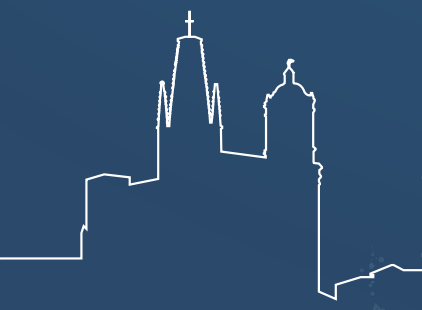
EMRA'17

Workshop on EU-funded MARINE ROBOTICS AND APPLICATIONS

PROCEEDINGS



GIRONA, Spain

MAY 15-16, 2017

Hosted by:

Universitat de Girona
Institut de Recerca en Visió per Computador i Robòtica
VICOROB

UNDERWATER VISION AND ROBOTICS LAB

Organized within the framework of:

EXCELLABUST

STRONG MAR

With the support of:

OES IEEE Oceanic Engineering Society

Funded by the European Commission under the H2020 EU Framework Programme for Research and Innovation (H2020-TWINN-2015 691980) and (H2020-TWINN-2015 692427)

ORGANIZING COMMITTEE

Marc Carreras
University of Girona

Nikola Miskovic
University of Zagreb

Eduardo Silva
INESC TEC and ISEP

www.marinerobotics.eu

WELCOME

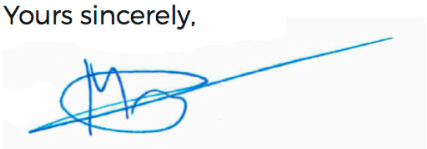
Welcome to the 4th EU funded Marine Robotics and Applications Workshop (EMRA '17)!

Following successful events hosted by CNR (Rome 2014), IST (Lisbon 2015) and Newcastle University (Newcastle 2016), the University of Girona will host the next workshop on marine robotics and applications on May 15th and 16th, 2017. The main goal of this workshop is to summarize current EU FP7 and H2020 projects on marine robotics and to provide a platform for marine stakeholders to share and discuss current technological challenges and achievements. It is an interdisciplinary event, providing an excellent opportunity for networking and cross-fertilisation of ideas in marine robotics, enabling technologies and applications. This edition of EMRA is organised and supported by two EU funded twinning actions: EXCELLABUST and STRONGMAR. The workshop will be held in the city of Girona, which offers a great combination of culture, gastronomy and sightseeing, especially during these days that coincide with the Girona Flower Festival.

The workshop will have two invited talks given by leading entities in marine robotics and twenty presentations related to the activities done in research projects, companies and research institutions. The meeting will be held in the facilities of the Science and Technological Park of the University of Girona, which provides an excellent environment for presentations and networking.

I would like to thank all participants of the workshop for their interest and collaboration. I hope you enjoy and find fruitful the meeting and you have a pleasant time in Girona. I would like to thank also the organizing committee from University of Girona, and EXCELLABUST and STRONGMAR teams for their support and effort in the organization of this successful event.

Yours sincerely,



Marc Carreras
EMRA'17 Organizing Committee Chair

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FACTS AND FIGURES

95 Attendees

45 European Institutions and Companies

15 Different Countries

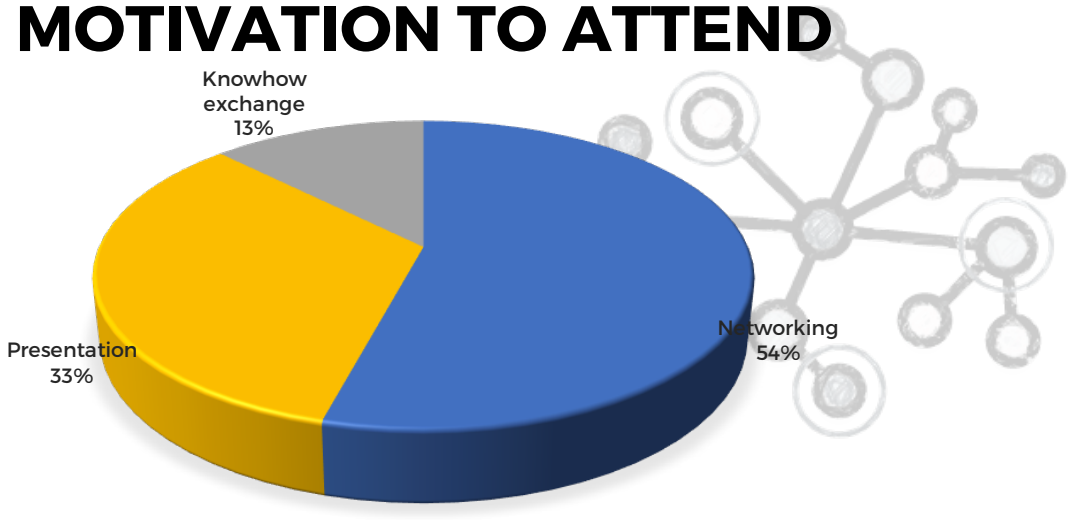
19 EU-funded projects presented

6 Private Sector and Tech Transfer Presentations

Average overall impression

9.36/10

MOTIVATION TO ATTEND



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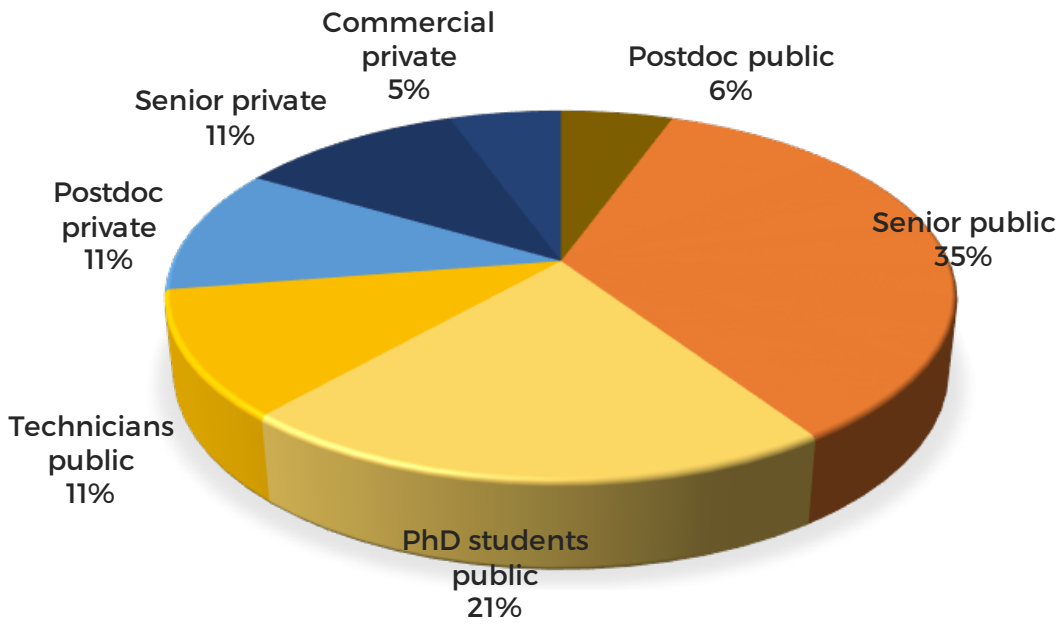
ATTENDEE PROFILE



27% private sector with experience & mostly in R&D departments
68% experienced profiles in both public and private sectors

EMRA 2017 feelings...

... Excellent event technically. Great **hospitality** on top.
... **Wonderful** event!
... I really appreciated the open discussion!
Very **interesting** event!
... It allows in a short period to have **a good overview of the state of research in marine robotics in Europe** and exchange ideas.

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EMRA'17

WORKSHOP PROGRAMME

15th MAY 2017, Monday

8:30	REGISTRATION OPEN - Good morning coffee
9:00	WELCOME Pere Ridao / Marc Carreras / Quim Salvi, University of Girona
9:15	KEYNOTE SPEAKER 1 - IFREMER Developed Hybrid ROV/AUV Ariane Lorenzo Brignone, IFREMER
10:00	DexROV: dexterous ROV interventions operated from an onshore control center Jeremi Gancet, Space Applications Services NV/SA
10:20	SWARMs: Smart and Networking UnderWAter Robots in Cooperation Meshes José-Fernán Martinez, Universidad Politécnica de Madrid
10:40	COFFEE BREAK
11:10	BRIDGES: Bringing together Research and Industry for the Development of Glider Environmental Services Laurent Mortier, ENTSA Paris Tech
11:30	TECH TRANSFER EXPERIENCE: From ICTINEU3 manned submersible to underwater robotics market Carme Paradeda, ICTINEU SUBMARINS
11:50	SOCIB-GF: Introducing SOCIB's Glider Facility and its Open-Access Program Marc Torner, SOCIB Glider Engineer
12:10	ROBUST: Robotic subsea exploration technologies Graham Edwards, The Welding Institute Ltd
12:30	MARIS: Marine Autonomous Robotics for InterventionS Pino Casalino, University of Genova (ISME)
12:50	LUNCH BREAK
14:00	The MEDUSA Deep Sea and FUSION AUVs: When research and business get together Bruno Cardeira, Instituto Superior Técnico (Lisbon)
14:20	SUNRISE and EASME Archeosub: Building the Internet of Underwater Things Chiara Petroli, University of La Sapienza (Rome)
14:40	TECNOAMBIENTE: SME marine survey industry challenges Héctor Martínez, TECNOAMBIENTE
15:00	subCULTron: A swarm of robots in the lagoon of Venice Ronald Thenius, Uni Graz
15:20	COFFEE BREAK
15:40	CADDY: Cognitive Autonomous Diving Buddy Nikola Miskovic, University of Zagreb - FER
16:00	The SeaCat Hybrid AUV: From toy to product Jörg Kawla, ATLAS ELEKTRONIK GMBH
16:20	VAMOS: Viable Alternative Mine Operating System Eduardo Silva, ISEP / INESC TEC
16:40	European Robotics League Emergency: A multi-domain outdoor robotics challenge Gabriele Ferri, CMRE
17:00	VISIT TO CIRS LAB Marc Carreras, University of Girona
17:30	END OF DAY ONE
18:30	Guided tour around the city of Girona (departure from Plaça Catalunya)
20:00	EMRA INFORMAL DINNER at Hotel AC Palau de Bellavista

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WORKSHOP PROGRAMME

16th MAY 2017, Tuesday

9:00	GOOD MORNING COFFEE
9:15	KEYNOTE SPEAKER 2 - Underwater Robotics: Current commercial capabilities and future requeriments Scott Reed, Seebyte Ltd
10:00	The WiMUST H2020 project: Widely scalable Mobile Underwater Sonar Technology Giovanni Indiveri, University of Salento (ISME)
10:20	MERBOTS: Multifunctional coopERative marine roBOTs for Intervention DomainS Pedro J Sanz, Universitat Jaume I
10:40	MARINE UAS: Innovative Training Network on Autonomous UAS for Marine and Coastal Monitoring José Pinto, LSTS - Feup (Porto)
11:00	COFFEE BREAK
11:20	MORPH: Marine robotic systems of self-organizing, logically linked physical nodes Bruno Cardeira, Instituto Superior Técnico (Lisbon)
11:40	OceanRINGS: Current State of Development and Future Work Edin Omerdic, University of Limerick
12:00	e-URready4OS: Underwater Robotics Ready for Oil Spill Javier Gilabert, Universidad Politecnica de Cartegena
12:20	ROBOCADEMY: the Future generation of Maritime and Underwater Robotics Research Thomas Vögele, DFKI
12:40	OPEN DISCUSSION - Future directions and opportunities in marine robotics Moderated by: Pere Ridao, University of Girona
13:15	LUNCH
14:30	END OF DAY TWO

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PRESENTED RESEARCH PROJECTS

STRONG MAR
www.strongmar.eu

EXCELLABUST
www.excellabust.fer.hr

EUROPEAN ROBOTICS LEAGUE
Brought to you by SPARC
www.eu-robotics.net

Wi MUST
Widely scalable Mobile Underwater Sonar Technology
www.wimust.eu

CADDY
Cognitive Autonomous Diving Buddy
www. caddy-fp7.eu

ROBOCADEMY
www.robocademy.eu

sunrise
www.fp7-sunrise.eu

subCULTron
www.subcultron.eu

DexROV
www.dexrov.eu

MERBOTS
www.irs.uji.es/merbots

URready4OS
www.upct.es/urready4os

¡vamos!
www.vamos-project.eu

ROBUST
www.eu-robust.eu

SWARMs)))
www.swarms.eu

MARIS
www.graal.dibris.unige.it

OCEAN RINGS
www.mmrrc.ul.ie

MORPH
www.morph-project.eu

BRIDGES
www.bridges-h2020.eu

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EXCELLABUST

The main goal of EXCELLABUST project is to address networking gaps and deficiencies between UNIZG-FER and internationally leading counterparts at EU level, by significantly strengthening marine robotics research within LABUST (Laboratory for Underwater Systems and Technologies, an integral part of University of Zagreb Faculty of Electrical Engineering and Computing). EXCELLABUST twinning will enhance S&T capacity, and help raise staff's research profile in marine robotics of linked institutions: UNIZG-FER, Consiglio Nazionalle delle Ricerche, University of Girona and University of Limerick.

STRONGMAR

INESC TEC is exploring the research area of marine science and technology in an effort to address the challenges imposed by the Portuguese region of maritime influence: Dimension: coverage of a vast area of water and soil, where the sole use of manned vehicles is unfeasible if physical presence on site is required AND Depth: exploration and exploitation of deep and ultra-deep sea, where human physical presence is not an option. Addressing these challenges implies putting together multiple competences, in many complementary scientific fields within the marine science and technology area. The multidisciplinary and applied nature of the area demands a new scientific and technological perspective.

Besides improving deep knowledge in their field, researchers will need to acquire new knowledge in adjacent fields of expertise and work together within multidisciplinary teams, bringing up a new multidisciplinary researcher profile that has broader and deeper scientific knowledge and understands the requirements of the stakeholders.

This will be of utmost importance to raise the levels of knowledge of INESC TEC's researchers and generate new ideas with higher scientific and economic impact, as well as to successfully address the challenges of applied research and work at different technology readiness levels.

EUROPEAN ROBOTICS LEAGUE

SPARC would like to introduce the exciting new concept of the European Robotics League (ERL) to our community. The ERL is a novel common framework for two indoor robotics competitions, ERL Industrial Robots and ERL Service Robots, and one outdoor robotics competition, ERL Emergency Robots.

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The European Robotics League local and major tournaments are based in Europe and are open to international participation. ERL Service and ERL Industrial Robots have a diffused set of benchmarking testbed across Europe where researchers compete, meet, discuss, learn and improve; whilst ERL Emergency Robots organizes a pre-competition summer school where attendees can prepare themselves for participating in the major tournament.

EUROPEAN ROBOTICS LEAGUE

These three unique competitions aim at replicating consistent benchmarking results more than stating a winner of a single event, and have been designed to target three clear objectives: the European societal challenge of aging population, the strengthening of the European robotics industry and to push the state of the art in autonomous systems for emergency response.

WiMUST

WiMUST aims at conceiving, designing, and engineering an intelligent, manageable, distributed and reconfigurable **underwater acoustic array** that could drastically improve the efficacy of the methodologies used to perform geophysical and geotechnical acoustic surveys at sea.

Wi MUST

The novel key feature of the WiMUST system consists in the use of a team of cooperative autonomous marine robots, acting as intelligent sensing and communicating nodes of a reconfigurable moving acoustic network.

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 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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CADDY

Divers operate in harsh and poorly monitored environments in which the slightest unexpected disturbance, technical malfunction, or lack of attention can have catastrophic consequences. They manoeuvre in complex 3D environments, carry cumbersome equipment, while performing their mission. To overcome these problems, CADDY aims to establish an innovative set-up between a diver and companion autonomous robots (underwater and surface) that exhibit cognitive behaviour through learning, interpreting, and adapting to the diver's behaviour, physical state, and actions.

The CADDY project replaces a human buddy diver with an autonomous underwater vehicle and adds a new autonomous surface vehicle to improve monitoring, assistance, and safety of the diver's mission. The resulting system plays a threefold role similar to those that a human buddy diver should have:

1. the buddy "observer" that continuously monitors the diver;
2. the buddy "slave" that is the diver's "extended hand" during underwater operations performing tasks such as "do a mosaic of that area", "take a photo of that" or "illuminate that"; and
3. the buddy "guide" that leads the diver through the underwater environment.

The envisioned threefold functionality will be realized through S&T objectives which are to be achieved within three core research themes:

- the "Seeing the Diver" research theme focuses on 3D reconstruction of the diver model (pose estimation and recognition of hand gestures) through remote and local sensing technologies, thus enabling behaviour interpretation;
- the "Understanding the Diver" theme focuses on adaptive interpretation of the model and physiological measurements of the diver in order to determine the state of the diver; while
- the "Diver-Robot Cooperation and Control" theme is the link that enables diver interaction with underwater vehicles with rich sensory-motor skills, focusing on cooperative control and optimal formation keeping with the diver as an integral part of the formation.

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ROBOCADEMY

The Robocademy ITN will establish a European training and research network to develop key skills and enabling technologies in underwater robotics for the scientific and economic exploration of the oceans (e.g. offshore oilfield of the future). Through the close collaboration of leading research institutes, academia, industry, and small-medium enterprises (SME) in robotics, marine technology, marine science, and offshore industry, Robocademy will provide firstclass training and research opportunities for Early Stage Researchers (ESR).

In well-defined and well-tutored PhD research projects, the Robocademy fellows will push the state-of-the-art in the area of robust, reliable and autonomous underwater robots. Specialized scientific training modules will enable the fellows to obtain both a sound basis in robotics and an introduction to topics that are specific to their research areas. This will be complemented by a high-quality soft-skills training programme for and the opportunity to gain extensive on-site hands-on experience through secondments to maritime industry and oceanographic research institutes.

Thus Robocademy will foster the formation of young professionals that are able to meet the urgent demand for highly-qualified researchers and engineers in the growing field of underwater systems and robotics.

SUNRISE

We must learn to both sustainably exploit and protect our vast oceans, provider of oxygen, food, hydrocarbons and other resources. A solution lies in sensing and interacting through an Internet of Things, with distributed networks of intelligent sensors and actuators. Unfortunately, we currently lack a marine Internet, crucial to achieve distributed, coordinated and adaptive control, due to the rapid absorption of light and radio waves in seawater.

The SUNRISE objectives are to develop:

- Five federated underwater communication networks, based on pilot infrastructure already designed, built and deployed by consortium partners, in diverse environments (Mediterranean, Ocean, Black Sea, Lakes, Canals), web-accessible and interfaced with existing FIRE facilities to experiment with Future Internet technologies.

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- A software-defined open-architecture modem and protocol stack that will empower open collaborative developments.
- Standard platforms for simulation, emulation and replay testing to estimate underwater communication networks at a fraction of time, cost, complexity of current at-sea experiments, validated by tests conducted on the SUNRISE networks over a variety of applications and environments.
- A user-friendly interface for diverse users to interact with SUNRISE systems to conduct trials and benefit from databases of underwater Internet of Things performance data gathered over long periods from the SUNRISE infrastructure.

SUNRISE directly addresses FIRE objectives by combining technology with novel paradigms in new, open experimental facilities, integrating physical systems with software development into the Internet of Underwater Things. It is the first project that develops this concept, based on joint research performed in this directions by University of Rome La Sapienza, CMRE, and some of the other partners, in the last few years. SUNRISE will also provide a way to select Internet of Underwater Things standards based on objective measures of performance, strengthening in its facilities as more sites are added in the future as a result of the two envisioned open calls.

SUBCULTRON

subCULTron aims for achieving long-term autonomy in a learning, self-regulating, self-sustaining underwater society/culture of robots in a high-impact application area: Venice, Italy.

Our heterogeneous system consists of 3 different agent types:

On the sea-ground, artificial mussels are the collective long-term memory of the system, allowing information to stay beyond the runtime of other agents, thus allowing to continue learning from previously learned states. These mussels monitor the natural habitat, including biological agents like algae, bacterial incrustation and fish.

On the water surface, artificial lily pads interface with the human society, delivering energy and information influx from ship traffic or satellite data.

Between those two layers, artificial fish move/monitor/explore the environment and exchange info with the mussels and lily pads. Artificial mussels are novel class of underwater agents.

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We aim to push forward the edge of knowledge with novel sensors (electric sense/electro-communication), novel bio-inspired algorithms (underwater hives) and novel energy harvesting in underwater scenarios.

We will improve the world's record for swarm-size in autonomous collective underwater robotics by almost one order of magnitude.

Our application field is a human- and animal-co-inhabited real-world environment of high impact: Venice canals & lagoon.

These habitats are highly dynamic and structured, expected to be reflected by a spatial self-structuring of our mussel population.

These sub-populations locally perform memetic or cultural learning algorithms on their specific local data. Thus our cultural evolution algorithms will promote sub-culture development, similar to the human society that does the same above the water level in parallel.

Overall, we aim for an artificial society underneath the water-surface to the service of a human society above the water.

DexROV

DexROV brings together seven different organisations from all over Europe to challenge the possibilities for undersea operations. DexROV will use and evaluate new technologies to allow safer and more cost-effective undersea operations with Remotely Operated Vehicles (ROVs).

The goals of the project are:

1. Move control of ROVs to shore, from a safe distance.
2. Overcome latency involved between onshore control centres and ROVs, through autonomous operations
3. Develop advanced dexterous tools with the capacity to grip and manipulate in ways similar to a human hand

DexROV is part of the long-term Blue Growth strategy to support sustainable growth in the European marine and maritime sectors.

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MERBOTS

MERBOTS aims at progressing in the underwater intervention systems development. To that end, we plan an extensive use of multi-robot cooperation and multimodal perception systems. Nowadays, when the mission area is too deep and risky to be carried out by divers, the alternative consists in using remotely operated vehicles (ROV). This is a difficult and expensive solution requiring sophisticated support infrastructure and specialized personnel. Consequently, the use of robotic technology is normally limited to strategic or high added value operations like rescue, offshore industry or security and defense. We propose a system and a methodology that will permit safer intervention tasks, at a lower cost, and operationally simpler. New application areas like marine archaeology at large depth can be attained, and thus, important results can be reached, not only from the economic, but also from the scientific, social or cultural points of view.

The methodology designed uses up to three heterogeneous vehicles cooperating in different configurations at each phase of the mission. A first stage is implemented with an Autonomous Underwater Vehicle (AUV) endowed with acoustic and optical sensors and an Autonomous Surface Craft (ASC) whose mission is the localization and supervision of the AUV and link it to the remote base. This configuration is used to elaborate, first, an acoustic map on which a second survey of the AUV is planned. Later, the AUV uses the optical sensors and moves closer to specific regions to record detailed information of potential targets. The data from these surveys, georeferenced by the ASC, permit obtaining an accurate 3D reconstruction of the area under study to plan the intervention stage. Next, an operator, using an HMI that includes a target recognition system, identifies the target and plans the manipulation stage. Finally, a Hybrid-ROV with a multifunctional system formed by a manipulator and a hoover carries out the supervised intervention task. During this stage, an AUV equipped with cameras stays close and supports the HROV operation providing images from an external viewpoint. This complementary information guarantees a robust and reliable manipulation, which is essential in archaeological missions. A good communication link between vehicles is important in all the stages of the mission, but critical during the last one. Hence, we will develop new wireless underwater communication systems, allowing the vehicles to exchange commands and images.

e-URready4OS

The general aim of this project, co-financed by Directorate-General Humanitarian Aid and Civil Protection of the European Comission, is to join forces to make available to European Civil Protection a fleet of autonomous underwater vehicles (AUVs), unmanned aerial vehicles (UAVs) and unmanned

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surface vehicles (USVs) with operational capability to intervene against oil spills in European Seas using new cooperative multivehicle robotic technologies.

Surface oil is not the only effect of an oil spills. Underwater oil plumes can come from bottom leaks and from surface patches forming subsurface plumes as recently been brought into the public eye during the 2010 Deepwater Horizon incident. This approach will allow us to use relatively lowcost standard sonar and oil-in water sensors, with novel advanced algorithms to get the most out these devices.

The distributed intelligence of these devices across the spill will then be able to build up a highly accurate and dynamic image of the spill. The robotic system will also be able to self-organise to improve the monitoring of the oil spill. Ultimately, this cooperating multivehicle robotic technology will allow a cheap, flexible, expandable, precise and rapid decision support system for Civil Protection decision makers, improving the capacity of responding to these events.

VAMOS

Europe has been actively mined over many centuries and many easy-to-access mineral deposits are mostly depleted, while deeper lying ones have not been fully explored. The major opportunities to access raw materials within the EU are in greater depths, in remote, but also in populated areas, in former mine sites, in low grade deposits, and in small deposits where larger mining operations may not be feasible. Estimates indicate that the value of unexploited European mineral resources at a depth of 500-1,000 metres is approximately €100 billion. ¡VAMOS! will contribute to ensuring the sustainable supply of raw materials to the European economy whilst increasing benefits for society as a whole by introducing a number of concrete research and innovation actions regarding automated mining, mining of small deposits and alternative mining.

ROBUST

There is a need to develop an autonomous, reliable, cost effective technology to map vast terrains, in terms of mineral and raw material contents which will aid in reducing the cost of mineral exploration, currently performed by ROVs and dedicated SSVs and crew. Furthermore, there is a need to identify, in an efficient and non-intrusive manner (minimum impact to the environment), the most rich mineral sites. This technology will aid the seabed mining industry, reduce the cost of exploration and

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especially the detailed identification of the raw materials contained in a mining sites and enable targeted mining only of the richest resources existing.

The ROBUST proposal aims to tackle the aforementioned issue by developing sea bed in situ material identification through the fusion of two technologies, namely laser-based in-situ element-analyzing capability merged with underwater AUV (Autonomous Underwater Vehicle) technologies for sea bed 3D mapping. This will enable resource identification done by robotic control enabled by the synergy between AUV hovering and manipulator capabilities. The underwater robotic laser process is the Laser Induced Breakdown Spectroscopy (LIBS), used for identification of materials on the sea bed. The AUV Robotic vehicle will dive, identify the resources that are targeted for LIBS scanning through 3D real time mapping of the terrain (hydro-acoustically, laser scanners, photogrammetry) and position the LIBS in the required locations of mineral deposits on the ocean floor to autonomously perform qualitative and quantitative analyses.

SWARMs

The primary goal of the SWARMs project is to expand the use of underwater and surface vehicles (AUVs, ROVs, USVs) to facilitate the conception, planning and execution of maritime and offshore operations and missions. This will reduce the operational costs, increase the safety of tasks and of involved individuals, and expand the offshore sector.

SWARMs project aims to make AUVs, ROVs and USVs further accessible and useful, making autonomous maritime and offshore operations a viable option for new and existent industries:

- Enabling AUVs/ROVs to work in a cooperative mesh thus opening up new applications and ensuring re-usability by promoting heterogeneous standard vehicles that can combine their capabilities, in detriment of further costly specialised vehicles.
- Increasing the autonomy of AUVs/USVs and improving the usability of ROVs for the execution of simple and complex tasks, contributing to mission operations' sophistication.

The general approach is to design and develop an integrated platform for a new generation of autonomous maritime and underwater operations, as a set of software/hardware components, adopted and incorporated into the current generation of maritime and underwater vehicles in order to improve autonomy, robustness, cost-effectiveness, and reliability of offshore operations, namely through vehicles cooperation.

SWARMs' achievements will be demonstrated in three field testing sites and occasions, taking into account different scenarios and use cases:

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- Corrosion prevention in offshore installations
- Monitoring of chemical pollution
- Detection, inspection and tracking of plumes
- Berm building
- Seabed Mapping

SWARMs is an industry-led project, where large technology companies collaborate with SMEs specialized in the subsea, robotics and communication sectors, and universities together with research institutions ensure that the state-of-the-art innovations in these domains will rapidly make their way into market. This process counts with the perspectives and expectations of two industrial end-users, which are also part of the consortium.

MARIS

The general objective of the MARIS project is studying, developing and integrating, technologies and methodologies enabling the development of underwater robotic systems for manipulation and transportation activities; within underwater scenarios which are typical for the off-shore industry, for the underwater search and rescue operations, as well as for the underwater scientific missions. Within such ambitious objective, the proposing institutional also intend to experimentally demonstrate, in the form proof-of-concept, the achievable operational capabilities; by also integrating the research results within real experimental systems. On the basis of the knowledges and experiences owned by the consortium; of its available logistic structures, laboratories and equipment; as well as the already available advanced-stage designs for the experimental systems; the consortium consider as really possible to coordinately develop all the necessary technological and methodological aspects; while also converging toward their final integration on the experimental to be in parallel realized; starting from the sub-systems and advanced-stage designs made available by some of the proposing institutions.

OCEAN RINGS

OceanRINGS is a set of smart technologies for subsea operations developed at the Mobile & Marine Robotics Research Centre (MMRRC), University of Limerick, Ireland. These technologies, developed under the OceanRINGS project, are applicable to the growing international off-shore oil and gas sector, and also for future deployment, monitoring, and maintenance of ocean energy devices. The primary achievement of the OceanRINGS project has been the development of a control and navigation suite for offshore commercial ROVs, far beyond state of the art. This technology helps in reducing shiptime and increases safety, leading to significant saving in ROV operations.

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OceanRINGS symbolically represents the dual character of smart technologies: The *Inner* and *Outer Rings* can be rotated/expanded independently of each other, indicating that any module can be transparently interchanged between the Virtual and Real-World Environment.

Specifically, OceanRINGS is a hardware/software and web service platform which enables product demonstration both offline, in a virtual environment (e.g., in a lab or trade show) and online, in real-world (for run-time survey application). This duality of operation opens up new frontiers for the applications of modern control, modelling and simulation tools in marine technology development. It provides a framework for researchers to develop, implement and test advanced control algorithms in a simulated virtual environment under conditions very similar to the real-world environment. Since virtual and real-world components are compatible on a signal level, switching between them is easy and transparent. New control algorithms can be developed in virtual environment and once they work there, they will also work in the field.

MORPH

The MORPH project proposes a novel concept of an underwater robotic system that emerges out of integrating, albeit in a non-physical manner, different mobile robot-modules with distinct and complementary resources. It will provide efficient methods to map the underwater environment with great accuracy in situations that defy existing technology: namely underwater surveys over rugged terrain and structures with full 3D complexity, including walls with a negative slope.

BRIDGES

The main objective of BRIDGES (Bringing together Industry for the Development of Glider Environment) in accordance with expected increase ocean industrialization, is to perform research on cost-effective, robust, re-locatable and easily-deployed autonomous platform with multiple sensing, surveying and monitoring capabilities to support long-term in-situ exploration and protection services of the coastal and deep ocean.

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IMAGE GALLERY

Getting ready for EMRA first session ©Alfredo Martins

Nikola Miskovic (UNI ZAGREB) presenting CADDY Project ©Alfredo Martins

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Pino Casalino (UNI GENOVA) presenting MARIS Project ©Alfredo Martins

Jörg Kawla presenting ATLAS ELEKTRONIK's HROV SeaCat ©Alfredo Martins

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DEMO prepared by UdG at CIRS Lab with GIRONA 500 AUV ©Alfredo Martins

Scott Reed (SEEBYTE Ltd.) on a discussion on "Underwater Robotics Future" ©Alfredo Martins

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R2B2 workshops for high school students demo ©Alfredo Martins

EMRA 2017 official group picture ©Alfredo Martins

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