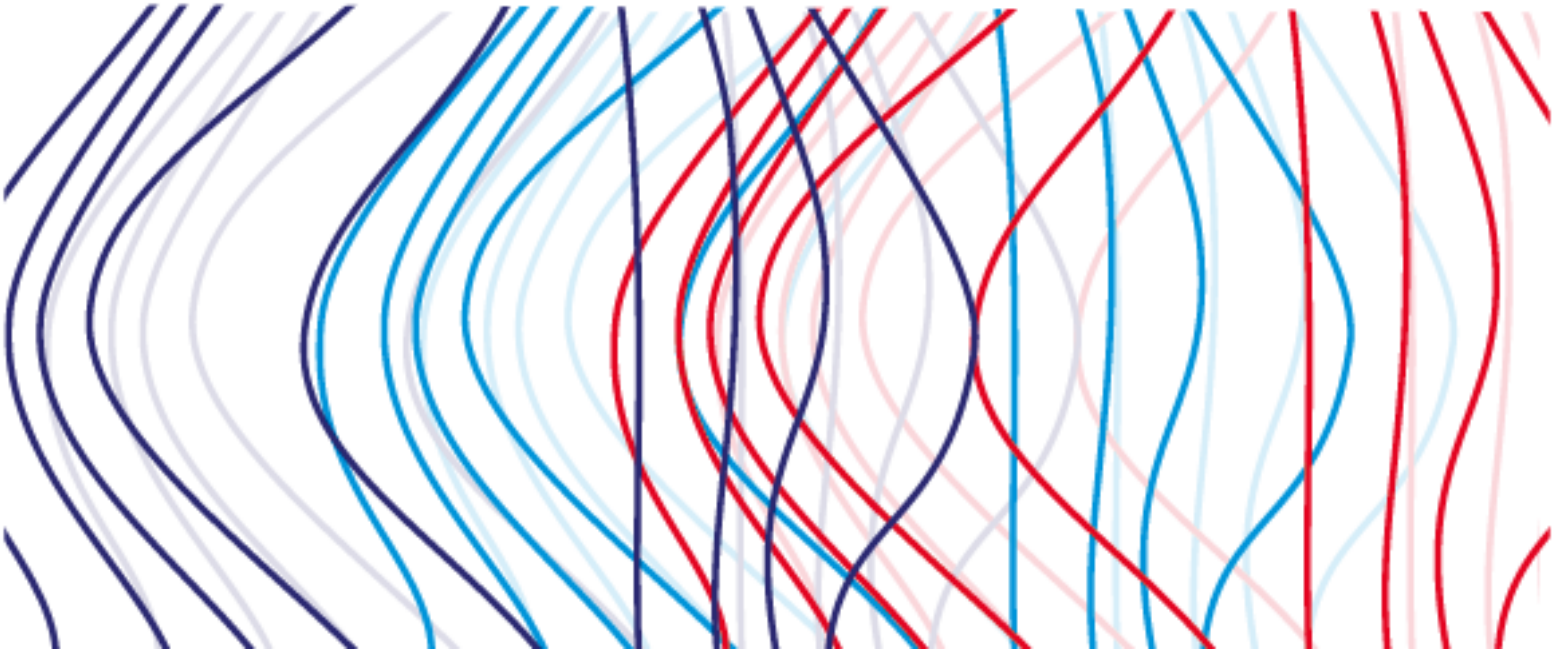
2019 29.09.- 06.10.

BREAKING THE SURFACE

BIOGRAD NA MORU, CROATIA

11th INTERNATIONAL INTERDISCIPLINARY FIELD WORKSHOP OF MARINE ROBOTICS AND APPLICATIONS



PROCEEDINGS

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1. INTRODUCTION

The **Breaking the Surface** 2019 was held from 29th September until 6th October in Biograd na Moru, Croatia and more than 210 people participated. The programme was divided in six program tracks: marine robotics (MAROB), marine biology and marine nature protection (MARBIO), maritime, nautical and ship archaeology (MARCH), oceanography (OCEAN) and company presentations. In 7 days, 35 lectures, 4 demonstrations and 7 tutorials were presented.

Dates: 29th September – 6th October 2019

Location: Biograd na Moru, Croatia

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

2. REPORT ORGANIZATION

The first part of the report describes the BtS 2019 organization, including the work program. The deliverable is accompanied with appendixes with abstracts, biographies and presentations of the programme presenters:

APPENDIX I. – Abstracts and biographies

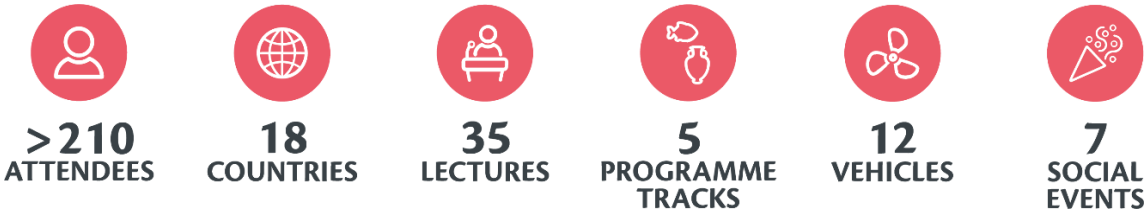
APPENDIX II. – Presentations (slides)

3. ABOUT BREAKING THE SURFACE

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

BTS2019 IN NUMBERS:



4. ORGANIZERS

Breaking the Surface summer school is organized under the European Union's Horizon 2020 project EUMarineRobots – Marine robotics research infrastructure network (GA 731103). 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 the Royal Institute of Technology (Sweden), Swedish Maritime Robotics Centre and Erasmus+ Impact.

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

Ivana Mikolić, mag. ing.
Organizing Committee Chair

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

mr. sc. Antonio Vasilijević,
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

Assoc. Prof. Dr. John Folkesson

KTH Royal Institute of Technology in Stockholm

Bill Kirkwood

Monterey Bay Aquarium Research Institute (MBARI)

Prof. Ivan Pterović, PhD

UNIZG FER

Asst. Prof. Dr. Sc. Irena Radić-Rossi

University of Zadar, Department of Archaeology

Joao Sousa

University of Porto

Ivan Stenius

KTH Royal Institute of Technology in Sttockholm

4.3. ORGANIZING COMMITTEE

Anamarija Miličević

LABUST

Ivan Trubić

LABUST

Barbara Mikašek

LABUST

Luka Manjkas

LABUST

Ivan Đerek

LABUST

Josip Kalafatić

LABUST

Lovro Kunović

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

Filip Mandić, mag. ing.

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Đula Nađ, dipl. ing.

UNIZG FER LABUST

5. PROGRAMME

5.1. PROGRAMME STRUCTURE

BtS program consists of academic lectures, hands-on tutorials, presentation of projects and equipment, company demonstrations and social activities.

5.1.1. LECTURES

Lectures by experts in the domains of:

List of speakers:

Marine robotics (MAROB):

- **Ioannis Kyriakides**, University of Nicosia Research Foundation: *Intelligent Maritime Information Acquisition and Representation for Decision Support*
- **Maretin Ludvigsen**, BluEye*: Adaptive Sampling With Autonomous Underwater Vehicles*
- **Massimo Caccia**, Consiglio Nazionale delle Ricerche – Istituto di Ingegneria del Mare (CNR-INM): *Marine robotics, learning from humans, and communication: the SWAMP example*
- **Xianbo Xiang**, Laboratory of Advanced Robotic Marine Systems (ARMs) Huazhong University of Science and Technology: *Underwater Cable Inspection and Dual-arm Intervention*
- **Francesco Maurelli**, Jacobs University Bremen: *Localisation in Marine Robotics*
- **Gerard Dooley**, CRIS UL: *Autonomous docking and inspection capabilities*
- **Jan Opderbecke***,* IFREMER: *Technological perspectives and new robotics applications in deep-sea ocean sciences*
- **Patryk Cieslak***,* Underwater Vision and Robotics Lab (CIRS), ViCOROB Institute, University of Girona: *Autonomous underwater manipulation from a floating I-AUV: The challenges of moving from the observation to the interaction with the underwater environment*
- **Lionel Lapierre***,* University of Montpellier / LIRMM: *Robots for karstic exploration: an underneath robotic journey*
- **Antonio Pascoal***,* Laboratory of Robotics and Engineering Systems (LARSyS), Institute for Systems and Robotics (ISR), Instituto Superior Técnico (IST), University of Lisbon, Portugal: *Cooperative Marine Robotics: Theory and Practice*
- **Jakob Verbeek***,* INRIA: *A brief introduction to deep learning for generative modeling*
- **Kimon Valavanis***,* University of Denver: *The entropy-based approach to modeling and evaluating autonomy in unmanned systems*
- **Ralf Bachmayer***,* University of Bremen: *Development and deployment of an unmanned iceberg observation system for offshore industry and iceberg modelling*
- **Fabio Bruno***,* University of Denver: *Improving the accessibility of underwater cultural heritage through digital technologies*
- **Marwa Salayma,** Institute of Sensors, Signals and Systems, School of Engineering and Physical Sciences, Heriot-Watt University: *Simulation Tools for Underwater Sensor Networks*
- **Maarja Kruusmaa***,* Tallinn University of Technology: *Flow Sensors for Underwater Robots and Oceanography*
- **João Tasso de Figueiredo Borges de Sousa***,* Laboratório de Sistemas e Tecnologias Subaquáticas, Faculdade de Engenharia da Universidade do Porto, Portugal: *Exploring dynamic features of the ocean with coordinated multi-domain robots? Yes, we can!!!*

- **Daniele Magazzeni**, King's College London: *Explainable AI Planning for Robotics*

Marine biology (MARBIO):

- **Fredrik Gröndahl**, Sustainable Development Environmental Science and Engineering (SEED), KTH: *The Dawn of a New Algae-Based Marine Industry in Sweden*
- **Ljiljana Iveša**, Ruđer Bošković Institute, Center for Marine Research, Rovinj: *Long-term fluctuations of Cystoseira forests along the west Istrian Coast (northern Adriatic, Croatia)*

Marine archaeology (MARCH):

- **Peter McCamley**, Gas Technologies Ltd: *The Lusitania Project 17.*
- **Dr. Rodrigo Pacheco-Ruiz**, MMT and The Centre for Maritime Archaeology, University of Southampton: *Deep Sea Archaeological Survey in the Black Sea – Robotic Documentation of 2,500 Years of Human Seafaring*
- **Michael Murray**, University of Southampton: *Recording Shipwrecks at the Speed of Light: A Low-Cost, Diver Deployed Underwater Laser Scanning System and Its Efficacy of Use in Maritime Archaeology Compared to Photogrammetry and Sonar in the 4th Industrial Revolution*

Oceanography:

- **Anna Wåhlin**, University of Gothenburg: *An Orange Submarine Underneath the Doomsday Glacier: Lessons Learned and Main Results*
- **Renato Mendes**, CIIMAR - University of Porto: *Multiple Autonomous Vehicles Applied to Detect, Track and Survey a River Plume*

5.1.2. TUTORIALS

- **JANUS: The first digital underwater communications standard** by Roberto Petroccia, NATO STO Centre for Maritime Research and Experimentation
- **ROS/Neptus Integration Tutorial** by Ignacio Torroba and Özer Özkahraman, KTH - Royal Institute of Technology
- **Control and navigation of unmanned robotic systems** by Kimon Valavanis, University of Denver
- **auvlib – Sonar data processing for machine learning** by Dr. Nils Bore, KTH Royal Institute of Technology
- **LSTS Toolchain: Bridging interoperability challenges** by José Pinto, Keila Lima and Manuel Ribeiro, University of Porto - Underwater Systems and Technology Laboratory (LSTS)
- **Software Defined USBL-Modem** by Oleksiy Kebkal and Veronika Kebkal, EvoLogics
- **Autonomous underwater manipulation from a floating I-AUV: Simulation and control strategies** by Patryk Cieślak, Underwater Vision and Robotics Lab (CIRS), ViCOROB Institute, University of Girona

5.1.3. DEMONSTRATIONS

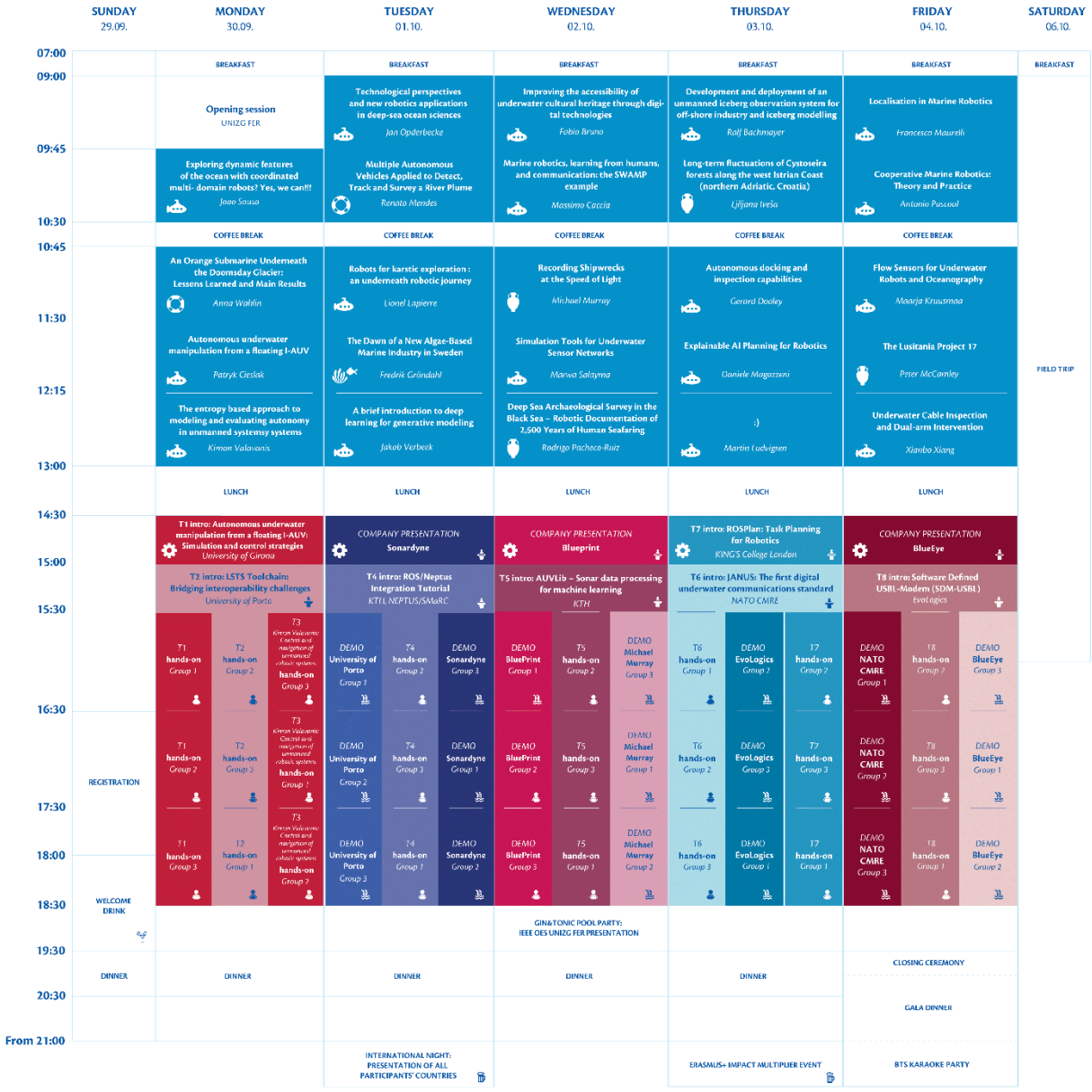
- **LSTS toolchain: Bridging interoperability challenges** by José Pinto, Keila Lima, and Manuel Riberio, University of Porto - Underwater Systems and Technology Laboratory (LSTS)
- **EvoLogics** by Oleksiy Kebkal and Konstantin Kebkal, EvoLogics
- **Hands-on with JANUS: understanding, implementing, and using the first digital underwater communications standard** by Roberto Petroccia, NATO STO Centre for Maritime Research and Experimentation

- **ULS-200 Underwater Laser Scanning Demonstration Information** by Michael Murray University of Southampton, the Centre for Maritime Archaeology, OARS-HPSG

5.1.4. COMPANY PROGRAMME

- **Sonardyne** by Malik Chibah and John Houlder
- **Blueprint subsea** by Robin Sharphouse, Kevin Webster
- **Planet Ocean Limited / ecoSUB Robotics Limited** by Ian Vincent and Jérémy Sitbon
- **Blueye Robotics** by Martin Ludvigsen

5.2. SCHEDULE



LEGEND

SESSION COLOURS

- Lectures
- Social events and special programme
- Company programme
- Tutorials
- Demonstrations

CATEGORIES

- MAROB
- MARBIO
- MARCH
- OCEANOGRAPHY
- COMPANY PRESENTATION

LOCATIONS

- LECTURE HALL – HOTEL ADRIATIC — ALL lectures and presentations
- DEMO POOL AND OPEN WATERS NEARBY — Equipment demonstrations, Gin&tonic pool party
- TUTORIALS ROOM – HOTEL ADRIATIC — Tutorial
- LAVENDER BAR – HOTEL ADRIATIC — Welcome drinks, Erasmus+ impact multiplier event
- BELVEDER BAR — BTS karaoke

REGISTRATIONS

Sunday, 29.09.
16:30 – 18:00

WELCOME DRINK

Sunday, 29.09.
18:00 – 19:30

INTERNATIONAL NIGHT

Tuesday, 01.10.
21:00

GIN&TONIC pool party: IEEE OES UNIZG presentation

Wednesday, 02.10.
18:30

Erasmus+ IMPACT multiplier event

Thursday, 03.10.
21:00

CLOSING CEREMONY

Friday, 04.10.
19:30 – 20:00

GALA DINNER

Friday, 04.10.
20:00 – 21:00

BTS Karaoke party

Friday, 04.10.
21:00

FIELD TRIP

Saturday, 05.10.
9:00 – 16:00

6. BTS PARTICIPANTS

In 2019, 214 participants from academia and industry from various fields joined Breaking the Surface.

7. 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).***

8. SUPPORTERS

FINANCED BY

Financed in the scope of the project *EUMarineRobots – Marine robotics research infrastructure network* (GA 731103) which has received funding from the European Union's HORIZON 2020 Research and Innovation Programme

9. APPENDIX I – ABSTRACTS AND BIOGRAPHIES

Abstracts and biographies are available here.

10. APPENDIX II – PRESENTATIONS

MONDAY 30th September 2019:

- João Tasso de Figueiredo Borges de Sousa: Exploring dynamic features of the ocean with coordinated multi-domain robots? Yes, we can!!!
- Patryk Cieslak: Autonomous underwater manipulation from a floating I-AUV: The challenges of moving from the observation to the interaction with the underwater environment
- Anna Wåhlin: An Orange Submarine Underneath the Doomsday Glacier: Lessons Learned and Main Results
- Kimon Valavanis: The entropy based approach to modeling and evaluating autonomy in unmanned systemsy systems

TUESDAY 1st October 2019:

- Jan Opderbecke: Technological perspectives and new robotics applications in deep-sea ocean sciences
- Renato Mendes: Multiple autonomous vehicles applied to detect, track and survey a river plume
- Ioannis Kyriakides: Intelligent Maritime Information Acquisition and Representation for Decision Support
- Fredrik Gröndahl: The Dawn of a New Algae-Based Marine Industry in Sweden
- Jakob Verbeek: A brief introduction to deep learning for generative modeling

WEDNESDAY 2nd October 2019:

- Fabio Bruno: AUVLib – Sonar data processing for machine learning
- Massimo Caccia: Marine robotics, learning from humans, and communication: the SWAMP example
- Michael Murray: Recording Shipwrecks at the Speed of Light: A Low-Cost, Diver Deployed Underwater Laser Scanning System and Its Efficacy of Use in Maritime Archaeology Compared to Photogrammetry and Sonar in the 4th Industrial Revolution
- Marwa Salayma: Simulation Tools for Underwater Sensor Networks
- Rodrigo Pacheco-Ruiz: Deep Sea Archaeological Survey in the Black Sea – Robotic Documentation of 2,500 Years of Human Seafaring

THURSDAY 3rd October 2019:

- Ralf Bachmayer: Development and deployment of an unmanned iceberg observation system for off-shore industry and iceberg modelling
- Ljiljana Iveša: Long-term fluctuations of Cystoseira forests along the west Istrian Coast (northern Adriatic, Croatia)
- Gerard Dooly: Autonomous docking and inspection capabilities
- Kotaro Yamafune: Digital Recording and Underwater Cultural Heritage
- Martin Ludvigsen: Adaptive Sampling with Autonomous Underwater Vehicles

FRIDAY 4th October 2019:

- Francesco Maurelli: Localisation in Marine Robotics
- Antonio Pascoal: Cooperative Marine Robotics: Theory and Practice
- Maarja Kruusmaa: Flow Sensors for Underwater Robots and Oceanography
- Peter McCamley: The Lusitania Project 17
- Xianbo Xiang: Underwater Cable Inspection and Dual-arm Intervention