Breaking the Surface 2020

Biograd na Moru, Croatia

27th September-4th October

PROCEEDINGS

Table of contents

1. INTRODUCTION

The **Breaking the Surface 2020** was held from 27th September until 4th October in Biograd na Moru, Croatia and more than 85 people participated (on-site and online). BTS 2020 was held in a hybrid format with a small set of lectures held virtually and part of the lectures streamed online. The program was divided in three program tracks: lectures, PhD presentations and one roundtable. In five days, ten lectures, ten PhD presentations, one roundtable, four demonstrations and six tutorials were presented.

Dates: 27th September – 4th October 2020

Location: Biograd na Moru, Croatia

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

2. REPORT ORGANIZATION

The first part of the report describes the BtS 2020 organization, including the work program. The deliverable is accompanied with abstracts, biographies, and presentations of the program presenters:

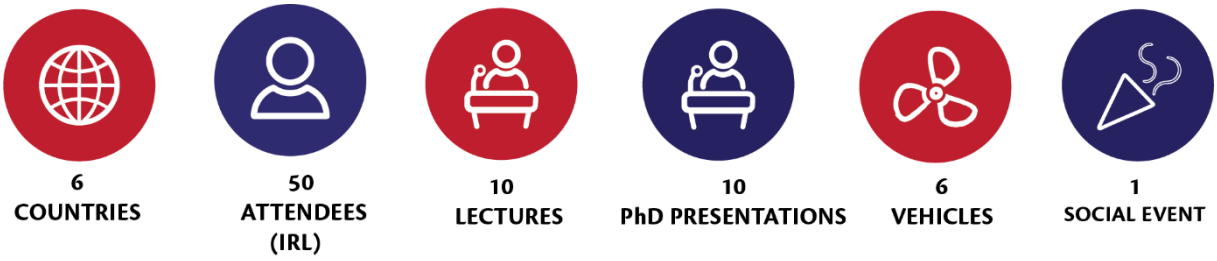
3. ABOUT BREAKING THE SURFACE

Breaking the Surface - BtS summer school has been organized by UNIZG FER LABUST for the last 10 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.

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, nautical and ship archaeology (MARCH), oceanography (OCEAN), and company presentations

BTS2020 IN NUMBERS:



4. ORGANIZERS

Breaking the Surface is organized under the European Union's Horizon 2020 project EUMarineRobots – Marine Robotics Research Infrastructure Network (GA: 731103), Interreg Italy-Croatia Innovamare project (ID: 10248782), H2020 AeRoTwin – Twinning Coordination Action for Spreading Excellence in Aerial Robotics (GA: 810321), IMPACT Erasmus+ (No: 2018-1-DE01-KA201-004259), and IEEE Oceanic Engineering Society. 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 the support from LARICS laboratory University of Zagreb Faculty of Electrical Engineering and Computing.

ORGANIZERS

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

IN PARTNERSHIP WITH

AMOS – Centre for Autonomous Marine Operations and Systems

Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento

Distretto Ligure delle Tecnologie Marine

Herriot Watt University

Institut Français de Recherche pour l'exploitation de la Mer

Integrated Systems for Marine Enviroment

Jacobs University

King's College London

Marine Institute Foras na Mara

Norwegian University of Science and Technology (NTNU)

NATO S&T Centre for Maritime Research and Experimentation

National Technical University of Athens

Natural Environment Research Council

Tallinn University of Technology

The Oceanic Platform of the Canary Islands

The Association of Instituto Superior Técnico for Research and Development

Universidade de Lisboa (ULisboa)

University of Bremen

University of Girona (UdG) University of Limerick (UL) University of Porto

BREAKING THE SURFACE ORGANIZATION STRUCTURE:

4.1. COMMITTEES CHAIRS

Prof. Dr. Sc. Zoran Vukić
General Chair

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

Assoc. Prof. Dr. Sc. Nikola Mišković
Programme Committee Chair
EXCELLABUST project Coordinator

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

Ana Golec, Organizing Committee Chair

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

Igor Kvasić, Technical Committee Chair

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

4.2. PROGRAMME COMMITTEE

Ralf Bachmayer

University of Bremen

Prof. Bridget Buxton, PhD

University of Rhode Island, Department of History

Fausto Ferreira, PhD

NATO CMRE

Massimo Caccia

Italian National Research Council (CNR)

Bill Kirkwood

Monterey Bay Aquarium Research Institute (MBARI)

Asst. Prof. Dr. Sc. Irena Radić-Rossi

University of Zadar, Department of Archaeology

Joao Sousa

University of Porto

Ivan Stenius

4.3. ORGANIZING COMMITTEE

Ana Golec

UNIZG LABUST

4.4. TECHNICAL COMMITTEE

Anja Babić, mag. ing.

UNIZG FER LABUST

Nadir Kapetanović, mag. ing.

UNIZG FER LABUST

Nikica Kokir

UNIZG FER LABUST

Ivan Lončar, mag. ing.

UNIZG FER LABUST

Igor Kvasić, mag. ing.

UNIZG FER LABUST

Frane Rogić, mag. ing.

UNIZG FER LABUST

Đula Nađ, dipl. ing.

UNIZG FER LABUST

5. PROGRAMME

5.1. PROGRAMME STRUCTURE

BtS program consisted of academic lectures, hands-on tutorials, presentations of PhD thesis, presentation of equipment, a round table session, experiments and testing, and social activities.

5.1.1. PROGRAMME ABSTRACTS, BIOGRAPHIES AND PRESENTATIONS

The daily programme follows below with the list of talks and speakers and links to the abstracts, biographies, a round table session, and streamed presentations.

Monday, 29th September

09:15 – 10:00 MARINE ROBOTICS AT CMRE: FROM COMPETITIONS TO REGULATION by FAUSTO FERREIRA

10:00 – 10:45 HYBRID ACOUSTIC-OPTICAL UNDERWATER COMMUNICATION NETWORKS FOR NEXT-GENERATION COOPERATIVE SYSTEMS by ANTÓNIO M. PASCOAL, ROBERTO PETROCCIA

11:00 – 11:20 PHD PRESENTATION: UNDERWATER LOCALIZATION by FRANE ROGIĆ

11:20 – 11:40 PHD PRESENTATION: A HYPER-HEURISTIC APPROACH TO ACHIEVING LONG-TERM AUTONOMY IN A HETEROGENEOUS SWARM OF MARINE ROBOTS by ANJA BABIĆ

11:40 – 12:00 PHD PRESENTATION: CONSENSUS-BASED DISTRIBUTED CONNECTIVITY CONTROL IN MULTI-ROBOT SYSTEMS by MARKO KRIŽMANČIĆ

12:00 – 12:20 PHD PRESENTATION: ACOUSTIC LOCALISATION OF UNDERWATER SENSORS USING COOPERATIVE UNMANNED MARINE VESSELS by IVAN LONČAR

12:20 – 13:05 ADAPTIVE OPTIMAL CONTROL IN COOPERATIVE AND DECENTRALIZED SYSTEMS by IVANA PALUNKO

14:30 – 16:00 SOFT ROBOTIC MANIPULATION IN SELECTED AGROTECHNICAL PROCEDURES BASED ON ARTIFICIAL INTELLIGENCE by MARSELA POLIĆ

16:15 -18:45 TUTORIAL: ROBOT OPERATING SYSTEM 2 (ROS2) by ĐULA NAĐ

Tuesday, 30th September

09:00 – 09:45 D2: A VEHICLE FOR DIVER-ROBOT COLLABORATION by ĐULA NAĐ

09:45 – 10:30 STRUCTURIZED ECOLOGICAL CULTIVATION WITH AUTONOMOUS ROBOTS IN INDOOR AGRICULTURE by MATKO ORSAG

10:30 – 10:50 PHD PRESENTATION: PRODUCTION, TESTING AND POSSIBLE USECASES OF UNDERWATER ACOUSTIC BEACONS by VLADIMIR SLOŠIĆ

11:05 – 11:25 PHD PRESENTATION: LARICS AT MBZIRC 2020 – AUTONOMOUS GROUND VEHICLE IN WALL BUILDING SCENARIO – THEORETICAL BACKGROUND by IVO VATAVUK

11:25 – 11:45 PHD PRESENTATION: LARICS AT MBZIRC 2020 – AUTONOMOUS GROUND VEHICLE IN WALL BUILDING SCENARIO – EXPERIMENTAL VALIDATION AND IN-FIELD EXPERIMENT by IVAN HRABAR

11:45 – 13:15 ROUND TABLE: INNOVAMARE PROJECT

14:30 – 16:30 TUTORIAL: SLAM IN COMPLEX LARGE-SCALE GNSS-DENIED ENVIRONMENTS by JULIO L. PANEQUE

16:45 – 18:45 BLENDER by MATKO ORSAG

Wednesday, 31st September

09:00 – 09:45 DATA ACQUISITION SERVICE FOR ENCORE ARCHITECTURE by STJEPAN BOGDAN

09:45 – 10:05 PHD PRESENTATION: SONAR-BASED OBJECT DETECTION METHODS by IGOR KVASIĆ

10:05 – 10:25 PHD PRESENTATION: ONLINE SEABED COVERAGE PATH PLANNING FOR AN AUTONOMOUS MARINE VEHICLE BASED ON SONAR DATA by NADIR KAPETANOVIĆ

10:25 – 10:45 PHD PRESENTATION: LOW-POWER DETECTION OF UNDERWATER ACOUSTIC SIGNALS by FRAN PENIĆ

11:00 – 11:45 SLAM IN COMPLEX LARGE-SCALE GNSS-DENIED ENVIRONMENTS by J. RAMIRO MARTINEZ-DE DIOS

11:45 – 12:30 ASYNCHRONOUS EVENT-BASED VISION FOR UAS PERCEPTION by AUGUSTO GÓMEZ EGUÍLUZ

12:30 – 13:15 ADAPTIVE MORPHOLOGY FOR AERIAL-AQUATIC ROBOTS by JULIEN DI TRIA, ANDRÉ FARINHA, CRYSTAL WINSTON

14:30 – 16:00 TUTORIAL: H2O ROBOTICS PRODUCTS FOR UNDERWATER LOCALIZATION AND COMMUNICATION by KRISTIJAN KRČMAR, VLADIMIR SLOŠIĆ

16:15 – 18:45 TUTORIAL: LAUV LUPIS – DEPLOYMENT, MISSION PLANNING AND ANALYSIS by NADIR KAPETANOVIĆ

Thursday, 1st October

09:00 – 11:00 TUTORIAL: THE BASICS OF A MONITORING MISSION by IVAN LONČAR, MARKO KRIŽMANČIĆ, ANJA BABIĆ

STREAMED PRESENTATIONS

All the technical talks were streamed and were made available to the public on Youtube. In the following links covering these talks.

Monday 28th September

Opening Session and 1st Morning Session (includes F. Ferreira and R. Petroccia & A. Pascoal lectures)
2nd Morning Session (includes PhD presentations by F. Rogić, A. Babić, M. Križmančić and I. Lončar and lecture by I. Palunko)

Tuesday 29th September

1st Morning Session (includes Đ. Nađ and M. Orsag lectures and V. Slošić PhD presentation)
2nd Morning Session (includes I. Vatavuk and I. Hrabar PhD presentations)
INNOVAMARE Round table

Wednesday 30th September

1st Morning Session (includes S. Bogdan lecture and I. Kvasić, N. Kapetanović and F. Penić PhD presentations)
2nd Morning Session (includes J. Ramiro Martinez-de-Dios, A. Gomes Eguíluz, and C. Winston, A. Farinha and J. Di Tria lectures)

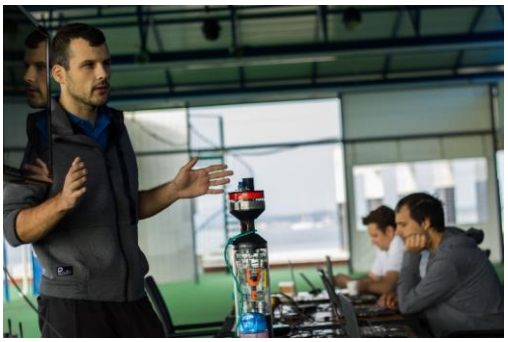
5.2. SCHEDULE

MONDAY, 28.09.		TUESDAY, 29.09.		WEDNESDAY, 30.09.		THURSDAY, 01.10.					FRIDAY, 02.10.				
09:00-09:15	OPENING SESSION	09:00-09:45	Lecture: D2 - a vehicle for diver-robot collaboration (Đ. Nađ)	09:00-09:45	Lecture: Data Acquistion Service for ENCORE Architecture (S. Bogdan)	09:00-11:00	Tutorial The Basics of a Monitoring Mission (Babić, Lončar, Križmančić) subCULTron				09:00-13:00	DEMO HEKTOR	DEMO H2O	DEMO CroMarX	DEMO Innova-MARE
09:15-10:00	Lecture: Marine robotics at CMRE: from competitions to regulation (F. Ferreira)	09:45-10:30	Lecture: Structurized Ecological Cultivation with Autonomous Robots in Indoor Agriculture (M. Orsag)	09:45-10:05	PhD Presentation: Sonar-Based Object Detection Methods (I. Kvasić)										
10:00-10:45	Lecture: Hybrid acoustic-optical underwater communication networks for next-generation cooperative systems (R. Petroccia & A. Pascoal, EUMR)	10:30-10:50	PhD Presentation: Production, testing and possible usecases of underwater acoustic beacons (V. Slošić)	10:05-10:25	PhD Presentation: Online seabed coverage path planning for an autonomous marine vehicle based on sonar data (N. Kapetanović)										
				10:25-10:45	PhD Presentation: Low-power detection of underwater acoustic signals (F. Penić)										
10:45-11:00	BREAK	10:50-11:05	BREAK	10:45-11:00	BREAK	11:00-11:15	BREAK								
11:00-11:20	PhD Presentation: Underwater Localization (F. Rogić)	11:05-11:25	PhD Presentation: MBZIRC 2020 - Autonomous ground vehicle in wall building scenario - Theoretical background (I. Vatavuk)	11:00-11:45	Lecture: SLAM in complex large-scale GNSS-denied environments (J. Ramiro Martinez-de Dios, AEROTWIN)	11:15-13:00	DEMO HEKTOR	DEMO H2O	DEMO CroMarX	DEMO Innova-MARE					
11:20-11:40	PhD Presentation: A hyper-heuristic approach to achieving long-term autonomy in a heterogeneous swarm of marine robots (A. Babić)	11:25-11:45	PhD Presentation: MBZIRC 2020 - Autonomous ground vehicle in wall building scenario - Experimental validation and in-field experiment (I. Hrabar)	11:45-12:30	Lecture: Asynchronous event-based vision for UAS perception (A. Gómez Eguíluz, AEROTWIN)										
11:40-12:00	PhD Presentation: Consensus-Based Distributed Connectivity Control in Multi-Robot Systems (M. Križmančić)	11:45-13:15	Round table INNOVAMARE project Topics: 1. Blue future - underwater robotics and sensors 2. Blue Sustainability - sea pollution 3. The economic value - inovation ecosystems												
12:00-12:20	PhD Presentation: Acoustic localisation of underwater sensors using cooperative unmanned marine vessels (I. Lončar)			12:30-13:15	Lecture: Adaptive Morphology for Aerial-Aquatic Robots (C. Winston, A. Farinha, J. Di Tria, AEROTWIN)										
12:20-13:05	Lecture: Adaptive Optimal Control in Cooperative and Decentralized Systems (I. Palunko)					13:00-14:30	LUNCH				13:00-14:30	LUNCH			
13:05-14:30	LUNCH	13:15-14:30	LUNCH	13:15-14:30	LUNCH										
14:30-16:00	Lecture: Soft robotic manipulation in selected agrotechnical procedures based on artificial intelligence (M. Polić)	14:30-16:30	Tutorial Slam in complex GNSS-denied environments (J. Paneque, AEROTWIN)	14:30-16:00	Tutorial H2Orologio + H2Observe	14:30-18:30	DEMO HEKTOR	DEMO H2O	DEMO CroMarX	DEMO Innova-MARE	14:30-18:30	DEMO HEKTOR	DEMO H2O	DEMO CroMarX	DEMO Innova-MARE
16:00-16:15	BREAK	16:30-16:45	BREAK	16:00-16:15	BREAK										
16:15-18:45	Tutorial ROS2 (Đ. Nađ)	16:45-18:45	Tutorial Blender (M. Orsag)	16:15-18:45	Tutorial LAUV Lupis - deployment, mission planning and analysis (N. Kapetanović)										

6. BTS PARTICIPANTS

In 2020, 50 participants from various fields joined Breaking the Surface in real life. Morning sessions were streamed with around 30 participants attending daily.





7. SUPPORTERS

SUPPORTED AND FINANCED BY

EUROPEAN UNION

EUMR

AeRoTwin

Interreg Italy - Croatia InnovaMare

HEKTOR

IEEE Oceanic Engineering Society OES

impact Erasmus+