



PROCEEDINGS OF BREAKING THE SURFACE 2016

Editors:

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1. INTRODUCTION

The **Breaking the Surface 2016** was held from 2nd until 9th October in Biograd na Moru, Croatia and more than 200 people participated. The programme was divided in five program tracks: marine robotics (MAROB); marine biology and marine nature protection (MARBIO); maritime security, naval and coast guard operations (MARSEC); maritime, nautical and ship archaeology (MARCH), and this year's novelty in the programme: Innovation Tuesday programme (INNOVA). In 7 days 34 lectures, 11 demonstrations and 1 tutorial were presented.

Breaking the Surface summary:



Dates: 2nd – 9th October 2016

Location: Biograd na Moru, Croatia

Website: <http://bts.fer.hr/>

Programme:

- 29 lectures
- 11 demonstrations
- 1 tutorial

Participants:

- 221 participant

2. REPORT ORGANIZATION

The first part of the report describes the BtS 2016 organization, including the work program. The documents is accompanied with appendixes with abstracts, biographies and presentations of the programme presenters:

APPENDIX I. – Abstracts and biographies

APPENDIX II. – Presentations (slides)

3. ABOUT BREAKING THE SURFACE

Breaking the Surface - BtS summer school has been organized by UNIZG FER LABUST for the last 7 years – first three years as a part of FP7-REGPOT CURE project, while in the following years with Office of Naval Research Global support. During the years, BtS served as a meeting place of experts and students of marine robotics and the marine robotics application areas such as marine biology, marine archaeology, marine security, oceanography, marine geology and oceanology. This is the world's first successful, multi-year field training program that combines academic topics in marine robotics and robotics application areas and hands-on working experience in the sea, doing remote sensing and sampling for various ocean sciences.

Breaking the Surface summer school is organized in attempt to strengthen links between marine robotics research and end-users and provide its partners with one-week intense summer school consisting of plenary talks, hands-on trainings and demonstrations of marine technologies, by its partners and worldwide experts.

The program is organized in the form of plenary talks, hands-on tutorials and demonstrations of marine technologies, e.g. marine robotics (MAROB); marine biology and marine nature protection (MARBIO); maritime security, naval and coast guard operations (MARSEC); maritime, nautical and ship archaeology (MARCH), oceanography (OCEAN), and this year's novelty in the programme: Innovation Tuesday programme (INNOVA).

4. ORGANISERS

Breaking the Surface summer school is organized under the European Union's Horizon 2020 project EXCELLABUST - Excelling LABUST in marine robotics (GA 691980). The main organizers are University of Zagreb Faculty of Electrical Engineering and Computing, Laboratory for Underwater Systems and Technologies and Centre for Underwater Systems and Technologies with organization support from Institute of Studies on Intelligent Systems for Automation - ISSIA, National Research Council of Italy (CNR), University of Girona (UdG), and University of Limerick (UL).

Breaking the Surface organization structure is as follows:

4.1. GENERAL CHAIR



Prof. Dr. Sc. Zoran Vukić

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*

4.2. PROGRAMME COMMITTEE



Assoc. Prof. Dr. Sc. Nikola Mišković
Chairman

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Marco Bibuli, PhD

*Centre Nazionale delle Ricerche - CNR
Institute of intelligent systems for automation - ISSIA*



Prof. Bridget Buxton, PhD

*University of Rhode Island,
Department of History*



Massimo Caccia, MSc

*Centre Nazionale delle Ricerche - CNR
Institute of intelligent systems for automation - ISSIA*



Assoc. Prof. Marc Carreras, PhD

*University of Girona
Computer Vision and Robotics Research Institute - VICOROB*



Dr.-Ing. Thomas Glotzbach

Ilmenau Technical University



Edin Omerdić, PhD

University of Limerick



Asst. Prof. Dr. Sc. Irena Radić-Rossi

*University of Zadar,
Department of Archaeology*



Prof. Pere Ridao, PhD

*University of Girona
Computer Vision and Robotics Research Institute - VICOROB*



Prof. Asgeir Sørensen, PhD

*Norwegian University of Science and Technology
Department of Marine Technology
Centre for Autonomous Marine Operations and Systems*



Prof. Daniel Toal, PhD

University of Limerick

4.3. ORGANIZING COMMITTEE



Ivana Mikolić, mag. ing

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Petra Mikolić, M. Phil

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Darija Josić, mag. exp. bio.

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*

4.4. TECHNICAL COMMITTEE



**mr. sc. Antonio Vasiljević,
Chairman**

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Kruno Zubčić

*Croatian Conservation Institute,
Heritage Protection Service,
Underwater Archeology Section*



Đula Nađ, dipl. ing.

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Filip Mandić, mag. ing.

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Anja Babić, mag. ing.

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



Milan Marković

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*



M. Eng. Marin Stipanov

*University of Zagreb,
Faculty of Electrical Engineering and Computing,
Laboratory for Underwater Systems and Technologies*

5. BREAKING THE SURFACE 2016

5.1. PROGRAMME STRUCTURE

BtS program is comprised of academic lectures, hands-on tutorials, presentation of projects and equipment and company demonstrations.

5.1.1. LECTURES

Lectures by experts in the domains of Marine robotics (MAROB), Marine biology (MARBIO), Maritime archaeology (MARCH), Maritime security (MARSEC) and Innovations (INNOVA).

List of speakers:

Marine robotics (MAROB):

- Stjepan Bogdan, University of Zagreb Faculty of Electrical Engineering and Computing, Croatia: *Unmanned system for maritime security and environmental monitoring*
- Massimo Caccia, National Research Council - CNR, Institute of intelligent systems for automation - ISSIA (Italy): *Modular portable marine robotics*
- Mandar Chitre, National University of Singapore (Singapore): *A decade of research in underwater cooperative navigation: what have we learned?*
- Giovanni Indiveri, University of Salento (Italy): *The H2020 project WiMUST: Widely scalable Mobile Underwater Sonar Technology. An overview*
- Mirko Kovač, Imperial College London (UK): *Aquatic Micro Aerial Vehicles (AquaMAV) for water sampling and marine exploration*
- Stephen C. Licht, University of Rhode Island (USA): *Deep sea sampling with soft robotics: early results and future directions*
- Alfredo Martins, Institute for Systems and Computer Engineering, Technology and Science (Portugal): *Marine robotics – A tool for increased awareness from land to the deep sea*
- Timothy Mundon, University of Washington (USA): *The role of underwater robotics in the growth of marine renewable energy*
- Dan Toal, University of Limerick (Ireland): *Robotics for challenging ocean intervention in marine renewable energy and other applications*
- Kotaro Yamafune, Texas A&M University (USA): *Methodology of recording and analyzing shipwreck sites using multi-image photogrammetry*

Marine biology (MARBIO):

- Sunčica Bosak, University of Zagreb Faculty of Science, Department of Biology (Croatia): *Observations from the Invisible Forest: the diversity of marine phytoplankton*
- Mark Jessopp, University College Cork (Ireland): *Co-existence of top marine predators and humans...and the role of technology*
- Francisco Sanchez, Spanish Institute of Oceanography (Spain): *Investigating the submarine canyons and seamounts in Spanish waters through non-invasive methodologies*

Marine archaeology (MARCH):

- Jens Auer, University of Southern Denmark (Denmark): *Recording "in the dark". The challenges of recording a submerged 8th century structure in the Schlei Fjord, Northern Germany*
- Smiljko Rudan, University of Zagreb Faculty of Mechanical Engineering and Naval Architecture (Croatia): *Nautical archaeology from the naval architecture point of view*
- Francesco Tiboni, University of Genoa (Italy): *Underwater and Instrumental Archaeology. A Special Relationship*
- Gustau Vivar, Centre d'Arqueologia Subaquàtica de Catalunya (Spain): *The Underwater Archaeology Centre of Catalonia. The works with AUV and submersibles in archaeological sites*

Maritime security (MARSEC):

- Cormac Gebruers, National Maritime College of Ireland (Ireland): *Marine Robotics Applications in Humanitarian, Search & Rescue and Civilian Focussed Security Operations – what might the future hold?*

Innovation Tuesday (INNOVA):

- Anders Aune, Norwegian University of Science and Technology - NTNU (Norway): *Value creation from research through university spin-offs*
- Kemal Delić, Hewlett-Packard Co (France): *The Art of Innovation*
- Erik Dyrkoren and Martin Ludvigsen, Blueye Robotics (Norway): *BluEye Robotics – providing underwater adventures for everyone*
- Francis Flannery, SonarSim (Ireland): *Bootstrapping SonarSim: A Start-up Journey*
- David Lane, Heriot-Watt University (UK): *From Research to Revenues - The Puzzle of the Market*
- Luis Madureira, OceanScan - Marine Systems & Technology, Lda (Portugal): *The Light Autonomous Underwater Vehicle – Affordable technology to address scientific and societal needs*
- Pere Ridao, University of Girona (Spain): *IQUA Robotics: from lab to market*
- Asgeir J. Sørensen, Norwegian University of Science and Technology - NTNU (Norway): *Why and how becoming a researcher and entrepreneur?*
- Darío Sosa Cabrera, ACSM (Spain): *Titanrob: 3d printed Titanium Manipulators Innovation in the ROV sector*
- Clayton Stewart, University College London (UK): *Comments on the Management of Technology Startup Companies*

5.1.2. TUTORIALS

- Edin Omerdić, University of Limerick (Ireland): *Thruster Control using LabVIEW Real-Time & FPGA Graphical Programming*

5.1.3. DEMONSTRATIONS

- Thomas Glotzbach, Technische Universitaet Ilmenau (Germany): *Surface-aided AUV path following: theory and practice. Demo with a Medusa-class vehicle*
- Luis Madureira, OceanScan (Portugal): *OceanScan: Mission Planning & Data Analysis*
- Pere Ridao, Natàlia Hurtós, Narcís Palomeras, University of Girona (Spain): *University of Girona: Mission Planning, Data Analysis and Girona500 deployment*
- EvoLogics (Germany) - Oleksiy Kebkal, Veronika Kebkal: *EvoLogics*
- Brodarski Institut
- Hydroid, Kongsberg – Graham Lester, Simone Di Giacomo

5.2. SCHEDULE

	SUNDAY 02.10.	MONDAY 03.10.	TUESDAY 04.10.	WEDNESDAY 05.10.	THURSDAY 06.10.	FRIDAY 07.10.	SATURDAY 08.10.
09:00 - 09:45		OPENING SESSION Misha Copic, Zoran Vukob, Nikola Mikolajevic	INNOVA 1 From Research to Revenue - The Puzzle of the Market David Lark	MARBO 1 Co-existence of top marine predators and humans... and the role of technology. Mark Jørgensen	MARBO 5 Robotics for challenging ocean intervention in marine renewable energy and other applications Dan Todd	MARBO 9 Unmanned systems for maritime security and environmental monitoring Sergiy Bogdan	
09:45 - 10:30		MARBO 1 The H2020 project NEMUST: Widely usable Mobile Underwater Sensor Technology. An overview Carmen Indiani	INNOVA 2 Comments on the Management of Technology Startups Companies Lorenzo Schiavon	MARBO 4 Modular portable marine robotics Mauricio Garcia	MARBO 2 Observations from the invisible Forest: the diversity of marine phytoplankton Suzanne Brink	MARBO 3 Investigating the sedimentary carbon and sequestration in Spanish waters through non-invasive methodologies Francisco Sanchez	
10:30 - 10:45		COFFEE BREAK	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK	
10:45 - 11:30		MARBO 2 Deep sea sampling with soft robotics: early results and future directions Sophie C. Lévy	INNOVA 3 The Art of Innovation Konrad Dolak	MARBO 5 The role of underwater robotics in the growth of marine renewable energy Tim Munkton	MARBO 7 Aquatic Micro Aerial Vehicle (AquaMAV) for water sampling and marine exploration Mikhael Khamis	MARBO 10 A decade of research in underwater cooperative navigation: what have we learned? Mauricio Chirre	
11:30 - 12:15		MARCH 1 Naval architecture from the naval architecture point of view Sergio Esteban	INNOVA 4 Why and how becoming a researcher and entrepreneur? Agnès Someren	MARCH 2 Revisiting "In the dark": The challenges of retaining a submerged 18th century structure in the Schiel Jørd, Northern Germany Jens Auer	MARCH 3 The Underwater Archaeology Centre of Catalonia: The work with AQU and submersibles in archaeological sites Cristina Vilà	MARCH 4 Underwater and Instrumental Archaeology. A Special Relationship Francesco T. Boni	FIELD TRIP
12:15 - 13:00		MARBO 3 Methodology of recording and analyzing shipwreck sites using multi-image photogrammetry Krzysztof Tomaszewski	INNOVA 5 Value creation from research through university spin-offs Andrés Auzan	MARSEC 1 Marine Robotics Applications in Humanitarian Search & Rescue and Civilian Protected Sectors Operations - what might the future hold? Caroline Catelain	MARBO 8 Marine robotics - A class for increased awareness from land to the deep sea Alfonso Mariani	MARSEC 2 Underwater and Instrumental Archaeology. A Special Relationship Adrian Dami	
13:00 - 14:30		LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	
14:30 - 14:45			INNOVA 6 OceanScan Luis Madureira	Company presentation Evelogics	Company presentation Hydroaid	University of Girona GironaSD data analysis	
14:45 - 15:00	Tutorial University of Girona Mission planning		INNOVA 7 Blueye Robotics Oskar B. Ludvigsen	OceanScan Data Analysis	Tutorial and Edin Omeragic Thruster Control using LabVIEW Real-Time & FPGA Graphical Programming	Company presentation Brodarski Institute	
15:00 - 15:15			INNOVA 8 Reconstructing Soma's Soma A Step-by-Step Journey Francis Hamann	DEMO Evelogics Group 1	DEMO CNR Group 2	DEMO subCULTron Group 3	Tutorial handi- on Group 1
15:15 - 15:30			COFFEE BREAK	DEMO Evelogics Group 2	DEMO CNR Group 3	DEMO subCULTron Group 1	Tutorial handi- on Group 2
15:30 - 15:45	Tutorial OceanScan Mission planning	Ecologica demo workshop	DEMO Blueye Robotics	DEMO Evelogics Group 3	DEMO CNR Group 1	DEMO subCULTron Group 2	Tutorial handi- on Group 3
15:45 - 16:00			INNOVA 9 KQAR Robotics from lab to market Pere Rivas	DEMO Evelogics Group 1	DEMO CNR Group 2	DEMO subCULTron Group 3	Tutorial handi- on Group 1
16:00 - 16:15			INNOVA 10 Eliconab Dario Sosa Cabrera	DEMO Evelogics Group 2	DEMO CNR Group 3	DEMO subCULTron Group 1	Tutorial handi- on Group 2
16:15 - 16:30	REGISTRATION	University of Girona GironaSD deployment	INNOVA 11 Rendez vous moderated by Agnès Someren	DEMO Evelogics Group 3	DEMO CNR Group 1	DEMO subCULTron Group 2	Tutorial handi- on Group 3
16:30 - 16:45				DEMO Evelogics Group 1	DEMO CNR Group 2	DEMO subCULTron Group 3	Tutorial handi- on Group 1
16:45 - 17:00				DEMO Evelogics Group 2	DEMO CNR Group 3	DEMO subCULTron Group 1	Tutorial handi- on Group 2
17:00 - 17:15				DEMO Evelogics Group 3	DEMO CNR Group 1	DEMO subCULTron Group 2	Tutorial handi- on Group 3
17:15 - 17:30				DEMO Evelogics Group 1	DEMO CNR Group 2	DEMO subCULTron Group 3	Tutorial handi- on Group 1
17:30 - 17:45				DEMO Evelogics Group 2	DEMO CNR Group 3	DEMO subCULTron Group 1	Tutorial handi- on Group 2
17:45 - 18:00				DEMO Evelogics Group 3	DEMO CNR Group 1	DEMO subCULTron Group 2	Tutorial handi- on Group 3
18:00 - 18:15				DEMO Evelogics Group 1	DEMO CNR Group 2	DEMO subCULTron Group 3	Tutorial handi- on Group 1
18:15 - 18:30				DEMO Evelogics Group 2	DEMO CNR Group 3	DEMO subCULTron Group 1	Tutorial handi- on Group 2
18:30 - 18:45	WELCOME DRINK			DEMO Evelogics Group 3	DEMO CNR Group 1	DEMO subCULTron Group 2	Tutorial handi- on Group 3
18:45 - 19:00		NORWEGIAN NIGHT		DEMO Evelogics Group 1	DEMO CNR Group 2	DEMO subCULTron Group 3	Tutorial handi- on Group 1
19:00 - 19:15				DEMO Evelogics Group 2	DEMO CNR Group 3	DEMO subCULTron Group 1	Tutorial handi- on Group 2
19:15 - 19:30				DEMO Evelogics Group 3	DEMO CNR Group 1	DEMO subCULTron Group 2	Tutorial handi- on Group 3
19:30 - 20:30	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER	DINNER

LEGEND:

Special sessions	Lecture MARCH	Tutorial	Hydroaid company programme	Brodarski Institute ship demo	CNR demo
Lecture MARBO	Lecture MARSEC	Evelogics company programme	University of Girona programme	LADDY EP7 project demo	NATO SpS MORUS project demo
Lecture MARBO	Lecture INNOVA	OceanScan company programme	AquaMAV demo	H2020 subCULTron project demo	SOCIAL EVENTS

LOCATIONS:

LECTURE HALL @ HOTEL AROMATIC (PURPLE) Programme: ALL. In-class and associated	LAVENDER BAR ROOM @ HOTEL AROMATIC (PURPLE) Programme: tutorial, seminar, jobbing, data analysis	SEA POOL & OPEN WATERS NEARBY Programme: equipment demonstration	LAVENDER BAR @ HOTEL AROMATIC (PURPLE) Programme: night social event
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5.3. PARTICIPANTS

In 2016, 221 participants from academia and industry from various fields joined Breaking the Surface.



6. PROGRAMME ABSTRACTS, BIOGRAPHIES AND PRESENTATIONS

Lectures abstracts and lecturers biographies are available in **APPENDIX I. – Abstracts and biographies.**
Slides from presentations are available in **APPENDIX II. – Presentations (slides).**

7. SUPPORTERS

FINANCED BY



EXCELLABUST



Financed in the scope of project EXCELLABUST - Excelling LABUST in marine robotics (GA 691980) which has received funding from the European Union's Horizon 2020 research and innovation programme.

SUPPORTED BY



Croatian Academy of Science and Art



Norwegian Embassy

The Royal Norwegian Embassy in Zagreb



Križevačka pivovara

ORGANIZED BY



University of Zagreb, Faculty of Electrical Engineering and Computing



LABUST
Laboratory for Underwater Systems and Technologies



CUST
Centre for Underwater Systems and Technologies



Institute of Studies on Intelligent Systems for Automation - ISSIA, National Research Council of Italy (CNR)



University of Girona (UdG)



University of Limerick (UL)

IN PARTNERSHIP WITH



NTNU
Norwegian University of Science and Technology
AMOS – Centre for Autonomous Marine Operations and Systems, Norwegian University of Science and Technology (NTNU)

8. Appendix I – Abstracts and biographies

Abstracts and biographies are available [here](#).

9. Appendix II – Presentations

Presentations are available on the BtS website <http://bts.fer.hr/>.