D.5.3.1. Workshop report

InnovaMare project

Blue technology - Developing innovative technologies for sustainability of Adriatic Sea

WP5 – Cooperation in innovation on robotic and sensors solution (TT) – pilot actions

Project References

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INTRODUCTION

The Adriatic Sea is one of the crucial industrial and touristic sites of the north east Mediterranean Sea and mitigate the anthropogenic impact on this area is crucial to protect the health of the ecosystems and of the people that leave by it. One of the main aims of InnovaMare Project is the monitoring of the health of the Adriatic Sea via an innovative robotic system and, specifically, the goal of WP5 is to put into practice the collaboration among the partners on robotics solutions to be used for the sustainability of the Adriatic Sea.

In the InnovaMare context, the WP5 was devoted to demonstrating the possibilities of robotics applications to environmental monitoring, such as multirobot systems, sensor solutions and Internet of Underwater Things (IoUT). These solutions, developed according to the Living Lab (LL) methodology, are flexible enough to provide integrated monitoring solutions that can be easily applied to several monitoring scenarios.

In the previous deliverables within the task 5.2, on pilots and solutions development, the multifunctional robotic and sensor solutions developed were described, detailing their hardware and software prototyping status (D5.2.2, D5.2.3). Moreover, use cases of potential application together with their connection to the GES MSFD descriptors were presented in D5.2.1, scenarios of demonstrations were presented in D5.2.4 and D5.2.5 and the results obtained in D.5.2.6 and D.5.2.7. This deliverable aims to summarize the different demonstrations to stakeholder not only in the BtS Workshop but also in other events, in the context of 3 main use case related with MFSD descriptors 1, 5, 6, 7, 10 and detailed in Table 1:

- Inspection and monitoring of aquaculture ecosystems
- Inspection and monitoring for marine litter detection
- Benthic habitat mapping.

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Table 1: Potential use cases, technologies and target groups.

Use cases	Technologies to be used		Target Groups
	ASVs+SV*+ROV	Buoys	
Inspection and monitoring of aquaculture ecosystems	Map and detect biofouling in aquaculture cages (MSFD 5)	Water quality inspection of sea in aquaculture farms (MSFD 5, 7)	Aquaculture companies
Inspection and monitoring for harbours and marinas including marine litter detection	Creating high resolution bathymetryc 3D model (by Multibeam echosounder system; MBES) and/or mosaic of the seabed (MSFD 6) Sediment erosion near structures (MSFD 7) Automatic (offline) marine litter detection on mosaics (MSFD 10) Creating high resolution digital ortophoto (aerial), surface litter/pollution detection on ortophoto map Creating interactive maps/GIS for charting/tracking pollution/litter	Water quality monitoring in marinas to detect wastewater (MSFD 5, 7) Traffic activity detection using acoustic monitoring of the environments (MSFD 11)	Municipalities, Marinas, Environmental Protected Areas (EPAs), Marine Protected Areas (MPAs), coastal authorities
Benthic habitat mapping	Benthic habitat mapping (MSFD 1 and 6)		EPAs, MPAs
Cultural heritage inspection and monitoring	Submerged archeological sites monitoring Inspection of buildings and structures conditions	Submerged archeological sites monitoring (intrusion detection)	Municipalities, archaeological superintendencies , UNESCO

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The remainder of this report is organized as follows. The general description is presented in the next section. Then, a summary of the demonstrations that took place at Breaking the Surface is reported followed by brief reports of other demonstrations at other INNOVAMARE related events. are briefly highlighted before introducing the equipment to be used. Participants, Participants responsibilities, Operating area, Event-setup and Health and Safety complement the document. Finally, the section Conclusions draws some conclusions.

GENERAL DESCRIPTION

Within the Innovamare activity 5.3, FER, CNR and other Innovamare stakeholders performed demonstrations of technologies that can be used to monitor and improve underwater conditions. A short description of each technology follows (more details in D5.2.2, D5.2.3) before reporting on each workshop/event.

SWAMP Autonomous Surface Vehicle, developed by CNR to access and monitor extremely shallow water by means of portable, modular, reconfigurable and highly maneuverable robotic vehicles. Within InnovaMare project, SWAMP was equipped with a multifrequency multibeam echosounder (MBES), an automated field spectroscopy device (RoX), a SUNA V2 nitrate sensor, a high resolution and high sensitivity AI underwater camera Guard1.
Korkyra Autonomous Surface Vehicle, developed by FER, Laboratory for Underwater Systems and Technologies (LABUST), is complimentary to the SWAMP ASV as it has a different size, top speed enableing the integration of signalling maritime lights, surveillance camera(s), LIDAR or other sensors etc.
Buoys: as part of the platforms offered by FER, innovative smart marine buoys for long-term operation and persistent deployment in marine environments were developed. The buoy can operate as a remote marine platform performing water quality measurements, as well as a relay for an extended underwater sensor network.
Blueye Pro ROV
This Remotely Operated Vehicle (ROV) is a commercial product and it has not been developed by any of the INNOVAMARE partners. However, it can be connected to and support Korkyra ASV in some use case scenarios as it shall be seen in and therefore it is briefly introduced here.

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Breaking the Surface Workshop

During the Breaking the Surface (BtS) Workshop that took place in Biograd na Moru, Croatia from 25th September to 2nd October, as detailed in Deliverable D2.5.2, robotic and sensor solutions from FER and CNR and the support vessel from GEOMAR were planned to be used to demonstrate stakeholders how can they be utilized in the monitoring and improvement of underwater conditions. Due to bad weather, GEOMAR support was unable to navigate to Biograd na Moru. However, a tutorial was given by GEOMAR on the usage of Multibeam echosounder (MBES) for hydrography and Benthic habitat mapping. The technical characteristics and capabilities of MBES, problems arising from work, data processing principles and the final product after post-processing were demonstrated.

On the other hand, CNR and FER demonstrated jointly a multi-robot system composed of two Autonomous Surface Vehicles (ASV), one Remotely Operated Vehicle (ROV) and one Smart Buoy applied to the inspection and monitoring for marine litter detection as shown in Fig. 1. In particular, when the CNR ASV (SWAMP) would detect marine litter, it would transmit that information through the Smart Buoy to FER's ASV (Korkyra). Then, ASV Korkyra would approach and launch the ROV for a closer look. This demonstration took place in front of all BtS stakeholders (200 attendees) and showed the value of the solutions developed in INNOVAMARE, their level of complexity and maturity. In the interest of conciseness, more information on this demonstration can be found in Deliverable D.5.2.7 which includes a scientific paper published.

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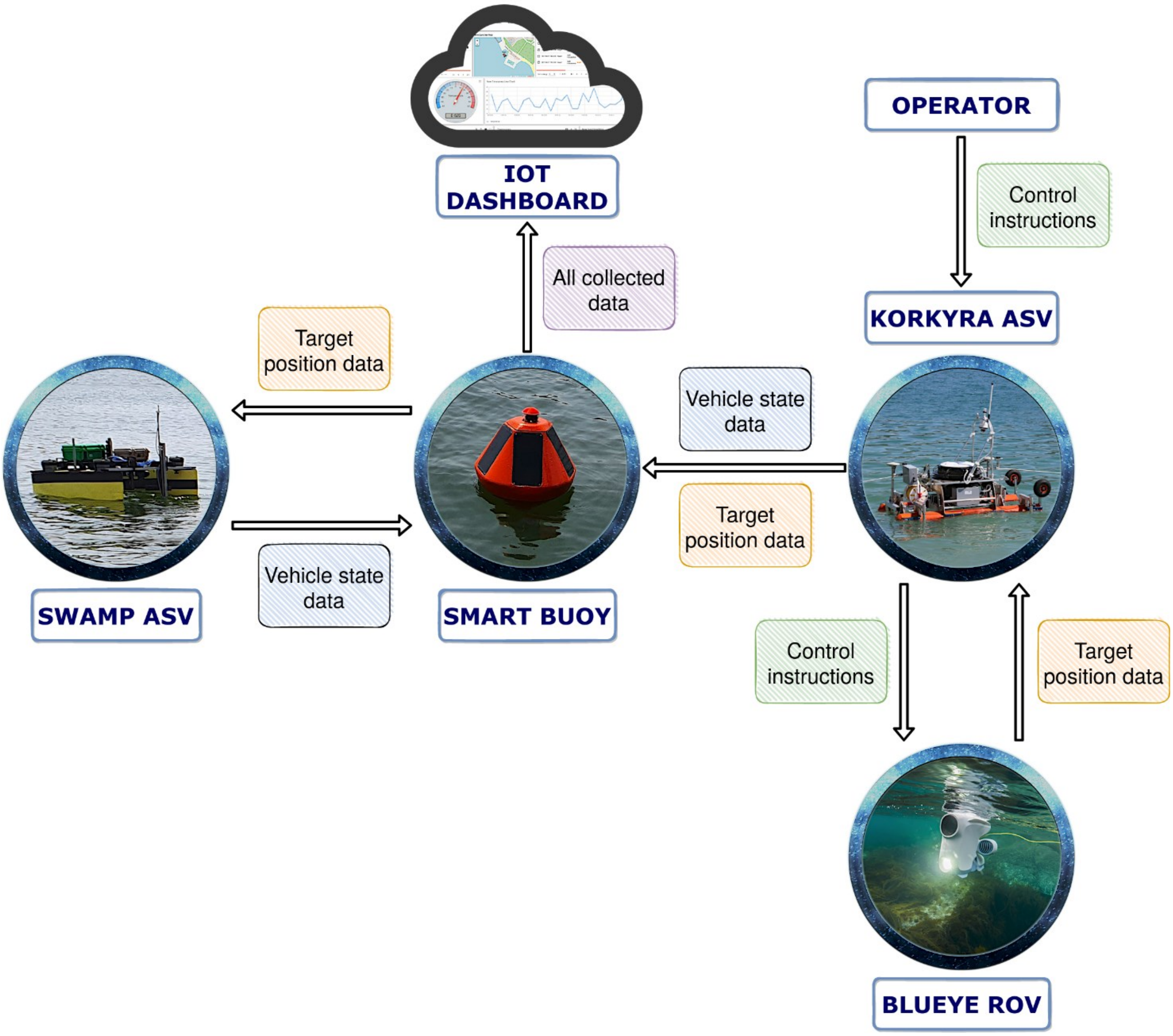

Fig. 1 Scenario high-level schematic for Breaking the Surface joint demonstration

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Rijeka Roadshow

During the Rijeka Roadshow, FER demonstrated an ASV for Benthic habitat mapping. In addition to demonstrating the basic capabilities of habitat mapping using an underwater camera, FER demonstrated remote control of the robotic platform over the Internet. In this demonstration, the operator was in Zagreb and was able to control the robot in Rijeka both with higher levels of control (e.g. waypoints only) and lower levels (e.g. joystick control). The connection delay was small enough to allow precise control and this capability can become very useful for external stakeholders such as local authorities, environmental protection agencies, etc. For instance, the platform can be deployed by FER but operated by an end-user anywhere in the world in a user-friendly manner.

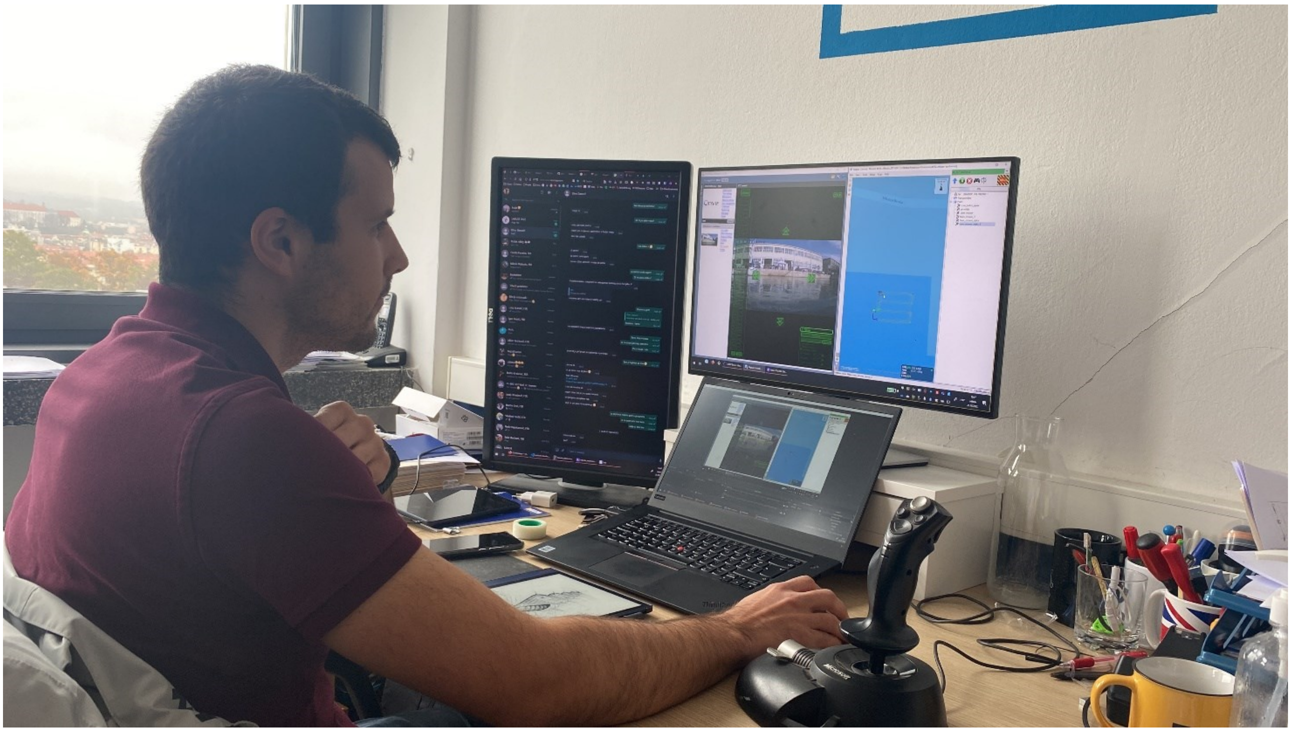

Fig. 2 Operator in Zagreb commanding robot in Rijeka during Rijeka Roadshow

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Bari Roadshow

During the Bari Roadshow, another joint demonstration CNR-FER took place. In this case, the simpler scenario described in D5.2.3 with the SWAMP ASV and the Smart Buoy was demonstrated in Bari given time and logistics constraints. This activity also served in preparation for the long-term deployment of the Smart Buoy and sensor nodes in an Inspection and monitoring of aquaculture ecosystems scenario which is better described in D.5.3.2.

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Fig. 3 a) Public demonstration of technologies during Bari Roadshow b) FER and CNR team with SWAMP ASV and Smart buoy

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ROBOTIMA

During ROBOTIMA, both FER and CNR demonstrated technologies for Benthic habitat mapping. Given the organization by a maritime cluster, this was an excellent opportunity to disseminate the work towards industrial stakeholders. Likewise, given the public character of the event, it was also useful for the dissemination towards the general public.

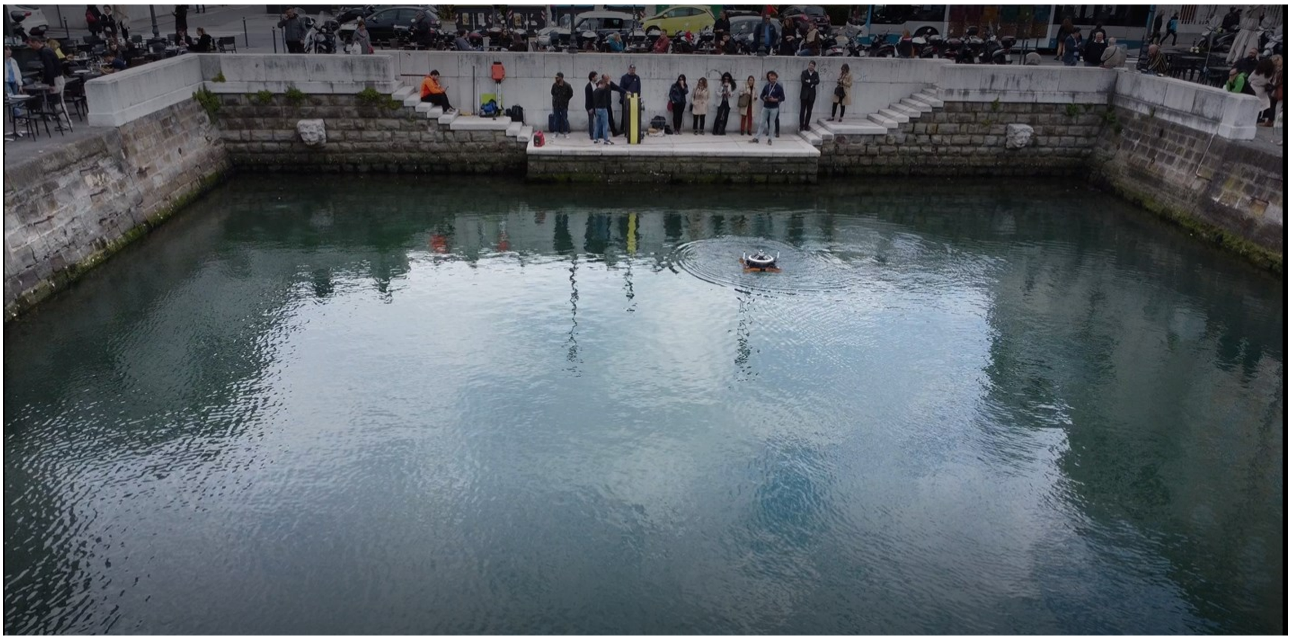

Fig. 4 Public demonstration of FER’s robotic platform during ROBOTIMA event

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INNOVAMARE Academy

During the INNOVAMARE Academy in Šibenik, Croatia, several demos were forecast to happen including CNR and FER demonstrations. Due to bad weather, this could not take place at sea but in the case of FER it was replaced by an live online demonstration from the Laboratory for Underwater Systems and Technologies (LABUST) pool in Zagreb to the attendees in Šibenik. Several technologies were shown including the latest robotic solutions developed by FER for the purpose of Inspection and monitoring of aquaculture ecosystems.

Fig. 5 Live demonstration of different FER technologies during INNOVAMARE Academy

EMRA Workshop

The Workshop on EU-funded marine robotics and applications (EMRA) 2023 took place in Šibenik, 20-21 June 2023. During the last day of EMRA Workshop, a deployment of FER's Smart Buoy with sensor nodes took place in an actual aquaculture farm located in the Krka river estuary, close to Šibenik (seen in Fig. 6). In this case, the request came from a stakeholder and FER provided the technology to monitor essential water parameters for the aquaculture ecosystem (e.g. in Fig. 7). This deployment will go beyond the duration of INNOVAMARE project contributing to the sustainability of the outputs and applicability of the technology in a real user-centric scenario. Further details regarding this deployment can be found in D5.3.2.

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Fig. 6 Buoy deployed in a mussel farm for monitoring of aquaculture ecosystem.

Fig. 7 Example of data being monitored and displayed in the dashboard.

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CONCLUSIONS

This report provides a summary of several demonstrations taking place in INNOVAMARE events related to the improvement of underwater conditions. To keep it concise, references to deliverables with more details of specific demonstrations have been included. As it has been shown, many different technologies were demonstrated and applied to the 3 different main use cases (Inspection and monitoring of aquaculture ecosystems; Inspection and monitoring for marine litter detection; and Benthic habitat mapping). It is important to mention that these technologies can be applied in many other scenarios as described in D.5.2.1 given needs of stakeholders. However, the demonstrations that took place in the different events were representative enough to give an idea to stakeholders of what technology can be applied to underwater conditions improvement. Finally, it is important to note that the final deployment of technology during the INNOVAMARE project was in a real, user-centric scenario and will last beyond the project providing a much sought sustainability of the outputs.

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GLOSSARY

ASV: Autonomous Surface Vehicle

Benthic zone: is the ecological region at the lowest level of a body of water such as an ocean, lake, or stream, including the sediment surface and some sub-surface layers.

GES MSFD: Good Environmental Status descriptors of Marine Strategy Framework Directive

GIS: geographic information system

IoT Internet of Things

IoUT Internet of Underwater Things

LABUST Laboratory for Underwater Systems

MBES: MultiBeam EchoSounder

ROV: Remote Operated Vehicle

SWAMP: Shallow Water Autonomous Multipurpose Platform

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