EXCELLABUST

EXCELLING LABUST IN MARINE ROBOTICS

Deliverable D2.4

Nine-month report on the progress of know-how exchange 4

Project Acronym:	EXCELLABUST	
Grant Agreement number:	691980	
Project title:	Excelling LABUST in marine robotics	
Funding:	Horizon2020 Twining	
Call:	H2020-TWINN-2015	
Type of action:	CSA	
Start date of project:	1st January 2016	
Duration:	36 months	
Project website:	http://excellabust.fer.hr/	
Delivery date:	31/03/2018	
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Lead participant	UNIVERSITY OF GIRONA	
Dissemination level:		
PU	Public	**X**
CO	Confidential, only for members of the consortium (including the Commission Services)	

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DELIVERABLE DATA SHEET

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Deliverable summary

EXCELLABUST project has, as one of its main goals, the increase of UNIZG-FER marine robotics scientific excellence and innovation capacity, and raise staff's research profile within the three scientific strategic domains: 1) mapping and perception, 2) advanced NGC, and 3) autonomy and cognition, by implementing strategic measures in the form of staff exchanges, invited talks, on-site trainings and innovation management trainings.

This deliverable covers the activity done within the consortium framework along M28-M36 of the project, from April to December 2019.

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INTRODUCTION

This WP is directly linked to EXCELLABUST **Objective 1: "Increase excellence and innovation capacity",** specifically:

Increase UNIZG-FER marine robotics scientific excellence and innovation capacity, and raise staff's research profile within the three scientific strategic domains: 1) mapping and perception, 2) advanced NGC, and 3) autonomy and cognition, by implementing strategic measures in the form of staff exchanges, on-site trainings and innovation management trainings that will:

Ensure S&T knowledge transfer from internationally leading partners to UNIZG-FER (staff exchanges and expert visits),

Provide hands-on S&T experience by internationally-leading partners (on-site trainings), and

Provide knowledge on innovation management to all involved research institutions (innovation management training)

WP2 objectives will be achieved through the following main activities:

1. **Short-term staff exchanges**

LABUST staff members visit each partner institution on two occasions, in the duration of 2 months, resulting in a total of 12 months of staff exchanges. Host institutions provide all the administrative assistance for the guest staff members. Researchers at host institutions supervise the guest staff progress and provide them with all the assistance required to ensure high quality know-how transfer. Research topics covered during the short-term staff exchanges are aligned with the defined strategic research domains in which the host institution has expertise. The outcome of these short-term staff exchanges result in joint journal and conference publications.

2. **Short-term trainings**

Each partner will organize one training at their institution along the project: CNR in year 1, UdG in year 2, and UL in year 3. During "Breaking the Surface" summer schools, all partners will organize training events that will include hands-on experience with real marine robotics equipment. Altogether, 12 trainings will be organized, four by each partner.

As a preparation for trainings, trainers will provide agendas and materials required for training events in a timely manner (at least 2 weeks before the training). Each trainer will provide infrastructure required for the execution of trainings. UNIZG-FER will provide the infrastructure for trainings at BtS while trainers will provide the training materials, and personnel and technology resources.

Research topics covered during the short-term trainings will be aligned with the defined strategic research domains in which the host institution has expertise. Training events will be attended by staff

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from all EXCELLABUST partners in order to increase cohesion between the groups and achieve more interaction and knowledge transfer during the trainings.

The outcome of this task will be transferred hands-on knowledge by trainers from internationally-leading partner institutions to all research staff members involved in EXCELLABUST twinning project.

3. Expert visits

Expert visits by each internationally leading partner to UNIZG-FER will be organized twice during the project lifetime. In addition to that, each internationally-leading partner institution will organize an expert visit each year during the BtS workshop. Altogether, this task includes preparation and execution of 15 expert visits to Croatia. Expert visitors will provide lecture materials which will be made public after the completion of the visit. Expert visits will be organized in a form of 2-3 day lecture series with theoretical topics that are aligned with the desired strategic research domains. Tentative titles of the lecture series are given in DoW.

The outcome of expert visits will be transfer of theoretical knowledge, through a series of lectures, in the topics defined by the strategic research domains.

4. Participation in innovation management trainings

This task will be devoted to participation in innovation management trainings which are required for efficient and high quality research management. These trainings are organized by professionals, either at partner institutions, or at third sites. Innovation management training will include topics such as proposal writing, project management and implementation, intellectual property protection, patent writing and application, etc. It is expected that young researchers with less innovation management will participate in these trainings. Within this task, research staff members from all EXCELLABUST consortium will participate.

The outcome of innovation management training will be increased level of knowledge in project management, innovation management and IPR issues.

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1. Short-term staff exchanges

1.1 Researcher Đula Nađ, PhD visited University of Limerick

During July and August 2018, LABUST member Đula Nađ was a guest researcher in the University of Limerick (UL), Department of Electronic and Computer Engineering, Centre for Robotics and Intelligent Systems (CRIS) where he was supervised by Dr. Edin Omerdić (UL).

The research plan and report for the visit are available in the repository.

The main outcomes of the visit were:

- Unity game engine operation and development skills were acquired.
- Operation and integration of HTC Vive in Unity were accomplished.
- Skill in designing simulators and multi-modal user interfaces were acquired.

These new skills will be used for the development of a new system for investigating diver-robot interactions and for a system providing end-user education and training.

2. Short-term Trainings

2.1. Training 3: “ROVs for Use in Challenging Conditions: I-ROV & ROV ÉTÁIN" held from June 14-15 June 2018 at University of Limerick

As part of the H2020 project "EXCELLABUST - Excelling LABUST in marine robotics", **dr. Edin Omerdić and dr. Gerald Dooly** held a tutorial titled "ROVs for Use in Challenging Conditions: I-ROV & ROV ÉTÁIN" on **14th - 15th June 2018** at the University of Limerick. Gerard Dooly provided a brief introduction to the hardware elements of the UL ROV Étáin prior to travelling into the UL Limerick Docks facility. At UL Limerick Docks students had the opportunity to get a hands-on hardware and software elements of the ROV and a brief training on how to operate the ROV and sub-systems (manual pilot control, copilot interfaces, LARS operation & manipulator control). The lectures on the second day included a description of features and physical layout of system components, standard ROV operation procedures and operation modes and results from ROV maiden voyage in May 2018.

3. Expert Visits

3.1. Tutorials

3.1.1. HANDS-ON: HANDS-ON WITH SOFTWARE DEFINED MODEMS & UNDERWATER NETWORKS (in the framework of BtS)

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Software-defined underwater modems and networks are rapidly gaining popularity due to the flexibility they afford in communicating underwater in challenging environments. With advances in low-power computing technology and flexible software architectures, some modems are able to support not only customizable network stacks, but also reprogrammable signaling at the physical layer. This enables researchers & engineers to customize the behaviors of the modems to robustly communicate in many challenging environments, and to take advantage of special features of the channel, such as propagation delay and channel sparsity. It also allows modems to interact closely with the command & control systems of autonomous underwater vehicles (AUVs), providing critical information for adaptive path planning in light of communication & navigation constraints. In this workshop, we will explore how software-defined modems and network stacks work, and provide attendees with hands-on experience developing applications that utilize the software-defined features of modems. We will see how the modems can be used for not only communication tasks, but also as transmitters and receivers for acoustic localization & navigation applications. The workshop will use UnetStack as the software platform for the hands-on part of the workshop.

3.1.2. HANDS-ON: SUBCULTRON – UNDERWATER MEASUREMENTS USING AMUSSEL (in the framework of BtS)

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 robot types: artificial mussels (aMussels) on the seafloor, artificial lily pads (aPads) on the water surface, and artificial fish (aFish) that move/monitor/explore the environment and exchange info with the mussels and lily pads. aMussels monitor the natural habitat, while each aPad serves as a charging and transportation station for aMussels and as a connection to the outer world. The project aims to construct 120 aMussels, 5 aPads, and 25 aFish. During this tutorial we will show how to program an aMussel platform to sink to the bottom, make an underwater measurement, transmit it acoustically to an aPad, return to the surface after a predefined time and SMS measurements to a cell phone.

3.1.3. INTRO: UNDERWATER OPTICAL IMAGE ENHANCEMENT TECHNIQUES (in the framework of BtS)

The underwater medium raises significant challenges for the processing of optical images. Two main processes dictate the behaviour of light in water: absorption and scattering. Absorption accounts for the conversion of light into heat and other forms of energy, whereas scattering refers to the changes in photon direction caused by variations in water density and interactions with suspended matter. These phenomena degrade the image-formation process in a much more significant way than the usual in-air imaging, leading to image blurriness, loss of color and loss of contrast. This session will overview a set of techniques for image enhancement, ranging from simple contrast enhancement to image dehazing and the removal of inconsistent illumination, with emphasis on practical applications.

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3.1.4. INTRO: SPARUS II (in the framework of BtS)

IQUA Robotics in collaboration with the Robotics and Underwater Vision group of the University of Girona will demonstrate the capabilities of the Sparus II AUV. This is a lightweight vehicle with hovering capability and a mission-specific payload area. The vehicle is designed to work in shallow water (up to 200 meters) and its torpedo shape with the ability to hover allows an easy deployment, as well as being able to be operated in environments where maneuverability is paramount. The Sparus II AUV uses an open software architecture based on ROS.

The tutorial will consist of a demonstration divided in three parts: first, inspect an area using an acoustic sonar; then, make a preliminary analysis of the gathered data; and finally, make a second survey, based on vision, in the areas of interest identified in the previous one.

An interface designed by IQUA Robotics will be used to define the missions, monitor their execution and perform preliminary analysis of the mission data.

3.1.5. Tutorial on a real-time embedded evaluation board NI myRIO by Edin Omerdić (UL)

As part of the expert visit within the H2020 project "EXCELLABUST - Excelling LABUST in marine robotics", **Dr. Edin Omerdić** from Centre for Robotics & Intelligent Systems, University of Limerick will hold a tutorial on "**a real-time embedded evaluation board NI myRIO and its applications**".

The two-day tutorial will start on **Thursday, November 15, 2018, at 14:30** in the **Gray Hall** of the Faculty of Electrical Engineering and Computing, and continue the next day on **Friday, November 16, 2018, at 14:00** in the same place.

More about the speaker and the tutorial is available in detailed news content and here.

PREREQUISITES FROM PARTICIPANTS

It's required to download the following documents from the Internet and read relevant sections:

NI myRIO Project Essentials Guide

The myRIO Project Essentials Guide serves as the guide to interfacing NI myRIO to the wide variety of sensors, actuators, and displays contained in the NI myRIO Starter Kit, NI myRIO Mechatronics Kit, and NI myRIO Embedded Systems Kit that students will need for projects. Each project concentrates on a specific component or device using a mixture of text and video to guide the student through the learning process necessary to successfully integrate the component or device into the student's system.

Weblink

NI myRIO Vision Essentials Guide

Through a mixture of written materials, video tutorials, and guided hands-on projects, students learn the essential techniques necessary to add vision to their NI myRIO project. Additionally, students create NI myRIO applications that interact with the visual world to sense motion, take physical measurements, read barcodes and printed labels, inspect products for defects, and respond to colours. Students will add LCD displays, switches, and servomotors and create a

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completely stand-alone application that controls physical apparatus such as a marble sorter and an auto-panning camera.

Weblink

NI myRIO-1900 User Manual

The National Instruments myRIO-1900 is a portable reconfigurable I/O (RIO) device that students can use to design control, robotics, and mechatronics systems. This document contains pinouts, connectivity information, dimensions, mounting instructions, and specifications for the NI myRIO1900.

Weblink

EXPERT VISIT PLANNED OUTCOMES:

- Learn how to connect, configure and use NI myRIO to design control, robotics, and mechatronics systems.
- Explore ways to use NI myRIO in Artificial Intelligence/Machine Vision applications.

LECTURE DESCRIPTION

NI myRIO: Getting Started (Day 1)

In this lecture, students will learn how to connect myRIO to PC, how to set up software and configure hardware, and how to create a first myRIO application.

NI myRIO: Deployment of a Standalone Executable App (Day 1)

During typical development, NI myRIO is connected to PC with a USB cable or wireless/wired network. After development is completed, it is possible to deploy the project as a stand-alone application stored on the myRIO solid-state hard drive, which starts automatically when myRIO is powered up. This lecture explains the steps for the deployment.

NI myRIO: SPI Serial Communication (Day 1)

This lecture is focused on demonstration of myRIO features how to configure SPI serial communication and how to send, read and process data.

Hands-on: PWM Control of T200 Thruster (Day 1)

This practical session is focused on the development of an interface between control software and physical actuators (thrusters) using NI myRIO. Two approaches will be explained: (i) approach based on Express VI (RT only, without the need to develop FPGA code), and (ii) approach based on RT & FPGA code development. Methods to overcome friction/dead zones for low-speed rotations will be demonstrated for both approaches. The practical session will demonstrate how to use FPGA to generate PWM signals for high precision speed and direction control of Blue Robotics T200 thrusters.

Hands-on: Discrete LED Demo (Day 2)

This practical session is focused on describing the essential concepts related to LEDs, selection of suitable current-limiting resistor and two different ways to control LED through myRIO DIO: current-sourcing interface and current-sinking interface.

NI myRIO: Machine Vision (Day 2)

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Machine vision systems play a critical role in manufacturing automation, shape and colour analysis, and robotics. With little more than a USB webcam students can create NI myRIO applications that interact with the visual world to sense motion, take physical measurements, read barcodes and printed labels, inspect products for defects, and respond to colours. The first part of this lecture introduces students to a generalized application development flow suitable for all of the machine vision projects in LabVIEW. The development flow includes defining the application's requirements, configuring the imaging system and acquiring representative images, calibrating to real-world units, developing the vision processing script with NI Vision Assistant, and developing and validating the complete machine application with NI LabVIEW. It also introduces the "Queued State Machine" design pattern that serves as the basis of the "Machine Vision App" (MVA) LabVIEW project template that students will use to implement selected application projects. The second part of the lecture will provide more insight into a procedure on how to set up and calibrate the camera.

Hands-on: Machine Vision (Day 2)

In the first part of practical session, students will learn how to connect a USB webcam to myRIO, how to acquire and process a single image and a video stream, how to set a webcam attribute such as saturation and how to use NI-MAX software to determine available video modes and attributes for a webcam. In the second part, students will explore a subset of ten advanced projects (Coin Counter, POS Terminal, Keyed Optical Lock, DMM Test Stand, Gauging Station, Product Label Inspector, Component Placement Inspector, Motion Detector, Auto-Pan Camera, Marble Sorter). Each of these ten design-oriented projects introduces new machine vision concepts and associated NI Vision implementation techniques.

BIOGRAPHY

Edin Omerdic received the Dipl. Eng. and M.S. degree in Electrical Engineering from the University of Zagreb, Croatia, in 1997 and 2001, respectively. In 2001 he joined the Mechatronics Research Centre, University of Wales, Newport, UK and took part in the EPSRC funded IMPROVES project. He received his PhD in Electrical Engineering from the University of Wales in 2004, with the thesis titled "Thruster Fault diagnosis and Accommodation for Overactuated Open-frame Underwater Vehicles".

Edin is currently employed by the University of Limerick as a Senior Research Fellow at the Department of Electronic and Computer Engineering. He is engaged in numerous research projects funded by the Higher Education Authority and the Marine Institute in the area of submersible robotics, he is also the main developer & designer of OceanRINGS concept & software suite, including the design of state-of-the-art control architecture for ROV LATIS, MRE ROV, and I-ROV. Edin's research interests include: Modelling & Simulation of Dynamic Systems, Real-Time Simulators & Real-Time Embedded Control Systems, Virtual Reality, Augmented Reality, Simulated Reality, MultiModal Human Machine Interface for Cyber-Physic Systems based on AI techniques (VR headsets, speech recognition, hand gesture recognition), Machine Learning, Application of AI Techniques (Neural Networks and Fuzzy Logic) in Intelligent Systems, Guidance, Navigation and Control System for Marine Platforms, Nonlinear Control Systems, Underwater Robotics, Fault-Tolerant Systems, Internet of Things and Network Security.

Up to date, he has 25 journals, 6 book chapters, 2 books, 59 papers in conference/workshop proceedings, 15 invited lectures, 4 keynotes/plenary talks, 11 tutorials, 22 presentations & technology demonstrations, 2 articles in business magazines, 2 online articles, 1 desk study. Dr. Omerdic received five awards for his work, including First Prize Winner in National Competition in Mathematics (Bosnia, 1985), Society of Underwater Technology (SUT) Prize for Best Multimedia Presentation (GCUV 2003) 'Thruster Fault Accommodation for Underwater Vehicles', IFAC prize for best online demonstration (MCMC 2003) 'Fault Detection and Accommodation for ROVs', IMarEST SMI Donald Maxwell Award Prize for Best Journal Paper (2004) 'A Fuzzy Track-Keeping Autopilot for Ship Steering' and Curriculum Paper Contest National Instruments International Competition LabVIEW in the Curriculum 2006 (First Prize Winner) 'Virtual Underwater Lab: Efficient Tool for System Integration & UUV Control Development'.

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3.2. Invited talks

3.2.1. Invited talk: "Eyes in the Ocean"

Eyes in the Ocean by **Stephen Hall**, *Society for Underwater Technology*, London, UK.

Abstract

The talk will look at how new technology is changing how humans interact with the global ocean. Marine autonomous systems and a new generation of advanced and reliable sensors enable remote sensing of the deep ocean and seafloor, exploration for minerals, oil and gas, provision of defence and surveillance and the gathering of oceanographic and biological data for marine spatial management and long-term monitoring of the environment. The cost of advanced ocean technology is reducing quickly so that even small colleges and ocean enthusiasts will soon be able to explore and protect their local ocean space. Before the middle of this century, robot explorers will even search the oceans of other worlds, with plans to send missions to Europa, Enceladus and Titan taking shape.

Short Bio

Stephen Hall is Chief Executive of the Society for Underwater Technology (www.sut.org) an international marine Learned Society headquartered in London established in 1966 by divers interested in science, today SUT has around 2000 members with branches in 8 countries and members in over 40 with a membership base centred in offshore oil, gas and renewables, marine science, underwater robotics, marine archaeology, salvage, defence, education and diving.

Steve has worked in marine science, education and policy for nearly 30 years, and was formerly Head of the International Office at the UK's National Oceanography Centre, and vice-chair of UNESCO's Intergovernmental Oceanographic Commission. He started off as a coastal and hydrographic surveyor before joining the UK's Natural Environment Research Council in 1990, initially as a tracer chemist on long oceanographic voyages in the Southern and Indian Ocean Oceans before joining the 'Autosub' team to manage science missions for autonomous underwater vehicles. He then worked in climate change research before specialising in ocean policy advising UK, EU and UN officials on a wide range of marine science and technology issues ranging from fishing to energy, marine spatial planning and education. He also served as a specialist in tsunami warning systems for UK territories in the Caribbean and as a member of the Secretariat for the UK government's marine science coordination committee. Steve lives in Wales and enjoys cycling, walking in the hills, and travelling.

3.2.2. Invited talk: Decentralized Coordination and Abstraction for Coupled Multi-Agent Systems

Decentralized Coordination and Abstraction for Coupled Multi-Agent Systems by **Dimitris Boskos**, *KTH Royal Institute of Technology*, Stockholm, Sweden.

Abstract:

High-level planning and control of multi-agent systems constitute active research areas with various applications in robotics, power systems, sensor networks, and other engineering disciplines. For the coordination of multi-robot teams, it is additionally required that the agents satisfy relative state constraints which can guarantee collision avoidance and network connectivity based on the robots' sizes and sensing/communication ranges. Motivated by such objectives, we present a robust connectivity maintenance control scheme, which is based on decentralized feedback laws and ensures that the network remains connected when bounded additive inputs

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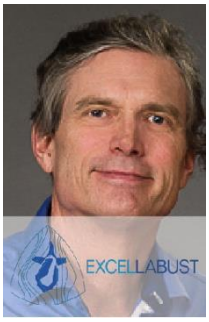
are further assigned to the agents. These can provide to each agent the ability for high-level planning, by leveraging a discrete representation, also called abstraction, of its interacting dynamics. We, therefore, present a framework on the derivation of distributed symbolic models for the agents, through appropriate space-time discretizations. The abstraction of each agent is based on the knowledge of its neighbors' discrete positions and the transitions are performed through hybrid control laws, which can drive the agent to its possible successor states. This approach is additionally modified towards the derivation of online abstractions, by discretizing over-approximations of the agents' reachable sets over a bounded time horizon. We finally outline how such tools could be leveraged as building blocks for more complex multi-robot coordination scenarios including cooperative tasks such as collaborative transportation services.

Short bio:

Dimitris Boskos was born in Athens, Greece in 1981. He has received the Diploma in Mechanical Engineering from the National Technical University of Athens (NTUA), Greece, in 2005, the M.Sc. in Applied Mathematics from the NTUA in 2008 and the Ph.D. in Applied mathematics from the NTUA in 2014. Since August 2014, he is a Postdoctoral Researcher at the Department of Automatic Control, School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology, Stockholm, Sweden. His research interests include distributed control of multi-agent systems, formal verification and observer design for nonlinear systems.

3.2.3. Invited talk: Underwater Robot Navigation and SMaRC



Underwater Robot Navigation and SMaRC by **Prof. John Folkesson**, *KTH Royal Institute of Technology*, Stockholm, Sweden.

Abstract:

Navigating underwater presents challenges well beyond those seen in indoor and outdoor robotics. There is poor visibility, sparse landmarks, strong disturbances, no gps and no communications.

Leveraging progress in SLAM to solve the underwater navigation problem has had only limited success due to the vastness of the oceans and the sparseness of distinguishing features. The talk will present some earlier work done on underwater SLAM and localization using forward looking sonar for mine counter measures. The Swedish Maritime Robotics Centre, SMaRC, is also very focused on the problem of navigation. The centre will be briefly introduced and the challenging scenarios being addressed will be presented. The problem of navigating under an Antarctic ice shelf in particular is being targeted by SMaRC. This is needed to collect dense and complete data on the energy flows into the under ice cavity from relatively warm dense ocean currents.

Understanding these energy flows is critical to prediction of ice melt and ocean level rise. Navigation for a week or more at a time in an unknown under ice environment will push the boundaries of the possible. Properly geo-referencing the data collected and accurately mapping the under ice topography will provide missing pieces to the puzzle of heat transfer between the water and ice.

Short bio:

John Folkesson is an Associate Professor at KTH - Royal Institute of Technology where he does research on robotics. After obtaining his robotics PhD in 2006 from KTH, he was a researcher Massachusetts Institute of Technology. At MIT he worked on autonomous underwater vehicles until, 2010 when he returned to KTH. His research has focused on interpretation of robot sensor data, including simultaneous localization and mapping, SLAM.

3.2.4. Invited talk: Embodiment Approaches to Sensorimotor Robot Policy Training

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Embodiment Approaches to Sensorimotor Robot Policy Training" by **Prof. Mårten Björkman**, KTH Royal Institute of Technology, Stockholm, Sweden

Abstract:

For robots to become truly autonomous and be able to overcome changes in either the working environment or its own embodiment, it needs to an ability to self-learn tasks and gradually adapt to changes. In our work, we have tried to move the human designer as far as possible from the learning process and allow the robot to create its own model of the world and with minimal prior information learn to exploit its embodiment through exploration, often in collaboration with a human partner. We will present some work in this direction from simple reactive behaviors learned from the ground up to more complex predictive behaviors learned in stages that consist of both simulations and real robot experiments. Using combinations of Gaussian process models, deep neural networks, and reinforcement learning, the emphasis is placed on data efficiency and adaptivity, allowing the robot to learn in a data-driven manner with a minimal number of trials.

Brief bio:

Mårten Björkman is an Associate Professor at the School of Computer Science and Communication at the Royal Institute of Technology, KTH. He received an MSc degree in computer science and engineering from Lund University in 1994 and a PhD degree in computer vision and robotics from KTH in 2002. He has been actively contributing to research to the EC funded projects CogVis, PACO-PLUS, eSMCs, and socSMCs. His research interests are a human-robot collaborative system, real-time object detection, and segmentation, and data driven mobile manipulation.

3.2.5. Invited talk: Polar robotics training

"Polar robotics training" by **Massimo Caccia,** The National Research Council (CNR)

SHORT BIO:

Director of CNR-ISSIA since October 16th, 2013. Principal investigator of the projects: "SEa Surface Autonomous MOdular unit" funded by the National Program of Research in Antarctica (2002-2004), "Harbour and coastal underwater anti-intrusion system" funded by IARP-FESR (2005-07), "Unmanned Multipurpose Vessel" funded by the Scientific and Technological Park of Liguria (2007-08), EC projects MINOAS, CART and MORPH (regarding CNR contribution), funded by EC. He is a member of the Steering Committee of the EC project EXCELLABUST, and of the Advisory Board of the EC project BRIDGES. He was NOC-Chair of the 9th IFAC Conference on Manoeuvring and Control of Marine Craft and Exhibit Co-Chair for the organization of the MTS/IEEE Oceans'15 Genova Conference. From 2010 he is a member of the IFAC Technical Committee 7.2 Marine Systems. From 2010 to 2011 he was a member of the Technical Scientific Committee on innovation in shipyards of the Italian Ministry of Infrastructures and Transport. From 2011 to 2017 he was a member of the Board of Directors of the Ligurian District of Marine Technologies. From 2014 to 2016 he was designated chair of the topics group 'Marine robotics' in euRobotics AISBL. From 2018 he is CapTech Governmental Expert in CapTech Guidance, Navigation and Control (GEM 04 GNC) in the framework of the European Defence Agency.

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3.2.6. Invited talk: From knowing where you are to understanding where you are

From knowing where you are to understanding where you are by **Prof. Patric Jensfelt**, *KTH Royal Institute of Technology*, Stockholm, Sweden.

Abstract:

In this presentation, I will outline our work on mobile robots which started as a quest to find the position of the robot and over time has shifted to understanding the environment and how to act in it. I will also mention some examples of entrepreneurial endeavours connected to the research, sometimes by design and sometimes out of surprise.

Bio:

Patric Jensfelt is a professor of computer science specialised in robotics at the Department of Robotics, Perception and Learning at the School of Electrical Engineering and Computer Science (EECS) and the Centre for Autonomous Systems (CAS), both at KTH. His main research interests center around autonomy for mobile robots, in particular, aspects connected to navigation, localization, and mapping. He is the co-founder of Intelligent Machines Stockholm AB and Volumental AB.

3.2.7. Breaking the Surface (Summer School invited lectures):

Marine robotics (MAROB):

ADVANCED MANEUVERING AND VISION ALGORITHMS FOR SURVEYS WITH THE SPARUS II AUV *- AVIAD AVNI -* ***University of Haifa, Israel***

UNDERWATER ACOUSTIC COMMUNICATIONS: FUNDAMENTALS AND NEW RESULTS *- MILICA STOJANOVIĆ -* ***Northeastern University***

KEY TECHNOLOGIES TOWARDS THE VISION OF COMPLEX AUTONOMOUS UNDERWATER OPERATIONS: FROM PROJECT SMIS TO MUM *- TORSTEN JEINSCH -* ***University of Rostock***

SHEARWATER: THE FUTURE OF HYBRID AUTONOMOUS MARINE VEHICLES *- WILLIAM KIRKWOOD -* ***Monterey Bay Aquarium Research Institute***

OCEANIDS: DEVELOPMENT OF NEXT GENERATION MARINE AUTONOMOUS SYSTEMS FOR OCEAN SCIENCE - *ALEXANDER PHILLIPS -* ***National Oceanography Centre***

MICRO-SCALE WAVE ENERGY GENERATION FOR AUTONOMOUS SENSORS AND ROBOTICS - *TIM MUNDON -* ***University of Washington***

AUTONOMY AND REMOTE CONTROL TECHNOLOGY IN SEA AQUACULTURE ACTIVITIES - *WALTER CAHARIJA -* ***SINTEF Ocean AS***

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CLOUD-BASED MANAGEMENT AND CONTROL OF AUTONOMOUS MARINE VEHICLES: CONCEPT AND DEMONSTRATION - *XIANBO XIANG* - ***Huazhong University of Science and Technology***

A FAST FISH-LIKE HUMAN-POWERED RACING SUBMARINE – *IAIN A. ANDERSON* - ***University of Auckland***

Marine biology (MARBIO):

CHASING OCEAN CARBON – FROM SKY TO SEA AND BELOW - *IVONA CETINIĆ*
NASA Goddard Space Flight Center/USRA

SUBMARINE TECHNOLOGY FOR THE STUDY AND CONSERVATION OF DEEP CORAL GARDENS AND COLD-WATER CORAL REEFS - *ANDREA GORI* - **Institut de Ciències del Mar - Consejo Superios de Investigaciones Científicas**

Marine archaeology (MARCH):

"WE'RE (NOT) GOING TO NEED A BIGGER BOAT": THE TECH THAT WILL REPLACE TRADITIONAL COASTAL RESEARCH VESSELS - *BRIDGET BUXTON* - ***University of Rhode Island***

HOW TO PROTECT AN OUTSTANDING SHIPWRECK SITE? - *IRENA RADIĆ ROSSI* - ***University of Zadar***

A BRIEF HISTORY OF ANCIENT SHIPS - *KOTARO YAMAFUNE* - ***A.P.P.A.R.A.T.U.S. LLC***

Maritime security (MARSEC):

CYBER-SECURITY SOLUTIONS FOR UNMANNED SYSTEMS, AND THEIR USE IN CONJUNCTION WITH NEW TECHNOLOGIES TO ADVANCE PORT SECURITY AND MARITIME DOMAIN AWARENESS - *PHILIP MCGILLIVARY* - ***US Coast Guard Pacific Area***

CYBER SECURITY FOR MARINE TECHNOLOGIES - *NIV DAVID* - ***Tel Aviv University***

Maritime geology (MARGEO):

NEW SURVEY VISUALIZATION: MERGING PHOTOGRAMMETRIC 3D MODEL WITH A MULTIBEAM BATHYMETRY - *HIRONOBU KAN* - ***Kyushu University***

ROV INSPECTION - *MARKO BAKAŠUN* - ***GEOmar d.o.o.***

EXPLORING THE OCEAN AND THE SEABED: OCEANOGRAPHIC CASE STUDIES WHERE MARINE ROBOTICS CAN BE APPLIED - *MANUEL BENSI* - ***Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS***

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3.3. Other activities

3.3.1: Underwater ROS workshop at the BtS

IQUA Robotics

Defining a ROS package to standardize underwater messages

Breaking the Surface (BtS) workshop, which brings together a significant part of the marine community will be held from 30 September until 7 October 2018 in Biograd na Moru, Croatia. On 2nd October 2018., in the scope of the BtS, the Computer Vision and Robotics Research Institute of the University of Girona along with IQUA Robotics is organizing a workshop to discuss the adoption of conventions in the underwater ROS community. If you plan to attend the underwater ROS workshop please fill this confirmation form and here you can find for more information about the meeting.

3.3.2. Participation as the Referees in ERL Emergency 2018

EUROPEAN ROBOTICS LEAGUE

Nikola Mišković, **Ivana Mikolić** and Barbara Arbanas (LARICS) participated as the Referees in **ERL Emergency Tournament 2018**held in La Spezia, Italy from 14th to 20th July 2018. They rewarded the best rookie team and the most creative team with Breaking the Surface vouchers for free attending its 10th edition. The European Robotics League is an innovative concept for robot competitions focuses on tasks that emergency response robots execute in a realistic emergency environment.

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4. Innovation Management Trainings

4.1. Local innovation training: Fundamentals of the intellectual property for the researchers

LABUST team participated in the workshop "*Fundamentals of the intellectual property for the researchers*" held in UNIZG-FER on the 28th March 2018. The workshop was organised and held by Mirjana Dozan, Head of the Office for Intellectual Property at UNIZG-FER, Igor Bošnjaković, Senior Adviser at State Intellectual Property Office, and Associate Professor Dubravko Babić from UNIZG-FER. The goals of the workshop were to promote and stimulate scientific research, establish a procedure for identification, protection, and commercialization of intellectual property and help researchers to track and record the intellectual property portfolio.

The workshop covered the following topics:

- Introduction to Intellectual property
- Intellectual property management
- Creating values of Intellectual property
- Patent registration
- Patent law

4.2. Local innovation training: Knowledge & Technology Transfer

The H2020 project "EXCELLABUST - Excelling LABUST in marine robotics", Centre of Excellence ACROSS CoE, Centre of Research Excellence DATACROSS and IEEE Croatia Section, Robotics and Automation Chapter will organize innovation management training on the topic of: **"Knowledge and Technology Transfer"** which will be held by **Prof**. **Manuela Arata,** Genova Makers's Village, Genoa, Italy

4.3. Innovation Management Training 3 - "Creativity, Innovation and Entrepreneurship"

On Monday, June 11, 2018, the 3rd Innovation Management Training named **"Creativity, Innovation, and Entrepreneurship"** was held at University of Limerick, under H2020 project "EXCELLABUST - Excelling LABUST in marine robotics". This highly interactive training was held by Mr. **Fergal Brophy** who is an entrepreneurial specialist at UCD Innovation Academy. Besides this, he is a growth planner and mentor at the Social Innovation Fund (SIF).

The goal of the training was to nurture and develop creative confidence, practice creativity in a fun, safe and collaborative environment, foster entrepreneurial mindset and to collaboratively develop an innovative solution for an everyday object.

INNOVATION TRAINING PLANNED OUTCOMES:

1. To nurture and develop your creative confidence.
2. To practice creativity in a fun, safe & collaborative environment.

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3. To foster your entrepreneurial mindset.
4. To collaboratively develop an innovative solution for an everyday object.

LECTURE DESCRIPTION:

Session 1 – Unlocking Creativity

Over the course of this fast-paced 90-minute session we will play a number of Innovation & Creativity problem-solving games that are fun, collaborative and guaranteed to pique your curiosity and spark you creativity.

The games will be revealed on the day, but all have significant learning outcomes.

You can reuse these games back at your workplace both for fun, to develop communication and collaborative skills and to unlock the creativity that is within all of us.

Session 2 – Innovation, Creativity & Entrepreneurship Challenge

Fun, fast-paced, immersive, collaborative problem-solving remain central to Session 2.

In the remaining 90 minutes you will use Design Thinking to reimagine an everyday object.

You will join colleagues in a small team of 4 and:

- Quickly gain insights from discovery and empathy.
- Define a problem-to-be-solved for the everyday object.
- Create multiple solutions.
- Make a rough-and-ready prototype to communicate your idea to your fellow teams. All very creative, innovative and entrepreneurial.

Session 3 – Panel session with SMEs & Startup CEOs

The panel session will host two speakers: Paddy Finn from Electricity Exchange and James Ives – CEO Xocean. Being both the successful entrepreneurs, their paths have been entirely different. We will have a chance to learn about two start-up showcases, compare the stories, challenges they faced, mistakes they made and goals they achieved.

The session will be divided into two slots: short presentations of each story following Fireside Chat moderated by Fergal Brophy. We expect the full interaction with attendees.

Dr Paddy Finn CEO Electricity Exchange. Paddy is a leading figure at the forefront of Demand Side strategy in Ireland and was listed in the Irish Independent's "30 under 30 Shaping Ireland's Future". With a background in Electronic Engineering, Paddy holds a PhD on „The facilitation of wind-generated electricity in Ireland's electricity market using demand response from the University of Limerick", and continues to publish his research in top tier peer-reviewed energy journals. Paddy is the lead manager and technical investigator on research, development, and commercialisation projects conducted in collaboration with Intel and EirGrid.

James Ives is the founder and CEO of Xocean, he is a Charted Engineer and Fellow of Engineers Ireland. James was previously the CEO of tidal energy business OpenHydro, a senior manager at Accenture and an engineer at Ricardo Consulting Engineers. Xocean is a startup company develops an innovative Autonomous Surface Vessel for the collection of ocean data.

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BIOGRAPHY:

Fergal Brophy is an entrepreneurial specialist at UCD Innovation Academy. His focus is on facilitating and mentoring innovation, creativity and entrepreneurship for large Corporates, small to medium sized firms (SMEs), postdocs and Undergraduates. He practices design thinking, lean startup and business model innovation and specialises in stakeholder discovery, jobs-to-be-done, problem framing, ideation, value proposition design, business model innovation, prototyping and experimentation. He presented on 'Mixing and Matching Ideas' at the UCD EdTECx talks 2017 and received a UCD Teaching Excellence Award in 2017.

Fergal facilitates and mentors on Go Global 4 Growth, an Enterprise Ireland (EI) programme specifically designed to challenge SME's in the technology sector to scale. He has also worked on EI's New Frontiers programme which supports high-potential startups. EI is a state agency focused on helping Irish-owned businesses to deliver new export sales.

Fergal is a growth planner and mentor at the Social Innovation Fund (SIF). SIF provides growth capital and supports to Ireland's best social innovators including FoodCloud, ALONE and CareBright.

Fergal facilitated the US Embassy/American Ireland Chamber of Commerce (AmCham) Future Leaders Summit 2017. He was Hack Leader at the Embassy's Social Entrepreneurship Hackathon in 2015 and is a regular contributor to the work of the US Embassy Youth Council. He has facilitated innovation sprints for MasterCard, Deloitte Blockchain Lab, PwC, ESB, Bank of Ireland, New Ireland Assurance, Irish Stock Exchange and at SciComm.

Fergal co-founded a financial services technology company in 2001 which was scaled and sold to one of Ireland's largest financial services in 2014. Open Financial Services created a new innovative business model when it pioneered the Worksite Marketing distribution channel. The Company piggybacked on two rapidly emerging trends and technologies at that time; the profileration of Corporate Intranets and the provision of voluntary benefits by HR professionals of Ireland's leading employers. Many leading multi-nationals facilitated Open's services includOpen created a new innovative business model when it was founded in 2001 as it pioneered the Worksite Marketing distribution channel. The Company piggybacked on two rapidly emerging trends and technologies at that time; the provision of voluntary benefits by HR professionals of Ireland's leading employers and the proliferation of Corporate Intranets.ing Apple, EMC, Dell, Oracle, Citi, Bank of America, JP Morgan, PwC, KPMG, Pfizer, Merck, Boston Scientific and Medtronic.

He has lectured at Dublin City University (DCU), the Institute of Public Administration (IPA), Dublin Business School and facilitated programmes at the DCU Ryan Academy. He previously held sales and brand management roles at Pepsi, Kellogg's and Nivea.

4.4. Innovation Tuesday at Breaking the Surface summer school (11 Innovation talks)

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In the scope of the 10th edition of Breaking the Surface, we organised an **Innovation Tuesday**, the whole day program dedicated to lectures about the creation of corporate spin-offs, on how to attract investments and tips and tricks in building international businesses. Robotics experts and entrepreneurs shared their experience in commercializing robotics-related technologies with the rest of interested participants.

Innovation Tuesday was held on **2nd of October** while **Breaking the Surface** was held **from 30th September until 7th October in Biograd na Moru, Croatia**. More than 200 participants from marine robotics field and its applications - marine biology, maritime archaeology, maritime security, geology, oceanology etc. participated in BtS programs.

As part of Innovation Tuesday, lecturers from various aspects presented their experience and knowledge.

Innovation Tuesday (INNOVA) lectures:

- **Yvan Petillot,** Heriot-Watt University, **(UK):** The ORCA Hub: Offshore robotics for certification of assets
- **Scott Reed**, SeeByte, **(UK):** The evolution of smart software within maritime robotics
- **Daniel M. Lofaro**, George Mason University, **(USA):** Robots in politics and business
- **Paul Oh**, University of Nevada Las Vegas, **(USA):** Consumer robotics in the age of acceleration
- **Miriam Rueda**, Asociación Emerge, **(Spain):** Protoatlantic – A European accelerator program of the marine sector
- **Marc Carreras,** IQUA Robotics, **(Spain):** IQUA Robotics: Past, present, and future
- **Iain Vincent**, Planet Ocean Limited / ecoSUB Robotics Limited, **(UK):** Democratising the AUV: ecoSUB Robotics – from concept to commercial reality
- **Enrique Gonzalez Sancho,** Nido Robotics, **(Spain):** Entrepreneurship in marine robotics
- **Marin Bek**, H2O Robotics, **(Croatia)**: Experiences in building an international business
- **James Ives**, XOCEAN, **(Ireland)**: Unmanned ocean data collection
- **António Sérgio Ferreira,** Laboratório de Sistemas e Tecnologia Subaquática (UPorto), **(Portugal):** EUMarineRobots: The "Oprah" of marine robotics

4.5. Innovation Management Training 4 - "Disruptive Business Models and cracking the code of Financial Forecasting"

"Disruptive Business Models and cracking the code of Financial Forecasting" by **Helena Deane**, WestBic, Ireland.

INNOVATION TRAINING PLANNED OUTCOMES:

- Understanding disruption and being able to successfully apply the principles of disruptive business modeling
- Understanding the difference between radical and disruptive innovation
- Understanding the impact of disruptive business models
- Understanding and assessing the scalability of business models
- Ability to apply improved analysis to the competitive and industry environment
- Ability to understand different factors influencing the composition of financial revenue and P&L and cash-flow forecasts
- Understanding different approaches to financial forecasting and presentation of forecasts to investors and funding agencies

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LECTURE DESCRIPTION:

Session 1: Disruptive Business Models

Introducing the principles of disruptive innovation, radical vs disruptive innovation, discussing disruptive business models' focus on creating, disintermediating, refining, re-engineering or optimizing a product/service, role/function/practice, category, market, sector, or industry. Case studies & examples of successful disruption. Analytical approach to assessing the competitors and industry environment. Understanding the scalability of business models.

Session 2: Cracking the Code of Financial Forecasting

Defining the limitations and assumptions. Understanding the market share factor and impact of 'willingness to pay'. Development and incorporation of risk models, revenue models, and pricing models. Financial forecasting modeling, approaches, and practical examples. Presentation & communication of financial forecasts to investors and funding agencies.

BIOGRAPHY

Helena Deane is a Projects Executive at WestBIC. Established in 1987, WESTBIC is the official EU Business & Innovation Centre operating in the NW Region of Ireland, with office locations and service points spread across the territory. It provides applied innovation services, tailored business advice, and support to the innovative enterprise, rural enterprise projects and social innovation and social/community enterprise projects, from concept to commercialisation. WESTBIC carries a portfolio of over 500 innovative enterprises, exporting and creating high-value jobs, including many rural enterprises, as well as support for over 100 social innovators/enterprises. WESTBIC is also the largest manager of community enterprise space in the region and also provides strategic development support to a number of community enterprise centres. WESTBIC is an active member of the Association of EU BICs in Ireland, and the European Business & Innovation Centres Network (EBN) with over 200 approved EU-BICs.

As part of the WestBIC team, Helena helps deliver a number of SME and start-up innovation supports, focusing on raising finance, improving competitiveness, growth and internationalisation. She also delivers a range of mentoring and training assignments and facilitates other entrepreneurial supports offered by WestBIC, as well as supporting and managing EU projects in the area of H2020.

In addition to her role at WestBIC, Helena manages the Intertrade Ireland cross-border development agency FUSION programme in the West of Ireland. This cross-border technology transfer programme is based on collaboration between the academic partners and an SME to develop or improve products, processes or services, streamline business processes to increase efficiency and performance, develop and implement new technologies, systems or processes and improve capabilities in innovation, design, and technology.

She has also been appointed as an expert and evaluator for the Horizon 2020 programme on behalf of the European Commission, as well as on behalf of the EUREKA funding programme. These roles involve evaluation of single entity and collaborative funding proposals ranging from €0.05-€5 million.

In addition to her innovation and entrepreneurship background, Helena has also over 10 years of industry experience, mainly in engineering projects, having worked, among other, for Engineering Consultancy Atkins Global, Alstom Transport Rolling Stock division and the Volkswagen Group

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4.6. Innovation Management Training 5 - “EU and Business R&D Project Management”

"**EU and Business R&D Project Management**" by following speakers: **Vesna Torbarina** (Croatian Chamber of Economy), **Manuel Jiménez Díaz** (Morera&Vallejo Group, Spain), **Silvia de los Santos** (CTA, Spain) and **Matko Barišić** (ABB, Norway).

During the three days of the workshop, an overview of the H2020 program and its successor (Horizon Europe) will be given to the attendees. H2020 will be explained in more detail, as well as the tools provided by the European Commission for its management. Finally, further specific hints and ideas about managing H2020 projects will be discussed.

INNOVATION TRAINING PLANNED OUTCOMES:

- Providing a general overview of EU calls, with special focus on H2020
- Remarking the importance of Expert profile in Participant Portal as learning tool for writing successful proposals
- Identifying the right calls & Training on writing EU proposals
- Providing a general overview on Management H2020 projects
- Networking: Croatia node of Enterprise Europe Network

LECTURE DESCRIPTION:

This workshop aims to give an overview of the 2020 program and its successor, Horizon Europe. We will work on H2020 key aspects and s practical exercise in writing a proposal will be carried out. European Commission Tool for the application and management of proposals will be also analysed, with a special interest in the expert profile. Finally, we will give a few hints about the management of European projects of H2020.

We recommend this course to those who are involved in the technical implementation of H2020 but never had been writing and requesting this kind of projects, as well as to those who have no experience in this program. It could be also interesting for personnel directly related to management and implementation activities and do not yet have an in-depth knowledge of Horizon 2020 financial issues.

BIOGRAPHIES

Vesna Torbarina, Croatian Chamber of Economy, Head of Division

She graduated in Zagreb at the Faculty of Economics, International Relations. As an Advisor for EU in Croatian Chamber of Economy, her job was related to the Croatian accession to the European Union and in 2006 she was a member of the Negotiating Group on Chapter 1: Free movement of goods. Working for the Croatian Chamber of Economy she constantly supports SMEs through different EU projects:

In 2007 as head of the Euro Info Centre in Croatian Chamber of Economy, she was preparing Croatian companies for legislation changes

From 2010-2012. as the project manager of “European Network of Ambassadors of female entrepreneurship”, she established a network of female ambassadors of entrepreneurship in Croatia that have encouraged other women to start an entrepreneurial activity and set up their own businesses

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In 2013 she was a project manager of Erasmus for Young Entrepreneurs, dealing with a cross-border exchange program for entrepreneurs.

From 2008 till today is the project manager of Enterprise Europe Network in Croatia works on boosting the competitiveness and innovation of SMEs.

She is a member of several international groups and sectoral monitoring committee for the implementation of projects in Croatia. She has well developed organizational skills and rich team work experience.

2. Manuel Jiménez Díaz, Morera&Vallejo Group

MS in Industrial Engineering, specializing in Industrial Management. Master degree in Strategic Management and International Business Currently, RTD Manager at Morera&Vallejo Group. Formerly, RTD Manager at DGH Robotics and managing director at FAICO – Innovation and Technology Centre. From 2007 to 2009 he was the head of the International R&D Projects Area of the Innovation and Technology Transfer Centre of Andalusia. Here he worked in the promotion and management of R&D international projects. In the same period, he worked as an International Project Manager in the IAT - Andalusian Institute of Technology. During the last ten years, he has participated and has been responsible for the management of a considerable number of industrial, research and innovation projects in the areas of ICT and production technologies, at national and European level, most of them financed by H2020, FP7, FP6, CIP, Interreg Programmes. In 2009 he was appointed as expert-representative in the Spanish delegation to the FP7-NMP Programme Committee. Since 2013 he has worked as independent expert and evaluator for the European Commission (FP7, H2020, EUREKA EUROSTARS). Member of RTD Committee at IIES (Spain Engineering Institute) since 2012. He has developed and given a large number of lectures, training courses and info-days for R&D managers on the management of project proposals to the EU Framework Programmes

3. Silvia de los Santos, CTA

Silvia de los Santos is an industrial engineer by University of Seville and expert in environmental management. She is currently Head of Aerospace and Production sectors of Andalusian Technological Corporation. From 2008 until July 2016 she was responsible for Knowledge Management and R & D Programs at the Center for Aerospace Advanced Technologies (CATEC) and director of its Technology Transfer Office (OTRI). This center specializes in the development of unmanned aerial vehicles, new production processes for the aeronautics industry and other aerospace technologies. Likewise, she has shown the representation of Andalusia in the NERUS network in order to promote the use of space technologies by the different European regions. She has been directly involved in the preparation and processing of more than 60 proposals from the 7th Framework Program and H2020 (ICT, NMP, ATT, REGPOGT, Marie Curie, LEIT, etc., including SESAR and CLEAN SKY proposals) and Interreg Programs (Europe, Atlantic, and POCTEP).

She has directly managed the projects led by CATEC: ARCAS (ICT, 11 partners, 8 M€ budget), SAFEMOBIL (ICT, 9 partners, 7 M€ budget) and MUAC-IREN (4 partners and 0,5M€ budget). She has also supervised the management of 9 other international projects in which the center participates and collaborated with the University of Seville in a project coordinated by it for H2020 (AEROARMS, 11 partners & 5M€+ Swiss funding). She has given numerous courses on international R & D projects for EOI, universities and technology centers regarding European Funding for R & D & innovation Projects and Horizon 2020 keys to success.

4. Matko Barišić, ABB

Dr. Matko Barišić (b. 1980) received his M.Sc. and Ph.D. degrees from the University of Zagreb, Croatia, in 2003 and 2012 respectively, in Electrical Engineering – Automation. After 9 years as a doctoral and post-doctoral researcher with the Laboratory for Underwater Systems and Technologies, he was employed at ABB AS Norway, BU Marine & Ports in 2013. In ABB, he progressed through several roles, from R&D Engineer, Senior R&D Engineer, to R&D Manager

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in 2017. He currently manages the R&D team in Norway, spread across three locations, in Billingstad, Ulsteinvik, and Trondheim, which works on Electrical and Digital Solutions in line with ABB Marine's Electrical. Digital. Connected. Strategy 2020. He continues to be an author of scientific and professional publications in a variety of journals and conferences, focusing on navigation, guidance, and control of marine vessels, and lately on power and energy management systems, electrical propulsion control, with a focus on ice-breaking, and autonomous shipping topics. He has also been an active reviewer in the EU HORIZON 2020 program since 2017. His professional interests include marine robotics, intelligent & autonomous shipping, machine learning, marine automation, filtering & estimation, simulation, and numerical modeling, data analysis, and block-chains. His management interests include Agile, Lean, Scrum, digital management tools and processes, managing change, managing complexity with the focus on managing engineering complexity, R&D risk mitigation, product development, lifecycle management, and leading KPIs. He is also a Lean Product Development champion in ABB Marine & Ports, and a Lean Coach certified by Talent Vectia, Finland.

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