

”Breaking the Surface” - international interdisciplinary field-training for experts, end-users and students

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Abstract—The international interdisciplinary field training of marine robotics and applications ’Breaking the Surface BtS started in 2009 as one of the two flagship dissemination activities of the EU-funded FP7 Capacities REGPOT-2008-1 project ’Developing the Croatian Underwater Robotics Research Potential - CURE’. Three BtS field-trainings were organized as CURE activities (BtS2009, BtS2010 and BtS2011). The first BtS2009 consisted of only three program tracks: marine robotics (MAROB), marine biology (MARBIO) and maritime archaeology (MARCH). From 2012 until 2014 the BtS was supported by the Office of Naval Research Global (ONRG) and under auspices of the President of the Republic of Croatia. The content and scope changed over the years. Today we can affirm that the BtS became a brand with high appreciation among all those that participated. Visibility of this event improved over the years and number of participants, especially students, increased each year.

I. INTRODUCTION

Underwater systems and technologies are used by various disciplines, and designers of these systems should be aware of end-user needs. The idea of joining together various disciplines came naturally as a way of how to appease these needs of cross fertilization among various disciplines. It was decided that the best way to accommodate different needs of end-users, designers/engineers, students and experts in the field is to offer a venue where all can join and exchange information about their particular know-how.

The structure, the content and the scope of the workshop has changed over the years, resulting in event with smooth and well accepted activities by participants. BtS field-training is not only popular because of its high quality activities, event also provides enough time for participants to discuss, exchange ideas, initiate joint research proposals and enjoy social program that deepens interaction and friendship.

The annual BtS workshop started in 2009 and the first five workshops were held in Murter (island Murter), Croatia. Since 2014, BtS changed location to Biograd na Moru, Croatia. From the very beginning duration of the workshop was set to one week and remained unchanged ever since.

More about all six field-trainings can be found at <http://bts.fer.hr>.



Fig. 1: Plenary lectures at BtS2014

II. BREAKING THE SURFACE

The first BtS2009 consisted of only three program tracks: marine robotics (MAROB), marine biology (MARBIO) and maritime archaeology (MARCH). The aim of the first workshop was to open perspectives and venues for interaction of marine robotics researchers with end-user researchers or professionals, primarily marine biologists and maritime archaeologists. The structure of the BtS2009 consisted of plenary type lectures by leading experts in the field (Fig. 1), demo



Fig. 2: Participants and organizers of the BtS 2014

presentation of research results or commercial products and two full days of field activities.

The MAROB module was focused on the quality of navigation (localization) and controllability of the UUVs, needed by end users. Two distinct problem areas were looked into: assisted human-in-the-loop control through implementation of the "smart ROV" paradigm i.e. collaborative use of an ROV in the same water-space as professional divers and ge-referencing of the data-sets acquired by an AUV, in order to provide a priori situational awareness (prior to human diving) of a particular site.

The MARBIO module was devised as an assessment of the red gorgonian (*Paramuricea clavata*) population in two locations of the Kornati National Park, using two different approaches. First, manual survey was carried out by divers using standard methodology to obtain population density, size and spatial distribution and then by an ROV in a partially automated survey. Data from both surveys were processed and results compared. Based on analysis of data quality and quantity, method effectiveness and the required resources, propositions were made for use of ROVs for inventory of species.

The MARCH module addressed two issues: inspection, mapping and documenting existing underwater sites at various depths and fast systematic survey of vast areas using AUV, which could greatly increase the likelihood of discovering archaeological sites (Fig. 3).

Supplementing the three existing program tracks MAROB, MARBIO and MARCH, a new track, Maritime Security (MARSEC) was introduced 2010. The program included 3 full days of field activities. The first two, MARBIO and MARCH, fieldworks were carried out in the Kornati archipelago National Park with a similar focus but with a different approach than



Fig. 3: AUV IVER 2 in action on the archaeology site Bisage, NP Kornati, BtS 2010

2009. The MARSEC fieldwork was supported by Croatian Navy and their Ship BDM-81 "Cetina". Application of the unmanned vehicles, ROV and AUV, for the MCM (Mine Counter Measures) was demonstrated. Demonstration was presented jointly by the Croatian Navy and Laboratory for Underwater Systems and Technologies.

For BtS2011, four program tracks remained unchanged while fieldwork locations were chosen much nearer to the venue, to cut down on ferrying time and allow more time for hands-on exercises. Groups of up to 6 participants were shuttled using RIB powerboats within dedicated time-table periods to a boat permanently positioned over the case study localities. In that way, a more hands-on approach to training could be practiced with respect to the activities in 2010.



Fig. 4: Tutorials, work in a small groups

Three years of ONRG support started 2012 and brought more US participants to the event. Exchange of research results and ideas and newly established overseas network resulted in couple of interesting joint research proposals which were initiated during BtS field-training.

The pillar program tracks remained the same with occasional incorporation of geology, oceanography and fisheries. On the other hand, realizing the participants interest and need not only for tools for data acquisition but also for tools for data processing and visualisation, hands-on tutorials were incorporated in the workshop program from 2012. Introduction of targeted tutorials of data analysis and GIS presentation and work in a small groups (figure 4) were very well accepted by the participants. A demonstration of an autonomous aerial vehicle was introduced 2013 and from then all three domains: air, sea-surface and sea-underwater were present at BtS. Program customization, improved visibility and broaden scope of the event increased the interest for BtS field-training.

As a result of the fieldwork activities, performed during the BtS events, substantial data collection was acquired. Data was primarily used for education and demonstration purposes but resulted in number of published scientific papers. The fact that published work is often result of the joint effort of the scientists from different disciplines and from all program tracks e.g. Marine Robotics [1], [2], [3], Marine Archaeology [4], [5], Marine Biology [6] and Maritime Security [7], is very encouraging and motivating.

Demonstrations at sea were very intensive and diverse every year (Fig. 5). During the years numerous national, European and international projects, such as: CURE (<http://cure.fer.hr/>), CART (<http://cart.posidonia.com/>), FILOSE (http://cordis.europa.eu/project/rcn/89451_en.html), GNALIC (<http://zadron.unizd.hr/>), Autonomous Naval MCM Neutralization, THESAURUS and ARROWS (<http://www.arrowsproject.eu/>), ICARUS (<http://www.fp7-icarus.eu/>), MORPH (<http://morph-project.eu/>), CADDY (<http://www.caddy-fp7.eu/>), just to name a few, have been presented and results demonstrated during the six BtS workshops.



Fig. 6: Demonstration of company products at BtS2014

Apart from the research project demonstrations the most of the key underwater technology companies have had an opportunity to present and operate their product during the BtS workshop (Fig. 6):

- Evologics (<http://www.evologics.de/>)
- Atlas (<https://www.atlas-elektronik.com/atlas-elektronik/>)
- VideoRay (<http://www.videoray.com/>)
- Hydroid-Kongsberg Maritime (<http://www.km.kongsberg.com/hydroid>)
- Ocean-server (<http://www.ocean-server.com/>)
- OceanScan (<http://www.oceanscan-mst.com/>).

Altogether 7 different AUV vehicle, 4 ROV vehicles, 4 surface vehicles, 2 aerial vehicles participated in BtS operations; many of them more than once. Number of participants reached 141 during the BtS2014: 13 members of organization committee, 25 invited lecturers, 12 representatives of companies, 50 other participants, and 41 students. The present program structure consist of: 20 plenary lectures; 5 hands-on tutorials; participatory field-work using various robots; company demonstrations; demonstrations of research results from EU research projects; social program (welcome party and a full day excursion).



Fig. 5: Fieldwork, participants operate an ROV

III. CONCLUSION

From the very beginning the workshop was devised as an event, open for scientists and end-users of marine technology. The format of event matured during the years. During the first two years the workshop program consisted of invited lectures and underwater fieldwork, combining scuba diving and marine robotics for each of the program tracks. The lessons learned and participants feedback emphasize the need not only for tools for data gathering but also for tools for data processing and visualisation. The program evolved accordingly, integrating company demonstrations of the marine systems, hands-on tutorials of applications for data analysis and presentation and fieldwork activities focused on potential of marine robotics for end users. As a result, the program is presently organized in the form of plenary talks, hands-on tutorials and research and company/commercial demonstrations of marine technologies.

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