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Italy - Croatia CBC Programme
Call for proposal 2019 Strategic

MARLESS (MARine Litter cross-border awarenESS and innovation actions)

Priority Axis: Environment and cultural heritage; Specific objective: 3.3 - Improve the environmental quality conditions of the sea and coastal area by use of sustainable and innovative technologies and approaches

D.6.5.4 – Design and implementation of autonomous mobile net array

AT 6.5

WP 6

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PROJECT MARLESS

Work Package:	WP6
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1. Introduction

Researchers from the University of Dubrovnik (UNIDU) Laboratory For Intelligent Autonomous Systems with help from the researchers from the Department for Applied Ecology designed and implemented the autonomous mobile net array for floating litter collection. After agreeing on the dimensions and mobility and control mode of the net array, the equipment needed for the assembly was purchased. The mobile net array consists of two H2Omni-X Unmanned Surface Vehicles connected with a net. The vehicles are equipped with 4 thrusters maximal speed of

thrusters is 1 m/s allowing them to move omnidirectional. They have autonomous navigation system as well as a Global Positioning System receiver capable for real time kinematics. In addition to that, they also have built in underwater and above-water video cameras. The integrated net is a typical one used for fishery, the dimensions are 7.5 x 0.9 m, with mesh size of 2.5 x 2.5 cm. It is connected to a lead core rope and styropore foam floaters.

Control algorithms for coordination and efficient litter collection were also developed and the prototype of the autonomous mobile net array was custom made. For the development of the autonomous net array the UNIDU research team spent in total around two years. The technologies used for design and development are sensors for autonomous navigation and localization, autonomous nonholonomic surface vehicles serving as actuators for the net array, path planning algorithms and machine learning algorithms. The first version of the system was ready 17 months after the beginning of the activity and the first public demonstration including all the stakeholders (general public, local, regional and national public authorities, regional and local development agencies, education and training organizations as well as universities and research institutes) was performed in May 2022. Until the end of the project the system was constantly updated, tested, and validated in real field experiment, with the last demonstration performed in April 2023.

The collection of floating marine litter was performed in the Bistrina Bay (Southern Adriatic), 55 km southern from Dubrovnik at the Laboratory for mariculture of the University of Dubrovnik. There, UNIDU has a research concession on sea area with floating longlines for suspended bivalve culture that was used to test the net array. Analysis of the floating marine litter collected by the mobile net array resulted with conclusions that the array is capable of collecting different materials such as wood, polystyrene and plastic belonging to various size and weight classes. The collected marine waste was catalogued by a Joint List of Litter Categories for Marine Macrolitter Monitoring and included drink bottles $\leq 0.5l$ and $> 0.5l$, plastic caps/lids from drinks, plastic pieces $> 2.5\text{ cm}$ $< 50\text{cm}$, polystyrene pieces $0-2.5\text{ cm}$, $> 2.5\text{ cm}$ $< 50\text{cm}$ and $> 50\text{ cm}$ as well as processed timber. Individual categories of collected waste ranged from 0,10 till 2,65 kg with 94% of items made from plastic and 6% from wood while the weight ratio was 31% of plastic and 69% of wood.

In conclusion, UNIDU designed and demonstrated the autonomous mobile net array for floating litter collection. After the project, the net array will be available to the local authorities, interested public and non-governmental organizations in a case they show interest in using it, especially in a case that Dubrovnik Old Town Port gets hit by a huge amount of the floating litter. The net array was successfully tested for collection of various types of common floating litter and it was presented at to different target groups. Interested parties can invest in supporting this kind of research with special focus on robotics design, development of control systems algorithm and artificial intelligence. The developed system has the ability to be further advanced into a fully autonomous system is the research and development continues to be funded.

2. MEDIA

The functioning of the autonomous mobile net array for floating litter collection developed by the University of Dubrovnik can be seen here:

- [UNIDU MARLESS mobile net array](#)
- [UNIDU MARLESS mobile net explained](#)

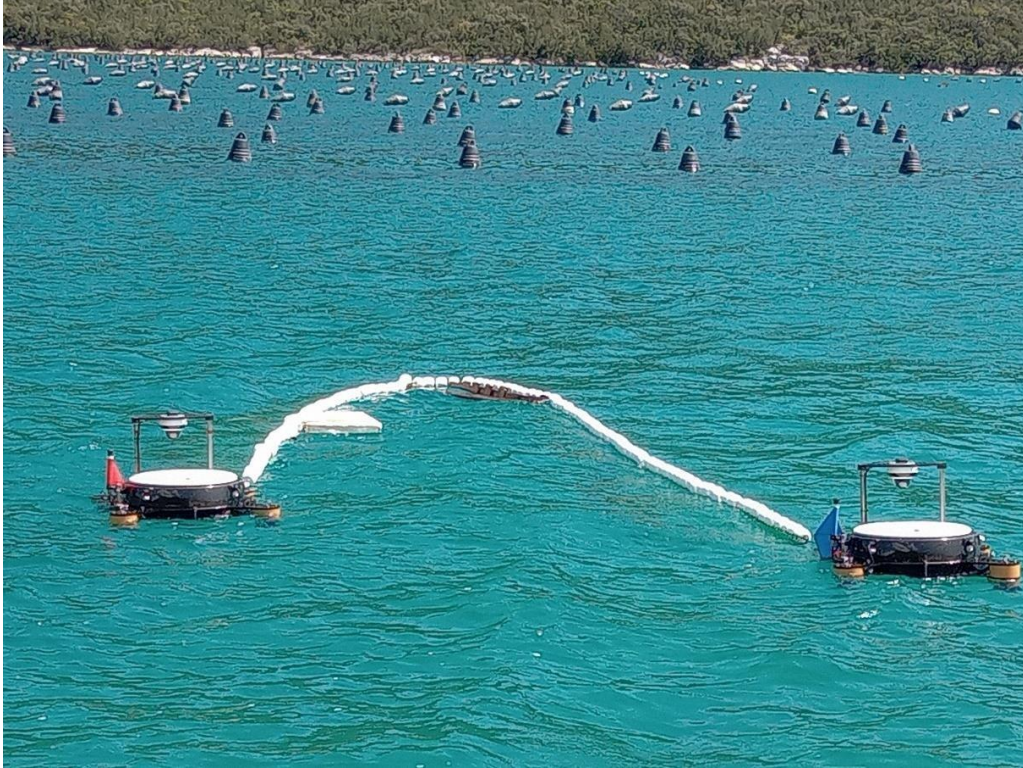


Photo 1. UNIDU MARLESS mobile net array collecting processed timber and Styrofoam

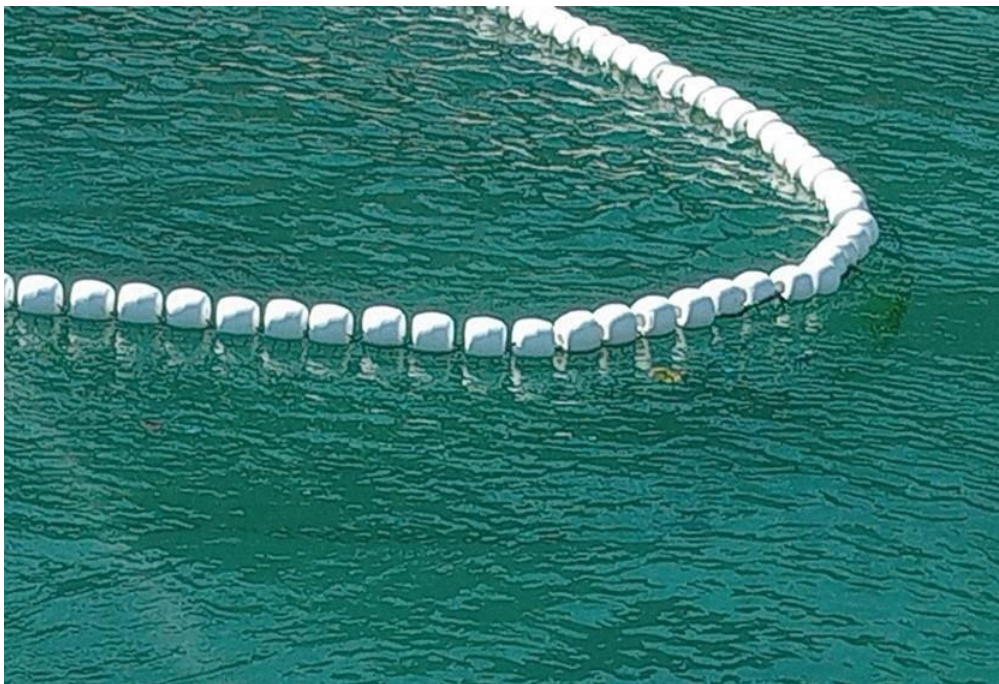


Photo 2. UNIDU MARLESS mobile net array collecting plastic lids from drinks



Photo 3. UNIDU MARLESS mobile net array collecting plastic bottles