H2020 – The EU framework programme for Research and Innovation (2014-2020)

Robotics projects resulting from H2020 – LEIT ICT 23 Call 1

Project Summaries

January 2015

Results of the Call for Proposals: H2020 – LEIT ICT 23 Call 1

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Project summaries may be edited for space reasons. First-named participant is the Co-ordinator and funding amounts are approximate. For further information visit the EU's Robotics website: http://cordis.europa.eu/fp7/ict/robotics/home_en.html
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Robotics in LEIT ICT Workprogramme 2014 - Robotics

ICT 23 – 2014: Robotics Publication: 11th December 2013 Deadline: 23rd April 2014	**Funding Scheme / Funding rate**	**Budget (M€)**
a. Research & Innovation Actions Priority domains: manufacturing, commercial, civil, agriculture b. Innovation Actions: Technology transfer - Robotics use cases Priority domains: none specified	a. Small & Large EU contributions[1] / 100% b. Small & Large contributions / 70% c. Large contribution / 70%	a. 57 b. 12 c. 5

[1] *Small contribution*: contribution from the EU of between EUR 2 million and EUR 4 million

- *Large contribution*: contribution from the EU of between EUR 5 million and EUR 8 million

AEROARMS

Title: AErial RObotic system integrating multiple ARMS and advanced manipulation capabilities for inspection and maintenance
Funding scheme: Research and Innovation action, **Proposal number:** 644271
Duration (months): 48, **Maximum grant awarded (Euros):** 4,722,852.00

Summary:
AEROARMS is developing the first aerial robotic system with multiple arms and advanced manipulation capabilities. The system is being designed for its application in industrial "inspection and maintenance" (I&M).

The objectives of AEROARMS are R&D on aerial manipulation to perform I&M. This includes, firstly, the development of systems which are able to grab and dock with one or more arms and perform dexterous accurate manipulation with another arm. Also, the project aims to develop higher capacity, helicopter-based, aerial manipulators, and with a dexterous arm to provide advanced manipulation capabilities. Secondly, the project aims to develop new methods and technologies for platforms which can fly and manipulate with the coordinated motion of the arms addressing constrained scenarios in which it is dangerous to use the helicopter and where it is not possible to grab to perform I&M operation. Finally, the project aims to validate the "grab and dock" system in two situations, 1) Installation and maintenance of permanent NDT sensors on remote components; 2) Deploy and maintain a mobile robotic system permanently installed on a remote structure.

Special attention will be paid to the design and system development in order to receive future certification taking into account ATEX and RPAS regulations.

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ALSTOM INSPECTION ROBOTICS AG	CH
Sensima Inspection Sarl	CH

AEROWORKS

Title: Collaborative Aerial Robotic Workers
Funding scheme: Research and Innovation action, **Proposal number:** 644128
Duration (months): 36, **Maximum grant awarded (Euros):** 3,671,935.00

Summary:
With aging infrastructure in developing-and-developed countries, and with the gradual expansion of distributed installations, the costs of inspection and repair tasks have been growing vastly and incessantly. To address this reality, a major paradigm shift is required, in order to procure the highly automated, efficient, and reliable solutions that will not only reduce costs, but will also minimize risks to personnel and asset safety. AEROWORKS envisions a novel aerial robotic team that possesses the capability to autonomously conduct infrastructure inspection and maintenance tasks, while additionally providing intuitive and user-friendly interfaces to human-operators. The AEROWORKS robotic team will consist of multiple heterogeneous "collaborative Aerial Robotic Workers", a new class of Unmanned Aerial Vehicles equipped with dexterous manipulators, novel physical interaction and co-manipulation control strategies, perception systems, and planning intelligence. This new generation of worker-robots will be capable of autonomously executing infrastructure inspection and maintenance works. The AEROWORKS multi-robot team will operate in a decentralized fashion, and will be characterized by unprecedented levels of re-configurability, mission dependability, mapping fidelity, and manipulation dexterity, integrated in robust and reliable systems that are rapidly deployable and ready-to-use as an integral part of infrastructure service operations. As the project aims for direct exploitation in the infrastructure services market, its results will be demonstrated and evaluated in realistic and real infrastructure environments, with a clear focus on increased Technology Readiness Levels. The accomplishment of the envisaged scenarios will boost the European infrastructure sector, contribute to the goal of retaining Europe's competitiveness, and particularly impact our service and industrial robotics sector, drastically changing the landscape of how robots are utilized.

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Centauro

Title: Robust Mobility and Dexterous Manipulation in Disaster Response by Fullbody Telepresence in a Centaur-like Robot
Funding scheme: Research and Innovation action, **Proposal number:** 644839
Duration (months): 42, **Maximum grant awarded (Euros):** 4,124,915.00

Summary:
Disaster scenarios, such as the Fukushima nuclear plant accident, clearly show that the capabilities of today's disaster response robots are not sufficient for providing the support needed to rescue workers. The CENTAURO project aims at the development of a human-robot symbiotic system, where a human operator is tele-present with its whole body in a Centaur-like robot, which is capable of robust locomotion and dexterous manipulation in the rough terrain and difficult conditions characterising disasters. The CENTAURO robot will consist of a four-legged basis and an anthropomorphic upper body and will be driven by lightweight, compliant actuators. It will be able to navigate in affected man-made environments, including the inside of buildings and stairs, which are cluttered with debris and partially collapsed. The Centauro system will be capable of using unmodified human tools for solving complex bimanual manipulation tasks, such as connecting a hose or opening a valve, in order to relieve the situation. A human operator will control the robot intuitively using a full-body tele-presence suit that provides visual, auditory, and upper-body haptic feedback. Rich sensors will provide the necessary situation awareness. Robot precepts and suggested actions will be displayed to the operator using augmented reality techniques. For routine manipulation and navigation tasks, autonomous robot skills will be developed. This will allow for the partial removal of the operator from the control loop, which will be required to cope with communication latencies, bandwidth limitations and to reduce the operator's workload. A series of increasingly complex tests with corresponding evaluation criteria will be devised from end-user requirements to systematically benchmark the capabilities of the developed disaster response system.

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CogIMon

Title: Cognitive Interaction in Motion
Funding scheme: Research and Innovation action, **Proposal number:** 644727
Duration (months): 48, **Maximum grant awarded (Euros):** 5,688,126.00

Summary:
Compliant control in humans is exploited in a variety of sophisticated skills. These include solitary actions such as soft catching, sliding, pushing large objects, and joint actions performed in teams such as manipulation of large scale objects or mutual adaptation through physical coupling for learning, in walking or in execution of joint tasks. We refer to this advanced ability of organizing versatile motion under varying contact and impedance as cognitive compliant interaction in motion. The CogIMon project aims at a step-change in human-robot interaction towards the systemic integration of robust, dependable interaction capabilities for teams of humans and compliant robots, in particular the compliant humanoid COMAN. We focus on interaction that requires active and adaptive regulation of motion and behaviour of both the human(s) and the robot(s) and involves whole-body variable impedance actuation, adaptability, prediction, and flexibility. This goal shall be achieved through sophisticated real world robot demonstrations of interactive compliant soft catching and throwing, interaction with COMANS under changing contact and team constellation, and in model-driven fully engineering multi-arm handling shared by Kuka LWR robots and humans working alongside. Key advancements towards this goal are targeted in mechatronics and whole-body motion control, in model-driven software engineering, in estimating and predicting motion for kinematic motion tracking data, in devising force and impedance primitives and architectures for respective technology combinations.

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EBERHARD KARLS UNIVERSITAET TUEBINGEN	DE

COMANOID

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing
Funding scheme: Research and Innovation action, **Proposal number:** 645097
Duration (months): 48, **Maximum grant awarded (Euros):** 4,244,481.25

Summary:
COMANOID investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited for narrow environments, specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots, that have larger support areas, are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge will be to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic serving; perception and localization; human-robot safety and the operational efficiency of cobotics solutions in airliner manufacturing.

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EurEyeCase

Title: Use Case for European Robotics in Ophthalmologic Micro –Surgery
Funding scheme: Innovation action, **Proposal number:** 645331
Duration (months): 36, **Maximum grant awarded (Euros):** 2,648,314.00

Summary:
EurEyeCase combines cutting−edge European robotic technology and creates an integrated setup for the very challenging use of vitreoretinal eye surgery. Nowadays, a selected number of highly −skilled ophthalmologists are treating large numbers of patients that suffer from various types of vitreoretinal eye diseases. The majority of these intra−ocular interventions lie on or even beyond the boundaries of human skills as they pose extreme requirements in terms of manipulation and positioning precision. As a result, current treatments are characterized by moderate success rates, and, even, an inability to adequately treat some common diseases. As a consequence, a large group of patients is left untreated or receives suboptimal treatment. Robotic technology can, and is likely to put an end to the current status-quo. Starting from existing hardware, knowledge, IP and in close collaboration with medical partners, EurEyeCase will build up and validate a convincing robot-assisted operation suite, which will help surgeons in treating a selection of particularly demanding vitreoretinal procedures, including the treatment of retinal vein/artery occlusion through cannulation and epiretinal membrane treatment. Current laboratory setups will be studied in detail, augmented and tailored for successful integration into the surgical workflow. Novel sensing technologies will be further developed and integrated with advanced control methods to deliver unprecedented levels of safety and performance. In-depth evaluation of the setup in different directions, i.e, performance, usability and clinical relevance, as well as the first steps to transferring the most challenging developments to the next phase of product development are key aspects of the project. EurEyeCase will demonstrate how medical robotics technology can boost success rates of urgent and critical surgical interventions and paves the way for novel promising treatment methods with demonstrated improvement in patient outcomes.

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FLOBOT

Title: Floor Washing Robot for Professional Users
Funding scheme: Innovation action, **Proposal number:** 645376
Duration (months): 36, **Maximum grant awarded (Euros):** 3,186,473.75

Summary:
Industrial, commercial, civil and service premises, such as supermarkets and airports have huge floor surfaces that have to be cleaned on a daily basis as well as infra-daily. These human activities are time consuming and repetitive and take place at sundry times, not necessarily covering a work-shift duration; this depends on the kind of premise and available time slots as well as on the type of organisation. The floor washing activities are favourably suited for robotization. There is currently no existing robot that satisfies the requirements of the professional users and cleaning services companies. Floor washing tasks are demanding under many aspects: autonomy of operation, navigation precision, safety, interaction with the human cleaning personnel, cleaning operations on demand during opening hours, presence of multiple robots at the same time, operating in the same area, optimization of paths, easy set-up of path and duties without reprogramming. The project FLOBOT addresses these problems, integrating existing solutions and knowledge of the partners to produce a professional floor washing robot for wide area of industrial, civil and commercial premises. The work that will be carried out on production prototypes will be at TRL8. The FLOBOT project derives requirements from professional users and implements four usage case validations in real world operational environments: Supermarkets, Airport and Civil Buildings.

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RIDGEBACK S.A.S. DI PAOLO BARATTINI & C.	IT
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Flourish

Title: Aerial Data Collection and Analysis, and Automated Ground Intervention for Precision Farming
Funding scheme: Research and Innovation action, **Proposal number:** 644227
Duration (months): 42, **Maximum grant awarded (Euros):** 3,560,870.00

Summary:
To feed a growing world population with the given amount of available farmland, we must develop new methods of sustainable farming that increase yield while reducing reliance on herbicides and pesticides. Precision agricultural techniques seek to address this challenge by monitoring key indicators of crop health and targeting treatment only to plants that need it. This is a time consuming and expensive activity and while there has been great progress on autonomous farm robots, most systems have been developed to solve only specialized tasks. This lack of flexibility poses a high risk of no return on investment for farmers. The goal of the Flourish project is to bridge the gap between the current and desired capabilities of agricultural robots by developing an adaptable robotic solution for precision farming. By combining the aerial survey capabilities of a small autonomous multi-copter Unmanned Aerial Vehicle (UAV) with a multi-purpose agricultural Unmanned Ground Vehicle, the system will be able to survey a field from the air, perform targeted intervention on the ground, and provide detailed information for decision support, all with minimal user intervention. The system can be adapted to a wide range of crops by choosing different sensors and ground treatment packages. This development requires improvements in technological abilities for safe accurate navigation within farms, coordinated multi-robot mission planning that enables large field survey even with short UAV flight times, multispectral three-dimensional mapping with high temporal and spatial resolution, ground intervention tools and techniques, data analysis tools for crop monitoring, weed detection, and user interface design to support agricultural decision making. As these aspects are addressed in Flourish, the project will unlock new prospects for commercial agricultural robotics in the near future.

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RETRAINER

Title: REaching and grasping Training based on Robotic hybrid AssIstance for Neurological patients: End users Real life evaluation
Funding scheme: Innovation action, **Proposal number:** 644721
Duration (months): 48, **Maximum grant awarded (Euros):** 2,784,831.00

Summary:
The aim of the RETRAINER proposal is to tune and validate advanced, robot-based technologies to facilitate recovery of arm and hand function in stroke survivors and to verify extensively the use of the system by end-users. RETRAINER will allow the users to use their own arm and hand as much and as soon as possible after the trauma so to achieve the best outcomes in rehabilitation. A continuous iterative process between the technology development and the testing feedback will drive the whole project. RETRAINER will implement a full technology transfer from the results of a previous FP7 project, MUNDUS, aimed at setting up a similar assistive device for severely disabled people in daily life activities. RETRAINER will make available two systems that could be either used in combination or as a stand-alone. RETRAINER S1 will provide the end-user with a robot that does not completely take over the user's tasks and substitute the functionality of the body, but specifically supports the user only whenever he/she really needs support. Residual functionality is trained and improved on rather than replaced by the robotic device. Arm movements will be supported by the combined action of a passive exoskeleton for weight relief and Neuromuscular Electrical stimulation (NMES) delivered to several arm muscles in a controlled manner. RETRAINER S2 will exploit a wearable NMES system with multiple arrays of electrodes for hand rehabilitation facilitating the grasping function. Both systems will benefit from use of interactive objects, i.e. daily-life objects able to supply information about themselves to drive usage. Within RETRAINER the same principle and module will be exploited to drive rehabilitation exercises and to monitor daily life. The systems will undergo a thorough randomized control clinical trial with end users to assess their efficacy in rehabilitation. Certification and qualification of the system will be pursued, given the adequate quality of experimental results.

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RobDREAM

Title: Optimising Robot Performance while Dreaming
Funding scheme: Research and Innovation action, **Proposal number:** 645403
Duration (months): 36, **Maximum grant awarded (Euros):** 5,401,911.00

Summary:
Sleep! For hominids and most other mammals sleep means more than regeneration. Sleep positively affects working memory, which in turn improves higher-level cognitive functions such as decision making and reasoning. This is the inspiration of RobDREAM! What if robots could also improve their capabilities in their inactive phases – by processing experiences made during the working day and by exploring – or "dreaming" of – possible future situations and how to solve them best? In RobDREAM we will improve industrial mobile manipulators' perception, navigation, manipulation and grasping capabilities by automatic optimization of parameters, strategies and selection of tools within a portfolio of key algorithms for perception, navigation and manipulation and grasping, by means of learning and simulation, and through use case driven evaluation. As a result, mobile manipulation systems will adapt more quickly to new tasks, jobs, parts, areas of operation and various other constraints. From a scientific perspective the RobDREAM robots will feature increased adaptability, dependability, flexibility, configurability, decisional autonomy, as well as improved abilities in perception, interaction manipulation and motion. The technology readiness level (TRL) of the related key technologies will be increased by means of frequent and iterative real-world testing, validation and improvement phases from the very beginning of the project. From an economic perspective, the Quality of Service and the Overall Equipment Efficiency will increase, while at the same time the Total Cost of Ownership for setup, programming and parameter tuning will decrease. These advantages will support the competitiveness of Europe's manufacturing sector, in particular in SME-like settings with higher product variety and smaller lot-sizes. They also support the head start of technology providers adopting RobDREAM's technologies to conquer market shares in industrial and professional service robotics.

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RoMaNS

Title: Robotic Manipulation for Nuclear Sort and Segregation
Funding scheme: Research and Innovation action, **Proposal number:** 645582
Duration (months): 36, **Maximum grant awarded (Euros):** 6,377,521.00

Summary:
The RoMaNS (Robotic Manipulation for Nuclear Sort and Segregation) project will advance the state of the art in mixed autonomy for tele-manipulation, to solve a challenging and safety-critical "sort and segregate" industrial problem, driven by urgent market and societal needs.
Cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents the largest environmental remediation project in the whole of Europe. Most EU countries face related challenges. Nuclear waste must be "sorted and segregated" so that low-level waste is placed in low-level storage containers, rather than occupying extremely expensive and resource intensive high-level storage containers and facilities. Many older nuclear sites (>60 years in UK) contain large numbers of legacy storage containers, some of which have contents of mixed contamination levels, and sometimes unknown contents. Several million of these legacy waste containers must now be cut open, investigated, and their contents sorted. This can only be done remotely using robots, because of the high levels of radioactive material. Current state of the art practice in the industry, consists of simple tele-operation (e.g. by joystick or teach-pendant). Such an approach is not viable in the long-term because it is prohibitively slow for processing the vast quantity of material. The project will: 1) Develop novel hardware and software solutions for advanced bi-lateral master-slave tele-operation. 2) Develop advanced autonomy methods for highly adaptive automatic grasping and manipulation actions. 3) Combine autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches. 4) Deliver a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility.

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SARAFun

Title: Smart Assembly Robot with Advanced FUNctionalities
Funding scheme: Research and Innovation action, **Proposal number:** 644938
Duration (months): 36, **Maximum grant awarded (Euros):** 4,037,265.50

Summary:
While Industrial robots are very successful in many areas of industrial manufacturing, assembly automation still suffers from complex time consuming programming and the need for dedicated hardware. ABB has developed FRIDA (Friendly Robot for Industrial Dual Arm Assembly), a collaborative inherently safe assembly robot that is expected to reduce integration costs significantly by offering a standardized hardware setup and simple fitting of the robot into existing workplaces. Internal Pilot testing at ABB has however shown that when FRIDA is programmed with traditional methods the programming time even for simple assembly tasks will remain very long. The SARAFun project has been formed to enable a non-expert user to integrate a new bi-manual assembly task on a FRIDA robot in less than a day. This will be accomplished by augmenting the FRIDA robot with cutting edge sensory and cognitive abilities as well as reasoning abilities required to plan and execute an assembly task. The overall conceptual approach is that the robot should be capable of learning and executing assembly tasks in a human like manner. Studies will be made to understand how human assembly workers learn and perform assembly tasks. The human performance will be modelled and transferred to the FRIDA robot as assembly skills. The robot will learn assembly tasks, such as insertion or folding, by observing the task being performed by a human instructor. The robot will then analyse the task and generate an assembly program, including exception handling, and design 3D printable fingers, tailored for gripping the parts at hand. Aided by the human instructor, the robot will finally learn to perform the actual assembly task, relying on sensory feedback from vision, force and tactile sensing as well as physical human robot interaction. During this phase the robot will gradually improve its understanding of the assembly at hand until it is capable of performing the assembly in a fast and robust manner.

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secondHands

Title: SecondHands: A Robot Assistant For Industrial Maintenance Tasks
Funding scheme: Research and Innovation action, **Proposal number:** 643950
Duration (months): 60, **Maximum grant awarded (Euros):** 5,994,000.00

Summary:
The subject of this proposal is a robot assistant that is trained to understand maintenance tasks so that it can either pro-actively or as a result of prompting, offer assistance to maintenance technicians performing routine and preventative maintenance. Conceptually the robot's task is to provide a second pair of hands to the maintenance engineer, such that once the robot has been trained it can predict when and how it can usefully provide help. The robot's behavioural repertoire is learnt in a training phase that includes the monitoring of maintenance technician activity, the construction of a knowledge base that describes the context of a task, and a theory of action that enables dynamic behaviour generation. The result is a set of competencies coupled with an ability to recognise the state of a task and an understanding of how these competencies can be usefully deployed given the state. The scope of work includes the construction of a robot assistant, the systems that facilitate the training, the actual training on a number of representative tasks, perceptual systems that facilitate activity recognition, and validation of the system's ability to usefully contribute to tasks in collaboration with a maintenance engineer. Assessment of the system will test its ability to recognise when it doesn't know something as well as its ability to generalise its knowledge to previously unseen tasks.

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ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	CH
UNIVERSITY COLLEGE LONDON	UK

Smokebot

Title: Mobile Robots with Novel Environmental Sensors for Inspection of Disaster Sites with Low Visibility
Funding scheme: Research and Innovation action, **Proposal number:** 645101
Duration (months): 42, **Maximum grant awarded (Euros):** 3,817,417.50

Summary:
SmokeBot is driven by the application needs for robots that operate in domains with restricted visibility. The focus is on civil robots supporting fire brigades in search and rescue missions, e.g. in post-disaster management operations in response to tunnel fires. Existing sensor technology and the related cognitive approaches cannot cope with such demanding conditions. SmokeBot addresses this shortcoming and can thus bring about a step change for robotics. It will deliver software and hardware components which facilitate robot systems to perform under harsh conditions of smoke, dust or fog. This will be demonstrated through integration of the project results in an industrial prototype of a Low Visibility Explorer Robot for providing situational awareness based on a commercial platform from partner TAUR. In close collaboration with TAUR (robotics industry) and end users (BFW, end users in the advisory group), SmokeBot will crucially improve the abilities of the selected platform, thus increasing safety of rescue staff and European citizens as well as improving the product of a European robotics company in an important market. An even wider impact is expected through the development of a novel sensor unit and the corresponding cognitive approaches. In addition to traditional sensors such as LIDAR and cameras, which are affected by smoke or dust, this sensing unit includes also a novel 3D radar camera, a thermal camera, and high bandwidth gas sensors. Fusion of sensor modalities will allow the inclusion of measurements from LIDAR and camera into the world model when they occasionally penetrate through e.g. smoke. In addition, means to integrate prior knowledge in the form of crude human sketch maps will be developed to allow for robust mapping and navigation even under low visibility in a harsh environment. Sensor technology from SmokeBot will result in new products to be brought to market after the project. Software developed will be made available as open source.

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SoMa

Title: Soft-bodied intelligence for Manipulation
Funding scheme: Research and Innovation action, **Proposal number:** 645599
Duration (months): 48, **Maximum grant awarded (Euros):** 6,321,278.75

Summary:
The main obstacle to a wide-spread adoption of advanced manipulation systems in industry is their complexity, fragility, and difficulty of use. This proposal describes a path of disruptive innovation for the development of simple, compliant, yet strong, robust, and easy-to program manipulation systems. The idea is: Soft Manipulation (SoMa). SoMa explores a new avenue of robotic manipulation with the environment, as opposed to manipulation of or in the environment. In our approach, the physical constraints imposed by objects in the environment and the manipulandum itself are not regarded as obstacles, but rather as opportunities to guide functional hand pre-shaping, adaptive grasping, and affordance-guided manipulation of objects. The exploitation of these opportunities, which we refer to as environmental constraints (EC), enables robust grasping and manipulation in dynamic, open, and highly variable environments. The key ingredient for the exploitation of EC is softness of hands, i.e. their embodied ability to comply and adapt to features of the environment. The traditional paradigm for robotic manipulation is in complete disarray in front of this shift of focus: state-of-the-art grasp planners are targeted towards rigid hands and objects, and attempt to find algorithmic solutions to inherently complex, often ill-posed problems. Further complicating matters, the requirement of planning for soft, uncertain interactions between hand and environment is entirely beyond the state of the art. However, this is how humans most often use their hands, and how we plan to change robotic manipulation.

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Institute of Science and Technology Austria	AT
THE WALT DISNEY COMPANY (SWITZERLAND) GMBH	CH
Ocado Innovation Ltd	UK

SWEEPER

Title: Sweet Pepper Harvesting Robot
Funding scheme: Innovation action, **Proposal number:** 644313
Duration (months): 36, **Maximum grant awarded (Euros):** 4,028,311.50

Summary:
In modern greenhouses there is a high demand to automate labour. The availability of a skilled workforce that accepts repetitive tasks in the harsh climate conditions of a greenhouse is decreasing rapidly. The resulting increase in labour costs and reduced capacity puts major pressure on the competitiveness of the European greenhouse sector. Present robotization of this labour has entered a high level of technological readiness. However, a gap remains which halts the transition from science to economic and societal impact; the so called 'Technological Innovation Gap'. In the EU-FP7-project CROPS, extensive research has been performed on agricultural robotics. One of the applications was a sweet pepper harvesting robot. It was shown that such a robot is economically and technically viable. The proven hardware and software modules (TRL: 6) developed in CROPS will be used as the groundwork. The successful CROPS software modules based on the Robotic-Operating-System (ROS) will be maintained and expanded in SWEEPER. Also the gripper end-effector will be retained. This patent pending module is able to grasp the sweet pepper without the need of an accurate measurement of the position and orientation of the fruit. In several experiments, it turned out that different growers use different cropping systems ranging in crop density. In SWEEPER, the cropping system itself will be optimized to facilitate robotic harvesting. In CROPS it was concluded that instead of a 9DOF, a 4DOF robot arm is sufficient, greatly reducing costs. To improve the level of robotic cognitive abilities, plant models will be applied to approximate location of sweet peppers. This "model-based vision" will increase and speed up fruit detection. Based on the insights of CROPS, sensors will be placed onto the gripper only. Also a LightField sensor will be introduced, which is able to record both colour and 3D information simultaneously.

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IRMATO ENGINEERING WEERT BV	NL
DE TUINDERSHOEK BV De	NL

WiMUST

Title: Widely scalable Mobile Underwater Sonar Technology
Funding scheme: Research and Innovation action, **Proposal number:** 645141
Duration (months): 36, **Maximum grant awarded (Euros):** 3,970,081.25

Summary:
The WiMUST (Widely scalable Mobile Underwater Sonar Technology) project aims at expanding and improving the functionalities of current cooperative marine robotic systems, effectively enabling distributed acoustic array technologies for geophysical surveying with a view to exploration and geotechnical applications. Recent developments have shown that there is vast potential for groups of marine robots acting in cooperation to drastically improve the methods available for ocean exploration and exploitation. Traditionally, seismic reflection surveying is performed by vessel towed streamers of hydrophones acquiring reflected acoustic signals generated by acoustic sources (either towed or on-board a vessel). In this context, geotechnical surveying for civil and commercial applications (e.g., underwater construction, infrastructure monitoring, mapping for natural hazard assessment, environmental mapping, etc.) aims at seafloor and sub-bottom characterization using towed streamers of fixed length that are extremely cumbersome to operate. The vision underlying the WiMUST proposal is that of developing advanced cooperative and networked control / navigation systems to enable a large number (tens) of marine robots (both on the surface and submerged) to interact by sharing information as a coordinated team (not only in pairs). The WiMUST system may be envisioned as an adaptive variable geometry acoustic array. By allowing the group of surface and submerged vehicles to change their geometrical configuration, an end-user can seamlessly change the geometry of the ”virtual streamer” trailing the emitter, something that has not been achieved in practice and holds potential to drastically improve ocean surveying. The project brings together a group of research institutions, geophysical surveying companies and SMEs with a proven track record in autonomous adaptive and robust systems, communications, networked cooperative control and navigation, and marine robot design and fabrication.

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