fusion scenarios, as well as small enough in diameter to be applicable to jet engine deployment through conventional inspection ports. The main objectives of COBRA include production of a full scale teleoperated prototype, inclusive of the control software, a range of shape sensors and two separate, interchangeable and innovative 'end effectors'. Firstly, a 3D camera to provide high resolution views of the environment and feed into an immersive interface with augmented reality elements. Secondly, a miniature laser processing head to allow robotic corrective action to take place. A miniature laser head has been developed by OpTek Systems Ltd for a specific application in Rolls-Royce Aerospace, but COBRA will develop the miniature laser control head to work in challenging new environments opening new markets for OpTek to exploit. The development of the super-slender continuum robot will fall chiefly to the University of Nottingham (UNOTT) who have extensive experience of developing and manufacturing prototype equipment of such nature, some of which have been demonstrated and used in service in the aerospace sector. Rolls-Royce and RACE will provide a number of demonstration scenarios to effectively prove the prototype device to TRL 6\. The consortium have plans to set up a UK supply chain toward the end of the project to provide productionisation of the concept and allow end users, such as Rolls-Royce, UKAEA and Sellafield, to utilise such a product.

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PERCEPTUAL ROBOTICS LIMITED	Autonomous Offshore Wind Farm Inspection	£492,500	£344,750
AUTONOMOUS SURFACE VEHICLES LIMITED		£140,697	£84,418
University of Bristol		£380,159	£380,159
VULCANUAV LIMITED		£257,998	£180,599

Project description - provided by applicants
Offshore wind is a key energy source for the UK. It will play an increasingly significant role in future years, as part of an energy mix that is moving towards cleaner and more renewable sources. Offshore Wind Turbines (OWTs) have significant environmental challenges in terms of both the marine environment and the weather. This project, led by Perceptual Robotics and in partnership with ASV, the University of Bristol and VulcanUAV - will be developing and testing key technologies to address the autonomous inspection of offshore turbines. Building on an existing capability for the inspection of onshore wind turbines, the team will be working on integrating this with an autonomous surface boat provided by ASV, creating a system which will automatically deploy and recover the inspection drone without the need for human interaction. The long term vision of this project is to enable fully autonomous inspection for OWT - working from an autonomous boat whilst being monitored remotely from land. Key challenges associated with this project include mechanical deployment, robust operations, multi vehicle cooperation, communications and the handling and processing of large datasets. The team consists of specialists in drone design, construction and operation with Perceptual Robotics and VulcanUAV; specialists in autonomous marine vehicles through ASV; experts in computer vision with Bristol University and the ideal facilities in which to develop and test the system at the ORE Catapult facilities. Working together to solve the problems associated with operating an autonomous system in the extreme environment found offshore, the team will need to use modern control theory, sensors, materials, computer technology and AI algorithms to create a platform which can carry out rapid, robust inspections in the marine environment. A fully autonomous system for offshore turbine inspection will not only significantly reduce the costs associated with ongoing inspection, but will also improve the quality and quantity of the inspection data. Modern sensing, including the vision processing offered by the University of Bristol will allow Perceptual Robotics to fly closer and more accurately with respect to the blades, thereby improving the images and maximising the flight envelope. This in turn will offer the potential for accurate condition monitoring and possible lifetime extensions. The UK is currently a world leader in offshore wind energy and this project will provide a further step change in the efficiency and quality of inspections.

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NATIONAL NUCLEAR LABORATORY LIMITED	Alpha Glovebox Decommissioning Feasibility Study	£35,988	£17,994
I3D ROBOTICS LTD		£51,216	£35,851
THE SHADOW ROBOT COMPANY LIMITED		£57,478	£40,235
TWI LIMITED		£30,911	£30,911
University of Strathclyde		£30,736	£30,736

Project description - provided by applicants
Recent studies and demonstration of new cutting techniques have identified that deployment of robots with lasers for remote cutting operations could offer significant benefit and go some way to achieve the desired outcome of safer, faster and cheaper nuclear decommissioning. However, there still remains significant uncertainty over the capability, integration and use of the technology, therefore there is a need to design, integrate and demonstrate the system(s) to enable size reduction of alpha contaminated gloveboxes and other large alpha contaminated items. This work will identify that laser cutting has real advantages over manual size reduction methods with the use of remote AI technologies. The robot laser cutting system with 7th axis control would consist of a manipulator arm type robot suspended from a movable track/crane/gantry. The robot would be a standard industrial robot -- for example, one from the KUKA KR series -- mounted underneath a movable platform. This platform would in turn be attached to a gantry crane (or similar) above a facility where the system was required. This would effectively allow the robot to be lowered in to the facility from above to perform manipulation tasks. The system needs to have an additional positional system for the platform being deployed. This would enable the position of the platform relative to some home position to be known at any given time. The robot would be programmed to know the position of its end effector relative to its base - which for this system would be the platform suspended from the gantry. Similarly, any tools would know positional data relative to the robots end effector. Thus, by applying the appropriate linear transforms from the home position, it should be possible to work out the exact position of the tool relative to the home position of the gantry. This would allow high accuracy operations to be performed by the robot in the facility. These might include high accuracy scans of a facility (using a point cloud scanning device), manipulation of items in the facility, size reduction, etc - any items which might otherwise be performed by a conventional facility with a stationary robot. The key aspects to success will be through the systematic project management ensuring: - Engineering design - Technology integration - Date fusion and data analytics - Software development - Laser and Fume management developments The output of the project will be a full feasibility study of the system.

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ARCHANGEL IMAGING LTD.	Watch Chain - adding infrastructure to extreme environments	£99,985	£69,990
Project description - provided by applicants			
We will develop remote monitoring equipment for infrastructure security.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SONARDYNE INTERNATIONAL LIMITED	Precise Positioning for Persistent AUVs	£1,043,343	£521,672
AUTONOMOUS SURFACE VEHICLES LIMITED		£208,167	£124,900
National Oceanography Centre		£176,414	£176,414
Project description - provided by applicants			
This project will improve the navigational accuracy of autonomous underwater vehicles (AUVs) helping to further reduce the dependency on offshore infrastructure for wide area surveys of challenging marine environments. This will be achieved by a combination of three novel techniques: 1. Using enhanced autonomy to increase the accuracy of Long BaseLine (LBL) calibration to achieve 1m, deep sea positional accuracy; 2. Reducing the power requirements of the navigation systems, and 3. Reducing AUV dive errors via novel techniques for deep sea errors for current profiling.			

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Innovate UK

Results of Competition: **Research and Development Competition for RAI in Extreme and Challenging Environments**

Competition Code: **1706_EE_CRD_RFHE**

Total available funding is £10m

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
AUTONOMOUS SURFACE VEHICLES LIMITED	SIMVEE - Synthetic Imagery training for Machine Vision in Extreme Environments	£857,976	£514,786
BMT SHIP & COASTAL DYNAMICS LIMITED		£348,571	£174,286

Project description - provided by applicants
Autonomous cars are frequently in the headlines due to their potential to revolutionise the industry and transform road safety. Similar technologies can be used in the maritime environment however due to the extreme and dynamic conditions more research is needed to address and achieve similar capabilities. This project will focus on innovate research using a combination of simulated and real world imagery to train deep learning neural networks to undertake object detection classification in extreme maritime environments. We will develop a sensor system for autonomous boats using artificial intelligence (deep learning) techniques to detect objects in extreme environmental conditions. The performance of such techniques is dominated by the volume and quality of training data, but collecting such a set in extreme conditions is prohibitive. We will therefore explore novel ways of combining simulated and recorded data together to develop a system that will detect, track and classify objects within extreme maritime environments. Currently there are no sensor systems able to detect small objects (such as humans or buoys) in extreme environmental conditions at sea. Hence we will exploit ground breaking research in mixed synthetic and real data training to address this sensing gap. Specifically we will integrate the BMT Rembrandt simulator and ASView control software together to research and develop AI classifier training performance (as well as in verification and validation) in extreme environments. We will additionally integrate the SARIS search and rescue mission planning tool to demonstrate this capability in a fully autonomous real world search-and-rescue scenario. This project will be led by ASV in collaboration with BMT. ASV is the world leading developer of autonomous surface vehicle systems and has been developing advanced autonomy for these systems for over 3 years. This research has resulted in an advanced autonomy system capable of utilising radar and AIS to complete collision avoidance across a wide range of scenarios at speeds of up to 30knots. BMT is a leading engineering, science and technology consultancy operating mainly in the maritime industries. With around 1,500 professionals located in 60 offices in Europe, Asia and the Americas we draw upon a wide range of experience and expertise to provide high-quality, high-value products and services. As USVs are fundamentally limited by sensing ability, full autonomous operation in extreme environments is currently not possible. This project seeks to address this and expand market opportunities.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
AUTONOMOUS SURFACE VEHICLES LIMITED	Windfarm Autonomous Ships Project (WASP)	£357,857	£214,714
HOULDER LIMITED		£96,900	£58,140
OFFSHORE RENEWABLE ENERGY CATAPULT		£125,280	£125,280
SEAPLANNER LIMITED		£231,721	£115,861
University of Portsmouth		£153,494	£153,494

Project description - provided by applicants
The UK economic opportunity in offshore wind energy is robust and growing. Further cost reduction is essential to achieve parity with fossil fuel and nuclear energy systems. The application of Robotics and Artificial Intelligence (RAI) is being assessed in all other major sectors. For offshore wind, RAI offers the opportunities to minimise the need to send personnel offshore, reduce health & safety risks, improve offshore wind turbine availability and potentially significantly reduce OPEX costs by c2.8% and reduce turbine downtime by c13%. A consortium led by ASV Ltd with SeaPlanner Ltd, Houlder, University of Portsmouth and Offshore Renewable Energy Catapult will carry out industrial research to establish the baseline for autonomous vessel operations in offshore wind and verify the timeframe for their introduction. Windfarm Autonomous Support vessels Project (WASP) will undertake an 18-month industrial research project to benchmark the technological challenges facing the sector transition to autonomous support operations and chart a roadmap for the phased introduction of RAI systems for spares supply, asset surveillance, security patrol and crew transfer. The project will also create design specifications for new offshore command & control infrastructure and an innovative autonomous vessel with integrated robotic cargo capability. WASP will pull through existing enabling technology from project partners ASV Ltd (autonomous vessel AI technology), Houlder (gyro stabilised robotic arm) and SeaPlanner (offshore wind marine coordinator systems) demonstrating their application to offshore wind cargo supply. University of Portsmouth will develop decision support algorithms to enhance SeaPlanner marine coordination software enabling integrated manned and autonomous vessel offshore operations. ORE Catapult's cost and performance analysis will pinpoint how this new capability increases uptime of offshore wind turbines. These products will be equally applicable to adjacent maritime sectors such as Oil & Gas, wave & tidal energy, border patrol, fishery protection, search & rescue and merchant cargo handling, where there is a need to reduce costs, enhance efficiency and minimise the need for manned offshore operations conducting dull and dangerous missions. Insights from the project will be made available by ORE Catapult to raise awareness in the offshore wind sector of the huge benefits that RAI can bring and to drive investment in RAI technology and infrastructure. This project will help stimulate the UK supply chain to become a major player in the offshore wind autonomous support vessel market.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
NURON LIMITED	Developing a miniature robot to install a nervous system within non-man entry sewers	£95,437	£42,947

Project description - provided by applicants
Sewer flooding in your home is one of the worst things to experience, costing owners and UK wastewater companies tens of millions of pounds each year. Blockages, which are one cause of sewer flooding, mainly occur in small non-man entry sewers with an internal diameter of less than 600mm. nuron has developed a unique fibre sensing technology that will provide a step-change for home owners and wastewater network operators alike. nuron fibre sensing technology has a unique containment system designed to be installed along the wall of a sewer network creating a nervous system for sewers so blockages, flooding and other environmental incidents can be predicted and prevented before they happen. The sewer environment itself represents a challenge to the installation of a monitoring system. It is confined and over and above the normal sewerage and fats, oils and greases, the gas that builds up in these small diameter sewers is a complex mixture of toxic and nontoxic gases produced by the decomposition of organic household or industrial waste with the potential to create fire or explosions. This project is focused on the design and development of a miniature robot for the installation of the nuron fibre sensing containment system in small non-man entry sewers of 225-600mm internal diameter, because there is currently no existing robot or other technique available on the market with the capability of installing our sensing technology within such a confined and inhospitable space. Our objective is to work with the industry leaders in sewer rehabilitation, TC Mechanical to design and develop a first of its kind robot that will give wastewater operators access to nuron technology across their entire sewer network, enabling characterisation and inspection, and the capability of localisation and mapping of issues in this critical infrastructure.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SEICHE LIMITED	Intelligent on-board processing of visual data for real-time situational awareness by Unmanned Surface Vessels (USVs).	£181,646	£127,152
AUTONAUT LIMITED		£84,791	£59,354
National Oceanography Centre		£40,114	£40,114

Project description - provided by applicants

This project will develop an intelligent visual imaging system (including infra-red) that is integrated into an unmanned surface vehicle (USV). The system will process data using computational algorithms and artificial intelligence to visually detect and track objects of interest at sea. A robust communication link will be developed to allow data transfer to a remote location for further action or analysis -- in near real-time. This will be a low-power, low band-width system capable of long-duration missions and integration into all autonomous platforms, including the wave-propelled AutoNaut USV.

Marine mammals and seabird are a key concern of the offshore energy industry and monitoring of such marine-life will be the primary aim. This application will enhance environmental impact assessments and assist completion of operations in line with worldwide environmental standards. This innovative method will also have potential in other marine domain awareness applications, such as; asset integrity monitoring, surveillance of marine protected areas, security, border patrol and defence.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
SOIL MACHINE DYNAMICS LIMITED	Project Anemoi	£1,707,453	£853,727
MAGNOMATICS LIMITED		£68,600	£48,020
OFFSHORE RENEWABLE ENERGY CATAPULT		£220,609	£220,609
Project description - provided by applicants			
The Anemoi project will create a technology step change in the system operability and functionality of Remotely Operated Vehicles (ROVs) in extreme offshore environments. Under this project SMD will undertake world leading industrial research with key partners Magnomatics and the Offshore Renewable Energy Catapult to improve the component level design and performance of their next generation ROV systems. This will look at new system enhancements to improve maneuverability in extreme offshore wind farm environments, plus the development and testing of novel sensing technology to improve the speed of operations and substantially reduce OPEX costs in relation to the deployment of offshore wind farm infrastructure.			

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