Report about the methodology followed for the comparison of traditional sampling methods and the new approach based on UUV surveys

Activity 4.2 - Comparative evaluation of the implemented monitoring technologies

WP4 - Implementation of the Georeferenced Open Access Database

SUSHI DROP project (ID 10046731)

Final Version of 28/02/2022

Deliverable Number D.4.2.1

Project Acronym	SUSHIDROP
Project ID Number	10046731
Project Title	SUstainable fiSHeries wIth DROnes data Processing
Priority Axis	3
Specific objective	3.2
Work Package Number	4
Work Package Title	Implementation of the Georeferenced Open Access Database
Activity Number	4.2
Activity Title	Comparative evaluation of the implemented monitoring technologies
Partner in Charge	LP - UNIBO
Partners involved	
Status	Final
Distribution	Public

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Abstract

WP4 is dedicated to the main challenges in the development of adequate procedure and software implementations to design and manage UUV missions and to process the huge amount of data collected during surveying operations. Within this WP, the activity number 2 that consists in a comparative study of the classical sampling methodologies with respect to the methodologies conducted using the UUV technology. In this deliverable are analyzed and highlighted the novel features that could bring the use of UUV technology in the context of monitoring of marine ecosystems.

Overview

This deliverable addresses the different classical sampling methodologies with respect to the new methodology by using UUV technology. In particular, both deep and shallow water sampling techniques are discussed specifically, emphasizing how the use of new technologies can lead to a completely non-invasive underwater monitoring.

Methodology comparison: Trawling nets

Traditional methods are particularly invasive for the environment and for this reason they are forbidden in protected marine areas, moreover they are linked to the morphology of the seabed. In fact these techniques cannot be applied in rocky environments, which for their conformation are areas of natural aggregation. Therefore, the non-invasive sampling methodologies, carried out through the use of drone, can be carried out in any type of marine ecosystem, going to increase the amount of information available until the creation of a marine digital twin. They also have high operational costs: all species captured are manually sorted by some specialized operators. The biological variables of each species caught are recorded manually. In comparison, using non-invasive methods of reconnaissance using UUVs and special sensors, it is possible to estimate these biological variables from the data acquired and then recorded in an automated stream with lower operational costs and without damaging the seabed.

All types of missions that can be carried out with Blucy are non-invasive: both surveys through the use of MBES and close seabed inspection. In analogy to what is carried out through the use of trawling nets, also with the use of the UUV system it is possible to cover the same mission area carrying out different surveys with transects of overflying the seabed at different depths. In this way it is possible to carry out a precise characterization of species, both pelagic and benthic.

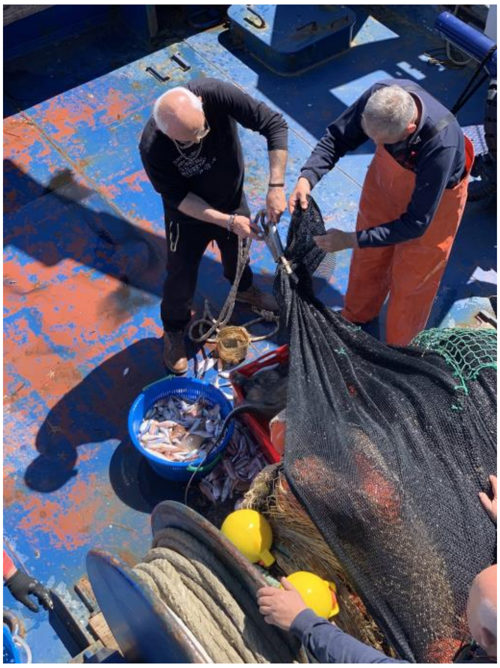

FIGURE 1 TRAWLING NETS IN SPLIT MISSIONS

In a concrete example, with the use of the MBES sensor and its WaterColumn mode, it is possible to detect schools of fish by monitoring their precise presence in the areas between the active sensor and the seabed. With an accurate planning of the trajectory, which is possible to review and update in real time according to the evolution of the survey and what was previously detected, we had the opportunity to get closer to the fish minimizing the impact of the survey thanks to the quietness of operations and the ability to make observations at a distance without contact. In fact, approaching at a sufficient distance from the fish and framing them with the different optical sensors on board, PilotCAM and BottomCAM, it is possible to make a recognition of the species identified. Finally, by cross-checking all the data acquired, both with active and passive sensors, it is possible to estimate the total number of specimens present in the area under investigation.

With the combined use of bathymetry data and models derived from WaterColumn analysis, it is possible to perform a quantitative characterization of the benthic communities present in the surveyed area. The amount of data obtained during the missions is currently analyzed manually by the operator during the processing of data in the laboratory, at the conclusion of the operational phases of the survey. Several automatic or semi-automatic analysis methodologies supported by artificial intelligence and machine learning algorithms are under development for the recognition and quantification of species present in the surveyed environment.

FIGURE 2 BLUCY DURING SURVEY IN DEEP WATER

Methodology comparison: Diver Survey

In shallow water inspection, survey activities are traditionally performed by trained personnel with special diver equipment. The diver usually operates in a way free from any fixed reference and brings with him in special cylinders the compressed gas in sufficient quantity for the duration of the planned mission. He can modify his buoyancy according to the needs of the mission with a buoyancy control device (BCD), using for this same operation a part of the air contained in the cylinders or the exhaled air. Overall, it is possible for the operator to remain underwater for periods that are variable and depend on the amount of gas that the system can carry and at the same time the depth at which it is breathed. In addition to the equipment necessary for survival in the underwater environment is generally necessary to bring equipment and sensors of different types to make the surveys, such as a camera and any lighting devices.

In this type of mission, a relatively small environment is monitored. Unlike the human operator, Blucy is able to monitor the extent of the seabed observed in a continuous and non-point source. The large amount of data collected is sufficient for an exhaustive description of the environment, thanks also to the possibility to observe from at least two different points of view: BottomCAM and PilotCAM. In this scenario, a precision navigation is required, obtained through a real-time streaming of the position and video feedback of the optical cameras through the fiber optic cable in ROV mode.
The mission performed by UUV has some significant advantages over the mission performed by diver.

Through the use of Blucy the mission time is significantly greater and depends only on the autonomy of the battery that powers the engines and sensors on board, in the order of several hours of continuous operation. Through an accurate positioning, possible thanks to the inertial and acoustic sensors, it is possible to perform multi-temporal surveys of the same environment allowing a subsequent repositioning in the same area of investigation. Using unmanned vehicles such as UUVs it is possible to reduce the risks for human operators and to carry out missions even in hostile environments with adverse maritime conditions and in the presence of strong currents, ensuring greater operability. In conditions of poor visibility it is always possible through sensors such as CTD and SVS to accurately measure chemical and physical parameters of the marine environment and even in the presence of water with high turbidity it is possible to have a vision of the environment detected through the use of active sensors such as MBES.
In conclusion, through the combined use of sensors equipped on a UUV as Blucy, it is possible to acquire a significant amount of scientific data that allow to characterize the marine environment in an exhaustive way. Thanks to an accurate planning of the survey it is possible to obtain complete three-dimensional models of the seabed and natural elements, at different spatial and temporal scales.


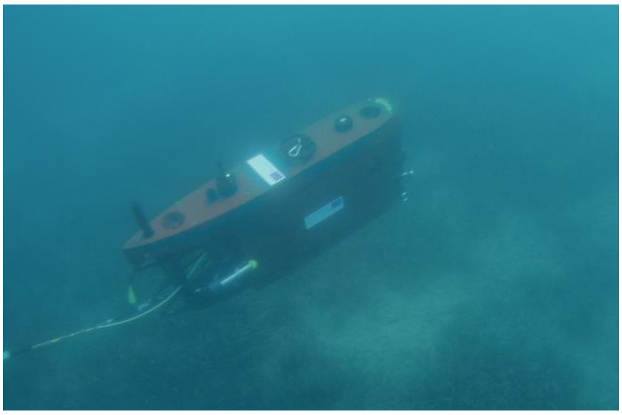

FIGURE 3 BLUCY DURING SHALLOW WATER MISSIONS

Abbreviations

The following abbreviations are used in this deliverable:

AHRS	Attitude and Heading Reference System
AUV	Autonomous Underwater Vehicle
DEM	Digital Elevation Model
DT	Digital Twin
DVL	Doppler Velocity Log
EKF	Extended Kalman Filter
FDI	Fault Detection and Isolation
FOG	Fiber Optic Gyroscope
FOV	Field of View
GNSS	Global Navigation Satellite System
GSD	Ground Sample Distance
INS	Inertial Navigation System
MBES	Multibeam Echosounder
NGC	Navigation, Guidance and Control
ROV	Remotely Operated Vehicle
RS	Remote Station
SFM	Structure from Motion
USBL	Ultra-Short Baseline
UUV	Unmanned Underwater Vehicle
GIS	Geographic Information System
CoG	Centre of Gravity
NMEA	National Marine Electronic Association
UDP	User Data Protocol

Acknowledgement

The material in this document is published in “Underwater Drone Architecture for Marine Digital Twin: Lessons Learned from SUSHI DROP Project” by Lambertini, A.; Menghini, M.; Cimini, J.; Odetti, A.; Bruzzone, G.; Bibuli, M.; Mandanici, E.; Vittuari, L.; Castaldi, P.; Caccia, M.; De Marchi, L. in *Sensors* **2022**, *22*, 744. https://doi.org/10.3390/s22030744