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The acceptance of the articles presented depends on their scientific quality and their adaptation to magazine's editorial line.

This year begins the so-called Decade of the Oceans, promoted by the United Nations with the slogan "The Science we need for the oceans we want".

Based on the premise that global investment in marine science research is insufficient, the main objective is to promote scientific advances in this field that support a sustainable management of the oceans, promoting a greater and more efficient flow of information between different regions or interest groups.

These developments will seek to resolve issues ranging from the identification of sources of pollution, the mapping of marine ecosystems or the food supply. All these new discoveries go through a better capacity for understanding the ocean and its behaviour and, therefore, through the development of increasingly advanced and precise measurement technologies.

As set out in the World Ocean Science Report 2020, the access to the technical infrastructure needed for marine science remains unevenly distributed, so the development of low-cost technologies will also allow for the transfer of ocean technology to less developed areas.

Linked to this technological development, promoting open access to ocean data, considering these a common good of society, will be another key aspect of the next decade.

Spain is already betting on this strategy through the European recovery funds. And Galicia leads one of the proposals in marine sciences focused on new technologies for observing the marine environment.

In this context, the MARTECH 2021 workshop, co-organized by the Campus do Mar of the Universidade de of Vigo and the Universitat Politécnica de Catalunya, responds to the most current needs in the marine field. This conference is a meeting point between different professionals in marine technologies, where they can share experience, knowledge, data and information and capabilities of this scientific community.

Welcome to MARTECH 2021

Ana Bernabeu
Chairwoman of the Organizing Committee

MARTECH 2021 TECHNICAL PROGRAM

TIME	WEDNESDAY 16			
09:30 - 10:00 h	OPENING SESSION Ms. Patricia Argerey, Director of Axencia Galega de Innovación, GAIN Ms. Belén Rubio Armesto, Vicechancelor for Research (Universidade de Vigo) Mr. Jordi Llorca, Vicechancelor for Research (Universitat Politècnica de Catalunya) Mr. Daniel Rey, Director of the Campus do Mar (Universidade de Vigo)			
10:00 - 11:00 h	Keynote talk: Dr. Juanjo Dañobeitia EMSO ERIC: a challenging distributed infrastructure for understanding complex processes and interactions in the deep ocean and water column. Presented by: Daniel Rey			
11:00 - 11:15 h	Q&A session-keynote talk			
	Coffee Break			
	Chair: Begoña Vila (INTECMAR) Marine Data Interoperability and data flow		Chair: Silvia Torres (CETMAR) Underwater imaging and communication	
11:45 - 12:00 h	MELOA Catalogue, Geoportal and Data Services: A Modern approach for a Marine in-situ measurements Spatial Data Infrastructure and Data Services	F. Pedrera	Image Hashing for Loop Closing in Underwater Visual SLAM	F. Bonin
12:00 - 12:15 h	Promoting FAIRness in marine data at Centro Nacional Instituto Español de Oceanografía	P. Otero	Developing an acoustic tag with bidirectional communications capabilities	I. Masmitja
12:15 - 12:30 h	EMSO ERIC's Authentication and Authorization Infrastructure	I. Rodero	A Visually-Guided Position Control Method, in Underwater conditions, using an Inexpensive Remotely Operated Vehicle	A. Solis
12:30 - 12:45 h	MOODA: The Module for Ocean Observatory Data Analysis and Harmonization	R. Bardají	Imaging of Deep Sea Fish Species for Classification via Machine Learning Techniques	T. Chen
12:45 - 13:00 h			Chair: Moncho Gomez-Gesteira (UVIGO) Renewable energies	
13:00 - 13:15 h	Simplifying quality control and standardization of CTD data under SeaDataNet requirements	P. Otero	Dynamic Analysis of a Pendulum-Type Wave Energy Converter for Oceanic Drifters by means of a 4 DoF Model	J. Ortiz de Haro
13:15 - 13:30 h	Real-time Data Quality Control applied at OBSEA	A. Fornós	Evaluation of two MPPT techniques in Low-Power Pendulum-Type Wave Energy Converters	M. Carandell
13:30 - 13:45 h	Use of TimescaleDB as a database for ocean-meteorological data storage	I. González	Magallanes Project: Testing the Marine Tidal Current Platform in the “Ría of Vigo”	C. Carrillo
13:45 - 14:00 h			Testing Green Maritime Resources in the Universidade da Coruña CIT Towing Tank	V. Díaz Casas
	LUNCH			

MARTECH 2021 TECHNICAL PROGRAM

	Chair: Jorge Acevedo (UVIGO) Seafloor observatories and sensor networks		Chair: Ramiro Varela (UVIGO) Technology for Marine Biology and Aquaculture	
16:00 - 16:15 h	Tele-operated Ecological Monitoring at the Seafloor Observatory (OBSEA)	A. Falahzad	Arduino controlled valvometry equipment for laboratory monitoring	M. Gilcoto
16:15 - 16:30 h	A decade of time series as produced by multiparametric ecological monitoring at the OBSEA	M. Francescangeli	Spiral Inertial Microfluidics for Size based Microalgae Separation	V. Magalhães
16:30 - 16:45 h	Water quality monitoring program through the KduSTICK, a low-cost and Do-It-Yourself instrument connected by the Internet of Things	C. Rodero	Advances in electronic monitoring of fishing catches based on artificial intelli-gence	L. T. Antelo
16:45 - 17:00 h	Development of a low cost, self-configuring ADCP and integrated deployment and recovery system	C. Molina	POLYBIUS2020, a cost-effective underwater autonomous video system to record fishing selectivity performance catching fish and marine litter	I. González
17:00 - 17:15 h	Implementation of a Low-Cost Ultra-Dense Tide Gauge Network in the Balearic Islands	A. Frank Comas	Emerging biotechnology for Aquaculture: Cryopreservation	E. Paredes
17:15 - 17:30 h	The WAVY drifters – Sensor and data validation	R. Chumbinho		

TIME	TUESDAY 17			
10:00 - 11:00 h	Keynote talk: Dr. Joao Sousa Ocean observation with multi-domain robotic vehicles: current trends and future developments Presented by: Pablo Otero (IEO)			
11:00 - 11:15 h	Q&A session-keynote talk			
	Coffee Break			
	Chair: Pablo Otero (IEO) Observatories and remote sensing		Chair: Ana Bernabeu (UVIGO) Seafloor and Water Column characterization	
11:45 - 12:00 h	Photogrammetry in Marine Science	S. Sammartino	Geophysical and geotechnical site characterisation for sustainable maritime dredging projects. The example of Port of Langosteira (A Coruña, Spain)	A. Deu
12:00 - 12:15 h	Simplified Creation of Photo-Mosaics from Aerial Images	F.Martín - Rodríguez	The physical conditions of the Barents Sea, a note to fishing vessels.	O. T. Gudmestad
12:15 - 12:30 h	Big Plastic Masses Detection using Satellite Images & Machine Learning	F.Martín - Rodríguez	Tidal propagation and frequency responses in the Guadalquivir Estuary	I. Nadal Arizo

MARTECH 2021 TECHNICAL PROGRAM

12:30 - 12:45 h	Bathymetric surveys from SAR satellite images	D. Santos	On-line measurement of water quality at Besòs estuary: effects of storm and heavy rain episodes	D. M. Toma
12:45 - 13:00 h	An integrated biogeochemistry observation system of the Besòs estuary	D. Toma	Autonomous portable module for continuous analysis of oceanographic variables along coastal transects	S. F. Bastero
13:00 - 13:15 h	RADAR ON RAIA: High frequency radars in the RAIA Observatory	S. Piedracoba	Using WIZ portable module to analyze Eutrophication Risk levels in the NW Iberian coast	L. Moreno
	Chair: Xulio Hermida (UVIGO) 2020 as a point between the past and the future			
13:15 - 13:30 h	Birth and decline of Hercules Control	X. Hermida	Analysis Review of the Reliability-Availability-Maintainability for the OWTs	J. Vázquez Taboada
13:30 - 13:45 h	Change of leadership in the social organization: Change of consciousness in the individual	X. Hermida		
	LUNCH			
	Chair: Soledad Torres (UVIGO) Instrumentation, Metrology, Signal processing		Chair: Miguel Gilcoto (IIM-CSIC) Marine Robotics: ROVs, AUVs, ASVs, Gliders	
16:00 - 16:15 h	How the implementation of a Data Management Quality Management Framework improves data process flows and operational processes in a multi-sensor cabled coastal observatory.	Paul MI	Uncrewed Surface Vehicles (USV): from survey to shipping	C. Barrera
16:15 - 16:30 h	An Interoperable Architecture for in situ Ocean Noise Monitoring	E. Martínez	Improving Visual Odometry for AUV Navigation in Marine Environments	F. Bonin Font
16:30 - 16:45 h	Monitoring and mapping of intertidal macroalgae using low-cost geospatial automated techniques	J. Rodgues. Somoza	LanderPick, a Remote Operated Trawled Vehicle to cost-effectively deploy and recover lightweight oceanographic landers	C. González - Pola
16:45 - 17:00 h	SPOT and GPRS drifting buoys for HF Radar calibration	A. Mtnez. Fernández		

MARTECH 2021 TECHNICAL PROGRAM

TIME	FRIDAY 18	
10:00 - 11:00 h	Keynote talk: Dr. Lucia Santiago Stability monitoring systems for fishing vessels Presented by: Ana Bernabeu	
11:00 - 11:15 h	Q&A session-keynote talk	
	Coffee Break	
	Chair: Daniel Rey (UVIGO) Coastal, regional, and offshore research vessels and platforms	
11:45 - 12:00 h	Vessel requirement for an offshore project	A. Rodríguez
12:00 - 12:15 h	SILENCIO: Introduction of electric propulsion to small inshore fishing boats to reduce their impact in the environment	C. Almécija
12:15 - 12:30 h	Comparing mesh-free and mesh-based numerical methods to deal with sloshing tank problems	J. González Cao
12:30 - 12:45 h	Comparison of the Electrolytic, Ultrasounds and Chemical Cleaning in Corroded Naval Steel	R. Devesa-Rey
12:45 - 13:00 h	Analysis and evaluation of corrosion in naval steels	R. Devesa-Rey
13:00 - 13:15 h	Development of a citizen monitoring program for the Barcelona coastal waters: the Scientific Patí Vela (PATI CIENTIFIC)	R. Bardají
13:15 - 13:45 h	CLOSING SESSION Ms. Ana Bernabeu, Steering Committee MARTECH 2021 (UVIGO) Mr. Joaquín del Río, Steering Committee MARTECH 2021 (UPC) Mr. Ramón Marín, Universitat Jaume I Mr. Pedro José Sanz, Universitat Jaume I	

ID1- IMAGE HASHING FOR LOOP CLOSING IN UNDERWATER VISUAL SLAM

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Abstract
This article presents an experimental assessment of a hash-based loop closure detection methodology specially addressed to Multi-robot underwater visual Simultaneous Localization and Mapping (SLAM). This methodology uses two different top quality image global descriptors, one learned (NetVLAD) and one handcrafted (HALOC). Complete tests were done to compare the performance of both hashing techniques applied in an extensive set of real underwater imagery.

Keywords
Visual Loop Closing Detection, Underwater Robotics, SLAM, Convolution Neural Networks.

I. INTRODUCTION AND OVERVIEW
Loop closing, which consists in detecting whether the robot is observing a previously visited area [1], is one of the most important tasks in a visual Simultaneous Localization and Mapping (SLAM) module for Autonomous Underwater Vehicles (AUV). This observation is reflected in pairs of images that overlap, regardless the differences in orientation, scale or viewpoint. Closing a loop is more than a simple visual place recognition, but also an image registration part, that is, the extraction of a transform, in translation and rotation, between the pair of images that close the loop. Large-scale or longterm missions projected with a single AUV generate large maps with huge amounts of visual data. A common approach to mitigate this issue is to join, in a common origin, different trajectories (so called sessions) estimated by one or multiple robots, in different times or simultaneously [2]. Due to the lack of geometric constraints between different sessions, one way to detect inter-session loop-closings is to apply brute-force visual feature matching techniques between an image of one session and all images of another session. But this process is extremely costly in computational resources and time, and requires, specially in centralised Multi-Robot systems, the delivery of huge amounts of visual data to the master robot [2]. Transferring images between underwater robots is particularly problematic since underwater communications bandwidth is extremely reduced if using acoustic baselines and blue light modems applied underwater require short distances and a certain directionality between the transmitter and the receiver. One way to solve this problem is reducing the images to a short vector of numbers, so called a global image signature, or a hash for short. Traditionally, a hash is usually used as a digital signature to authenticate dispatched messages. Conventional hashes are extremely sensitive; a change in 1 bit of the input message changes the output dramatically [3]. However in applications of scene recognition or visual loop closing, it is accepted that similar or overlapping images produce similar or close hashes while distinct images produce clearly distinctive hashes [4]. Hashes are very fast to calculate and to compare, reduce drastically the data storage and exchange, and do not compromise the global localization process since, hashes are obtained from visual features, and, in visual-based navigation architectures, visual features have to be obtained for all images, to calculate the visual odometry and to register images that close loops.

In the context of the ongoing national project TWINBOT (TWIN roBOTs for Cooperative Underwater Intervention Missions) [5], diverse missions of cooperative intervention must be run using one or several AUVs in underwater areas with different benthic habitats. Sharing visual data between different robots is necessary to estimate a common map. This paper presents an essentially applied work: the assessment of a hash-based loop closing detection methodology that uses, alternatively, two top image hashes that showed excellent performance: 1) NetVLAD [7], a well known Convolutional Neural Network (CNN) architecture specially trained for weakly supervised place recognition in urban environments, and that, once trained returns a global descriptor in the form of a vector with 512 floats, and b) HALOC [6], a handcrafted global image descriptor formed by a vector of 384 floats; HALOC has already demonstrated a great performance in limited underwater scenarios [8].
In order to save time and resources, the proposed methodology consists in: a) All images of all sessions are hashed. Find a set of N candidates to close a loop with a current query, as those images among all captured in other sessions that present the lowest difference, in terms of L1-norm, between their hash and the query hash, b) Candidates to close a loop with the query are confirmed by means of a RANSAC-based process described in [9], c) Candidates confirmed by RANSAC will be True or False Positives (TP/FP) if they really do close or not a loop (determined visually); candidates rejected by RANSAC will be either True or False Negatives (TN/FN), also determined by visual inspection.

EXPERIMENTAL ASSESSMENT AND RESULTS
A new dataset of 642 underwater images obtained by us in the Mediterranean has been created recently to perform the assessment presented here. The dataset has been organised in order to minimize/avoid the overfitting in the NetVLAD training/testing. Images were separated in 75 queries and another database of 567 candidates. Images were taken with 3 different bottom looking cameras (a GoPro, a Point Grey CM3-U3-31S4 and a Manta G283), by divers and using an AUV, model SPARUS II, in 5 different points of the coast of Mallorca, in different environments with different benthic habitats, forming different types of sea bottoms. Three different datasets were formed with all these images, named DS1, DS2 and DS3. Each one had 25 query images, and 183, 177 and 207 database images, respectively, in such

Dataset	A	R	FO		Training Dataset	Testing Dataset	Model	A	R	FO
DS1	0,92	0,86	0,08		DS3	DS1	Caffe VLAD	0,76	0,79	0,28
DS2	0,9	0,88	0,09		DS3	DS2	Caffe VLAD	0,82	0,93	0,22
DS3	0,86	0,71	0,12		DS1	DS2	Vd16 AVG	0,82	0,87	0,22
Mean	0,89	0,82	0,09		DS1	DS3	Vd16_AVG	0,87	1	0,20
Mean	--	--	--		--	--	--	0,82	0,89	0,23

Table 1. *Testing results using HALOC (left) and NetVLAD (right)*

a way that, every query has, at least, one loop closing in the corresponding database. The three datasets together with the Matlab files that contain their structure and contents, and the NetVLAD configuration files are available and accessible for the community in a corporative github repository [10]. NetVLAD was trained using 6 different configurations: two different networks, AlexNet and VGG-16, and for each network, the last convolutional layer was cropped with 3 different options: a max pooling layer, an average layer and the NetVLAD layer. The 6 configurations were applied on the 3 different datasets, in total 18 tests. Trainings with DS1 and DS3 were validated with DS2 and training with DS2 was validated with DS1.

According to [7], the trained models that presented the highest Recall metrics were selected for the final loop closure detection assessment: a CNN using Alexnet with the NetVLAD layer, called Caffe_VLAD, and another using VGG16 with the average pooling layer, called Vd16_AVG. Caffe_VLAD and Vd16_AVG were used to hash all images of DS1/DS2, and DS2/DS3, respectively. All images of all datasets were also hashed using HALOC. Afterwards, each query of each dataset was associated with 5 top loop closing candidates taken from the corresponding database. The 5 candidates were those that presented the lowest difference (L1-norm) between their hash and the hash of the query, and all were confirmed/rejected using RANSAC. The number of TP, TN, FP and FN were obtained by means of visual inspection. Table I shows a summary of the tests performed with HALOC and NetVLAD, and the obtained results in terms of Accuracy (A), Recall (R) and Fall-out (FO).

CONCLUSIONS

The results of the assessment of the hash-based loop closing detection methodology using HALOC and NetVLAD, revealed a certain better performance of HALOC. HALOC gives, in average, a slightly higher Accuracy and Recall, and a clearly lower Fall-out. However, the NetVLAD results should not be underestimated because differences in Accuracies and Recalls are very small. The problem is the Fall-out: higher Fall-outs imply more FP. The merit of the NetVLAD results is in that they were obtained training a maximum of 642 images, in front of the thousands used to train the urban models described in [7]. Ongoing work includes trying to reduce the NetVLAD Fall-out with more training images since the objective would be using learned descriptors in order to increase the adaptability of the loop-closing detection processes in different environments.

REFERENCES

[1] Angeli, Adrien & Doncieux, Stéphane & Meyer, J.-A & Filliat, David. (2008). Real-Time Visual Loop-Closure Detection. Proceedings - IEEE International Conference on Robotics and Automation. 1842 - 1847. 10.1109/ROBOT.2008.4543475.

[2] M. Labbé and F. Michaud. 2018. Long-term Online Multi-session Graph-based SPLAM with Memory Management. Autonomous Robots 42, 6 (Aug. 2018).

[3] V. Monga and B. L. Evans. Perceptual Image Hashing Via Feature Points: Performance Evaluation and Tradeoffs. IEEE Transactions on Image Processing, 15(11):3452–3465, 2006.

[4] U Jain, V.P. Namboodiri, and G. Pandey. Compact Environment-Invariant Codes for Robust Visual Place Recognition. In 14th Conference on Computer and Robot Vision (CRV), pages 40–47, 2017.

[5] Laboratory UJI-IRSLab (Interactive, Robotic Systems), University of Girona (CIRS), and Balearic Islands University (UIB-SRV Group). TWIN roBOTs for Cooperative Underwater Intervention Missions, 2019. http://www.irs.uji.es/twinbot/twinbot.html.

[6] P.Ll. Negre Carrasco, F. Bonin-Font, and G. Oliver-Codina. 2016. Global Image Signature for Visual Loop-Closure Detection. Autonomous Robots 40 (2016), 1403–1417.

[7] R. Arandjelović, P. Gronat, A. Torii, T. Pajdla, and J. Sivic. 2018. NetVLAD: CNN Architecture for Weakly Supervised Place Recognition. IEEE Transactions on Pattern Analysis and Machine Intelligence 40, 6 (June 2018), 1437–1451.

[8] P.Ll. Negre Carrasco, F. Bonin-Font, and G. Oliver Codina. 2016. Cluster-Based Loop Closing Detection for Underwater SLAM in Feature-Poor Regions. In Proceedings of the IEEE International Conference on Robotics and Automation (ICRA). 2589–2595.

[9] A. Burguera, F. Bonin-Font, and G. Oliver. 2015. Trajectory-based Visual Localization in Underwater Surveying Missions. Sensors (Switzerland) 15, 1 (2015), 1708–1735.

[10] F. Bonin-Font. Underwater Dataset for CNN-based Loop Closing Detection, 2019. https://github.com/srv/Underwater-Dataset.

ID2- EVALUATION OF TWO MPPT TECHNIQUES IN LOW-POWER PENDULUM-TYPE WAVE ENERGY CONVERTERS

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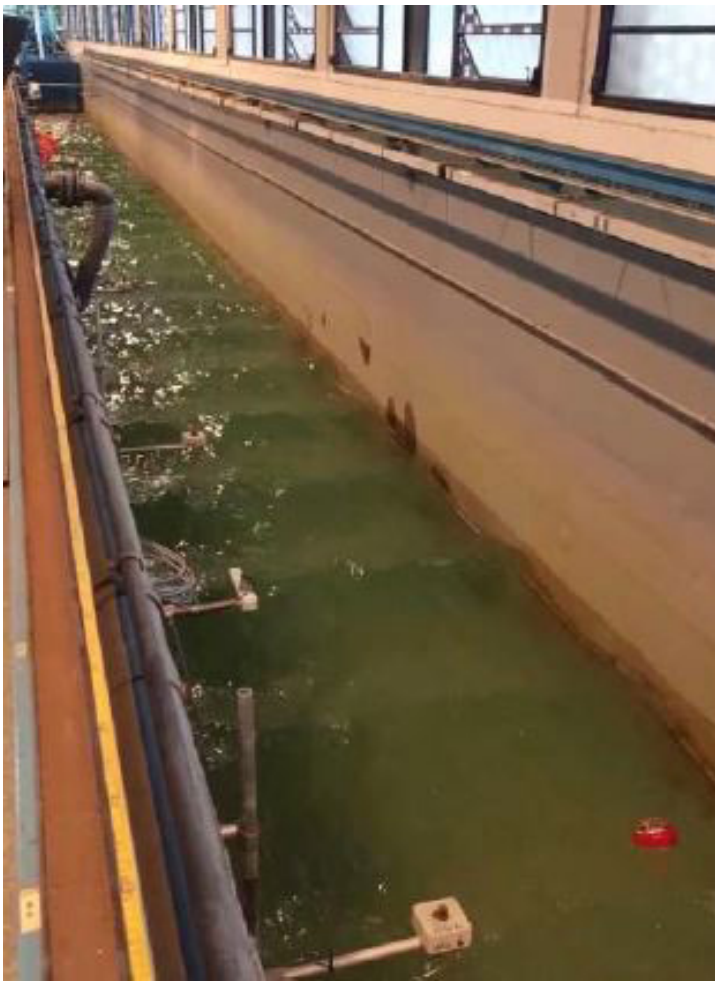
2 e-CAT research group, Electronic Engineering Department, Universitat Politècnica de Catalunya

Keywords
Lagrangian Drifter, Kinetic Energy Harvester (KEH), Power Management Unit (PMU), Maximum Power Point Tracking
(MPPT), Fractional Open Circuit Voltage (FOCV).

ABSTRACT
Lagrangian Drifters are autonomous floating passive devices that provide oceanographic surface data. They are low-cost, low-power and easy-deployable marine instrumentation used in climate research. One of the main challenges of drifters is energy autonomy. Wave Energy Converters (WEC) have proved their viability in high-power electric generation plants to work as Kinetic Energy Harvesters (KEH) [1] and now they are also showing up at smaller power rate applications in order to power devices such as ocean buoys and drifters [2]. In this latter case, a wise and efficient energy management is crucial to maximize the lifespan of the device. To achieve this goal, a Power Management Unit (PMU) is used, which can also include a Maximum Power Point Tracker (MPPT) to extract maximum energy from the KEH device.



At [3], we presented a novel pendulum-type KEH device that transforms the motion of the waves into rotation of a microgenerator to produce electrical energy. A PMU based on a commercial chip (ADP5092, TI) was used after the KEH device. Also, a test drifter was designed to embed the KEH system and perform real sea tests, where information is gathered about the motion of the drifter and the output power provided by the KEH system.

The micro-generator of the KEH device can be modeled by the electrical Thévenin equivalent, where VOC is the open circuit voltage and Vgen the output voltage. As for the MPPT, a dynamic tracking mode was used based on the fractional open circuit voltage (FOCV) technique. In this technique, VOC is periodically sampled and a fraction of it is used to dynamically fix its output voltage (Vgen) at its maximum power point (MPP). According to the Thévenin model of the KEH device, maximum power can be achieved for Vgen = 0.5VOC and this ratio was thus set at the PMU. On the other hand, the MPPT sampling period is preset to 16 s by the PMU chip, which can be too long. If the sampling instant happens when the generator is not spinning, the sampled data of VOC will be null, which will lead to gathering a null power from the KEH device during the next 16 s, until a new sample is collected. This will lower the collected energy. So, here we propose to use another MPPT technique, the constant voltage (CV), which is compared with the FOCV technique. The CV technique is simpler and can also be implemented by the same PMU chip. It consists on fixing a constant voltage for Vgen, which should be selected near the average MPP point expected during the actual deployment.

Tests have been carried out in a controlled environment, the water channel shown in Fig. 1, where wave height and period were set at 30 cm and 1.25 s, respectively. The tests for the two MPTTs were performed consecutively with the same test drifter. Based on previous results [3], the CV was fixed to 0.4 volts. Fig. 2 shows the results using the CV (left) and FOCV (right) MPPT techniques. From top to bottom, the following variables are shown: PMU input voltage (brown) and current (blue), PMU output voltage (purple) and current (green), PMU input (red) and output power (black). Mean power and current values are also shown. In both cases, the PMU samples VOC every 16 s, but then for the CV the input voltage (Vgen) is fixed to 0.4 V, whereas for the FOCV Vgen is placed at 0.5VOC.Output voltage was set in both cases by a Li-ion battery of 2.2 Ah at 4.1 V. On the other hand, during the first 35 seconds (almost two sampling periods), the input voltage was nearly null for the FOCV. The reason for that is that the PMU sampled two consecutive null voltages for VOC (generator not spinning). So, although the generator of the KEH device started to rotate and thus provide current to the PMU, the generator output voltage (Vgen) and thus power (input for the PMU) were null. Even so, in this case, the average power generated by the FOCV was higher than that generated by the CV (264 µW in front of 208 µW), probably due to the alignment of the KEH pendulum with the direction of the waves. Future work can include using different voltages for the CV technique and lowering the sampling period for the FOCV in order to achieve higher energy in both cases.

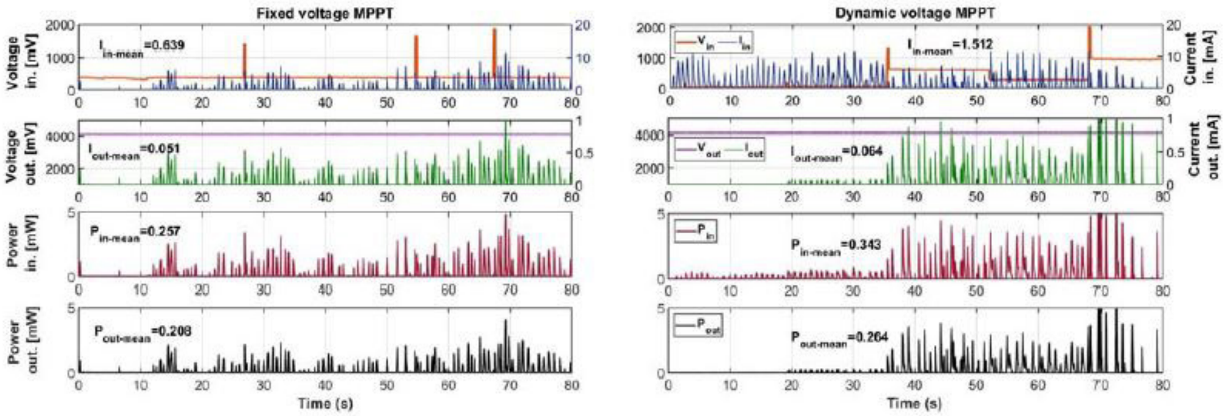


Fig. 2. Power Management Unit (PMU) input and output variables during the channel test of the drifter for the two MPPT techniques: CV (left) and FOCV (right). From top to bottom, PMU input voltage (brown) and current (blue), PMU output voltage (purple) and current (green), PMU input (red) and output power (black). Mean power and current values are also shown.

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REFERENCES
[1] G. Bracco, A. Cagninei, E. Giorcelli, G. Mattiazzo, D. Poggi, and M. Raffero, "Experimental validation of the ISWEC wave to PTO model," Ocean Eng., vol. 120, pp. 40–51, 2016.
[2] Y. Li et al., "Study of an Electromagnetic Ocean Wave Energy Harvester Driven by an Efficient Swing Body Toward the Self-Powered Ocean Buoy Application," IEEE Access, vol. 7, pp. 129758–129769, 2019.
[3] M. Carandell, D. M. Toma, M. Carbonell, J. del Río, and M. Gasulla, "Design and Testing of a Kinetic Energy Harvester Embedded into an Oceanic Drifter," IEEE Sens. J., no. Advanced Interface Circuits for Autonomous Smart Sensors. Accepted, 2019.

ID3- DEVELOPING AN ACOUSTIC TAG WITH BIDIRECTIONAL COMMUNICATIONS CAPABILITIES

I. MASMITJA[1,3], S. GOMARIZ[1], P.J. BOUVET[2], J. AGUZZI[3] AND J. DEL RIO[1]

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Abstract
The study of marine animal behaviour is crucial to manage fisheries stocks and to understand the climate change effect on them, especially their moving patterns. In order to achieve that, different methods have been developed during the last years, specially using acoustic tags. However, all the tags available nowadays are transmitters, and therefore, can only be used as a "listen method". Here, we present a new acoustic tag with bidirectional communications capabilities (i.e. can transmit and also receive acoustic signals). This approach will allow the possibility to use new techniques to study marine animals (e.g. range-only and singe-beacon methods with autonomous vehicles), and therefore, increase the knowledge of their behaviour.

Keywords
Acoustic tag, tagged animals, underwater target localization, autonomous vehicle, acoustics

INTRODUCTION
In this paper, we present a new acoustic tag with bidirectional communications capabilities (i.e. can transmit and also receive acoustic signals). This approach will allow the possibility to use new techniques to study the marine animals and their movement patterns, for example the Range-Only and Singe-Beacon (ROSB) target tracking method with autonomous vehicles. The ROSB method can be used when the range between the target and the tracker is known, as shown in [1]. Those range measurements are usually conducted by acoustic modems which have bidirectional communication capabilities, and therefore, the range can be computed through the Time Of Flight (TOF) of exchanged messages. Nonetheless, the commercially available acoustic modems have important dimensions, and cannot be fitted in small objectives (e.g. marine animals such as jelly fish or Norway lobsters). One alternative to track small targets could be the method developed in [2,3] which uses small acoustic tags instead of modems. However, these tags do not have bidirectional communication capabilities, and therefore, the range between the target and the tracker cannot be measured, and therefore the overall performance is reduced.

FIRST IMPLEMENTATION USING COMPACTRIO
The platform used to design and test the acoustic modem was the CompactRIO (cRIO), which is programmed through the LabView language. The main parts of the cRIO system are: a real-time computer, a Field-Programmable Gate Array (FPGA) module, and a slots' bus to connect either analog or digital modules. Consequently, this versatile platform is useful to implement and test different parts of the designed acoustic modem. In this case, two cRIO model NI cRIO-9024 were used. Both equipped with a Digital-to-Analog Converter (DAC) and Analog-to-Digital Converter (ADC) modules, the NI-9263 and the NI-9215 respectively. These cRIO were controlled with a Personal Computer (PC) and the corresponding LabView software. The signals generated were amplified with a power amplifier and then transmitted using an acoustic transducer into a test tank. Then, the signal received with another transducer was conditioned and processed with a second cRIO.

a) Block Diagram
The main parts of the software developed, which has been used to implement all the aspects of an acoustic communication between two devices, are represented in Fig. 1. In this case, one modem was used as a master and a second modem was used as a slave. The master started the communication sending a waveform signal (TX) through the channel (in this case, the channel could be real or simulated). Then, the signal was received by the slave modem (RX). The signal generated had two main parts: a wake up tone and a chirp signal. The slave modem was waiting for a wake up tone. When this was detected, it started the decoding and correlation procedure. Each time a correlated signal was detected, the slave computed the time between the start acquisition time and the correlated signal detection. Then this time was used to compute a constant time between the slave signal detection and the acknowledgement signal transmitted by the slave. This is an important step, because the master cannot know a priory the time required by the slave to process the signal, and therefore, this time must always be the same. Finally, the master computed the range between both modems using the TOF elapsed.

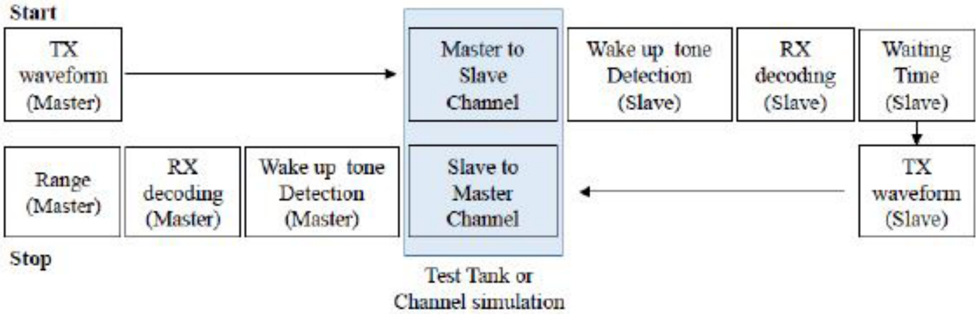

Fig. 1. Bloc diagram of the communication scheme used to measure the slant range between two acoustic devices.

b) Laboratory tests

The experimental results were conducted at Institut Supérieur De L'electronique Et Du Numérique (ISEN) - Brest (France) (isen-brest.fr), using the L@bISEN research laboratory testing facilities. There, they have a water tank for underwater acoustics with all the required acoustic instrumentation. The photographs presented in Fig. 2 show the water tank as a test-tank, the cRIO modules, and all the set used. Moreover, some of the results obtained are also shown, where we can observe the correlation signal between the received and the transmitted signal (left) and the range computed (right). The separation between transducer where 2 m.

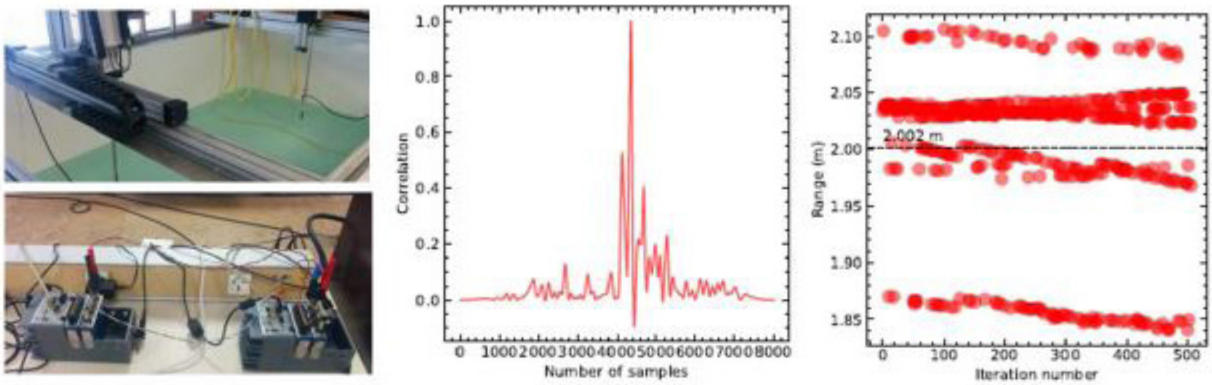

Fig. 2. Images taken during a laboratory experiment (left), correlation between RX and TX signal (center) and the computed slant range (right).

TAG PROTOTYPE SCHEMATIC DESIGN

After the first implementation using the cRIO an initial acoustic tag prototype has been developed. The bloc diagram of the designed schematic is shown in Fig. 3, where the main elements of this design are: a) Piezoelectric driver, using a boosted class D amplifier with bridge-tied load configuration; b) Analog switch, to select between transmission and reception; c) Signal conditioning, using a pre-amplifier, an automatic gain control amplifier, and a band-pass filter; and d) Micro Controller, based on ARM Cortex M4 with sleep mode and wake-up for ultralow power consumption.

PRINTED CIRCUIT BOARD DESIGN

Finally, the Printed Circuit Board (PCB) designed can be observed on Fig. 3. One of the main challenges is to reduce the size and weight of the whole system. Therefore, small packages have been used such as Wafer-Level Packaging (WLP) and 0201 components. With that, the initial acoustic tag PCB size is 21 mm x 8.9 mm (with components in both sides).

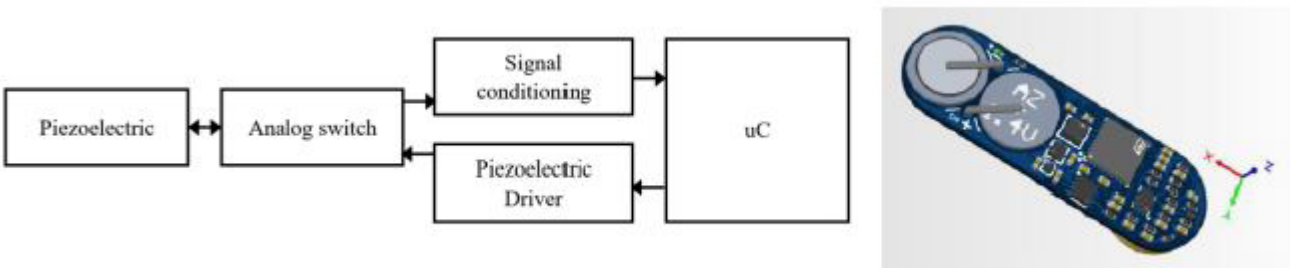

Fig. 3. Bloc diagram of the schematic design (left), and PCB design (right).

CONCLUSIONS

This work describes the first approach to design and build an acoustic tag with bidirectional communications capabilities, where an initial cRIO implementation, laboratory tests and schematic/PCB prototype are presented.

ACKNOWLEDGMENT

This work received financial support from the Spanish Ministerio de Economia y Competitividad (contract TEC2017-87861-R project RESBIO, and RTI2018-095112-B-I00 project SASES), and from the Generalitat de Catalunya "Sistemas de Adquisición Remota de datos y Tratamiento de la Información en el Medio Marino (SARTI-MAR)" 2017 SGR 371. This work has been directed and carried out by members of the Tecnoterra-associated unit of the Scientific Research Council through the Universitat Politècnica de Catalunya, the Jaume Almera Earth Sciences Institute and the Marine Science Institute. IM was funded by a MSCA-IF-GF (ID:893089, H2020-EU.1.3.2, European Commission)

REFERENCES

[1] I. Masmitja et al., "Range-Only Single-Beacon Tracking of Underwater Targets From an Autonomous Vehicle: From Theory to Practice," in IEEE Access, 2019.
[2] I. Masmitja et al., "Area-only method for underwater object tracking using autonomous vehicles," OCEANS 2019 - Marseille, Marseille, France, 2019, pp. 1-10.
[3] I. Masmitja et al., "Mobile robotic platforms for the acoustic tracking of deep-sea demersal fishery resources," Sci. Robot., vol. 5, no. eabc3701, 2020.

ID4- AN INTEGRATED BIOGEOCHEMISTRY OBSERVATION SYSTEM AT BESÒS ESTUARY

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Keywords
Biogeochemistry, observation platforms, Sensor Web Enablement, Sensor Observation Service

ABSTRACT
Estuaries are coastal indentations where freshwater mixes with seawater (Pritchard 1967), and are found everywhere in the world. Moreover, the estuarine ecosystems are usually characterized by high biological productivity and great biodiversity. However, these characteristics are very sensitive to the climate regime, the geological environment and the hydrological quality. In metropolitan environments with high social, urban and economic complexity, river flows usually play an important role in the regulation of estuary biochemistry, and therefore their control is essential.

Such estuary, is the one generated by the Besós river, located in the north of Barcelona, where the management of the water cycle of its riverbed and its mouth is a shared strategy for the development of the territory between the municipality of Sant Adriá del Besòs, the town hall of Badalona, the Consorci del Besòs, the Polytechnic University of Catalonia and the b_TEC Foundation. These institutions share the Territorial Specialization and Territorial Competitiveness Project (PECT) of the Besòs Sustainable Territory coast, where one of its objectives is the improvement and use of water and coastal resources in the Besòs environment. In this framework, it is intended to reduce the impact of heavy rain scenarios and frequent sewer overflows, which involve poor water quality scenarios on the beaches near the river mouth, through the use of surplus groundwater to improve the water quality of the riverbed, instead of being sent to the sewer.

To evaluate the degree of improvement provided by this solution, in the Besòs estuary it has been deployed and installed a new integrated biogeochemistry observatory that includes (a) a costal buoy with a multi-sensor system and (b) a riverbed platform with a multi-sensor system as shown in Figure 1, that provide long series of real-time data.

Description of costal buoy monitoring platform (a)
This monitoring platform uses a surface buoy located at 544 m in from the mouth of the Besòs river (41º24'59.87 "N; 2º14'20.25" E). The buoy is moored at a depth of 13 m using a galvanised chain and two deadweights. The buoy has solar panels and batteries needed to power the submerged measurement instruments and the acquisition and communication system, located on surface. The surface system is composed by a router with wireless communications (GSM), weather station and control electronics in charge of the data acquisition of the instruments. The installed instruments are a B&C Electronics multiparameter probe and a Turner Designs C3 fluorometer. Since November 2019, the costal buoy is providing in real-time biogeochemical data such as dissolved oxygen, pH, concentration of coloured dissolved organic matter (CDOM), turbidity (NTU), oxidation reduction potential, refined oil and fluorescein. Moreover, the buoy provides physical parameters such as sea water conductivity, temperature and pressure. All these parameters are acquired for approximately 10 minutes with a rate between 1 hour to 3 hours.

Description of riverbed monitoring platform (b)
To deploy the measuring probe of different biogeochemical parameters for the evaluation of Besòs riverbed water, a manhole has been placed next to the inflatable dam on Avenida de la Catalana 171 in Sant Adrià de Besòs, and closed with a metal lid to protect against vandalism. The manhole and the river are connected with a PVC tube, through which the water from the river circulates to the measuring probe and returns to the riverbed.

Inside the manhole is the hydraulic system, with a water pump responsible for providing the river water samples to the probe, the multiparametric probe and the acquisition and communication system. The multiparameter probe is the same as the the probe installed in the costal buoy (a) and provides biogeochemical observations such as dissolved oxygen, pH, tur-

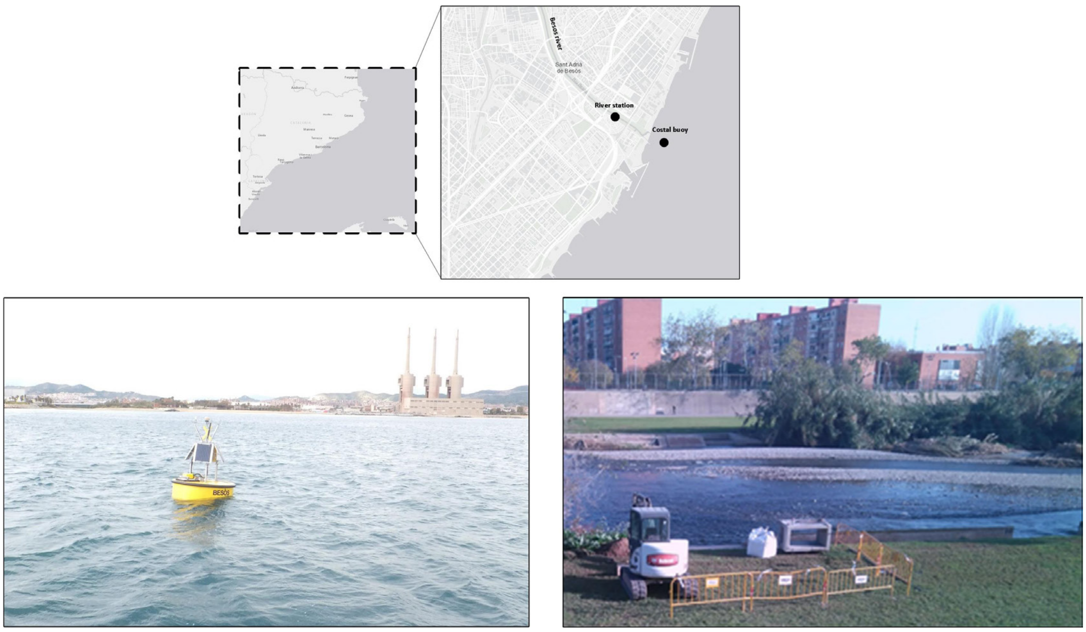

Figure 1 Map of study area with 2 stations in the Besòs river and Catalan coast. Costal buoy deployed in front of the Besòs river mouth. Riverbed station.

bidity (NTU) and oxidation reduction potential and physical parameters such as temperature and conductivity. These parameters are acquired for approximately 10 minutes every 3 hours.

The data acquisition system of the two platforms is based on a generic software for sensor web enablement following the OGC standards. Through the SWE Bridge generic software (Martínez et al., 2017), the data is directly inserted into a centralised SOS (Sensor Observation Service) server (Bröring et al., 2012; 52 North SOS 2.0 implementation) and into a laboratory monitor system (Zabbix LabMonitor) for recording events and alarms. Based on the SensorML description of each instrument, the generic software for sensor web enablement can automatically connect to a real-time data stream, parse the data stream and generate transaction compliant with Observation & Measurement standard 2.0 which are directly injected in the OGC SOS server (https://obsea.es/data/pect.php).

AKNOWLEDGEMENT
This work was supported by the project Projecte d'Especialització i Competitivitat Territorial (PECT) Litoral Besòs Territori Sostenible. Operació Recerca per la sostenibilitat. Actuació Sensòrica. Monitorització de la qualitat de l'aigua del riu Besòs. 001-P-0008 04. This work used the EGI infrastructure with the dedicated support of INFN-CATANIA-STACK.

REFERENCES

[1] Pritchard, D. W. 1967. What is an estuary: Physical viewpoint, p. 52– 63. In G. H. Lauff [ed.], Estuaries. American Association for the Advancement of Science.
[2] Bröring A., Stasch C., Echterhoff J., 2012. "OGC® Sensor Observation Service Interface Standard", http://www.opengis.net/doc/IS/SOS/2.0, 2012-04-20
[3] 52 North SOS 2.0 implementation, http://52north.org/communities/sensorweb/sos/
[4] Martínez, E.; Toma, D.M.; Jirka, S.; Del Río, J. Middleware for Plug and Play Integration of Heterogeneous Sensor Resources into the Sensor Web. Sensors 2017, 17, 2923

ID5- MAGALLANES PROJECT: TESTING THE MARINE TIDAL CURRENT PLATFORM IN THE "RÍA OF VIGO"

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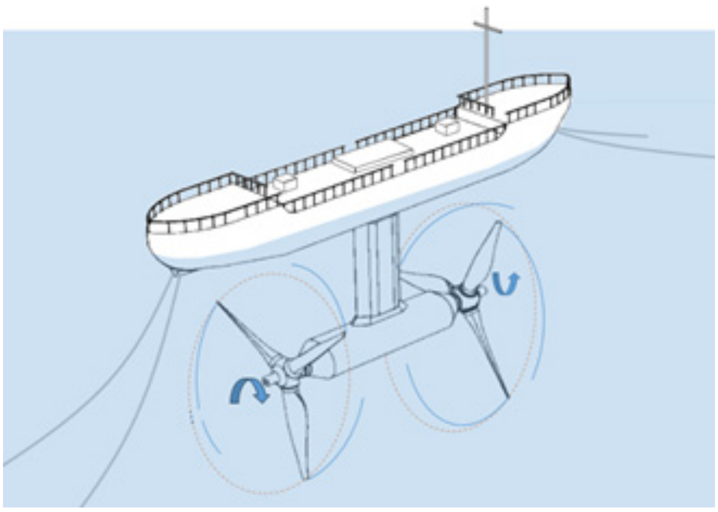
Abstract
In this study, the behavior of a platform for tidal energy is analyzed. The turbine of this platform is formed by two counter-rotating rotors aligned with the tidal current, such that one rotor is always under the wake of the upstream rotor.
The platform has been tested by towing it with a tugboat to emulate tidal currents. The results of these tests are analyzed in this paper in order to estimate the generation capabilities of the platform.

Keywords
Marine current turbine, tidal energy, counter-rotating rotors, towing test.

INTRODUCTION
The floating system called ATIR, developed by Magallanes Renovables, is based on a platform that incorporates a submerged part where rotors are installed [1][2]. The ATIR platform has a horizontal axis tidal current turbine, which appears to be the most mature technology in tidal energy systems [3][4]. The main element of the platform is the turbine, which is formed by two counter-rotating rotors aligned with the tidal current (from bow to stern or backwards), as shown in Fig. 1. The blades have pitch variation capability that allows to them to change their rotation direction, such that it can harvest energy from the two tide directions without moving the platform.

The main focus of this study is on modeling the turbine formed by two counter-rotating rotors by using data collected during tests that took place at the Ria de Vigo (Spain). To emulate tidal currents, the platform was towed by means of a tugboat.



FLOATING TIDAL ENERGY PLATFORM
The tidal energy platform, developed by Magallanes Renovables (Spain) and called ATIR, consists of a floating platform joined to a marine current turbine (MCT) with a double rotor. During the tests, it was not possible to establish a connection to the power network. Therefore, the network was emulated by means of an autotransformer (400 kVA; 690 V/400 V), a diesel generator (350 kW), and a bank of dump load resistors (600 kW).

TEST RESULTS
In this work, the results of the tests in which the tidal current was emulated by towing the platform with a tugboat are analyzed. The tests were conducted in the Ria of Vigo (Northwest of Spain) where the seabed is at a depth of approximately 40 m, and was thus not expected to interfere with the platform behavior.

The performance of the rotor in terms of the maximum torque, maximum power, or minimum thrust is more easily analyzed in terms of the power, torque, and thrust coefficients. Therefore, these coefficients were used to analyze the rotor behavior.

The measurement data from the tests were used to obtain values for these coefficients. However, most of the measurements were conducted in the power converter and in the high-speed shaft. As a consequence, to estimate the rotor behavior, it is necessary to consider the performance in terms of the losses in the generators, gearboxes, and AC/AC converters [5]. From the power values in rotor and generator and the measurements in marine current, the power coefficient in the rotor (cp) and the generator (cpg) can be obtained using the following equation:

$$c_p = \frac{c_{pg}}{\eta_{gb}\eta_g}$$

where P is power in the rotor, Pg is the power in the generator, ηgb is the gearbox performance, and ηg is the generator performance.

The power coefficient values obtained using the measurements are shown in Fig. 2. It should be noted that the tests were conducted at a power lower than the 50% of platform rated power, and accordingly, the rotor speed was also lower 50% of the rated speed. In this situation, the performance values of the generator and gearbox are approximately equal to 70% and 90%, respectively. The estimated maximum value for the power coefficient at the generator side was approximately 0.5.

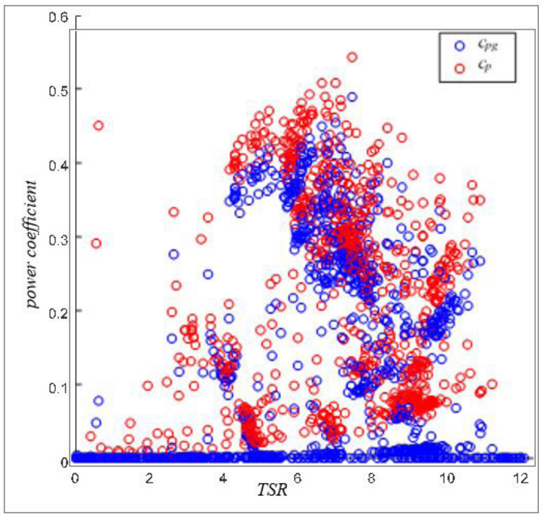


Fig. 2. Power coefficient at rotor side (c_p) and at generator side (c_{pg})

REFERENCES

[1] Magallanes, "The Magallanes Project," 2019. [Online]. Available: http://www.magallanesrenovables.com. [Accessed: 18-Sep-2019].

[2] Magallanes Renovables, "Magallanes Renovables," 2019. [Online]. Available: http://www.magallanesrenovables.com. [Accessed: 07-Jul-2019].

[3] K. W. Ng, W. H. Lam, and K. C. Ng, "2002-2012: 10 Years of Research Progress in Horizontal-Axis Marine Current Turbines," Energies, vol. 6, no. 3, pp. 1497–1526, 2013.

[4] W. Li, H. Zhou, H. Liu, Y. Lin, and Q. Xu, "Review on the blade design technologies of tidal current turbine," Renew. Sustain. Energy Rev., vol. 63, pp. 414–422, 2016.

[5] Y. Li, H. Liu, Y. Lin, W. Li, and Y. Gu, "Design and test of a 600-kW horizontal-axis tidal current turbine," Energy, vol. 182, pp. 177–186, 2019.

ID6- TELE-OPERATED ECOLOGICAL MONITORING AT THE SEAFLOOR OBSERVATORY (OBSEA)

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Keywords
Autonomous Underwater Vehicle (AUV), OBSEA, Internet Operated Vehicle (IOV), Ecological Monitoring

ABSTRACT
The development of new cabled oceanographic observatories is becoming of extreme importance to monitor in real-time a continuously changing environment. In this context, a local coastal network of fixed and mobile video-monitoring platforms was created at the OBSEA (www.obsea.es; [1]) as European Multidisciplinary Seafloor and water column Observatory EMSO Testing-Site [2]. The cabled platform is located 4 km offshore of Vilanova i la Geltrú coast (Barcelona, Spain), at a depth of 20 m. The observatory has been used to install a network of cameras including OBSEA fixed camera, plus a movable satellite tripod. Also, a mobile camera will be installed on an Internet Operated Vehicle (IOV), as a coastal crawler. These tele-operated vehicles are being used by marine scientists, to carry out multiparametric environmental studies (via the diversified set of oceanographic and geochemical sensors) centered on faunal monitoring via imaging. As far as cabled seafloor observatories (and also OBSEA) are not able to move and their data collection capability is limited, it was decided to expand the monitoring capacity of the OBSEA, by connecting it to a new costal crawler. This crawler is a modified prototype of the "Wally" platform series, which is operating at the Ocean Networks Canada (ONC; www.oceannetworks.ca) since 2010 [3]. This coastal crawler will be used to perform back and forth video transects between the fixed OBSEA camera and its satellite tripod camera (80 m away), to analyze the possible effect of environmental heterogeneity on the perceived fish community abundance and composition. This will also allow scaling the biodiversity gathered data over a larger and more ecologically-representative area. In this scenario, we aim to present the technological design and specifications of the modified coastal crawler (Fig. 1). A mobile camera (1) in a glass sphere (rated for 3000 m depth) with 360° pan and 180° tilt operability has been installed, to allow the operator to perform SCUBA divers as visual census transects, by looking forward during transect progression, widening the visual field with panoramic sweeps when needed. The tracks (2) are independent parts allowing to scale the inner part of the vehicle simply by mounting a broader main plait. The chains are made of rubber with embedded steel. Each track is driven by a powerful DC motor with a reduction gear of 989:1. The motor housings are pressure compensated by fluid filling. The junction cylinder (3) contents the driving electronics and an Ethernet switch to connect the camera and the control cylinder to the main communication cable. This housing can variate in material and dimensions to allow its use at different depths. The main cable (4) is a of special underwater Ethernet floating type to avoid problems like seabed abrasion and platform entanglement. A control cylinder (5) is used for controlling the crawler and the camera, providing power from the junction cylinder to supply motors. Finally, there are two 12V, 3W lights (6) that can turn on for filming at night.

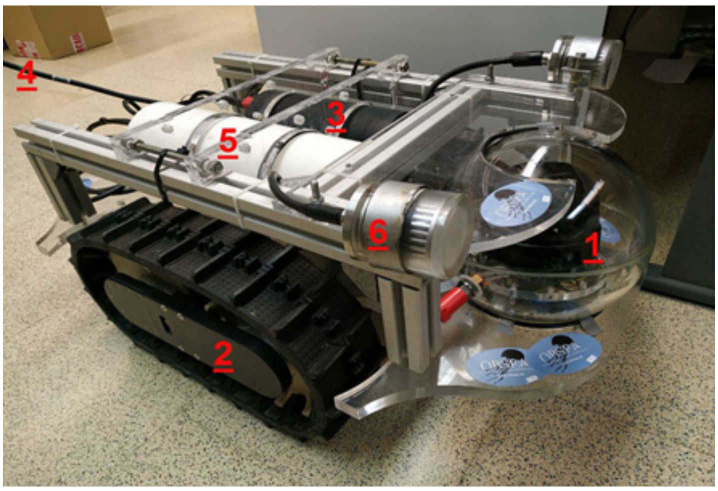

Fig. 1: The crawler with the components numerically listened, as described by ordinal number in the text.

Acknowledgements
This work is partially funded by Generalitat de Catalunya "Sistemas de Adquisición Remota de datos y Tratamiento de la Información en el Medio Marino" (SARTI-MAR)" 2017 SGR 371 and by the Spanish Ministry of Education and Science (MEC) with the project "Redes de sensores submarinos autónomos y cableados aplicados a la monitorización remota de indicadores biológicos" TEC2017-87861-R. Researchers want to acknowledge the support of the Associated Unit Tecnoterra composed by members of Universidad Politécnica de Cataluña (UPC) and the Consejo Superior de Investigaciones Científicas (CSIC). This work used the EGI infrastructure with the dedicated support of INFN-CATANIA-STACK. The crawler was provided by OceanLab of Jacobs University Bremen (L. Thomsen).

References
[1] J. Aguzzi et al., "The new seafloor observatory (OBSEA) for remote and long-term coastal ecosystem monitoring," Sensors, vol. 11, no. 6, pp. 5850–5872, 2011.
[2] P. Favali and L. Beranzoli, "EMSO: European multidisciplinary seafloor observatory," Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip., vol. 602, no. 1, pp. 21–27, 2009.
[3] A. Purser et al., "Temporal and spatial benthic data collection via an internet operated Deep Sea Crawler," Methods Oceanogr., vol. 5, pp. 1–18, 2013.

ID7- GEOPHYSICAL AND GEOTECHNICAL SITE CHARACTERISATION FOR SUSTAINABLE MARITIME DREDGING PROJECTS. THE EXAMPLE OF PORT OF LANGOSTEIRA (A CORUÑA, SPAIN)

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Abstract
The knowledge of the marine subsoil is a fundamental fact for the correct development of a modern and sustainable dredging project. An accurate definition of all geological deposits and their dredgeability is directly related to a realistic cost estimation and to the employment of the most efficient equipment. In this sense the combination of geophysical and geotechnical techniques allows optimizing marine investigation surveys and obtaining more precise subsoil models in terms of morphology and dredgeability properties of the different units involved. The experience in this kind of projects in different sea conditions and a widely range of soil/rock has allowed defining the most appropriate research techniques as well as the suitable equipment and the necessary type of vessel. This paper also presents some brief results of a geophysical and geotechnical marine investigation carried out in the Port of Langosteira (A Coruña, Spain) for dredging works in a rocky seabed.

Keywords
Marine geophysics, marine geotechnics, sustainable dredging, seafloor characterization

INTRODUCTION
The correct description of soil and/or rock material is one of the most important elements for the planning of maritime dredging operations, as the material to be dredged determines the selection of dredging equipment and drives the productivity computations [1]. In addition to this, there are several parameters than are also relevant in main processes related to a dredging project: excavation, transport, unloading and potential re-use of the dredged material. Thus, the more suitable and reliable available information of the soil and rock, the more specific and sustainable the dredging project will be.
The combination of geophysical and geotechnical research techniques for maritime investigations allow obtaining an accurate subsoil model. Nevertheless, the use and adaptation of these techniques for the high technical and QHSE requirements of dredging projects is not a short term task. Not only the work methodologies have to be mastered, but also the personnel must be highly qualified. Therefore, it takes time to achieve enough level to carry out highly demanded marine geophysical and geotechnical surveys for dredging projects in often complex working areas.

GEOPHYSICAL AND GEOTECHNICAL TECHNIQUES
There are numerous methodologies that allow obtaining direct and indirect information about soil/rock dredgeability, its behaviour during transport and the suitability for its re-use. The most common investigation techniques are listed below. It must be pointed out that the applicability of each of these techniques has to be evaluated for any particular project.

Geophysical techniques
Marine geophysics allows covering large areas with fairly light equipment and vessel. Therefore, it provides a large amount of subsoil information in a short period of time and at a very competitive cost. In order to obtain high-quality data that reaches the target depth for each project, a proper selection of the suitable techniques is a key factor. Here below some common techniques that can be used for marine dredging projects:

• Seabed investigation: Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS) and magnetometry.
• Sub-surface investigations: Sub-Bottom Profiler (SBP), seismic reflexion and seismic refraction.

Geotechnical techniques
Marine geotechnical studies allow obtaining subsoil models based on morphology and in-situ physical and mechanical properties of the successive layers below the seabed. Sampling for a further laboratory tests campaign is also a key objective. Moreover, they are also an useful tool for calibrating the geophysical models previously performed. The selection of the most suitable equipment is directly related to the type of project and the expected soil and/or rock to be investigated. Here below some of the most commonly used for maritime dredging projects:

• In-situ tests: Cone Penetration Tests with pore water measurements (CPTU).
• Sampling: Grab samples, Vibrocoring for soils and submarine drilling rigs for rocky seabed.

MARINE SOIL INVESTIGATION IN THE PORT OF LANGOSTEIRA
A geophysical and geotechnical site characterisation was carried out in the Port of Langosteira (Northwest of Spain) with the aim to provide precise subsoil information for the development of a dredging project for the deepening the access channel. Two main areas were investigated: (i) exterior of the port with water depths ranging between 22 and 26 m and (ii) interior with water depths between 11 and 15 m. The marine geophysical survey provided a first qualitative model of the entire project site. It consisted on:

• MBES in the channel access area.
• Seismic reflexion and refraction survey with a streamer fit out with 24 hydrophones and a Sboom as an energy source.

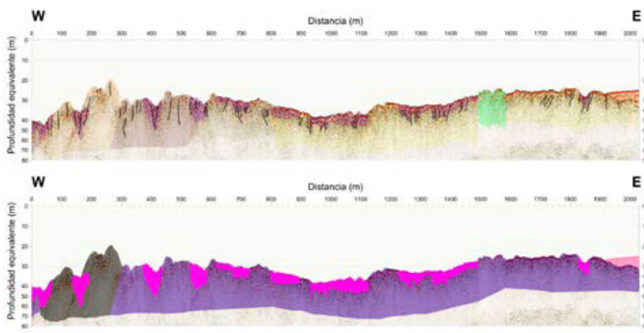

Fig 1. Seismic profile with geological interpretation (up) and with levels based on dredgeability based on [1] (down)

The marine geotechnical survey provided accurate information of the selected investigation points which was then used for the calibration of the preliminary model, based on geophysical results. It consisted on:

• 13 rotary boreholes with a remotely operated submarine drilling rig. The maximum achieved depth was 2.7 m.
• Laboratory tests on rocky samples recovered during field works: UCS, vp determination, Young and Poisson Modulus and Cerchar abrasiveness, among others.

Fig 2. Remotely operated submarine drilling rig used for rotary boreholes

The combination of all these techniques and data sources allowed defining a 3D geological model as well as the main mechanical and classification properties of involved levels and their dredgeability, based on referenced documents such as [1].

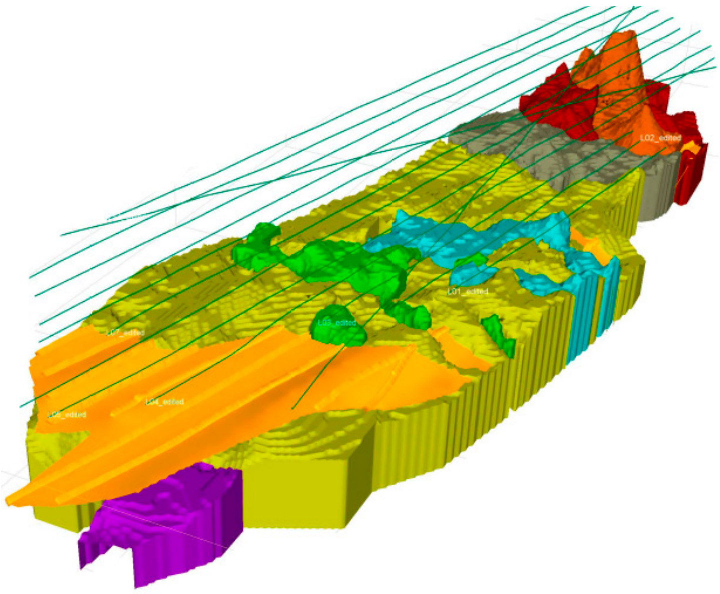

Fig 3. 3D model with different rock units based on its dredgeability

CONCLUSIONS

An accurate subsoil model is a key factor for developing a proper and sustainable maritime dredging project. The selection of the suitable dredging equipment and the productivity computations are directly related to the ground conditions. In this sense, the combination of marine geophysical and geotechnical techniques is a suitable methodology when a soil and/or rock investigation is required. These different data sources allows not only optimizing marine investigations surveys but also obtaining precise subsoil models in terms of morphology, mechanical properties and dredgeability.

ACKNOWLEDGEMENTS

Authors wishes to thank DRAVOSA for their support on this project and on the redaction of this paper.

REFERENCES

[1] PIANC, Classification of soils and rocks for the maritime dredging process, PIANC Report nº144, 2016.

ID8- A DECADE OF TIME SERIES AS PRODUCED BY MULTIPARAMETRIC ECOLOGICAL MONITORING AT THE OBSEA

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Keywords
Rhythmic behaviour, environmental cycles, cabled seafloor observatories, climate change, biodiversity indicators, environmental drivers, fish community.

ABSTRACT
All biological processes, from molecular to physiology and behavioural, are essential for organisms to regulate their survival in response to the environment (e.g., irradiance and temperature) and to intra- or inter- specific interactions (e.g. predation and competition). In the marine environment, there is a strong correlation between biological rhythms and light cycles, which varies upon the depth, with the relevance of other factors, such as current speed, still far from fully understood. Rhythmic behavioural regulation results in the massive displacement of organisms at different depths over diel and seasonal scales, and this may result even in bathymetric or geographic distribution shifts over the years, as a result of coping with climate change conditioning. Even if the timing of biological processes is essential for all organisms, those processes are seldom studied in the marine environments, compared to the terrestrial ones. Today, the collection of data from cabled seafloor video-observatories equipped with mobile video-platforms (e.g. crawlers) is becoming feasible. Cabled observatories enable researchers to collect environmental and biological data in a concomitant fashion, and when monitoring networks of platforms are deployed, more spatially representative long-term studies on the biases that behavioural rhythms (i.e. massive population displacements) exert on population size and biodiversity assessments are accessible. In this framework, a local coastal network of fixed and mobile video-monitoring platforms was created at the OBSEA (www.obsea.es), located at 4 km off of Vilanova i la Geltrú (Barcelona, Spain), at a depth of 20 m. The OBSEA is a cabled observatory bearing two fixed cameras (i.e. the platform one includes camera 1 and a second camera, camera 2, as a movable tripod), focusing two different artificial reefs. The concomitant time-lapse imaging by different cameras and environmental multiparametric data acquisition would allow the analysis of different biodiversity indicators such as the composition of communities (i.e. richness) and relative abundance of species (i.e. evenness), as well as ecosystem functions (e.g. food-web structure, carbon and energy fluxes etc.), at different time scales, together with inference of potential cause-and-effects principles between environmental drivers and biological variables. Here, we aim to fully present the multidisciplinary data set acquired since January 2012, at a high-frequency (30 min), continuously during the day and the night, reporting count fluctuations in 27 bony fish species. Every photo captured each 30 min from the two installed cameras was analyzed manually by trained operators. All photos had a stamped time code to match each detected faunal entry (classified by trained operators) to the concomitant environmental data acquired by different sensors. A CTD and an ADPC provided data on temperature and salinity as well as pressure and water current speed and direction, respectively. Those data were associated to turbidity and chlorophyll data. Furthermore, we used automatically recorded meteorology entries by a Catalan Meteorological Service station in Sant Pere de Ribes (6 km from the OBSEA), to derive data on the global sun irradiance, wind speed and direction, as well as rain. Difficulties in data acquisition due to sensors maintenance are described along with potential examples of data treatment, in spite of the marked diel and seasonal variations in total fish-community counts as a product of behavioural rhythms (Fig. 1). This tendency is maintained throughout the seasons with the amplitude of the total fish counts curve following the variation in the photophase length amplitude, described through the sun irradiance (Figure 2). The comparison between the total number of fishes and the irradiance shows a consistent increase in individual counts during the day for the large majority of species. Then, the polynomial curve analysis derived from the raw total count data was introduced, to further highlight that diurnal tendency. Even so, this curve shows two up-turning tails during night time due to the presence of few active nocturnal species in the area. Furthermore, we observed that the faunal abundance curve width is larger than the irradiance curve. This could be explained by the presence of crepuscular species that avoid fully diurnal visual predators, by anticipating or dealing the timing of their activity according to a trade-off between energy gaining and mortality risks. We also introduced a diel threshold, the Midline Estimated Statistic of Rhythm (MESOR) to evidence peaks limits in terms of the onset and offset timings of significant count increases within the fish community. This has been calculated by re-averaging all the time series mean values. All the analyses were carried out with custom algorithms developed in Python.

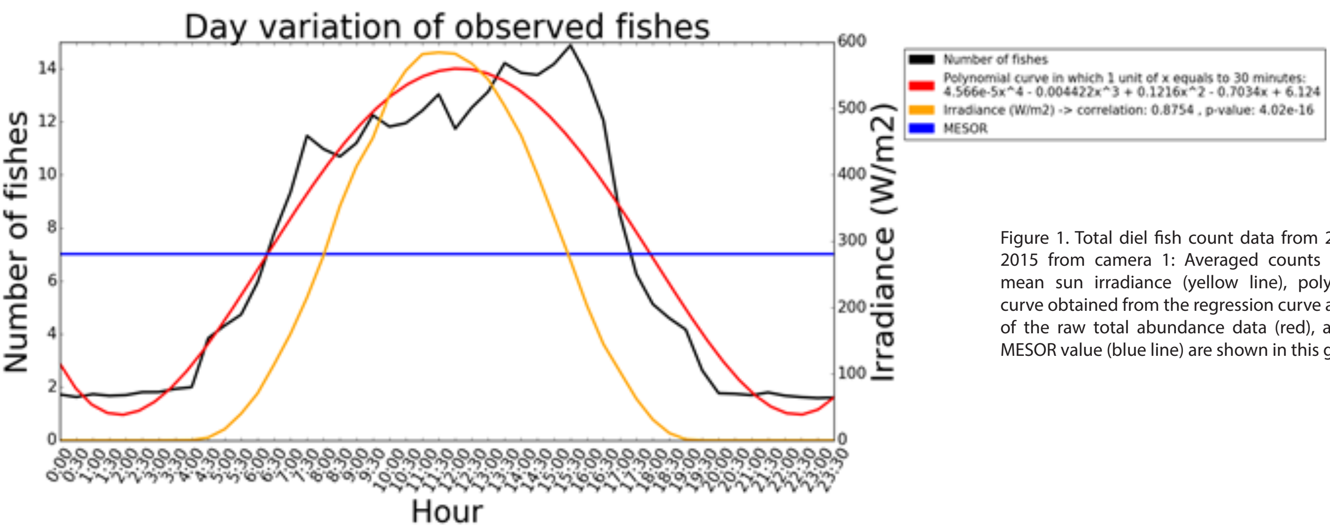

Figure 1. Total diel fish count data from 2012 to 2015 from camera 1: Averaged counts (black), mean sun irradiance (yellow line), polynomial curve obtained from the regression curve analysis of the raw total abundance data (red), and the MESOR value (blue line) are shown in this graph.

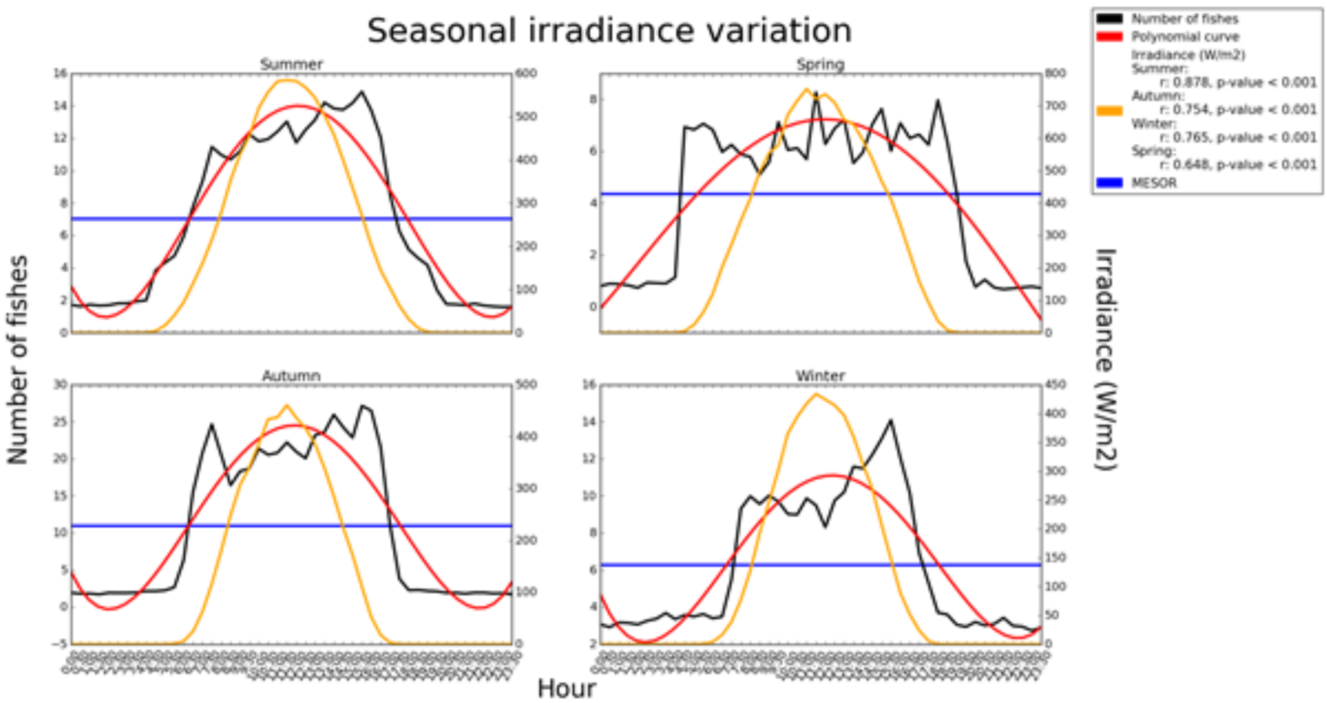

Figure 2. Total diel fish count for each seasons, using the same data from 2012 to 2015 as in Figure 1: Average counts (black), mean sun irradiance (yellow), polynomial curve obtained from the regression analysis of the raw total abundance data (red) and the MESOR value (blue). Summer placed at the top-left, spring at the top-right, autumn at the bottom-left, and winter at the bottom-right.

AKNOWLEDGEMENTS

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ID9- VESSEL REQUIREMENT FOR AN OFFSHORE PROJECT

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Choosing a suitable vessel for an offshore project can lead to significant savings in both cost and time.
There are many factors that influence the choice of the vessel to be used for the development of a project, among which are:
- Type of vessel; multipurpose, multicat, tugboat, jack-up.
- Mobilization cost and daily rate of the vessel.
- The type of positioning of the vessel, either dynamic or through the use of anchors.
- Operational limits; wind, wave and tide.
- Availability of the vessel for the required dates.
- Available deck space for the equipment.
- Adequate lifting equipment for the work. It will be necessary to consider if the ship has a crane, winch or A-frame and the capacities of elevation, height and length of the cables.
- The draught of the vessel especially for shallow waters projects.

Fig 1. Vessel Mintis
- Accommodation capacity.
- Autonomy.

Igeotest is a company specialized in the study of the ground and subsoil with a professional career of more than 20 years. During the last years, our activity has been focused on the realization of offshore projects among which we can highlight the sectors of oil and gas, renewable energies, maritime infrastructures, ports and coastal developments, dredging, cables and piping.
The aim is to analyse and provide a vision based on the experience acquired during the offshore projects carried out by Igeotest, developing the criteria used to choose the type of vessel that is most suitable for the execution of a project, whether by means of vessels or jack-up.
The different scenarios to face a project with a vessel will be contemplated and analysed how the choice of the right vessel can condition the success or failure of a project.

Fig 1. Vessel Mintis

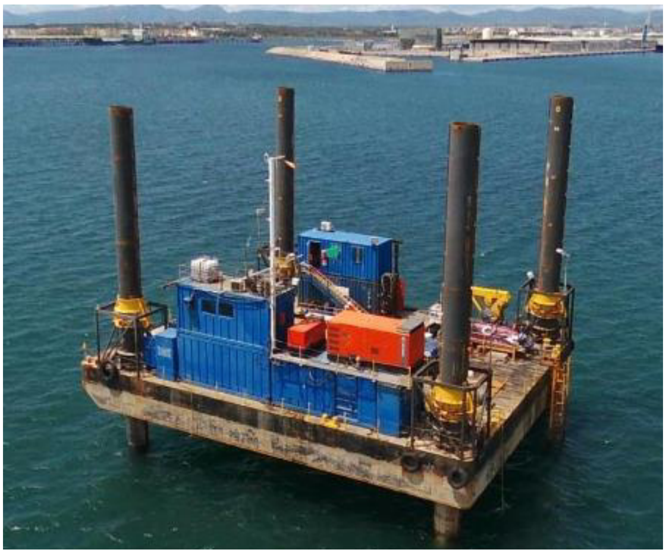

Fig 2. Jack-up IG-IV

ID9- AN INTEROPERABLE ARCHITECTURE FOR IN SITU OCEAN NOISE MONITORING

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Abstract
Anthropogenic noise in the oceans has been significantly raising in the past decades due to an increment of human activities, adversely affecting the marine habitat. In order to assess and limit this impact, the long-term monitoring of underwater noise is crucial. Currently, real-time ocean sound data is mainly obtained using cabled observatories, where communications and power are not a constraint. The temporal and spatial coverage of in-situ measurements would be greatly improved if other observation systems such as gliders, moored buoys and profilers could provide real-time ocean sound data. However, these platforms have some intrinsic constraints such as telemetry, computational capacity and power availability. In order to overcome these limitations, an in situ ocean sound monitoring tool is proposed. This tool aims to provide a standardized and homogeneous framework for ocean sound monitoring, compliant with the MSFD directive, capable of interfacing any off-the-shelf hydrophone and deployable from almost any observation platform regardless of its underlying architecture.

Keywords
Ocean Sound, Underwater Noise, MSFD, OGC Standards, SensorML, Interoperabiility, Real-time systems

INTRODUCTION
There has always been underwater background sound in the oceans due to natural factors. However, human activities such as shipping, construction, sonar and seismic exploration have been raising the sound level to unprecedented levels in the past decades [1] . Underwater ambient sound is an important environmental factor for many species, especially to those using underwater sounds for localization and communication (e.g. marine mammals) [2] . Thus, the introduction of energy into the marine habitat in the form of acoustic noise needs to be properly monitored and studied to minimize its harmful impact on the marine ecosystem.

In order to achieve a good environmental status, the European Union developed the Marine Strategy Framework Directive (MSFD) which aims to protect the marine environment and its ecosystem. This directive includes a set of indicators to measure the status of European waters, including maximum underwater sound levels considered as acceptable (MSFD indicator 11.2.1). This indicator requires the long-term measurement of Sound Pressure Level (SPL) at 63 Hz and 125 Hz 1/3 octave bands. However, it has been suggested to extend the monitored bands from 10 Hz to 20 kHz in order to achieve a more accurate assessment of ocean sound [3] .

Currently commercial off-the-shelf hydrophones do not provide SPL measurements, so acoustic data has to be post-processed at shore stations. Due to the high sampling rate used by hydrophones (usually from tens to hundreds of kHz), streaming raw acoustic data from the observation platform to shore stations is only possible with broad-band Ethernet connection, i.e. in underwater cabled observatories. Other platforms such as unmanned vehicles, moored buoys and profilers do not have the bandwidth to transmit acoustic data in real-time. Furthermore, telemetry is usually one of the more power-demanding components of an autonomous system, thus reducing the data transmission (and its associated power consumption) is vital to extend their autonomy.

However, if the acquired data could be processed in-situ, the amount of information to be transmitted will decrease by several orders of magnitude. This would allow the measurement of ocean sound in real-time from autonomous platforms, greatly improving the temporal and spatial coverage. Nevertheless, processing acoustic data in real-time is not a trivial task due to the required computational resources (specially in constrained platforms relying on microcontrollers). Although some hydrophone prototypes capable of calculating SPL levels have been presented, they have not been widely used yet [4] .

Commercial off-the-shelf hydrophones (as the vast majority of marine sensors) use vendor-specific proprietary protocols, so its integration into existing monitoring systems is a time-consuming task. Manufacturers usually provide dedicated software tools to setup the configuration and acquire acoustic data, but they are mainly developed for desktop environments, making them unsuitable to be deployed in autonomous observation platforms. In other words, when deploying off-the-shelf hydrophones to observation platforms ad-hoc software tools need to be developed to acquire, store and process acoustic data.

IN SITU OCEAN SOUND MONITORING SYSTEM
In order to overcome the presented difficulties, an in situ interoperable ocean sound monitoring software tool is proposed, based on the SWE Bridge universal driver [5] . The SWE Bridge is a cross-platform software package with a dual role: provide a syntactic interoperability layer to abstract hydrophone characteristics and to implement a computationally efficient ocean sound algorithm for on-board processing, compliant with the MSFD requirements [6] .

The syntactic interoperability service uses the SensorML standard to provide an unambiguous and semantically robust hydrophone descriptions, including metadata such as sensitivity, sampling rate, communication protocol and more [7] . Based in this SensorML description, the SWE Bridge is able to interface the instrument without any a priori information of the sensor. It also implements optimized real-time ocean sound algorithm, compliant with the requirements of the MSFD technical subgroup on Underwater Noise [3] . Raw acoustic data is stored locally for validation and further analysis after the platform recovery. Its cross-platform and optimized nature make it suitable to be deployed in any kind of resource-constrained observation platform such as underwater gliders, profilers and mooring stations.

Furthermore, it also provides a semantically-enriched output, following Observations and Measurements standard [8] . This data and its associated metadata can be directly integrated in spatial data services such as the Sensor Observation Service (SOS) [9] . Spatial Data Infrastructures such as EMODnet can then gather, archive and process the published data. An example of the proposed system deployed in an underwater glider is depicted in figure 1. The raw acoustic data in wav format is also stored onboard for validation and further processing.

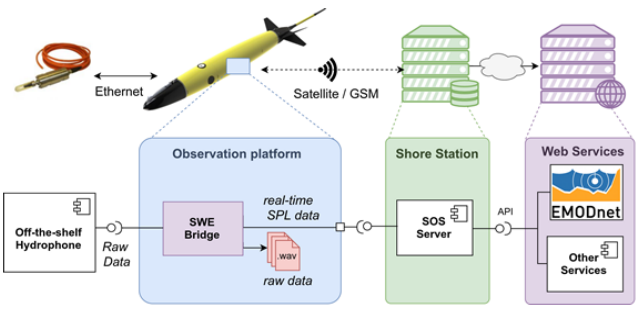

Fig 1. Ocean sound monitoring system deployed in an underwater glider

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REFERENCES
[1] J. A. Hildebrand, "Anthropogenic and natural sources of ambient noise in the ocean," Mar. Ecol. Prog. Ser., 2009, doi: 10.3354/meps08353.
[2] H. Slabbekoorn, N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A. N. Popper, "A noisy spring: the impact of globally rising underwater sound levels on fish.," Trends Ecol. Evol., vol. 25, no. 7, pp. 419–27, 2010, doi: 10.1016/j.tree.2010.04.005.
[3] R. P. A. Dekeling et al., "Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications," Luxembourg, 2014. doi: 10.2788/27158.
[4] D. M. Toma et al., "Smart embedded passive acoustic devices for real-time hydroacoustic surveys," Measurement, vol. 125, pp. 592–605, 2018, doi: 10.1016/j.measurement.2018.05.030.
[5] E. Martínez, D. M. Toma, S. Jirka, and J. Del Río, "Middleware for plug and play integration of heterogeneous sensor resources into the sensor web," Sensors (Switzerland), 2017, doi: 10.3390/s17122923.
[6] E. Martinez, A. Garcia-Benadi, D. M. Toma, E. Delory, S. Gomariz, and J. Del Rio, "Metadata-driven Universal Real-time Ocean Sound Measurement Architecture," IEEE Access, pp. 1–1, Feb. 2021, doi: 10.1109/access.2021.3058744.
[7] M. Botts and A. Robin, "OGC® SensorML," OGC 12-000. Open Geospatial Consortium, 2014, [Online]. Available: http://www.opengis.net/doc/IS/SensorML/2.0.
[8] S. Cox, "Observations and Measuremets-XML Implementation," Wayland, MA, USA, 2011. [Online]. Available: http://www.opengis.net/doc/IS/OMXML/2.0.
[9] A. Bröring, C. Stasch, and J. Echterhoff, "OGC Sensor Observation Service," Open Geospatial Consortium, Wayland, MA, 01778, USA, 2012. [Online]. Available: http://www.opengis.net/doc/IS/SOS/2.0

ID10- MONITORING AND MAPPING OF INTERTIDAL MACROALGAE USING LOW-COST GEOSPATIAL AUTOMATED TECHNIQUES

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Abstract
The global extent of macroalgae is declining with important consequences on marine biodiversity and ecosystem processes. Tracking the status and trends of macroalgal cover is, therefore, an emerging priority for ocean and coastal management. A remote sensing technique combining UAVs surveys with in situ data acquisition was developed to map intertidal macroalgae from rocky shores in a marine protected area, the Atlantic Islands of Galicia National Park (Illas Cíes, NW Spain). The classification by groups (brown and green macroalgae) achieved a good precision. A more precise classification would be achieved by focusing on those spectral bands where the highest differences between species appeared.

Keywords
Multispectral camera, UAV's images, image classification, photogrammetry, spectral signature

INTRODUCTION
Due to the high ecological importance of macroalgae on ecosystem processes, habitat provision, and food web support [1, 2, 3], there is a need to monitor their coverage and diversity in marine areas. This is especially relevant in the case of marine protected areas that comprise one potential tool providing ecosystem resilience of native communities to human-induced stressors. However, in situ surveys are costly and time consuming tasks that need to move specialized staff to the intertidal, with important logistic and economic efforts. Our main objective was to provide with a free user-friendly online tool that offers a quick diagnosis of the macroalgal coverage. For that, we developed an innovative geo-spatial automated methodology that uses images from unmanned aerial vehicles (UAV) for the quantification of the abundance of intertidal macroalgae.

METHODOLOGY
A supervised classification was performed with the Semi-Automatic Classification Plug-in (SCP) [4] in the free software tool QGIS. The SCP was trained with field data (geo-referenced manual photography) and with multispectral images from UAV in order to obtain the spectral signatures of the macroalgae.

Field work
a) In situ data collection. Three plots of 100 m2 in the intertidal of the Illas Cíes were visited once a month from July to October 2019. In each visit, 45 photographs of the macroalgal community within sampling quadrats of 0.5 x 0.5 meters were taken. The position of the
photographs was measured with a GPS Trimble R8 (Figure 1).

b) Uav survey. The aerial images of the macroalgae were obtained from an UAV DJI-Matrice 600 Pro equipped with a multispectral MICASENSE ALTUM sensor. The images were georeferenced by measuring the coordinates of targets deployed in the intertidal.

Acquired data were processed with the software PIX4D to obtain reflectance values (bands: RGB, Red Edge and NIR), that were later used for the image classification (Figure 1).

Data processing
The photographs were geo-referenced and the 8 target macroalgae (the most abundant species in the intertidal) were manually delimited and labelled in a new vectorial shape file, generating a manual classification.

First, the manual classification shapefiles were used to train the software by indicating the ground truth. For that, a virtual raster containing the reflectance of the target spectral bands was generated. The bandwidth was adjusted and the spectral signature for each class was calculated. The final classification was performed using the algorithm "minimum distance" (Figure 1).

Three types of classification were performed: general (macroalgae, inerts and water), groups (green and brown macroalgae, inerts and water) and species (the 8 species, inerts and water). Finally, the success rate of each classification with respect to the ground truth was calculated.

RESULTS
Results showed that the species classification was the less precise (~50-60 % of success), groups classification achieved a success rate of 60%, whereas the general classification achieved an 80% (Figure 2). Therefore, a higher level of detail implied a lower success rate of the classification.

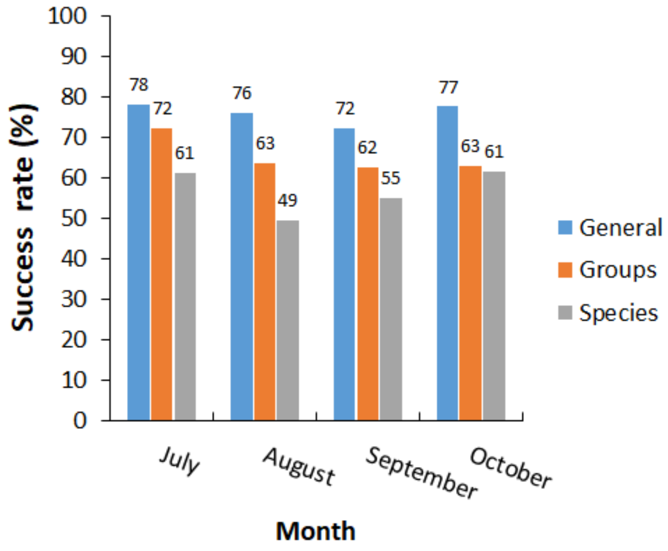

Fig 2. Success rate of the three classifications performed

CONCLUSIONS

The developed tool showed a good performance for a large-scale rapid assessment of the macroalgal coverage at the intertidal. However, the high similarity among the analyzed spectral signatures limited the rate of success of the classification at a species level. The success rate would increase by further analyzing those bands of the electromagnetic spectrum where higher differences between species appear.

REFERENCES

[1] J. C. Surís-Regueiro and J. L. Santiago, "Characterization of fisheries dependence in Galicia (Spain)," Mar. Policy, vol. 47, pp. 99–109, 2014.

[2] M. J. Powers, C. H. Peterson, H. C. Summerson, and S. P. Powers, "Macroalgal growth on bivalve aquaculture netting enhances nursery habitat for mobile invertebrates and juvenile fishes," Mar. Ecol. Prog. Ser., vol. 339, pp. 109–122, 2007.

[3] A. G. B. Poore, S. T. Ahyong, J. K. Lowry, and E. E. Sotka, "Plant feeding promotes diversification in the Crustacea," Proc. Natl. Acad. Sci., vol. 114, no. 33, pp. 8829–8834, 2017.

[4] Congedo, L., 2016. Semi-Automatic Clasification Plugin. https://doi.org/10.13140/RG.2.2.29474.02242/1

ID11- SIMPLIFIED CREATION OF PHOTO-MOSAICS FROM AERIAL IMAGES

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Abstract
This communication is about a simplified method to build image mosaics from aerial images. Getting very exact, orthonormally projected mosaics (orthomosaics) from aerial imagery is nowadays a standard technique performed with the so called "Photogrammetry" [1,7] applications.
Nevertheless, photogrammetry applications are normally expensive proprietary software (despite some open-source options of less quality and difficult to use), creating orthomosaics is normally a slow process. In this paper, we try to develop an easy method able to create a simplified mosaic useful for some applications (mainly computer vision applications where very exact geometry measurements are not necessary). Furthermore, our method is much faster than classic photogrammetry as it is based on algorithms used to synthesize panoramic images [2]: control points are automatically derived using SURF [3,4] algorithm and then used to compute geometric transformations [5] so that warped images coincide in the overlapping part. Images are warped and overlapped to form a whole mosaic.

Keywords
Drone, orthomosaic, beach, SURF algorithm.

IMAGE CAPTURE
We have built our own capture system based on a "Raspberry PI" minicomputer [9]. This platform supports the connection of one or more cameras which can be equipped with filters to select different frequency bands. Housing was built in 3D printer. Images will be captured periodically, with a small application (python+OpenCV) [10,11]. With proper relationship between firing rate and drone speed, we can set the desired overlap between photographs.

Fig 1. Payload mounted on a DJI (Phantom IV) quadcopter.
Housing can bear one or two cameras.

ORTHOMOSAIC CREATION
Method is inspired by methods used for synthesis of panoramic images from individual images. This type of algorithms finds the similarities between consecutive images to derive geometric transformations capable of matching the overlapping part. Doing so, in principle, it is possible to obtain mosaics for straight flight sections only. Proposed method uses SURF algorithm (Speeded Up RobustFeatures) to find common points between consecutive images, see figure 2.

II. ORTHOMOSAIC CREATION
Method is inspired by methods used for synthesis of panoramic images from individual images. This type of algorithms finds the similarities between consecutive images to derive geometric transformations capable of matching the overlapping part. Doing so, in principle, it is possible to obtain mosaics for straight flight sections only. Proposed method uses SURF algorithm (Speeded Up RobustFeatures) to find common points between consecutive images, see figure 2.

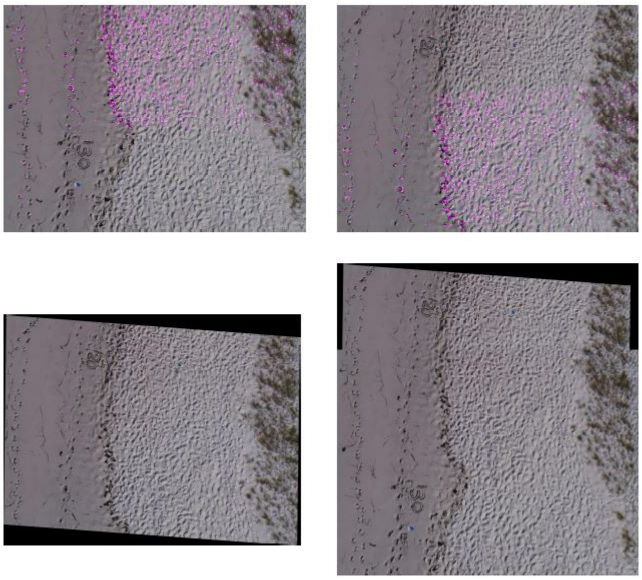

Fig2. Above: individual images with their control points.
Below: second image after applying the transformation and mosaic of the two images.

II. ORTHOMOSAIC CREATION
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A. Color Equalization.
When the images correspond to shots in automatic or semi-automatic mode (if camera optimizes some parameter in each shot), we can have non-uniform lighting and/or color conditions that will affect the result.
Therefore, it is desirable to be able to standardize the color characteristics of the images and we have designed a preprocessing to perform this task. Process is based on computing the average color histogram of all images and transforming them to fit such average [14].

B. Execution times
Times are important in this work since the real objective is to convert hours into minutes. Testing an implementation in matlab [15] on an Intel computer (I7-6700HQ 2.60 GHz, 8Gb RAM, Windows 10) we have the following results, see Table I.

TABLE I
EXECUTION TIMES

Series:	Nº images.	Time (s)	Time/image (s)
1	13	341	26
2	18	568	32
3	27	1789	66

See that time/image is not constant. This can be justified because system operates with bigger images at each processing stage. Color equalization uses about 4 seconds per image. These results would be improved using a more efficient (compiled) programming language like C++.

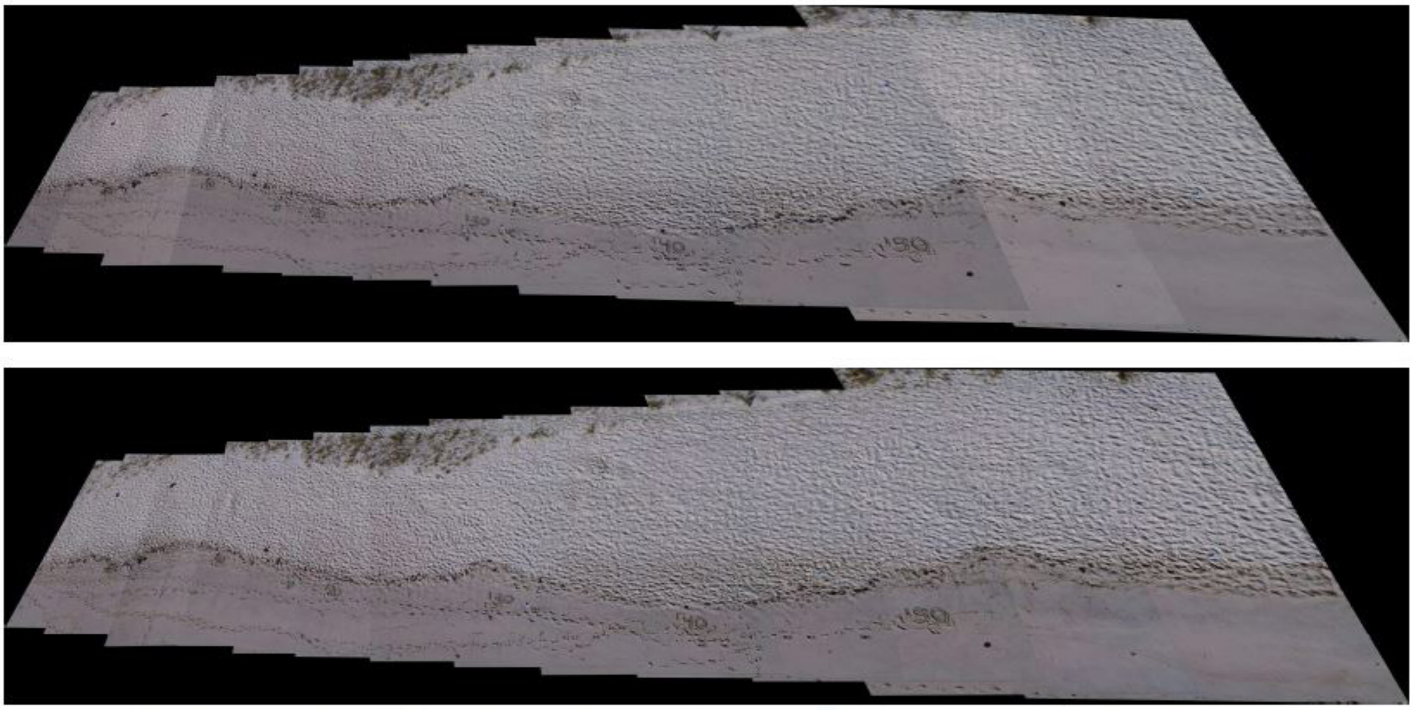

Fig3. Above: without color equalization. Below: with color equalization. 13 images, ~15m flight height.

CONCLUSIONS
A simple and economical (but versatile) capture system has been developed. We have also developed software capable of merging quickly an unlimited number of images, provided that they belong to an approximately rectilinear flight segment. As possible future lines, we can point out trying new transformations and merging several parallel rectilinear sections.

ACKNOWLEDGEMENTS
Authors wish to thank all personnel in atlanTTic who collaborated in this work. We also thank the "Parque Nacional de las Islas Atlánticas de Galicia" for allowing our flights in the beaches of the Cíes islands. We also thank European Commission for funding first stages of this work through the action "EASME/EMFF/2016/1.2.1.4" and spanish ministry for "Transición Ecológica y el Reto Demográfico" for continuing funding through program "Pleamar 2019" (project BEWATS).

REFERENCES
P.R Wolf , B.A. Dewitt, B.E. Wilkinson, Elements of Photogrammetry with Application in GIS, Cuarta edición, McGraw-Hill Education, 2014.
[2] K. Seongdo et al, "Generating panorama image by synthesizing multiple homography", 19th IEEE International Conference on Image Processing, 2012.
[3] H. Bay, T. Tuytelaars, L. Van Gool, "Speeded Up Robust Features" (SURF), ETH Zurich, Katholieke Universiteit Leuven.
[4] S.R. Panchal, S.K. Shah, P M Panchal, "A Comparison of SIFT and SURF", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 1, Issue 2, April 2013
[5]http://alumni.media.mit.edu/~maov/classes/comp_photo_vision08f/lect/08_image_warps.pdf
[6] F. Martín-Rodríguez et al, "LitterDrone: monitorización de basura marina empleando drones y análisis de imagen" Proceedings de URSI-2019, Granada, septiembre 2018.
[7] https://www.photomodeler.com/
[8] https://www.micasense.com/es/rededge-mx
[9] https://www.raspberrypi.org/
[10] https://www.python.org/
[11] https://opencv.org/
[12] L. Gottesfeld Brown, "A survey of image registration techniques", Journal ACM Computing Surveys (CSUR), Volume 24 Issue 4, Dec. 1992, Pages 325-376, ACM New York, NY, USA.
[12] V. Muto Foresi, Curso de Métodos Numéricos, Universidad del País Vasco (http://www.ehu.eus/~mepmufov/html/docencia-mnesp.html).
[14] A.K. Jain.Fundamentals of Digital Image Processing, Pearson Educación, 1999.
[15] https://es.mathworks.com/

ID 12- BIG PLASTIC MASSES DETECTION USING SATELLITE IMAGES & MACHINE LEARNING

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Abstract
This communication describes a preliminary research on detection of big masses of plastic (marine litter) on the oceans and seas using EO (Earth Observation) satellite systems. Free images from the Sentinel 2 (Copernicus Project) platform are used. To develop a plastic recognizer, we start with an image where we can find a big accumulation of "non-floating" plastic: Almería. We made a test using remote sensing differential indexes, but we got much better results using all available wavelengths (thirteen bands) and applying Machine Learning (Neural Networks). Keywords – satellite, Earth Observation, Neural Networks.

Keywords
Satellite, Earth Observation, Neural Networks.

INTRODUCTION
Marine litter has become a major environmental problem. Consequently, there are many initiatives about it. Part of them are "proximity projects", focusing efforts on beaches and/or water near coastline [1].

Other initiatives aim to attack the problem of large masses of floating garbage that accumulate in the sea. Currents and tides tend to accumulate waste in large masses (litter islands). Within the categories of marine litter [2], in this case (floating debris), we must focus on plastic.

For large floating accumulations, the use of satellite imaging (EO: Earth Observation) is interesting [3,4]. The Sentinel 2 satellite produces multi-spectral images with thirteen wavelengths [5] that can be useful. Public images have a precision of 10m/px (on visible bands), which is low but enough for large masses. Automated vision applications can help fighting marine litter by detecting, quantifying, and monitoring large accumulations.

Sentinel 2 is limited to near-shore waters (although it includes the entire Mediterranean). In the ocean, we could extend development to the most recent Sentinel 3 (21 bands, 300m/px).

For this development, it is necessary to have images with significant amounts of plastic material. Although it is not floating plastic, an area known for huge plastic covers is Almería, Spain (where there exists an enormous extension of plastic greenhouses, figure 1).

USE OF DIFFERENTIAL INDEXES
In remote sensing, the so-called standard indexes are often used. These indexes are computed from pairs of chromatic components [6,7]. Another index-based methodology is presented in [8], where authors recommend a combination of two indexes. Testing this method on the former image, we get this result (figure 2).

Fig1. RGB composition from Sentinel 2, Almería, 100 Mpx,
10 m/px (100x100 Km2).

Studying plastic behavior at different wavelengths, we thought about an alternative index using bands 9 and 8. Id EST: computing (B8-B9)/(B8+B9).

Fig2. Indexes from [8].

Fig 3. Bands 8 & 9.

Combining these methods with a cloud detection method [9] and discarding the land areas with the help of maps, we could meet the purpose. However, in next section we will see more powerful tools that getting better results more directly.

NEURAL NETWORKS
With thirteen numerical values per pixel, we can think of this as a pattern recognition problem. For each point, we naturally obtain a feature vector.

The idea is using artificial neural networks [10] to learn the implicit relationships between different bands that may characterize plastic.

Network structure.
We use a single output network training it to obtain values of 1.0 for plastic and 0.0 otherwise. Under these conditions, a multilayer perceptron structure (MLP [10]) may work well. With three layers (one hidden level). Testing with ten hidden neurons (slightly less than number of inputs), we obtain good results and so we do not try more complex structures.

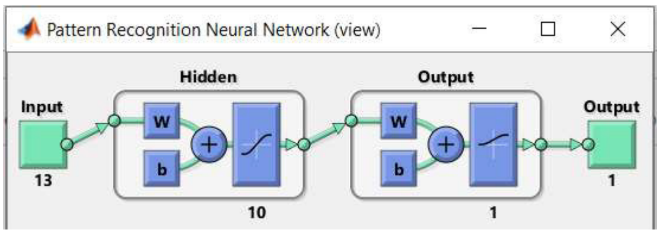

Fig 4. Network structure.

Studying plastic behavior at different wavelengths, we thought about an alternative index using bands 9 and 8. Id EST: computing (B8-B9)/(B8+B9).

Training and Test

We have started by labeling the original image manually (drawing a detailed mask on top of plastic areas, figure 5). Number of samples is more than enough. Even at smallest resolution, we have 3,348,900 samples for: 14 * 10 + 11 = 151 weights (number of samples should be over fifteen times the number of weights). We also balance the training samples (dropping randomly some samples of the majority class to avoid training problems).

We use MATLAB [11] training with Back-propagation algorithm [12]. 70% samples are dedicated to training, 15% to validation (verification for algorithm stop) and 15% to final testing.

Training has been successful, obtaining an error rate of 2%, see figure 6 (confusion matrixes) and figure 7: recognition result on a different image of the same place (to demonstrate generality of method).

Fig 5. Truth table.

Fig 6. Confusion matrixes.

Fig 7. Neural network result.

CONCLUSIONS

We have studied methods for the automatic detection and quantification of plastic waste floating in the sea. Although the use of differential indexes (very typical in remote sensing) may have some utility, the use of neural networks is the solution that provides the best result. In the future, it is planned to develop an application that automatically downloads and analyzes images to detect, quantify, and track large accumulations on sea. To study the great oceans, the work would have to be extended to the OLCI sensor of Sentinel 3 (21 bands).

ACKNOWLEDGEMENTS

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REFERENCES

[1] F. Martín et al, “LitterDrone: marine litter characterization using drones and image analysis”, Instrumentation Viewpoint, vol 20 (Martech-2018), pp 55-56.

[2] Convenio OSPAR: https://www.ospar.org/. Last access 24/03/2021.

[3] M. Arias et al, “Observational limitations for marine litter monitoring: Earth Observation to the rescue” in Atlantic from Space Workshop (ESA), Enero 2019, Southampton (UK).

[4] V. Martínez Vicente, “Optical Methods for Marine Litter Detection (OPTIMAL): From User Requirements to Roadmap Design for Marine Plastic Detection System” in Atlantic from Space Workshop (ESA), Enero 2019, Southampton (UK).

[5] https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi/resolutions/spatial. Last access 24/03/2021.

[6] B. Gao, “NDWI A Normalized Difference Water Index for Remote Sensing of Vegetation Liquid Water From Space”, Remote Sensing of the Environment (Elsevier), vol 58, 257-266, 1996.

[7] S.K. McFeeters, “The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features”, Int. Journal of Remote Sensing, Volume 17, 1996 - Issue 7.

[8] Biermann, L., Clewley, D., Martinez-Vicente, V. et al. “Finding Plastic Patches in Coastal Waters using Optical Satellite Data”. Scientific Reports 10 (Nature), 5364 (2020).

[9] D. Frantz et al, “Improvement of the Fmask algorithm for Sentinel-2 images: Separating clouds from bright surfaces based on parallax effects”, Remote Sensing of Environment, Volume 215, No. 15, pp. 471-481 (2018).

[10] S. Haykin, Neural Networks: A Comprehensive Foundation (2 edición), Upper Saddle River, NJ (U.S.): Prentice Hall, 1998.

[11] MATLAB, https://es.mathworks.com/products/matlab.html. Último acceso 18/04/2020.

[12] E.M. Johansson et al, “Backpropagation Learning for Multilayer Feed-Forward Learning Neural Networks Using the Conjugate Gradient Method”, International Journal of Neural Systems, Vol. 02, No. 04, pp. 291-301 (1991).

ID13- REAL-TIME DATA QUALITY CONTROL APPLIED AT OBSEA

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Keywords
QARTOD, cabled seafloor observatory, real-time quality control, OBSEA.

ABSTRACT
The expandable seafloor observatory OBSEA (https://obsea.es) is located at 4 Km off Vilaonva i la Geltrú (Catalonia, Spain) at 20 m depth. This cabled observatory obtains different environmental data from a meteorological station, CTD sensor, hydrophone, ADCP, buoy and seismometer. Previously, the quality control of the acquired data was not in real-time and oversighted erroneous data values guiding to a misunderstanding of the environment.

Accounting that the data collected from the OBSEA observatory needs to comply with the Copernicus Marine Environment Monitoring Service (CMEMS) In Situ Thematic Assembly Center (INS TAC) procedures and the inefficiency of the previous data quality control processes, a new automatic real-time data quality control system has been developed. The quality control consists of a set of automatic tests according to the manual for real-time quality control of in-situ temperature and salinity data of the Quality Assurance/Quality Control of Real Time Oceanographic Data (QARTOD, https://ioos.noaa.gov/project/qartod) project of the Integrated Ocean Observing System (IOOS, https://ioos.noaa.gov). The follow-through of the QARTOD manual for the development of the tests was made considering the community acceptance, notability and previous work of the IOOS.

The developed quality control tests flag the data depending on its reliability to enrich its associated metadata (Table 1).

FLAG	0	1	3	4	9
SPECIFICS	No quality tests applied	Reliable	Suspicious	Bad	Missing

Table 1: Value of the flags attached at the data values by the tests and its interpretation.

The construction and implementation of the tests was orchestrated considering the characteristics of the data acquired by the sensors of the OBSEA, the scientific requirements and the QARTOD recommendations (Table 2).

TEST NAME	SPECIFICS	PROOF	RELEVANCE
No value	Proves if there is a value attached to the data set delivered by the sensor	Find sensor acquisition or delivering errors	Proposed by research group
Gross range	Checks if the value is within the sensor and reasonable range	Find outliers, sensor errors and suspicious data considering the region	Required
Climatology	Checks if the value is within a reasonable range considering the season its acquired	Find suspicious data considering the time of the year	Required
Rate of change	Correlate the value with the previous reliable value to spot if it is a spike	Find if the value is a spike considering the standard deviation of that variable for the season it is acquired	Strongly Recommended
Flat line	Match the value with previous values to detect if they change at all	Find if the sensor has some type of problem acquiring or sending the values	Strongly Recommended
Attenuated signal	Measure the variation of previous values to detect if their change is big enough	Find if the sensor has some type of problem acquiring the values	Suggested

Table 2: Test names with their specifics, importance and relevance.

Data generation algorithms were designated to study, evaluate and optimize the tests according to their particular needs and crafted to reveal their weak spots, lighten up their confidence level and, ultimately, find optimization solutions. Additionally, the tests were applied to all CTD data acquired by the OBSEA between 2016 and 2019 (Figure 1) and the results compared with the OBSEA data in the Pangaea databank (https://www.pangaea.de) to corroborate their trustworthiness and see the real importance of the quality control application.

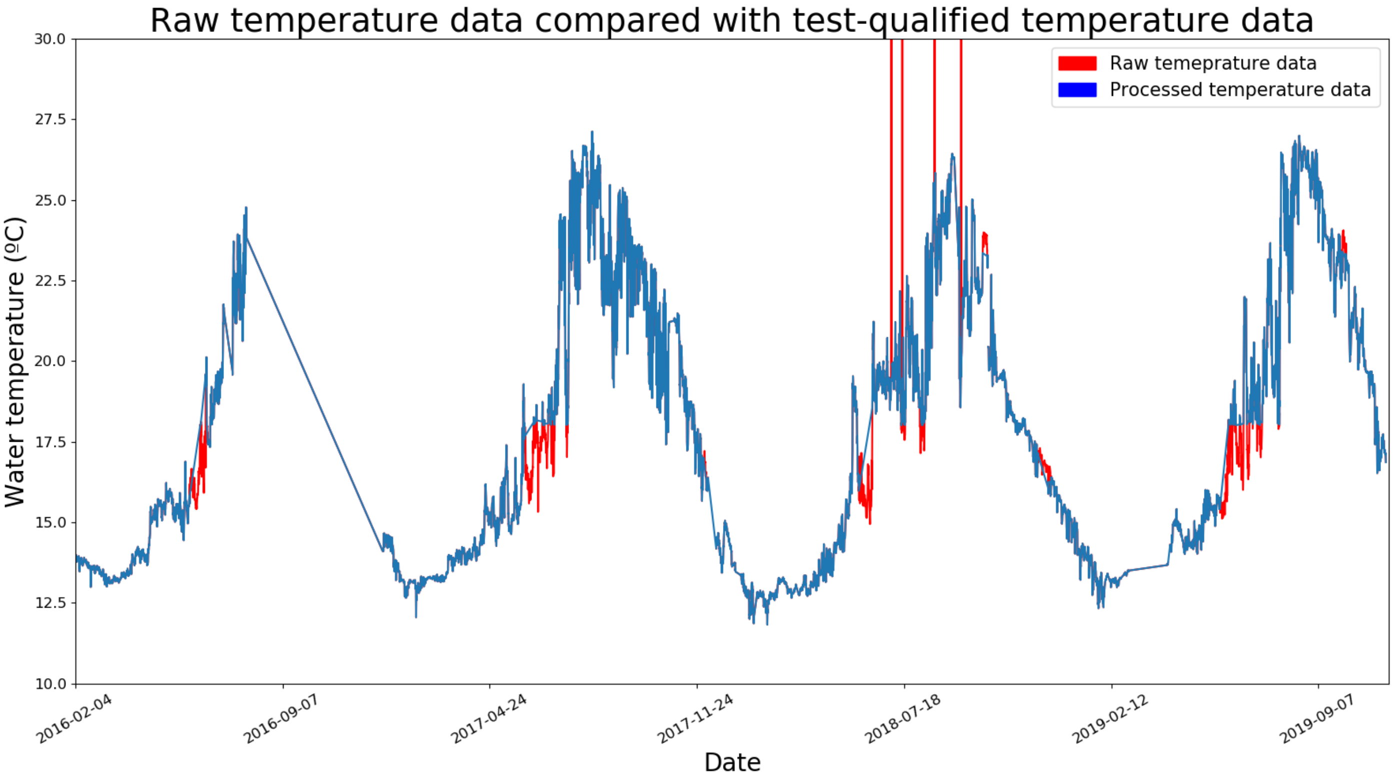

Figure 1: Sea water temperature (ºC) between 2016 and 2019 acquired by the OBSEA: raw sea water temperature (red) and sea water temperature flagged with good quality by the implemented tests (blue) are shown in the graph.

After these procedures and an exhaustive look through the tests commenced their modification for their continuous application to the real time data acquisition.

AKNOWLEDGEMENTS
This work is partially funded by Generalitat de Catalunya "Sistemas de Adquisición Remota de datos y Tratamiento de la Información en el Medio Marino" (SARTI-MAR)" 2017 SGR 371 and by the Spanish Ministry of Education and Science (MEC) with the project "Redes de sensores submarinos autónomos y cableados aplicados a la monitorización remota de indicadores biológicos" TEC2017-87861-R. Researchers want to acknowledge the support of the Associated Unit Tecnoterra composed by members of Universidad Politécnica de Cataluña (UPC) and the Consejo Superior de Investigaciones Científicas (CSIC). This work used the EGI infrastructure with the dedicated support of INFN-CATANIA-STACK.

ID14- THE PHYSICAL CONDITIONS OF THE BARENTS SEA, A NOTE TO FISHING VESSELS

OVE TOBIAS GUDMESTAD

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Operational Oceanography

Keywords
Waves, Sea Spray Icing, Polar Low Pressure, Search and Rescue

Abstract
The physical conditions of the Barents Sea, a note to fishing vessels.

The conditions for fishing in the Barents Sea are excellent. An abundance of fish and well-regulated agreements between Norway and the European Union Countries.

For fishing vessels, there are, however, aspects to be aware of in relation to the physical environment:

• The extreme wave conditions in the area are characterized by large waves, Norsok Standard N003. The fetch giving rise to the largest waves is from the south western direction and it is noted that the waves are longer than in the North Sea. This may influence on the response of vessels to the wave conditions.

• In case of Polar Low pressures, the forecasts are very uncertain and in general vessels should not be in the area of a passing Polar Low Pressure. Meteorologist will issue warnings to fisheries to be prepared to leave the locations of potential tracks of Polar Lows. Very large waves may occur within an hour in case of the most extreme conditions (Orimolade et al., 2016).

• In case of high winds, large waves and low temperatures, sea spray icing may grow very fast and vessels must initiate ice removal procedures to avoid loss of stability (Johansen et al., 2020). A warning occurs prior to dangerous situations as the roll period of the vessel increases when approaching unsafe stability conditions, low GM values. Note that in case of Polar Low pressures, there may be heavy snow following the Polar Low. The snow may easily freeze to ice, hampering the stability of the vessel. The Norwegian Meteorological Institute issues icing warnings to seafarers.

• In case of sea spray icing, the ice will accumulate on the fore part of the vessel and on the bridge, less on the back of the vessel. It should be possible to trim the vessel to ensure an even keel voyage.

• Due to the northern latitude, GPS signals may disappear and back-up navigation tools shall be available.

• In case of distress, the Norwegian Rescue Center; The Joint Rescue Coordination Center (JRCC) in Bodø, Norway, is in charge of search and rescue. The Norwegian Coast guard is normally on duty in the Barents Sea and will assist all vessels in the area.

References

Johansen K., Sollid M. P., Gudmestad O. T. (2020). Stability of Vessels in an Ice-free Arctic. TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 14, No. 3, doi:10.12716/1001.14.03.19, pp. 663-671.

JRCC, The Joint Rescue Coordination Center, Bodø, Norway. https://www.hovedredningssentralen.no/english/.

Norsok Standard N003 (2017). Actions and Actions Effects. Standards Norway, Lysaker, Norway.

Orimolade, A. P., Furevik, B. R., Noer, G., Gudmestad, O. T., Samelson, R. M. (2016). Waves in polar lows. Journal of Geophysical Research, Oceans; Volume 121 (8) p. 6470-6481.

ID 15- BATHYMETRIC SURVEYS FROM SAR SATELLITE IMAGES USING WAVELETS

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Abstract
When waves propagate in coastal areas they suffer changes in the wavelength and wave direction resulting from the interaction with the sea bottom. In SAR images, the waves can be identify through variations in the gray tones of the image, making it possible to infer the bathymetry from the variations in the wavelength. Commonly, the fast Fourier transform (FFT) is used to estimate the wavelength in domains close to the coast, recognizing, however, that this method has some limitations, mainly for small depths. To overcome the limitations of FFT, this work uses wavelet spectral analysis to estimate bathymetric data. The new image processing methodology shows positive and promising results for mapping shallow marine environments.

Keywords
Satellite imagery, Bathymetry, Wavelength, Wavelet Transform

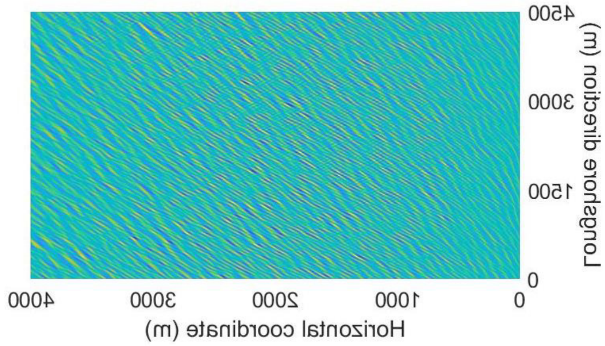
INTRODUCTION
The study of the seabed provides information that can be applied in several scientific areas such as marine geology, physical oceanography or civil engineering. The seabed, especially closer to coastal areas, is an extremely dynamic system, with variations in its morphology over short periods of time. Due to these rapid variations, constantly monitoring the morphology of the seabed, especially in coastal areas and harbour areas, is of particular relevance both for navigation safety and in terms of coastal erosion. Currently, the most used methods for monitoring the seabed are based on acoustic systems. These methods, although presenting a very high precision, are relative expensive, difficult to operate in shallow waters and their use depends on weather and wave conditions [1], so monitoring is not done regularly. In areas closer to the coast, the disadvantages mentioned above can be overcome with the use of SAR images obtained by remote sensing. The use of SAR images is possible for two reasons: (i) the waves, as they propagate towards the coast, suffer variations in their wavelength, from the moment the depth is smaller than half the wavelength, and (ii) SAR sensors can capture variations in the roughness of the ocean surface associated with the wavelength. The changes in the wavelength can be estimated using spectral analysis and the dispersion relation can be solved inferring the bathymetry. The most used spectral analysis methodology to estimate the wavelength is the Fast Fourier Transform (FFT). However, previous studies [2] show that this technique presents some limitations to calculate the bathymetry, particularly, for small depths. The NAVESAFETY project "Emerging remote sensing technologies to support real-time safety in navigation in harbour areas" seeks to develop an algorithm that allows estimating the wavelength and associated bathymetry when applied to SAR satellite images.

METHODOLOGY
The wavelet transform (WT) is a technique that decomposes a signal into several parts and then analyse the parts separately, enabling to represent a signal in the time and frequency domain at the same time, providing information about the 'when' and 'where' different frequency components occur. Satellite images allow coverage of a wide area, so it is difficult to validate with real data due to their scarcity. In this way, the application of WT to estimate the wavelength was tested with images generated from synthetic data. The advantage of synthetic data is that it is known exactly which bathymetry should result from the application of the WT. The produced synthetic images of the sea surface, that mimic real satellite images (e.g., SAR), were obtained using a wave propagation model that describes properly the temporal and spatial variations in the wave height and wave direction over different known bottoms. The wave propagation model FUNWAVE-TVD that solves the Boussinesq's equations was selected for that purpose.

RESULTS
When considering the propagation of irregular waves, with changing wavelength and height patterns, the direct application of the wavelet transform does not work with the accuracy that it does for regular waves. The evaluation of the properties of random waves on a wave-by-wave basis would provide very different wavelength estimates in the analysed spatial domain. Therefore, some solutions were explored to help solving this problem. It was found that performing simultaneously an analysis by subdomains and filters, the results of the methodology were optimized. However, at some points in the spatial domain, some estimated wavelength values revealed sudden unreal changes, differing significantly from other estimates. The solution found to remove these outliers was to use the median in the analysis process. Fig 1 shows the results of applying the WT for a case study with a sand bar in which the propagation of irregular waves was simulated according to a JONSWAP spectrum (γ=3.3) with a significant wave height of 2m and a peak period of 10s. The results show that the calculated isobaths are roughly disposed parallel to the coast and the sandbar is also reproduced. The errors are small and mostly below 10%, representing absolute errors always below 2 m.

The determination of the seafloor bathymetry from remote sensing imagery presents a rather easier process to explore potentially widespread areas. The direct application of the wavelet transform for irregular waves does not work with accuracy as for regular waves. However, the results of the applied spectral analysis can be optimized by performing simultaneously subdomains analysis and by adopting filters. By doing so, the methodology indicates that the WT is a powerful tool, providing fairly accurate bathymetries. The observed capabilities of this new methodology justify additional work to map shallow marine environments from satellite images that enable retrieving the wave field (e.g., Sentinel-1).

CONCLUSIONS



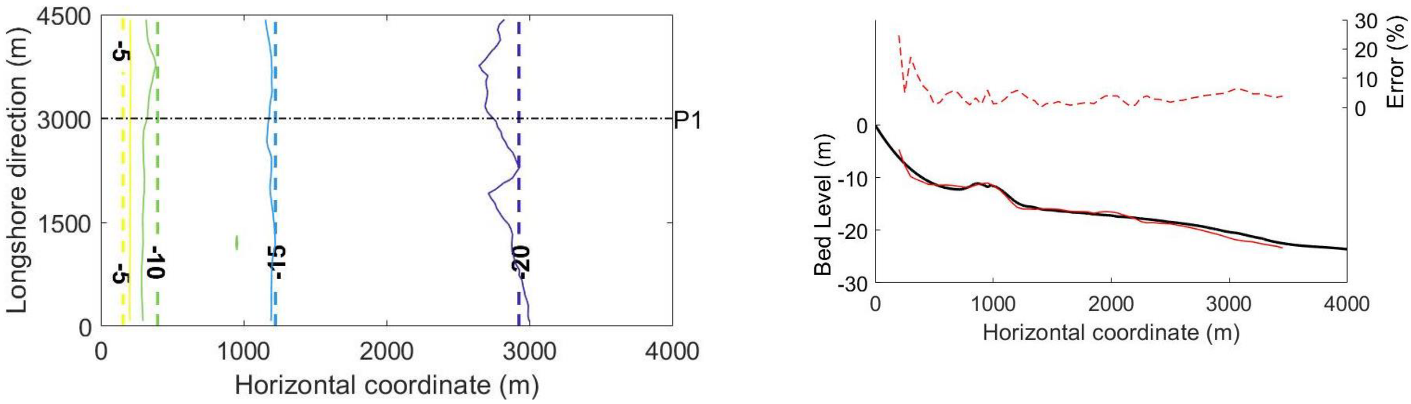


Fig 1. Irregular waves propagating over a sandbar at oblique incidence: (a) generated image representing the two-dimensional wave propagation at the surface; (b) isobaths of the calculated bathymetry over the real bathymetry; (c) cross-shore profile P1 (real - black line; estimation using wavelets - red line) and respective relative errors.

REFERENCES

[1] Jawak, S.D.; Vadlamani, S.S.; Luis, A.J. (2015) A Synoptic Review on Deriving Bathymetry Information Using Remote Sensing Technologies: Models, Methods and Comparisons. Advances in Remote Sensing, 4, 147-162

[2] Pereira, P.; Baptista, P.; Cunha, T.; Silva, P.A.; Romão, S.; Lafon, V. (2019). Estimation of the nearshore bathymetry from high temporal resolution Sentinel-1AC-band SAR data-A case study. Remote Sensing of Environment, 223, 166-178

ID16- ADVANCES IN ELECTRONIC MONITORING OF FISHING CATCHES BASED ON ARTIFICIAL INTELLIGENCE

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Abstract
Monitoring plays a key role in all aspects of fisheries management, including those related to sustainable management of resources, the economic performance of the fishery, and the distribution of benefits from the exploitation of the fishery and environment. In this work, software improvements made on the remote electronic monitoring (REM) device iObserver are described towards the improvement of fisheries monitoring by precisely identifying and quantifying fishing catches on board commercial vessel´s. To this aim, we exploit deep learning and convolutional neural networks (CNNs) capabilities and potential.

Keywords
Remote Electronic monitoring systems (REMs), catch identification, species quantification, deep learning, convolutional neural networks.

INTRODUCTION
Sustainability is a basic premise for the economic and social future of fisheries and the main objective of fishing policies, such as the Common Fisheries Policy of the European Union [1]. An immense challenge faced by sustainable fisheries management and policies is that of finding cost-effective monitoring methods. The digital revolution must contribute to guarantee accurate data on the record of total catches, including landings, discards, as well as by-catches, verification of fishing effort and fishing capacity applicable to the engine power of the vessels, better traceability of the fishery products and better catch certification systems. So, digitization and advanced tools applied to fishing, such as remote electronic monitoring systems (REM), artificial intelligence tools, machine and deep learning, data from different sensors and high-definition satellite images resolution, have enormous potential to optimize fishing operations and improve our ability to collect and analyse data, as well as to improve monitoring and control capabilities and ultimately support the sustainable management of marine biological resources. Several REM systems are available to that purpose [2]; however, many of them exhibit a number of drawbacks that prevent its generalization among fleets (e.g. off-line evaluation of catches by the so-called dry observers in land, crew interferences and distrust, etc.). To overcome these drawbacks, robust and reliable innovative technologies for registering captures are required.

In this regard, we have developed the iObserver [3], an electronic device for real-time, automatic identification and quantification of the whole catch on board fishing vessels. The iObserver is installed in the fishing park, over the conveyor belt, just before the fishing separation zone. The system takes images of everything that crosses this conveyor belt during the separation process. The recognition software automatically analyses every image, identifies all the individuals, estimates their length and generates a report containing the results. Identification/quantification results are sent to the RedBox application that we also developed. This software is connected to the vessel's instrumentation (from which it receives data such as position, speed, time or depth) and to the iObserver (from which it receives the composition of each haul). It processes all the information and can send it to land via satellite or GPRS/3G/4G network, practically in real time, in a very small file (300-500 Kb) that contains the amounts caught of each of the species above and below the minimum conservation reference size (MCRS) together with its geolocation.

In this work, and in the framework of the SICAPTOR project (co-funded by the EMFF through the Pleamar Programme of Fundación Biodiversidad), a very significant improvement of the iObserver was carried out on the recognition and quantification software, as presented in the next section.

RESULTS
The very first prototype of the iObserver (fully described in [3]) uses morphological and colorimetric parameters to carry out the identification and quantification of main target species of Galician trawling fleets operating in ICES areas 6, 7, 8c and 9a, failing when the specimen of each haul passing through the conveyor belt of the fishing parks are slightly overlapped or without a minimum separation among them. To overcome this issue, we tried to take advantage of the enormous potential that artificial intelligence, and more precisely deep learning (DL), offers to improve the recognition and quantification capacities of our REM system. As a reminder, deep learning is a class of machine learning algorithms that uses multiple layers to progressively extract higher-level features from the raw input [4]. For example, in image processing (that is the case of our work), lower layers may identify edges, while higher layers may identify the concepts relevant to a human such as digits or letters or faces. The deep learning algorithms for species recognition algorithms included in the iObserver use Convolutional Neural Networks (CNNs). Two models were created with transfer learning and data augmentation techniques:

1) an instance segmentation model for specimen detection and classification, i.e., identification of the area occupied by each object instance (fish individuals) in the photograph. The implementation of the Mask R-CNN algorithm in Keras and Tensorflow has been chosen with FPN and ResNet101 base network pre-trained with the MS COCO data set. This implementation uses images resized to 1,024 pixels tall. Advantages of these new algorithm include: i) greater precision, ii) the ability to segment the image and; iii) the ease of manipulating and applying geometric data augmentation techniques with the help of the segmentation masks of each instance. Its main disadvantages are: i) the greater labelling effort since it involves outlining the contour of each fish for the training images and; ii) the slowest inference.

2) a regression model for fish length estimation based on a convolutional network MobileNet-V1 trained from scratch and modified to include as input the results of the segmentation algorithm.

To train and test both models, a set of about 6,000 images (like the one presented in Figure 1) were labelled with mask, species and length of each individual for a selection of 14 of the most relevant species for the local fisheries (see their FAO 3-alpha codes on the axis of Figure 2). Obtained results are very promising since precision and recall of 98% and 95% respectively for species recognition (as it can be stated in the confusion matrix presented in Figure 2) and 3.2% mean absolute percentage error for length estimation in the test data set, where individuals exhibit a low or medium level of overlapping. In Figure 2, the rows show the results of the predictions, that is, the precision. The number that appears in parentheses, next to the name of the species, indicates the number of times that the algorithm has identified the objects in the images as that species. For example, BIB (54) indicates that the algorithm has identified 54 objects as pout (Trisopterus luscus). Moreover, columns show the real data, that is, data obtained by a human observer. The number that appears in parentheses, next to the species name, indicates the number of times that species appears in the images according to the human observer. The number below indicates the percentage of times the algorithm has correctly identified the species, that is, the recall. For example, in the images there were 55 specimens of pout (BIB) and these specimens have been correctly identified 96.4% of the time (53 out of 55).

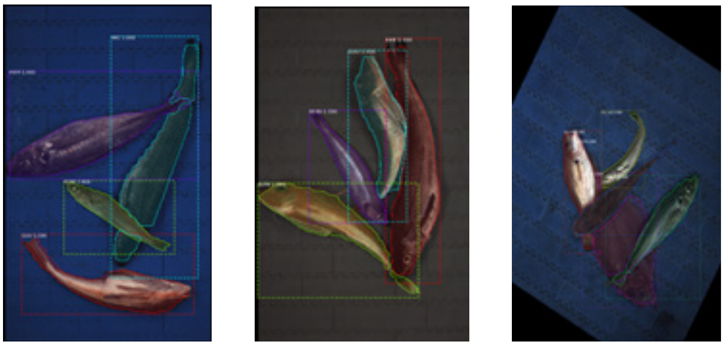

Fig 1. Species identification results in the test set for the final detection algorithm.

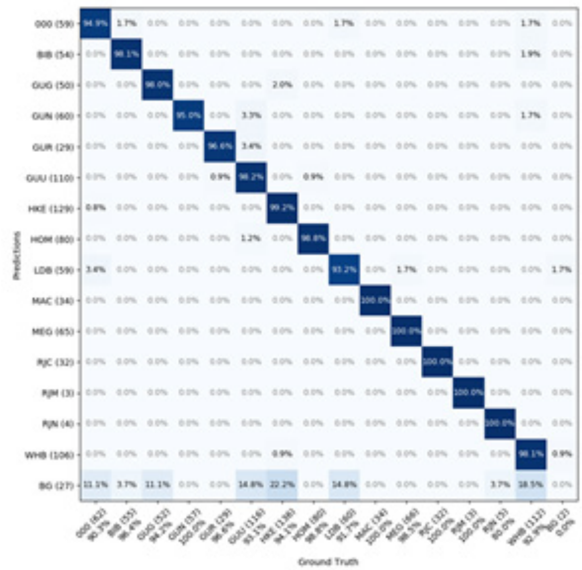

Fig 2. Confusion matrix resulting from the comparison between the measurements of the human observers and the predictions of the model for the set of test images.

CONCLUSIONS

Size estimation and species identification results were satisfactory improved by the developed DL algorithms, even when fish on the conveyor belt are moderately overlapping. Additional images will be obtained and processed in order to improve the capabilities of the algorithms. However, improvements are still required for the case of high levels of overlapping, that could demand the analysis of implementing additional mechanical solutions (acting also over the hardware level) in the fishing park (like vibrating devices, flexible barriers or variable-speed segments in the conveyor belts) to avoid it and maximize the performance of the algorithms and, therefore, or the iObserver. In addition, work on minimizing the equipment size in order to not disturb fishermen activity and to generalize its use in other fisheries or small-scale fleets should be also considered in the near future.

REFERENCES

[*1] European Commission. Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, 2013*

[2] James K.M. et al. Tools and Technologies for the Monitoring, Control and Surveillance of Unwanted Catches. In: Uhlmann S., Ulrich C., Kennelly S. (eds) The European Landing Obligation. Springer, Cham, 2019. https://doi.org/10.1007/978-3-030-03308-8_18.

[3] Vilas, C., Antelo, L.T., Martin-Rodriguez, F., Morales, X., Perez-Martin, R.I., Alonso, A.A., Valeiras, J., Abad, E., Quinzan, M., Barral-Martinez, M. Use of computer vision onboard fishing vessels to quantify catches: The iObserver, Marine Policy, 116, 2020 https://doi.org/10.1016/j.marpol.2019.103714.

[4] Deng, L.; Yu, D. Deep Learning: Methods and Applications. Foundations and Trends in Signal Processing. 7 (3–4), pp. 1–199, 2014. https://doi.org/10.1561/2000000039

ID17- OPERATING AROUND OFFSHORE INFRASTRUCTURE AND SAFE MANOEUVRING BY AUTO-NAUT USV

In 2017, an AutoNaut wave-propelled unmanned surface vehicle (USV) conducted a “close pass” trial in proximity of an operating oil and gas platform. The 4-day mission required the vehicle to follow a series of pre-planned transect lines within a 4km sq area around the asset. Multiple close passes on all four sides of the asset were completed. At the closest point, a transit within 150 metres of the asset was achieved.

A strict 500metre “safety zone” is typically implemented around offshore oil and gas assets. Within which vessel traffic is restricted to essential operations. For this task, a marine autonomous system (MAS) offered two key advantages over other data collection methods close to platforms; such as conventional vessels or drifting devices:

1. A significantly reduced risk profile – no personnel, small size and propulsion characteristics of the Autonaut.
2. Movements following pre-planned transects in a controlled manner

Precise and consistent positioning of the AutoNaut USV was vital to mission success and for safety assurance. Throughout the mission the AutoNaut operated in sea states up to Beaufort 5-6 and surface currents of up to 1knot. Complete reliability was required of the command/control system and protocols: Offshore based remote operators on a supporting vessel (outside the safety-zone) utilised wireless comms, specifically for close-pass manoeuvres during day time periods. Shore based remote operators located in a different time zone oversaw USV operations during night time periods over iridium satellite link.

Challenges were posed by operating a USV in a busy working area, with other fixed assets and support vessels in the vicinity undertaking simultaneous operations. Robust planning and following established procedure were vital to meet stringent safety requirements and gain industry assurances for the operation of a USV near an oil and gas asset.

ID18- USE OF TIMESCALEDB AS A DATABASE FOR OCEAN-METEOROLOGICAL DATA STORAGE

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Abstract
Traditionally, time series databases (TSDB) are usually NoSQL, due to an improvement issue in the processing of large amounts of information and infrastructure management. TimeScale is a PostGreSQL extension that provides storage-level improvements that increase reading and writing processes to NoSQL levels and maintains the fundamental SQL tools for performing temporary space queries of ocean-meteorological data.

Keywords
TSDB, SQL, TimeSeries, OceanDataSet, TimescaleDB

INTRODUCTION
The monitoring of the environment is essential to know and study the different phenomena that occur in the natural environment. [1]. Atmospheric and oceanographic data sets share many characteristics. They can be very large; many cover limited periods of time and have a limited spatial extent; gaps (lack of data) and outliers are common; The spatial distribution of several observation networks is uneven; and, often, the time series of data are not homogeneous. The data sets contain variables that, in general, are not independent in time or space; therefore, most of the variables must be seen within a multivariate context [2].
A time series database [3] (TSDB) is a database optimized for timestamp data. These databases have the ability to provide queries with subsamples, gap filling or aggregations throughout the time series, must be stored efficiently to be inserted and retrieved quickly. TimescaleDB [4] is implemented as an extension on PostgreSQL, and exposes what look like singular tables, called hypertables, that are actually an abstraction or a virtual view of many individual tables holding the data, called chunks (created by partitioning the hypertable's data into one or multiple dimensions).
We will proceed to perform a series of tests to test the performance of TimeScale and compare it with other databases of the same style. Small comparisons will be made both in writing and reading data. Special emphasis will be placed on reading large datasets.

CREATE DATASET
We assume that we have 12 oceanographic stations (buoys), which have many sensors and one of which is the battery voltage of the station. The structure of the data is as follows: name (String), function (String), volt (Float32), volt_std (Float32). It used a sines and cosines function that simulate coherent temporal data. We use a random function with a probability of 0.01 that the data is not acquired (for simulate an error in the acquisition. For the standard deviation, we choose a normal probability. With all these considerations we generate the time series and add the values of the variables for a range of 10 years. We will get approximately 525600 data per year and season, total, for 10 years and 12 stations: approximately 63 million

PERFORMANCE TESTS
A) A write performance test was performed simulating data entry for 10 years from 12 different stations. This gives us approximately 63 million data. To match things, and avoid cache and buffer problems, we will proceed to write to the database in blocks of 10,000 items at a time. TimescaleDB being the fastest.
B) Temporary data reading
In this test, all the data contained in the table between two ranges of dates are requested. TimescaleDB is the winner, but keep in mind that MongoDB does not have Sharding activated.
D) Maximum and minimum reading
To test comparison features, we will perform a maximum and minimum search test in a time range.
The application has to perform comparative tasks on numbers, testing how the database works byte comparator. The conclusions are almost identical to the previous test: the penalty for having to consult all the data makes MongoDB take a long time compared to the other two.
D) Reading of arithmetic means
In this test we check the ability of the application to perform cumulative operations on the data. The arithmetic averages of the chosen time range are calculated. We can test how the application behaves before a mathematical calculation at the database level. The same problem mentioned above reappears.
E) Reading hourly metrics
In this case, we make a real request for aggregation on the generation of hourly metrics. To do this, you must take representative measurements of each hour (60 measurements per hour) for each station.

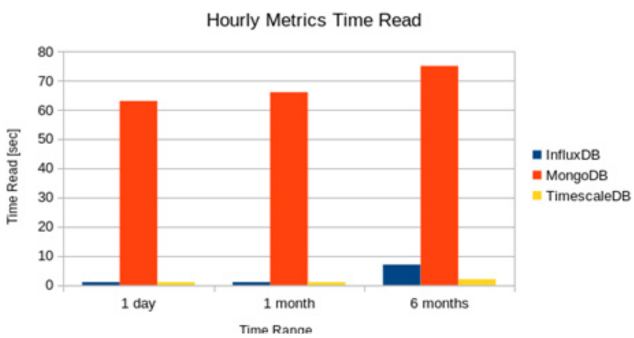

Fig 1. Time metric results

It can be seen that TimescaleDB provides better calculation algorithms than InfluxDB, since previous aggregation requests were on par, but now TimescaleDB has been better.
Possibly due to the fact that by leveraging the entire postgreSQL infrastructure, the algorithms are better debugged and better performing.

CONCLUSIONS
What has pleasantly surprised us is the application of TimescaleDB, which although very young (about 2 years), has spectacular performance. And it is also compatible with the entire ecosystem of PostgreSQL, GIS, pure SQL queries and more. It is just one more extension and, perfectly compatible with the PostGIS extension and integrable in data visualization programs as Grafana.

Fig 2. Grafana data monitor

[1] M.Estrada, E. Álvarez, A. Barragán, O. Bermúdez, M. Garcı a, A. Lavı n, P. Masqué, F. Pérez, J. Piera *Reflexiones sobre la gestión y custodia de datos oceanográficos en España. Recursos existentes y recomendaciones para el futuro*, Scientific Committee on Oceanic Research, 2005

[2] Ifremer, Data Management Handbook: Handbook for Data Management activities regarding data flow and data integration, Deliverable AtlantOS 633211, 2016

[3] Namiot, Dmitry, Time Series Databases. 2015

[4] TimeScale Software, [online] https://www.timescale.com/ Jan 2020.

ID19- CHANGE OF LEADERSHIP IN THE SOCIAL ORGANIZATION: CHANGE OF CONSCIOUSNESS IN THE INDIVIDUAL.

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Abstract
This pandemic has been the starting signal to implement the paradigm shift necessary for social organization in the information age. As everything is very recent we are not yet able to see 'the light at the end of the tunnel'.

The triad 'Science, Technology, Market', which has been the driving force in the industrial era, seems, in these times of pandemic, to have ceded leadership to the Departments of Defense, Pharmaceuticals and Psychopolitics.

Different levels of technologies reach society in different ways. Those that enhance the capabilities of the individual are provided by the market **and** regulated by politics. When the impact can be very strong, they are controlled by the Defense departments.

Humanity's level of awareness must be raised in order to be able to apply the technologies developed in the deep sea.

Keywords
Pandemic, technology, awareness, social management, chaordic space, paradigm shift, deep sea.

Pandemic as a chaordic space to bring about the necessary paradigm shift
These times of pandemic are a chaordic space (Fig 1); in which the phenomena of emergence of new forms of organization take place. It is important to be aware that in this space everyone is uncomfortable because the natural tendency of human beings is to seek order in their actions. And it is important to remain in this discomfort until new organizational models emerge.
A paradigm shift cannot be 'thought' by one person; it has to be 'built' step by step by society itself and in this process of change, each individual plays a fundamental role. [1, 2, 3, 4, 5, 6, 7]

Science, Technology, Market
Until February 2020 the triad 'Science, Technology, Market' (STM) has been the great engine that has brought us into this world of 'nomadism' in which the surrounding landscape changes as fast as the nomads who continually change places. [5]
Because of this development and extension of technology, we as humanity needed a reflection process [3] to understand the potential of the developed technologies and decide how to use them (or whether to use them or not) in the years after 2020.
This reflection process is necessary because of the enormous potential of the technologies and the enormous danger of using them without proper ethics or controls.

After 2020, with the pandemic, actors have appeared that were not in my field of vision. In the pandemic (and I don't know if afterwards as well, or until when) the social engine falls on the triad 'Departments of Defense, Pharmaceuticals, Psychopolitics' (DFP) that is indicating what people can and cannot do. [4, 5]

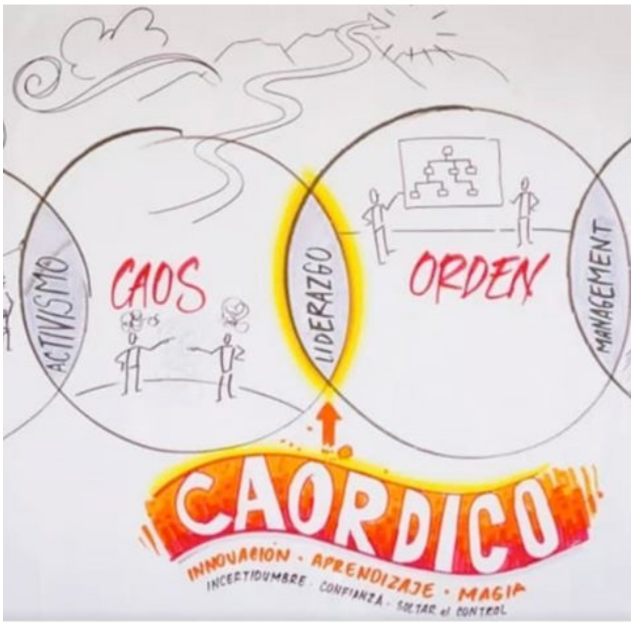

Fig 1. (@dani_sosa) Chaordic space is a form that emerges from non-linear, complex and diverse systems. "On the edge of chaos" is where life innovates, where things are unstructured and flexible enough for new solutions to occur. While the pandemia we are in a chaordic space where the emergence of a new paradigm may occur.

Pandemic as a chaordic space to bring about the necessary paradigm shift
These times of pandemic are a chaordic space (Fig 1); in which the phenomena of emergence of new forms of organization take place. It is important to be aware that in this space everyone is uncomfortable because the natural tendency of human beings is to seek order in their actions. And it is important to remain in this discomfort until new organizational models emerge.

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4 levels of technology and their final destination

In the development of technology, certain leaps occur depending on how 'high' that level of development is:

1 Electricity.- Incipient stages of development (mechanical and electrical) allow certain things to be done (washing machine with a motor and a bucket of water). At this level, the market and mass production make it possible to spread these products in society. At the same time, these technological elements provoke a social transformation (from the car, roads are built, from household appliances, women are incorporated to work outside the home).

2 Computers.- At the next level, with computers, machines can be made to do 'almost anything'. This happens with the advent of digital systems and the introduction of information technology. It is the time of computers and the associated social transformation is that almost every job ends up being done with a computer. The computer is the new interface for a very large number of jobs. And it is everywhere in the world.

3 Internet.- At the next level come communications, cell phones and the Internet. People continue to do the same jobs as in the previous level, but now we communicate with each other in a more instantaneous and efficient way (bring up bread, I'll pick up the children, where are you?, I can't see you). [6, 7] Multimedia content stored on the network and accessible from any device allows anyone to access any knowledge at any time and place. The development of technology soars and artificial intelligence, biometric recognition, monitoring of people are created.

4 Social networks and more.- And we reach this last level (for now) where the developed technologies, artificial intelligence, facial recognition, image interpretation, etc., are NOT converted into products to be sold in the market. They are technologies that are reserved for the Defense Departments (as in its time was the radar, the microwave oven or the structure of the Internet).

What happens at sea 'escapes the conscience'.

From 2000 to 2020 we have developed technologies that make it possible to do anything:
- on the earth's surface, (aerial drones, autonomous vehicles on roads, autonomous robots in homes).
- in space (Elon Musk is going to put as many stars in the sky as there were before him)
- at sea (autonomous ships, submarines, ROV's, underwater mining).

What happens on the earth's surface, although it can be hidden, requires an effort to hide it.
What happens in space, although it can be seen, does not show what may actually be happening.
What happens in the sea is not seen at all. By default, it absolutely escapes the conscience (eyes that do not see, heart that does not feel).

Who then, how and with what ethics, should be able to access this environment that 'escapes consciousness'?

If anyone is to be able to access that environment, then each individual must have the proper ethics to do so. When, as individuals, we feel the peace of mind to think that whoever is there will be doing it in the best possible way, we will be ready for the new paradigm of social organization. [1]

Occupying those spaces at the societal level will have to go hand in hand with an awareness at the individual level of the power of each of our acts. And we will use those acts (and words and thoughts) seeking the best for the one to whom we apply our acts (and words and thoughts).

To move forward, let's work on the individual

I admit the limited nature of human understanding and I make use of two pieces of wisdom advice: [1]
-All worry is vanity" Fray Luis de Leon.
-If the puzzle of society seems too complex to solve, solve the puzzle of the individual that depends only on you. Once solved, turn it around and you will see that the puzzle of Society has also been solved. The puzzle of the Individual and the puzzle of Society are two sides of the same puzzle. Buddhist phrase.

Conclusions
Solve the puzzle of the individual, which depends only on you. Remain unconfortable letting the new paradigm to emerge. Trust in the individuals; there is no future if we don't trust. Social networks, real and virtual, are the new shell where human life will occur.

References

[1] Dalai Lama El universo en un solo átomo. Amazon.
[2] Xulio Fernández Hermida, Profesores universitarios como referentes do novo paradigma necesario para a era Post-Información. 2º Congreso de Innovación Educativa, Universidad de Vigo, 30/6/2011.
https://sites.google.com/site/xuliofh/Home/conferen/profesoresuniversitarioscomoreferentesdonovoparadigmanecesarioparaaerapost-informacion
[3] Xulio Fernández Hermida, Efecto 2020: El cambio de conciencia que necesita el planeta, SIEC 2020, 15 a 18 Jun 2020, virtual
https://www.dropbox.com/s/itnic913n6pyqyu/Efecto2020_Cast_SIEC_v13.pdf?dl=0
[4] Byung-Chul Han. Psicopolítica, Ed. Herder
[5] Gastón Soublette, Entrevista a Gastón Soublette. Limache, mayo, 2020.
https://www.youtube.com/watch?v=KZcbEj9iJnA&feature=youtu.be
[6] Skyler Gisondo, Documental El dilema de las redes sociales. Netflix.
[7] Eduard Punset, Documental El poder de las Redes Sociales.
https://youtu.be/NBvS4Kyqsho

ID20- BIRTH AND DECLINE OF HERCULES CONTROL; HCTECH

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Abstract
A brief overview of Hercules Control's ten years of existence as a marine technology developer. HCTech, with high impact developed products, is not able to bring them to the market.

The people involved (research professor and biologist-entrepreneur), their motivations, knowledge and ways of doing things are analyzed. The environment for this initiative is also analyzed from CIS (the mother company from which HCTech arises), from the Uvigo (as an institution and as support to the researcher), from the Administration (as institutional support to ebt's) and from the bank (as mandatory financial support due to the small size of CIS and the need for advances of project funds with the Administration).

A reflection on the collective aspect of any creation is made. In this case, a lack of entrepreneurial culture in the whole Galician society (administration, financiers, businessmen, workers, and even clients) is to be noted.

Keywords
University SpinOff, marine technology, .entrepreneurial culture, failure,

Introduction
It is said that it is more important to count the failures than the successes. Here we will explain the life of Hercules control, a SpinOff of the University of Vigo that with absolutely groundbreaking products (authentic Killer applications) was not able to survive more than 10 years: from 2011, when we created it to give business form to Hidroboya, until 2021, when it is buried in the bureaucracy of the bankruptcy.

Data, dates and developments.
Created in 2011 by CD and XF after having developed and patented the Hidroboya in the United States with a great technological niche because there is nothing similar in the market. The Hidroboya solves in a clean and effective way the problem of the fouling that are fixed on the sensors, rendering them useless, when you want to measure parameters in the water. I have no doubt that in not many years, or another groundbreaking development appears, or all the sampling of parameters in the sea and inland waters will be done with Hidroboya technology.

The company is participated a few years later by the Uvigo as a Technology Based Business Initiative (iEBT).

Another groundbreaking development is the Ecodraga, a dredge that limits almost to zero the environmental impact of dredging processes (which is currently very high). In this project, small changes, not difficult to implement in many existing suction dredges, are designed to turn the polluting dredge into an ecodredge that does not pollute. The social benefit of implementing this project is enormous. It would be desirable that in a few years, all dredges would be Ecodredges.

Another development of great potential was RAMICA, a buoy that takes samples of seawater, typically in the vicinity of outfalls, performs a fecal bacteria culture and sends the data to a server on land.

Success in research projects
The tamdem CIS-HCTech has a very high success in obtaining R & D projects both regional and national or European. This allows us to maintain 2 or 3 researchers on an almost permanent basis. This is one of the keys to success in the developments because it allows a huge increase in their value as researchers because there is a knowledge that accumulates and is exploited from one project to another.

Characteristics of the people involved
XF is a born researcher. If there is something that motivates him, it is a challenge to solve. He loves inventing (and is good at it) and easily spreads his enthusiasm to the researchers in the group. He works very well as a research group leader.

CD is a long-time biologist. Because he loves to dive, he took his biologist work into the marine environment. With another biologist and a financier he created CIS as a consulting company doing a lot of good work and getting recognition for his good work in his area of influence.

CD enjoys understanding the client's problem and offering them what solves their problem. This closeness to the customer and his problem was a very helpful element to maintain the innovation of what we were doing from the first prototypes in the laboratory to the equipment built, assembled and installed at sea serving that customer.

That same proximity to the customer was a huge hindrance because each customer has a specific need. Thus, we were not able to develop ONE product. A unique product (with its variants if necessary, but unique) that we could produce in a regulated, structured way, and always the same.

Means and motivations
All the years of HCTech, and since we started doing research projects, there was a very good interweaving between company and university: We manufactured prototypes in the laboratory of the Uvigo and did product R&D in the company's workshop.

What motivated us was to innovate up to the installed product (which is an enormous difficulty). As what we like is to invent, we are unable to stop with ONE product and commercialize it (and that kills us!). We are unable to separate R&D from production, sales and putting it into service.

Problems:

- In managing people.
This collaborative environment of inventing and building means that problems in other aspects of the company get mixed up with work in the workshop and even in the laboratory.
As a result, problems in the company become fights with the workers. And this causes that the objectives of the workers are no longer aligned with the objectives of the company. And this is bad; intrinsically bad.
- Random institutional support
Research projects are granted, but payments are infinitely delayed,

causing cash flow problems that undermine morale.

- Random financial support

When public money does not arrive, CD has to resort to banks which, after many years of joint work and without problems, refuse to give credit lines even for projects that have been granted and justified. Shouldn't they be able to collect from the Administration?

- Difficulty in implementing a business model

The long and successful trajectory of CD as a consultant is possibly a limitation when it comes to manage a company like HCTech that must develop and, if anything, manufacture and sell PRODUCTS. Moreover, the products (Hidroboya, Ecodraga, RAMICA, ...) are of an enormous scope (the market for them is worldwide!). Perhaps we did not know how to take the right step here*.

*. Steve Jobs put Apple in the hands of ... because he believed that this was the person who could lead Apple to cover the market that was opening up for these computers in the world! [3]

- Limited business culture

From Galicia as the environment where HCTech lives. This limitation is in everyone. It affects therefore from the administration to the bank, to the entrepreneurs themselves, to the workers and also to the customers, who consider better what comes from outside than what is created here by people from here.

Is it all lost?

Hidroboya and Ecodraga will be the way to measure water parameters and dredging in the near future. Low cost wave buoys and New Oceanography will be everyday in the near future. They will not come from the hand of HCTech, but they will come; and that is more important.

At Martech'11 I presented Hydroboya and the newly created Hercules Control as: "Born in the industrial age to provide services in the information age". In a way creating HCTech was the way to 'go from inventions to products and bring these products to market'. We go from inventions to products ... and it will be others (or another way of doing) that will put those products to serve people.

Conclusion/Self-reflection

The pandemic that started in 2020 was the way out of the hidden problems that we sensed behind our problems with the payments of the Administration and the non-granting of credit lines with the banks when there was an Administration as payer.

Referencias

[1] Web page of Hércules Control.
https://www.herculescontrol.com/
[2] Web page of Xulio Fernández.
http://xuliofh.webs.uvigo.es/
[3] Steve Jobs' speech at Stanford University, subtitles in Spanish
https://youtu.be/HHkJEz_HdTg

ID21- RADAR ON RAIA: HIGH FREQUENCY RADARS IN THE RAIA OBSERVATORY

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Abstract
The RADAR ON RAIA project aims to update and extend beyond the Galician border the High Frequency (HF) radar network that has been operating since 2011 in the framework of the RAIA Observatory. The Project is allowing the establishment of a cross-border collaboration beyond the physical infrastructure itself, developing a sharing strategy of maintenance procedures, validation and data processing on both sides of the border, as well as an easy and public access to all the information.

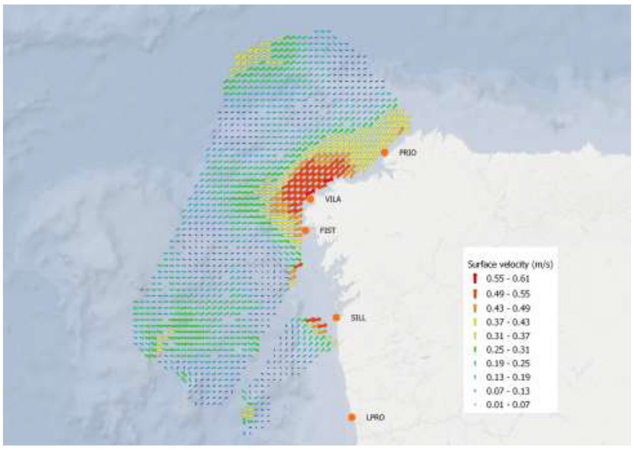
In addition, new products are being developed to exploit the potential of the HF radar technology.

Keywords
HF radar, validation, data management, currents, waves, wind direction, products and services, RAIA Observatory

INTRODUCTION
The RADAR ON RAIA project (http://radaronraia.eu/en/) aims to update and extend beyond the Galician border the HF radar network in the RAIA Observatory throughout the Consolidation of a cross-border HF radar network; fostering and sharing new methodologies of Data validation and management; the implementation of a common Spatial Data Infrastructure and finally the development of Products for end users. RAIA Observatory is a cross-border ocean observing and forecasting system at the coast and shelf of the NW of the Iberian Peninsula (Galicia-Spain and N of Portugal). RAIA relies on three basic pillars: (1) an observing infrastructure, (2) modeling capabilities, and (3) the provision of services through the portal www.marnaraia.org. This observatory was initiated in 2009 and is in constant evolution and facing new challenges. Support received through projects such as RAIA, RAIAco, RAIAtec, MarRISK and more recently RADAR ON RAIA (all financed by the European Regional Development fund (ERDF) through the INTERREG V-A Spain-Portugal program-POCTEP) have enabled the RAIA Observatory to develop and increase its capabilities to support coastal communities.

PRELIMINARY RESULTS
Consolidation of a cross-border HF radar network

Currently, the extension and consolidation of the HF radar network through the integration with other pre-existing ocean observation infrastructures has been achieved thanks to the installation of Leça de Palmeira antenna. A new HF radar station (13.5MHz) for Leça da Palmeira has been installed and integrated (Figure 1) in the HF radar Galician Observation System. At the same time the adjustment of the Cabo Fisterra antenna and the start-up of Ría de Vigo network is taken place to get a greater coverage area in the Galicia and North Portugal region. Besides, it is expected to develop a common management strategy at both sides of the border and a traceability study of the radial and total current data of all HF radar sites (5MHz, 13.5MHz and 42.6MHz).



Data validation and management:

The proper operation of all equipment is ensured thanks to the homogenization of maintenance procedures, standardization of data formats and their accessibility as well as data quality monitoring in near real-time.

Complementarily, the assessment of the accuracy of surface current velocities and waves measured by HF radar systems from a geophysical point of view is tackled by Eulerian and Lagrangian validations. A number of drifters with different drogues have been built and released during lagrangian experiments conducted in the framework of the project, some of which are still ongoing.

Spatial Data Infrastructure:

In order to assuring data accessibility through the development of a spatial data infrastructure, compatible with the RAIA Observatory, some partners are working on: a) the standardization of radial, total and interpolated current data in a single format with a unified list of metadata; b) the consolidation and start-up of the catalogue, display and download services based on the standards for their exploitation. This spatial data infrastructure will be the basis for the development of a training course, which will contribute not only spreading the use of HF data but also fostering ocean literacy initiatives.

Products for end users:

Finally, the development of products and services to support an efficient management of the marine environment based on the HF radar network of the RAIA Observatory is one of the ultimate and promising goals of the project. A wide range of products are being obtained involving all the variables derived from HF radar technology. The design of a web portal, composed of discovery, viewer and downloader services, based on Open Geospatial Consortium (OGC) emerging norms and following INSPIRE directive, will help to distribute not only general products but also specific stakeholders'
applications.

At a starting point, we are working on implementing three specific products: 1) upwelling index derived from HF radarderived surface currents [1] along with other indices such as those calculated by the Spanish Institute of Oceanography; 2) operational observation of waves from HF radar stations [2]; 3) combined product consisting of daily averages calculated from HF Radar and buoy winds, and daily satellite data (SST and Chl a Level 4 products) served by Copernicus. Other products developed in the project include surface currents in a homogenous spatial grid, wind fields from HF radar spectra and Lagrangian Coherent Structures (LCS) from HF radar data.

CONCLUSIONS

The RADAR ON RAIA project aims to update and extend beyond the Galician border the HF radar network that has been operating since 2011 in the framework of the RAIA Observatory. The cross-border infrastructure allows to give support to decision makers in key maritime sectors like Safety and Security at the sea, Marine Renewable Energy or Spatial Planning
which will contribute to the development of a sustainable Blue Economy.

ACKNOWLEDGMENTS

The authors also would like to thank the support of Project RADAR ON RAIA (0461_RADAR ON RAIA_1_E) co-funded by the European Union through EP-INTERREG V A España-Portugal (POCTEP) program

REFERENCES

[1] P. Lorente, S. Piedracoba, P. Montero, M. G. Sotillo, M.I. Ruiz, E. Álvarez-Fanjul. "Comparative Analysis of Summer Upwelling and Downwelling Events in NW Spain: A Model-Observations Approach", Remote Sensing, 12(17), 2762, 2020, doi.org/10.3390/rs12172762

[2] A. Basañez, P. Lorente, P. Montero, E. Álvarez-Fanjul, V. Pérez-Muñuzuri. "Quality Assessment and Practical Interpretation of the Wave Parameters Estimated by HF Radars in NW Spain", Remote Sensing, 12(4), 598, 2020, doi:10.3390/rs12040598

ID22- SPOT AND GPRS DRIFTING BUOYS FOR HF RADAR CALIBRATION

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Abstract
Traditional drifting buoys have been designed to measure the surface currents at a nominal depth of 15m with drogues of 6m height. Herein, in order to assess the performance of HF Radars two designs of Lagrangian drifting buoys have been developed and targeted to provide the vertically averaged velocity of the currents in the first 2 and 0.5 meters of the water column. These are the layer heights of the HF Radars of RAIA observatory. The buoys were made with standard materials and off-the-shelf electronics, to keep costs as low as possible.

Keywords
Drifting Buoy, HF Radar, Observing System.

RADAR ON RAIA HF Radar network and drifting buoys for antenna calibration

The INTERREG V-A Spain-Portugal (POCTEP) project RADAR_ON_RAIA has established a cross-border network of HF Radar antennas from Leça de Palmeira to Cabo Prior [1]. This observatory consists of 5 antennas (Leça, Silleiro, Fisterra, Prior and Vilán) working at 5Mhz and 13.5MHz that sense the currents in the first 2 meters of the water column on shelf overlapping areas. In addition, in the Ría de Vigo another HF Radar system using two antennas (Toralla and Cíes) working at 42.6MHz is providing high-spatial resolution observations of surface velocities in the first 0.5m of the water column.

These antennas are routinely calibrated with transponders to get their correct Antenna Pattern Measurement (APM) for correcting the signals received at each station [2]. However, external calibration with another source of velocity observations is advisable in order to assess the quality of the data gathered by the antennas. One of the best options to undertake such a task is the use of drifting buoys [3].

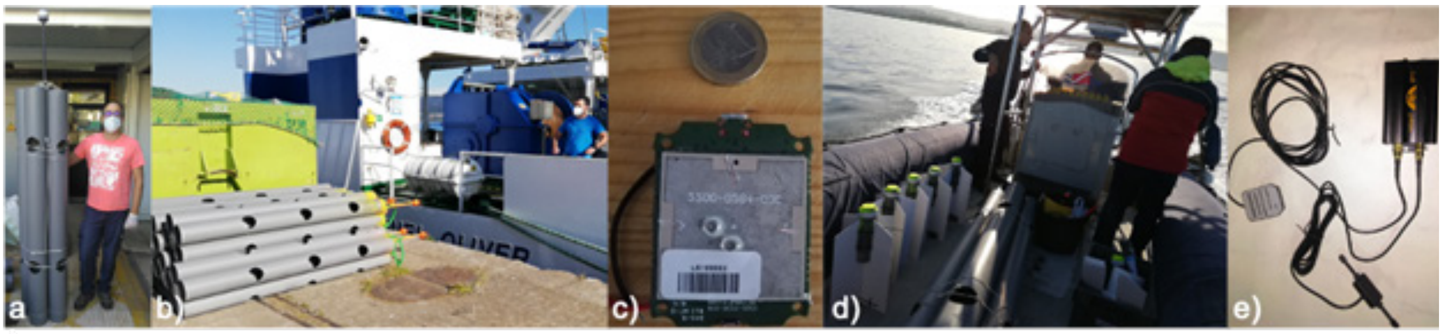
In Spain, there is some tradition in the construction and use of drifting buoys [4, 5] although based on the classic buoy design for the WOCE/ TOGA Surface Velocity Program [6, 7, 8]. The SVP based buoys consist of two parts: a 6m height drogue centred at 15m depth and a surface sphere providing buoyancy and hosting sensors and communication electronics. But, for calibrating the HF Radars the drifters must follow the currents in the upper 2m of the off-shelf waters and the 0.5m of the interior Ría de Vigo waters.

The communication capabilities needed and layer height targeted defined the key design parameters of two new models of drifting buoys, named i) SPOT and ii) GPRS, developed at IIM-CSIC. Both models present high aerial to underwater surface ratios (both greater than 45) to avoid direct wind drag on buoys as much as possible. Also, both were made with standard PVC materials and off-the-shelf GPS/ communication electronics to keep the costs as low as possible.

SPOT buoy

The SPOT drifting buoy (Fig. 1a) uses the SPOT TRACE satellite tracking device (https://www.findmespot.com/en-gb/products-services/spot-trace). This device has a dedicated and standard (no RTK) GPS to fix its geographic position and the Globalstar Satellite Network to transmit the GPS coordinates to the www.findmespot.com internet service where the user can download the tracking records. The internal electronics (Fig 1c) of the SPOT TRACE were installed in a small PVC cage on the top of the aerial part of the buoy (Fig 1a). The main buoy body consists of a 2m height PVC central cylinder, enclosing rechargeable batteries and providing buoyancy to the whole system, surrounded by another 5 PVC open cylinders which augment the water drag area in the submerged volume of the buoy (Fig 1a, b). Once drifting free, the buoy stands vertical and the top of the PVC cylinders keeps level with the sea surface, only the antenna with the SPOT electronics is in the air.

a) First 2.5m height SPOT buoy prototype made
b) seven SPOT buoys ready to get on board R/V Miguel Oliver during IEO Pelacus campaign
c) Spot-Trace device electronics used in the SPOT buoy
d) GPRS buoys ready for deployment
e) TK103B electronics for GRPS buoy.



GPRS buoy

The GPRS buoy relays in a commercial car tracker, the GPS tracker TK103B which includes a standard (no RTK) GPS and a 3G GPRS modem (Fig 1e). The electronics were configured to stream the positions to the IIM-CSIC servers using the UDP protocol. This small (0.5m height) buoy consists of a central PVC cylinder that provides buoyancy, houses the rechargeable batteries and the TK103B and supports the drogue made with two perpendicular low-density PVC planes (Fig 1d).

CONCLUSIONS

In collaboration with MyCOAST and MELOA projects during the Caminha 2020 Oil Spill Exercise two SPOT drifters were released on 22 Sep 2020, one of them lasted more than 170 days recording positions every 3 minutes. Other 7 SPOT buoys were released during the IEO Pelacus campaign in April 2021, six of them seemed to be run over by merchant ships in the Finisterre corridor. The field experiments with GPRS buoys are planned for September 2021, only a short release (2h) was made in the Ría de Vigo in March 2020.

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The authors also would like to thank the support of Project RADAR ON RAIA (0461_RADAR ON RAIA_1_E) co-funded by the European Union through EP-INTERREG V-A España-Portugal (POCTEP) program.

REFERENCES

[1] Piedracoba, S. et al., RADAR ON RAIA: High frequency radars in the RAIA Observatory, Martech 2020, Marine Technology Workshop,16-18 June, 2021.

[2] Barrick, D. E., and B. J. Lipa, Correcting for distorted antenna patterns in CODAR ocean surface measurements, IEEE Journal of Oceanic Engineering, 11(2), 304-309, doi:10.1109/JOE.1986.1145158, 1986.

[3] Terry, J.J., Validación de las Corrientes superficiales oceánicas medidas con Radar HF en la Ría de Vigo usando boyas lagrangianas, Trabajo Fin de Máster, Universidad de Vigo, 60pp, 2018.

[4] García-Ladona, E., et al., Thirty years of research and development of Lagrangian buoys at the Institute of Marine Sciences, Scientia Marina, 80(S1), 141-158, doi:10.3989/scimar.04325.14A, 2016.

[5] Cardona-Díaz, L., Estudio de la corriente superficial en Canarias mediante el seguimiento de boyas de deriva, Tesis Doctoral, Universidad de Las Palmas de Gran Canaria, 227pp, 2015.

[6] Niiler, P., J.D. Paduan, A. L. Sybrandy, and L. Sombardier, The WOCE/TOGA Lagrangian surface drifter, Proceedings of the Oceans'91, IEEE, pp. 839-843, Honululu, doi:10.1109/oceans.1991.627966, 1991.

[7] Sybrandy, A. L., and P. P. Niiler, The WOCE/TOGA SVP Lagrangian drifter construction manual. Scripps Institution of Oceanography Rep. 91-6, 58 pp. [Available from Scripps Insti- tution of Oceanography Library, University of California, San Diego, 9500 Gilman Dr., Dept. 0219, San Diego, CA 92093-0219.], 1991.

[8] Sybrandy A., Niiler P., Sombardier L., Technical improvements to the WOCE/TOGA lagrangian drifter, Proceedings of the Oceans'92, IEEE, vol. 2, pp. 718-720, doi:10.1109/OCEANS.1992.607671, 1992.

ID23- SIMPLIFYING QUALITY CONTROL AND STANDARDIZATION OF CTD DATA UNDER SEADATANET REQUIREMENTS

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Abstract
Sharing marine data through SeaDataNet infrastructure ensures preservation and promotes reusability. Submission of data to this infrastructure demands a set of technical tasks that cover quality control processing, adoption of common vocabularies, implement file format standards and preparation of associated metadata. Although common software tools are made available to Data Centres and/or End Users to facilitate data and metadata preparation, these tasks continuous to be complex and time-consuming. To speed-up this process, a Python-Flask web application is presented here to quality check and create metadata and data according to SeaDataNet requirements. The web tool focuses on CTD vertical profiles, although code could be easily adapted to process other type of records.

Keywords
CTD, Python, SeaDataNet, quality control, interoperability.

INTRODUCTION
SeaDataNet infrastructure manages the large and diverse datasets collected by the oceanographic fleets and the automatic observation systems in the countries bordering the European seas. This infrastructure agglutinates the National Oceanographic Data Centres (NODCs) of 34 countries, active in data collection, and provides integrated datasets of standardized quality on-line.

The Instituto Español de Oceanografía (IEO) acts as NODC and submits to SeaDataNet both data and metadata coming from different types of sensors. Although common software tools are made available to NODCs to facilitate data and metadata preparation (see https://www.seadatanet.org/Software) these tasks continuous to be complex and time-consuming. For example, the technician must use MIKADO software to edit and generate XML metadata entries that follow the ISO 19139 Schema, are INSPIRE-complaint and adopt SeaDataNet Common Vocabularies; NEMO software to convert from any type of ASCII format to common data transport formats; and OCTOPUS software to check the compliance of a file. Additional software must be used to quality check and properly flag each individual record.

Taking into account that hundreds of CTD vertical profiles are recorded by IEO each year and that their associated data usually follows the same format and involves similar processing, a web application has been developed to perform all these tasks straightforward. The aim is to save processing time and to reduce human interaction that could lead to errors or lack of uniformity in data.

METHODS AND RESULTS
Software to parse, quality check, flag and format CTD data and their associated metadata has been coded in Python combined with Flask. Flask is a lightweight WSGI web application framework, easy to get started because there is little boilerplate code for getting a simple app up and running.

To proceed, the user must provide as input to the application a XML file containing information of the cruise, also known as Cruise Summary Report (CSR). The software parses the CSR metadata file and extracts information about the cruise, dates, marine region, the name of the researcher, the project associated to the data acquisition and so on. This information will be used later to ensure that common information is translated unequivocally to formatted data files and also to new metadata.

On the other hand, the user provides a set of CTD files in ASCII format. The software parses CTD files and split the profile to select downcast, check depth, geographical position and time, rename parameters according with common vocabularies, check pressure and apply different quality test. Most of the tests done by the application simply reproduce the procedure recommended by GTSPP[1] and SeaDataNet manual[2]. For example, the application checks if the date is valid, the station is at sea, records are in the expected range (globally and regionally), compares with climatology, detects spikes and performs a density inversion test. Some of these tests have been implemented in the code by adapting the CoTeDe[3] and Python-CTD[4] packages. Depending of the success during the test, a flag is assigned to each individual record and also an overall flag to each parameter and to the entire profile. The application also plots temperature and salinity profiles and their comparison with climatologic values. Bad or suspicious points are highlighted. Data are also formatted to the SeaDataNet MEDATLAS auto-descriptive ASCII format.

Finally, ISO 19139 XML metadata are created for each individual profile following a template. These metadata are known as Common Data Index (CDI) and gives users a highly detailed insight in the availability and geographical spreading of marine datasets that are managed by the SeaDataNet data centres.

CONCLUSIONS
The development of a web application to create CTD data and metadata according with SeaDataNet standards has demonstrated to save time and reduce human errors. With the user experience in mind, a web-based application was chosen to avoid any installation process, skip upgrades and use cross-platform. Obviously, this kind of app requires connectivity to internet and could be useless on board some research vessels. However, the app pursues to create SeaDataNet-conformant data and metadata files; and to do this, a CSR file must already exists in the SeaDataNet infrastructure. This implies processing necessarily in delay mode, minimizing the problem of internet dependency.

REFERENCES
[1] UNESCO–IOC, 2010. GTSPP Real-Time Quality Control Manual. first revised edition. UNESCO–IOC. United Nations Educational, Scientific and Cultural Organization 7, Place de Fontenoy, 75352, Paris 07 SP. IOC/2010/MG/22Rev.
[2] SeaDataNet, 2010. Data Data Quality Control Procedures. Version 2.0 May 2010. Available at https://www.seadatanet.org
[3] http://cotede.castelao.net
[4] Fernandes, F. (2014, August 25). python-ctd v0.2.1 (Version v0.2.1). http://doi.*org/10.5281/zenodo.11396*.

ID24- PROMOTING FAIRNESS IN MARINE DATA AT CENTRO NACIONAL INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

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Abstract
The Spanish Institute of Oceanography is responsible, among other aspects, for scientific and technical advice for the Government's fisheries policy as well as for the protection and sustainability of the marine environment. In this task, it generates a large amount of oceanographic data characterized by its spatial dispersion during acquisition as well as by its different typology. The purpose of both the National Oceanographic Data Center and the GIS team is to safeguard data and to disclose what data exists and where, how and when it has been acquired and, in addition, to provide access to that data through the collaboration with different international data infrastructures like EMODnet or SeaDataNet. To this end, the data and metadata are subjected to quality control and formatted for integration into a national Spatial Data Infrastructure (SDI). This SDI has a GeoNetwork catalogue with ~ 1750 oceanographic campaigns, together with (meta)data and services that are continuously being revised and incorporated. All this with the ultimate goal of making the data increasingly FAIR.

Keywords
Marine data, metadata, GeoNetwork, FAIR, SDI.

INTRODUCTION
The IEO, as National Oceanographic Data Centre (NODC), acts as one of the core partners of the SeaDataNet, an operational infrastructure for managing, indexing and providing access to ocean and marine data. SeaDataNet promotes common standards for metadata and data formats, controlled vocabularies, quality flags and services for marine data management, which are widely adopted and used for improving FAIRness (Findable, Accessible, Interoperable and Reusable) [1]. For years now, the IEO has shared part of its data through this infrastructure, which has meant adopting common standards and also technology for the sake of interoperability. On the other hand, the GIS team has been in charge of adapting metadata and layers to the INSPIRE Directive, and since 2009 has been development the IDEO (Spatial Data Infraestructure of IEO), among other tasks. The need to make data localizable to national authorities and adapt to a wider variety of data has led to the merge efforts of both teams and implement several of the already explored FAIR criteria into a national Spatial Data Infrastructure (SDI).

METHODOLOGY
As a common access point to different resources, the datos.ieo.es landing page has been created and implemented on GeoNetwork, a free software code and environment to catalogue resources referenced in the geographic space (see Fig. 1). This catalogue is the core element of the SDI. In turn, the main element of the catalogue is the collection of oceanographic campaigns. Currently there are about 1750 registered, carried out since 1950. The metadata of the campaigns known as Cruise Summary Report (CSR) follow the ISO 19139, and although similar to those reported to SeaDataNet, here they have been adapted following a XSL transformation to facilitate the data discovery to the Spanish community. The catalogue also has data from tide gauges, the Augusto Gonzalez Linares ocean-meteorological buoy and thermosalinograph measurements, among others. The catalogue is also the entry point to provide GIS layers within the mandate of the EU Marine Strategy Framework Directive and/or important environmental projects such as INTEMARES. The INSPIRE-compliant layers with biological, geological and physical resource data can be found through the catalogue and are linked to the corresponding map services. Finally, the catalogue also has metadata for a variety of interactive resources and applications.

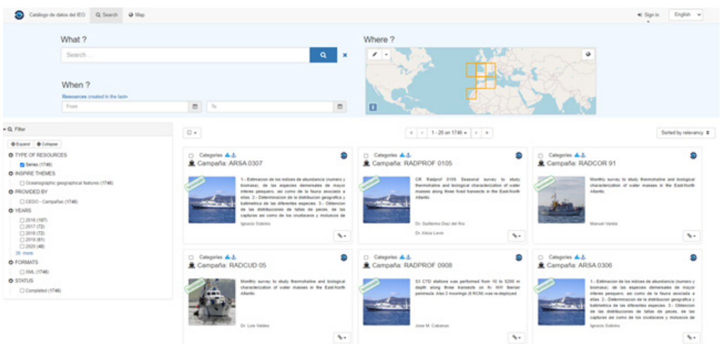

Fig 1. Screenshot of the metadata catalogue (datos.ieo.es), showing here the collection of campaigns.

CONCLUSIONS
Within the IEO, an effort is being made to combine oceanographic data managed by the NODC and those GIS layers in the same portal. At this point, the campaign metadata becomes the parent metadata for easy data localization. In this strategy, an open source metadata catalogue has been chosen and metadata standards (ISO 19139, INSPIRE), common vocabularies, data transport formats and persistent identifiers (PID) have been adopted. However, there is still a long way to add more data to the catalogue, make them accessible, and generalize the use of digital objet identifiers (DOI) to facilitate their discoverability among other aspects.

REFERENCES
[1] Wilkinson, D., Dumontier, M., Aalbersberg, I.J.; Appleton, G.; et al. (15 March 2016). "The FAIR Guiding Principles for scientific data management and stewardship". Scientific Data. 3: 160018. doi:10.1038/sdata.2016.18

ID25- POLYBIUS2020, A COST-EFFECTIVE UNDERWATER AUTONOMOUS VIDEO SYSTEM TO RECORD FISHING GEAR SELECTIVITY PERFORMANCE CATCHING FISH AND MARINE LITTER

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Abstract
Underwater video cameras are a highly versatile survey solution for marine fisheries research. The POLYBIUS2020 is a system specially designed to be used as a tool for video recording inside towed fishing gears. Its design allows for rapid installation onboard commercial fishing vessels as well as for quick reconfiguration and battery replacement. The system is based on simple commercial components to ensure low costs and the opportunity of future studies using house technology. The field experiments carried out have shown the flexibility and ability of the system to obtain key information about fishing selectivity, flora and fauna characterization and marine litter presence.

Keywords
Towed fishing gear, selectivity performance, video transect, discards, marine litter

INTRODUCTION
Despite their high performance in a variety of underwater tasks, Autonomous Underwater Vehicles (AUV) or Remote Operated Vehicle (ROVs) cannot operate inside nets due to their sensibility to hard impacts. The research on selectivity of fishing trawls includes large, heavy and mobile nets, producing hard strikes and impacts during trawling. Image recording makes necessary to securely place the underwater cameras at different points within the net (headline, top panel, codend). To overcome the mentioned issues, a cost-effective video system was built using a low-cost set of devices to record videos inside fishing nets in a very harsh submarine environment where it can be severely shocked and impacted by the net, fish and water flows.

DESING AND APLICATIONS
The system consists of an underwater camera placed in an underwater housing with a range of 250 m depth and a LED light source which are assembled in a protection housing made of Nylon. This material offers good properties in terms of resistance, strength, coefficient of friction and degree of bearing and wear. Besides, its mid-range price compared to other engineering plastics must be taken into account if dimensional stability of parts is required. Additionally, a sheet stabilizes the system and also functions as a sail. Plastic compounds are assembled with stainless steel bolts and nuts which allow to easily replacing damaged spare parts.

The high resolution of digital video/photo allows to get a better knowledge of net performance and to improve the understanding of fishing process. It provides information about the complexity of fish behaviour and ability of marine fauna to escape out the net. This knowledge is key to the design of more sustainable fishing gears with better selectivity characteristic to avoid discards and accidental catch of unwanted species as shown in several projects [1] and has successfully used to obtain information about seabed marine litter [2].

Their low operational cost and the lack of need for skilled personnel make these filming systems highly appealing for many marine scientific researches.

ACKNOWLEDGEMENTS
POLYBIUS2020 system takes part of IEO and CETMAR strategy to support new technological developments. It has been used during the trials of the Projects DESCARSEL-IEO[1] and CLEANATLANTIC[2] with excellent performance to marine litter monitoring.

Fig 1. POLYBIUS2020 design

2. Attachment and position in the net

Fig 3. Video recording during fishing

REFERENCES
[1] Project DESCARSEL-IEO Study of strategies to reduce discards and unwanted species, fishing selectivity and fish survival. http://datos.ieo.es/geonetwork/srv/api/records/urn:SDN:CSR:LOCAL:29MO202008290
[2] Project INTERREG-CLEANATLANTIC Tackling Marine Litter in the Atlantic Area. http://www.cleanatlantic.eu/

ID26- EMSO ERIC: A CHALLENGING INFRASTRUCTURE TO MONITOR ESSENTIAL OCEAN VARIABLES (EOVS) ACROSS EUROPEAN SEAS

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Abstract
The European Multidisciplinary Seafloor and water Column Observatory (EMSO, www.emso.eu) is a distributed research infrastructure (RI), composed of fixed-point deep-sea observatories and shallow water test sites at strategic environmental locations from the southern entrance of the Arctic Ocean all the way through the North Atlantic through the Mediterranean to the Black Sea. Working as a single powerful system, it is a valuable new tool for researchers and engineers looking for long time series of high-quality and high-resolution data to study and continuously monitor complex processes interactions among the geosphere, biosphere, hydrosphere and atmosphere, as well as to test, validate and demonstrate new marine technologies.

Keywords
European Research Infrastructure, ocean observation systems, deep seafloor and water column, EOVs

INTRODUCTION
EMSO is a European Research Infrastructure Consortium (ERIC) legal entity since September 2016 currently with nine members: Italy, France, Greece, Ireland, Portugal, Romania, Spain the United Kingdom, and the Kingdom of Norway. The host country of EMSO ERIC is Italy and the statutory seat of the organization is established in Rome.

EMSO comprises 14 multisensor Regional Facilities (RFs) distributed in 11 deep-sea observatories (cable and stand-alone) and 3 shallow water test bed (Fig.1), with the aim to lead the advancement of knowledge of ocean processes and to understand and evaluate the anthropogenic effects in the water column, seafloor and sub-seafloor, promoting an interdisciplinary and multidisciplinary approach [1].

EMSO distributed Research Infrastructure
EMSO ERIC includes open-ocean, water-column moorings and seafloor observatories at key environmental locations such as the high-latitude Nordic Seas, at the entrance to the Arctic, the North Atlantic, through the Mid-Atlantic Ridge spreading centre, and intraplate volcanic areas in the Canarias entering the Mediterranean through the Eurasia-Africa collision zone and through the seismic and volcanic zones of the central and eastern Mediterranean ending in the anoxic Black Sea.

Fig. 1. EMSO Regional Facilities deep-sea observatories (empty circles), shallow-water test sites (solid circles) and the new observatories added (red circles)

These large-scale RFs provide high-quality data at continental scale integrating the EMSO time series with data acquired from other locations.
EMSO ERIC promotes the development and progress of marine technologies and responds to environmental demands of European society, such as the Blue Growth Strategy, United Nations decade of the Oceans Science for Sustainable Development and Horizon Europe, EU framework programme. Each RF provides important services and products as a distributed infrastructure, EMSO increases data availability and continuity throughout European seas, and address broader questions. Furthermore, the integrated observatory infrastructure can enhance collaboration among the nodes to provide wider-reaching and higher-impact services.

CONCLUSIONS
The sea level rise as well as warming and acidification of the oceans are indicators of ongoing, global change. In addition, contamination of nutrients by anthropogenic activities, the proliferation of toxic algae, and the harmful pollution of millions of tons of plastic waste in the sea, are significant challenges within the marine environment. EMSO ERIC aims at monitoring and disseminating these environmental processes and the complex interactions between geosphere, biosphere and hydrosphere. EMSO's main scientific objective is to help scientists to understand these global processes through time-series on EOVs and to stimulate the development of new technologies and knowledge through the adoption of standards in sensors increasing its interoperability and collaboration between environmental RIs [2].
Modern society requires a better understanding of the ocean [3]. EMSO ERIC, with its wide range of innovative and novel services integrating top-quality

science, engineering, logistics, data management, communication, education, innovation and industry addresses this requirement head-on while also providing valuable social benefits to its member states in the form of employment and economic development.

REFERENCES

[1] Favali, P., Beranzoli, L., De Santis, A. (2015). Seafloor Observatories: A New Vision of the Earth from the Abyss. Springer-Praxis books in Geophysical Sciences, Springer-Verlag Berlin Heidelberg, doi:10.1007/978-3-642-11374-1, 676 pp.

[2] Dañobeitia, J.J., Pouliquen, S., Johannessen, T., Basset, A., Cannat, M., Pfeil, B.G., Fredella, M.I., Materia, P., Gourcuff, C., Magnifico, G., Delory, E., del Rio Fernandez, J., Rodero, I., Beranzoli, L., Nardello, I., Iudicone, D., Carval, T., Gonzalez Aranda, J.M., Petihakis, G., Blandin, J., Kutsch, W.L., Rintala, J.-M., Gates, A.R., and Favali, P. (2020). Toward a Comprehensive and Integrated Strategy of the European Marine Research Infrastructures for Ocean Observations. Frontiers in Marine Science, 7,180, doi:10.3389/fmars.2020.00180.

[3] Ruhl, H.A., André, M., Beranzoli, L., Çağatay, M.N., Colaço, A., Cannat, M., Dañobeitia, J.J., Favali, P., Géli, L., Gillooly, M., Greinert, J., Hall, P.O.J., Huber, R., Karstensen, J., Lampitt, R.S., Larkin, K.E., Lykousis, V., Mienert, J., de Miranda, J.M.A., Person, R., Priede, I.G., Puillat, I., Thomsen, L., and Waldmann, C. (2011). Societal need for improved understanding of climate change, anthropogenic impacts, and geo-hazard warning drive development of ocean observatories in European Seas. Progress in Oceanography, 91, 1-33.

ID27- EMERGING BIOTECHNOLOGY FOR AQUACULTURE: CRYOPRESERVATION

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Cryopreservation is the only reliable method for long-term storage of biological material that guarantees genetic stability. This technique can be extremely useful for the conservation of endangered species and restock natural populations for declining species. Cryopreservation has also become a powerful tool for improvement of hatchery spat and enhance competitiveness of the aquaculture industry. Cryopreservation can provide a sustainable supply of competent shellfish juveniles irrespective of the season; hence it can avoid the reliance to wild catches. It has been really promising to ensure the implementation of selective breeding programs on aquaculture, enabling the possibility to make crosses of preserved families whose genes provide resistance to adverse events or certain diseases, which is also really encouraging for the restock of natural populations and decrease of fishing pressure on shellfisheries. The cryopreservation knowledge focused on aquatic species is scarce and it is under development in many areas. In our lab we have developed and tested cryopreservation of species of aquaculture interest like mussels, clams, sea urchins or sea cucumbers. The aim of this work is to showcase successful applications of cryopreservation that could be used by aquaculture companies and related sectors right now, closing the gap between academia and private sector by providing an accurate portray of this new biotechnology.

ID28- SILENCIO: INTRODUCTION OF ELECTRIC PROPULSION TO SMALL INSHORE FISHING BOATS TO REDUCE THEIR IMPACT IN THE ENVIRONMENT

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Abstract
Human activities affects each environment, even the most remote, and the acoustic impact that these activities generate on the marine environment is not an exception. The Silencio project aims to developed innovative and sustainable solutions to reduce the impact of fisheries and shell-fisheries in ecosystems, mainly noise but also carbon footprint, by the assessment of the use of electric propulsion by small inshore fishing boat. Besides, the knowledge about the sources of underwater noise in areas under high fishing pressure will be improved by the characterization of the ambient noise in Rías Baixas. Further, the project will spread the idea of an environmentally sustainable, socially responsible and economically viable extractive sector.

Keywords
Underwater ambient noise, noise monitoring, Rías Baixas, Electric engines, Inshore fishing

CONTEXT
The human introduction of noise in the environment is considered one of the most stressful disturbances for animals and plants in the terrestrial environment [1]. However how the marine noise is and how water ecosystems are affected by the anthropogenic noise-sources have been less studied. Several studies and reviews characterize wide natural soundscapes and their vary sources as rain, ice-melting or underwater volcanos [2, 3]. Other authors highlight that numerous groups of animals are using the sound to perform their biological and social functions -not only marine mammals [4] but also less evolved animals as crustaceous [5]- and they evidence that human activities in the soundscape, especially impulsive noise, are impacting in their hearing, communication capability, behaviour and physiology, from invertebrates [6] to fishes [7] or cetaceans [8].

In order to assess and mitigate this impact some policy frameworks, as United Nations or the European Union by several programmes, are encouraging and supporting initiatives and projects that improve the knowledge of underwater noise and propose innovative solutions to alleviate its effects in the ecosystems and to achieve a good marine environmental status (e.g. Implementations of the Marine Strategy Framework Directive MSFD, 2008/56/CE).

On this context Silencio Project arises (December 2020-Decembre 2021). Silencio´s main goal is to establish the bases for a more sustainable and noiseless fishing and shell-fishing activities, contributing to minimize their acoustic impact. Silencio´s team aimed objectives to reach this purpose:

(1) Improvement of knowledge about the principal sources of marine noise in areas with high fishing and shell-fishing pressure by the characterization of the ambient noise in Rías Baixas, an incomparable natural seascape, where there are several areas with special protection of natural values. Besides, this area is (and has been) exposed to significant inshore-fishing pressure.

(2)Development of innovative and sustainable solutions to reduce the impact of fishing (and shell-fishing) activities in the environment (noise and carbon footprint) by the assessment of the use of electric propulsion by small inshore fishing boat.

(3) Strengthening the fishing sector´s commitment with the problem of marine noise and spreading the idea of an environmentally sustainable, socially responsible and economically viable extractive sector.

Therefore, Silencio Project is aligned with the priorities of the European Maritime and Fisheries Fund (EMFF), especially with priority 1 "Fostering sustainable fisheries and the conservation of marine biological resources".

CHARACTERIZATION OF UNDERWATER AMBIENT NOISE IN RÍAS BAIXAS (GALICIA, NW IBERIAN PENÍNSULA)
Cortegada platform, one of the recording stations of RAIA Observatory (http://marnaraia.org), is settled in the Ría de Arousa, near the Illa of Cortegada, next to the border of the National Park NPMT Illas Atlánticas but into the Marine ZEPA Rías Baixas (ES0000499). It was installed in 2008, therefore more than 10 years of several oceanic data -like Temperature, Conductivity or water currents (direction and velocity)- and meteorological -like temperature, humidity, wind (direction and velocity) have been recorded.

A hydrophone (IcListenHF) is also installed in Cortegada since 2016, although the record exhibits several gaps and changes of configuration. Currently, in the framework of SILENCIO project, an IcListenHF hydrophone is performing at a sampling rate of 51.2 kHz, recoding 1 minute of raw data every 3 minutes. Data are processed every 36 minutes, focused in computing sound pressure levels (SPL re luPa) at the targed frequences of the MSFD (63 Hz and 125 Hz) as well as 2 kHz and global (full band), and the results are sent in real-time to Emodnet Physics Portal (www.emodnet-physics.eu) in order to make data accessible and available to the community. Afterwards, raw data are downloaded directly in Cortegada Platform each maintenance visit, every 2 or 3 weeks.

The ambient noise records have been treated and studied by the Universidade de Vigo, an international reference Group in Underwater noise, in order to detect natural and human sources of noise. Clicks and whistles of cetaceans have been located in Cortegada´s record.
Besides, Obsea (Expandable Seaflor Observatory from UPC) located on the seabed off the coast of Vilanova i la Geltrú (Barcelona, NE Iberian Península) will install another IcListenHF hydrophone to compare the underwater sound record and to assess the capability of applicating the algorithm developed in the project to other noise records.

THE ASSESSMENT OF THE USE OF ELECTRIC PROPULSION BY SMALL INSHORE FISHING BOAT.
Small Inshore fishing boats carry out lots of different extractive activities depending on the type that fishing gear that is allowed to use, the closure of fishing seasons (to protect fishies and shellfishies species), the ocean-meteorological conditions or the market value of their captures.

Firstly, Silencio´s team is characterizing inshore fishing fleet by the use of the Register of Fishing Vessels of Galicia [9], especially data for the Fishing guild that collaboratare with Silencio. Inshore fishing boats up to 10 and 7 meters of length are studied attending to their fishing gear and engine power to distinguish the more usual inshore fishing-activity type. Afterward all this fishing types are typified in terms to time, distante, kind and uses of the engine, gas consume, docker facilities, etc. Some of them are being also tracked by a GPS device.

Silencio´s team will assess the capability of current affordable technology to perform some of these fishing activities attendig to autonomy, volume and weight of batteries, price, profitability, etc. Furthermore, some of these activities will be recreated by the use of some electrified outboard engines, developed in Silencio. Besides, regarding to the reduction of the impact this innovative solution could involve, some experiencies will be recreated to cuantify the noise and carbon footprint reduction.

CONCLUSIONS

Silencio Project is an small but ambitious project that contributes to the underwater noise knowledge and to clarify which is the human effect in the marine soundscape. In addition, the outboard engine electrifiction of small inshore boats will be evaluated to the feasibility of reducing the anthropogenic marine noise. Further information will be available in the project website: https://www.programapleamar.es/proyectos/silencio-introduccion-de-sistemas-de-propulsion-electrica-en-embarcaciones-pesqueras-de and in different outreach events. Please, be in contact by @SILENCIO_CETMAR.

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REFERENCES

[1] Pijanowski et al., “What is soundscape ecology? An introduction and overview of an emerging new science”, Landscape Ecology, vol. 26, pp. 1213–1232, 2011.

[2] Howe et al., “Observing the oceans acoustically”, Frontiers in Marine Science, vol. 6, pp. 42, 2019.

[3] Duarte et al., “The soundscape of the Anthropocene ocean”, Science, vol. 371, 583, 2021.

[4] Erbe et al., “Communication masking in marine mammals: A review and research strategy”, Marine Pollution Bulletin, vol. 103, pp. 15–38, 2016.

[5] Montgomery et al., “Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans”, Advances in Marine Biology, vol. 51, pp. 143–196, 2006.

[6] Walsh et al., “Noise affects resource assessment in an invertebrate”, Biology Letters, vol. 13, 20170098, 2017.

[7] Simpson et al., “Anthropogenic noise increases fish mortality by predation”, Nature Communications, vol. 7, 10544, 2016.

[8] Erbe et al., “The effects of ship noise on marine mammals: A review”, Frontiers in Marine Science, vol. 6, 606, 2019.

[9] https://www.pescadegalicia.gal/rexbuque/

ID29- UNDERWATER LIGHT ESTIMATION USING THE OBSEA CAMERA

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Abstract
This is a description of the method used in the OBSEA observatory to obtain a value for the amount of light present in the seafloor using the existing video surveillance camera.

Keywords
Cabled seafloor observatories, light measurement, underwater camera.

INTRODUCTION
OBSEA is an underwater seafloor observatory located in a shallow water environment at 20m depth and 4km offshore Vilanova i la Geltrú coast. OBSEA is equipped with many oceanographic instruments one of them is a PTZ camera [1]. The camera is a Sony SNC-RZ25N model for video surveillance mounted inside a hemispherical glass dome model OPT-06 developed by "Ocean Presence Technologies". With this camera is possible to take pictures of the environment of the observatory [2]. Due to the observatory is not equipped with any light detector, it has been considered to use the video surveillance camera to estimate the amount of light present at the seabed. Due to the camera is not providing any value for the light measurement an algorithm has been developed to make a first estimation from the normal parameters that can be obtained with a camera. All the algorithm for the calculations and control of the camera has been developed with a LabVIEW graphical programming.

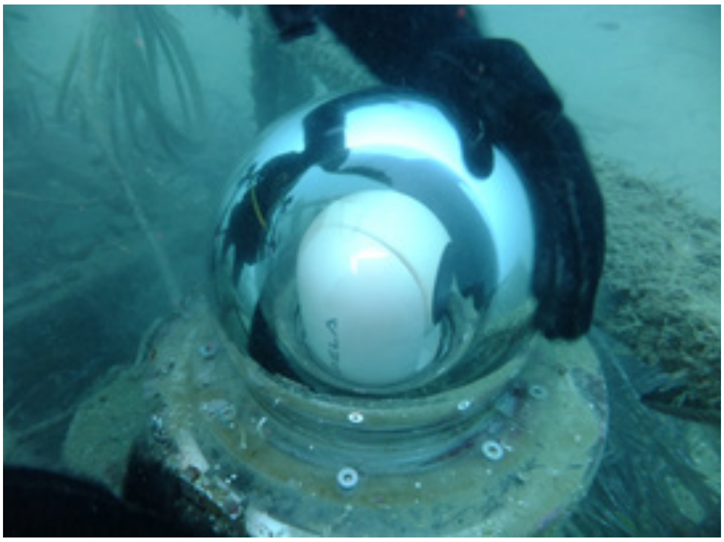

Fig 1. Underwater camera OPT-06

MATERIAL AND METHOD
To be able to obtain an estimation of light quantity proportional to the real light present in the seafloor, it has been used the mean value of luminance of the captured jpeg image and three configuration parameters of the camera: the shutter speed, iris and gain. In addition, to avoid influence of the white balance in the measurement, it has been configured a fixed white balance with the parameters of R and B gain more adequate for the most part of light conditions. The first step of the algorithm is to calculate de exposure value (EV), that is a logarithm function of exposure time (T) and F number or iris aperture (N):

$$EV = log^2(N2/T)$$

At the same time is obtained the illuminance value (Y) of the taken picture. The illuminance is the mean value of the pixels (R, G and B) of the picture compensated by a weight for the colour of the pixel. In order to improve the feasibility of the measurement, every measurement has been done taking 3 pictures with different values of EV. At the same time to have a quality indicator of the measure it is registered if the picture was correctly exposed or if it was over or under exposed.

$$Y = (R*0.2126 + G*0.7152 + B*0.0722) / 256$$

The method to evaluate the quality of the exposition is observing the histogram of the picture. Only histograms with all the pixel values different from 0 and 255 are accepted. This method avoids that dark or overexposed images can be used to compute the light of the scene.

Then the value for the light (L) is a function of the Exposure Value (EV), Illuminance (Y) and Gain (G).

$$L = Y * (A^{EV}) / G \quad \text{where} \quad A=1.707$$

Where A is an empirical value obtained from the measurements that minimizes the variability of the measurements in function of the exposure value.

Due to all this method has been developed without the possibility to calibrate the measurements in a known environment, the obtained value of light does not have physical units and it is usable only as a relative measurement of the light variability along the time. In any case, when it will be possible to recover the underwater camera from the seabed and bring it to the laboratory a calibration process will be done to convert the light measurement to Lux.

After measuring the light periodically for 4 months is possible to see the light variability in the observatory in the following pictures. In the Fig.2 is shown a 9 days sample of the calculated data, the unfiltered data has all the measures from the camera, the filtered one has the only the measures coming from images correctly exposed. Due to most of the images taken during the night are underexposed filtered data only has information of the day.

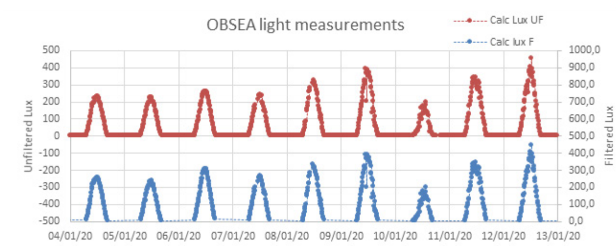

Fig 2. Seafloor light measurement

Fig.3 shows data organized in hours and days. The first day of the test was 13/11/2019 and the last (#118) was 11/03/2020. This figure has been done averaging data in periods of 15 minutes and is possible to see how is increasing the daylight time along the year. It is possible to see also that in some periods there is very few light during the day, these periods of darkness are done to big storms that move so much sediment that they do not let any light reach the sea floor. From these data been has extracted the schedule of daylight in the seafloor and compared to the official sun schedule. In fig.4 can be seen that light is present in the observatory around 20 minutes before the sunrise and 30 minutes after the sunset. In the fig. 5 can be seen the histogram of the dataset where the highest values are concentrated between 10:00 and 14:00 and the lowest values between 16:00 and 8:00.

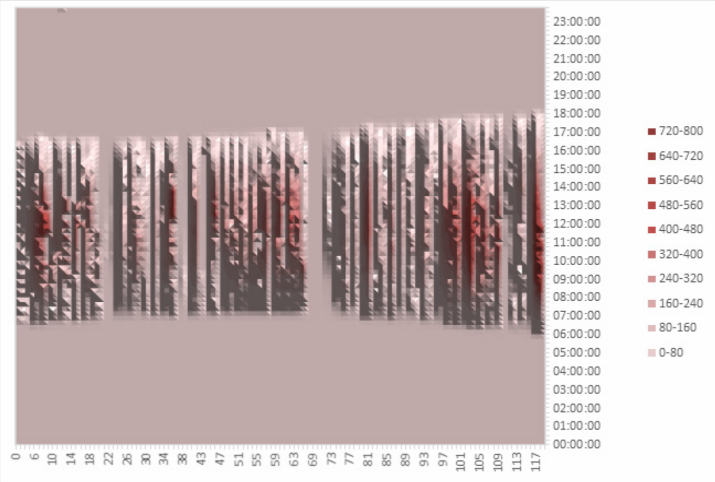

Fig 3. Mean light measurement per hour and day

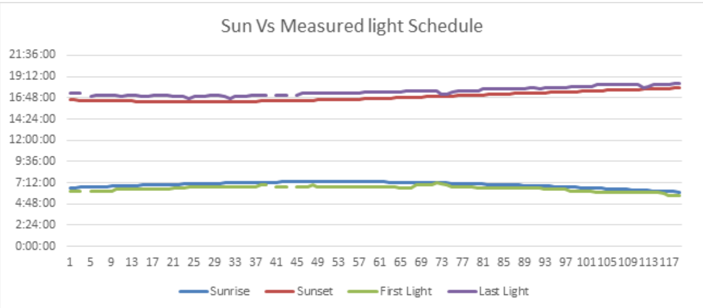

Fig 4. Sunrise and Sunset versus measured light schedule

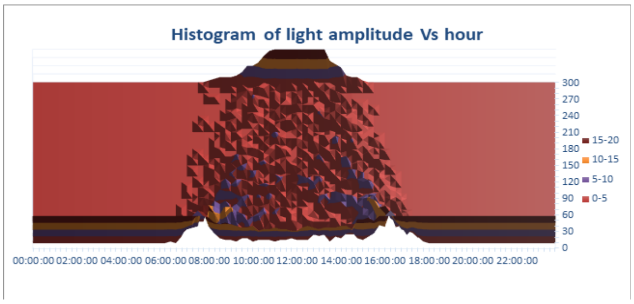

Fig 5. Light histogram

CONCLUSIONS

In conclusion, this method of underwater light measurement can be useful for the correlation of other measurements that are being done in the observatory using the camera such as the marine species monitoring.

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REFERENCES

[1] Nogueras Cervera, Marc; Santamaria Català, Josep; Mànuel, Antoni. "CONSTRUCTION OF THE OBSEA CABLED SUBMARINE OBSERVATORY. Instrumentation viewpoint, 2007, Núm. 6, https://www.raco.cat/index.php/Instrumentation/article/view/84612

[2] Nogueras Cervera, Marc; del Río Fernandez, Joaquín. "Automatic Panoramic Image Creation System from OBSEA PTZ Underwater Camera". Instrumentation Viewpoint, 2019, Núm. 20, https://www.raco.cat/index.php/Instrumentation/article/view/348172.

ID30- ARDUINO CONTROLLED VALVOMETRY EQUIPMENT FOR LABORATORY MONITORING

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Abstract
High-Frequency Non-Invasive (HFNI) instruments are currently used in bivalve mollusks in order to use them as bioindicators of the local conditions of the environment. Under the STRAUSS project an Arduino controlled equipment has been developed to log the valve movements activity of clams (Polititapes rhomboides) using Hall-effect sensors. The equipment is able to record at 10Hz the signals of 16 Hall-sensors, to store the records in internal microSD cards and to send the stream of data to a personal computer for storing and plotting them in real-time.

Keywords
HFNI, Arduino, Hall-effect, bio-sensor.

MOTIVATION

There is an increasing demand to fully understand the impacts of coastal environments variability on marine fauna. Particularly, when socioeconomic implications exist, e.g. shellfisheries. Currently, the use of biosensors is playing a crucial role on exploring either natural environmental variability or a number of natural and anthropogenic stressors while emerging monitoring systems and technologies, as High-Frequency Non-Invasive (HFNI) instruments, are also being very useful [1]. Accordingly, since they are (bio)indicators of the local conditions, bivalve mollusks are target organisms for this type of studies combining biosensors and HFNI. From valve´s movements of these organisms it is possible to infer individuals' health or status [2]. Amplitude of valve opening and tendency to (or fully) closure would be an indication of stress and the magnitude of these changes in behaviour may offer signalling of environmental change. A number of monitoring devices have been implemented for both laboratory or field experiments to be used as early warning alerts in environmental monitoring through changes in animal´s behaviour (e.g. MolluSCAN eye; [1]). The principle for the use of these (bio)sensors includes the gluing a Hall-effect sensor in one valve and a magnet in the other valve, the intensity of the magnetic field felt by the sensor will change with the distance between the two valves. The Hall-effect sensor outputs the magnetic intensity as voltage levels that can be logged with dynamic-strain recording devices (DC 204R, Tokyo Sokki Kenkyujo Co., Japan).

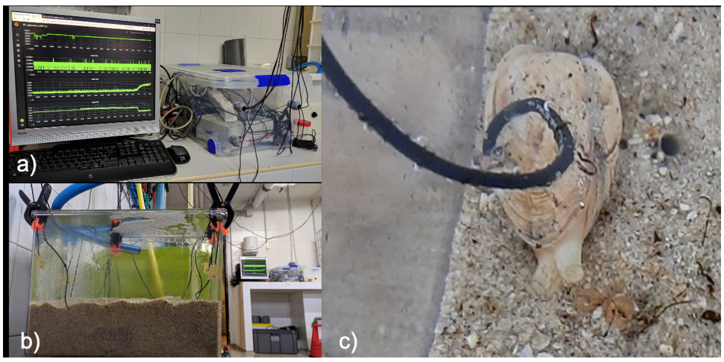

Fig 1. a) Grafana dashboard on the TFT screen and the equipment electronics stored in the plastic box, b) small tank with 4 buried clams monitored with hall sensors as shown in c) close-up.

The method to evaluate the quality of the exposition is observing the histogram of the picture. Only histograms with all the pixel values different from 0 and 255 are accepted. This method avoids that dark or overexposed images can be used to compute the light of the scene.

Then the value for the light (L) is a function of the Exposure Value (EV), Illuminance (Y) and Gain (G).

HFNI technology has been already successfully applied to mussels in Galician waters and laboratory studies, under natural variability rhythms of mussels attached to cultivation system (rafts [3]) and under toxic Alexandrium minutum exposure in experimental tanks [4], respectively. Recently, the impact of ocean acidification and seawater warming on populations of the Mediterranean mussel Mytilus galloprovincialis were also explored using this technology [5,6]. In these cases, very expensive devices were used (DC 204R) with limitations for the number of organisms to be tested. Since another cheaper options are available [7], our intention is to implement the HFNI technology with lower costs for real-time monitoring of the behaviour of marine bivalves. Pursuing that, we have developed an Arduino controlled equipment (Figure 1) using this open source electronic ecosystem and also, as much as possible, open source software.

EQUIPMENT DESCRIPTION

The hardware components of the equipment were integrated in a Mega2560 R3 Arduino board (Table 1). The equipment has been designed to operate as part of a real-time monitoring system using a personal computer (PC). A USB cable is used to communicate the PC with the Arduino. A microSD card adapter serves as backup storage system, independent from the PC, and a real time clock (RTC) is used to timestamp each record stored in the SD card. The data stream arriving at the PC through the USB is received by a Python script that logs the records as ASCII files in the hard disk of the PC and also transfers the data to a MySQL Server running in the computer. The MySQL dabatabase is connected to a Grafana visualization platform that, in turn, can plot the data through dashboards in any Internet browser.

Component description	Model/Version
Hall-effect Sensor	49E
Cable from sensor to AD converter	MOGAMI AWG33 -3C
Real Time Clock Module	Adafruit DS3231
MicroSD Card Adapter Module	HW-115
Analog-to-Digital Converter Module	Adafruit ADS1115
Power Supply Unit	Mean Well 5V-5A
Arduino board	Elegoo Mega2560 R3
Workstation	Dell Precision T1700 Windows10
Python Script	Python 3.9
Database Software	MySQL Server 8.0.20
Visualization	Grafana 7.3.6 and FireFox/Chrome/Safari

Table 1. Equipment components

CONCLUSIONS

In the context of STRAUSS project, a real-time monitoring system has been developed, using an Aduino controlled equipment with 16 Hall-effect sensors sampled at 10Hz, to log the valvometry activity on clams Polititapes rhomboides in order assess the effects of temperature and turbulence as stress factors.

ACKNOWLEDGMENTS

The authors also would like to thank the support of Project STRAUSS (PID2019-106008RB-C21) funded by the Spanish Ministry of Science and Innovation.

REFERENCES

[1] Andrade, H., Massabuau, J,C., Cochrane, S., Ciret, P., 627 Tran, D., Sow, S., and Camus, L., "High Frequency Non-invasive (HFNI) Bio-Sensors As a Potential Tool for Marine Monitoring and Assessments", Front. Mar. Sci. vol. 8, pp. 137, 2016, doi: 10.3389/fmars.2016.00187

[2] Nagai, K., Honjo, T., Go, J., Yamashita, H., Seok Jin, O, "Detecting the shellfish killer Heterocapsa circularisquama (Dinophyceae) by measuring bivalve valve activity with a Hall element sensor", Aquaculture vol. 255, pp. 395–401, 2006

[3] Comeau, L.A., Babarro, J.M.F., Longa, A., Padin, X.A., "Valve-gaping behavior of raft-cultivated mussels in the Ria de Arousa, Spain", Aquacult Rep vol. 9, pp. 68–73, 2018, doi: 10.1016/j.aqrep.2017.12.005

[4] Comeau, L.A., Babarro, J.M.F., Rioboó, P., Scarratt, M., Starr, M., Tremblay, R., "PSP-producing dinoflagellate Alexandrium minutum induces valve microclosures in the mussel Mytilus galloprovincialis", Aquaculture vol. 500, pp. 407-413, 2019, doi: 10.1016/j.aquaculture.2018.10.025

[5] Lassoued, J., Babarro, J.M.F., Padín, X.A., Comeau L.A, Bejaoui, N., Pérez, F.F., "Behavioural and eco-physiological responses of the mussel Mytilus galloprovincialis to acidification and distinct feeding regimes", Mar. Ecol. Prog. Ser. Vol. 626, pp. 97–108, 2019, doi: 10.3354/meps13075

[6] Lassoued, J., Padín, X.A., Comeau, L.A., Bejaoui, N., Pérez F.F., Babarro, J.M.F., "The Mediterranean mussel Mytilus galloprovincialis: responses to climate change scenarios as a function of the original habitat", Conserv. Physiol. vol. 9(1), pp. coaa114, doi:10.1093/conphys/coaa114

[7] Gandra, M., Seabra, R., Lima, F.P., "A low- cost, versatile data logging system for ecological applications", Limnol. Oceanogr: Meth. vol. 13(3), pp. 115-126, 2015, doi: 10.1002/lom3.10012

ID31- A VISUALLY-GUIDED POSITION CONTROL METHOD, IN UNDERWATER CONDITIONS, USING AN INEXPENSIVE REMOTELY OPERATED VEHICLE.

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Underwater interventions have become a trend in the past years, from industrial applications like installing oil pipes, to rescue applications like retrieving a black box from a sunken plane. The increasing interest in underwater exploration has led the scientific community to put efforts into developing new technologies to enhance underwater operations. The idea of giving the vehicle a semi-autonomous behavior comes from the fact that sometimes manual teleoperation can be inaccurate if the operator does not have enough skill to manipulate the robot. Even if the operator is skilled enough, in an underwater environment where the currents can cause some disturbances and the vehicle needs to perform a task that requires precision, such as grabbing an object, it is safer that the vehicle can aid the user by positioning itself at an optimal location to execute the desired task. To provide autonomous position control with respect of an object to an underwater vehicle, a proper recognition of the object and a way to measure its features is required, amongst other things.

There are three main problems while dealing with underwater image capturing [1]. The first is described as view-disturbing noises, this includes any floating matter that can produce noise in the camera's field of view, such as small fishes, bubbles or sand particles. The second problem occurs due to the refraction of light. Objects are appreciated differently according to the environment where they are placed and their respective refractive index. This causes distortions that affect the measurements of the position and shape of the object. The third problem is the light attenuation. The intensity of the light will decrease as the distance between the object and the camera increases.

To solve the issues of underwater image capturing some techniques have been developed such as the Multi-View Laser Reconstruction [2] method which uses a laser emitter and a camera attached to the forearm of a robotic arm. The arm allows the camera and the laser to be moved across the scene. While the laser scans the environment, the camera is recording the image, in this way the scene can be reconstructed, and a 3D model of the target object can be obtained. Another proved method [3] to identify objects underwater proposes to use stereo vision or laser reconstruction to obtain a model of the scene. Then using a Random Sample Consensus (RANSAC) segmentation method the background of the object is removed. A second run of the RANSAC algorithm is used to approximate the object to a geometrical figure.

Although the state of art methods provide a novel and successful approach in the object recognition task, they require high-end technology such as lasers. Thanks to the fast-paced growth of open-source software and hardware communities, underwater teleoperated drone technology has recently become accessible to a wider public. The develop of low cost Remotely Operated Vehicles (ROV) has allowed institutes and universities to support the research in the underwater exploration and intervention topics. The BlueROV2 is a low-cost underwater vehicle that relies only on a video camera as a visual input and its LED lights as a brightness variable control input. In this case it is necessary for the case study to use algorithms and methods which can be implemented using just a camera. Given the architecture of the BlueROV it can be easily programmed using python, which also gives us access to the OpenCV library, a free access library that contains a large compilation of algorithms for computer vision applications.

The goal of this case study is to propose and test a vision algorithm using the OpenCV library that can segment a specific object, in this case a cylindrical tube, under the water and provide a setpoint that can later be used for a control task. This abstract reports the preliminary results of implementing such algorithm.

The main idea is to use the moments of a segmented image where the object is outlined to mark the center of the object, this way it can be used as a reference for the vehicle to move along the z and y axis. (See vehicle coordinate system, Fig. 1a).

For the reference across the x axis, we can take advantage of the shape of the object and use the Hough lines algorithm to trace two vertical parallel lines on each side of the cylinder. The distance between the lines (d) will be used as the reference for the robot to move along axis x. Depending on the distance from the camera to the object, the lines will be more separated or close to each other (Fig. 1b, Fig. 1c).

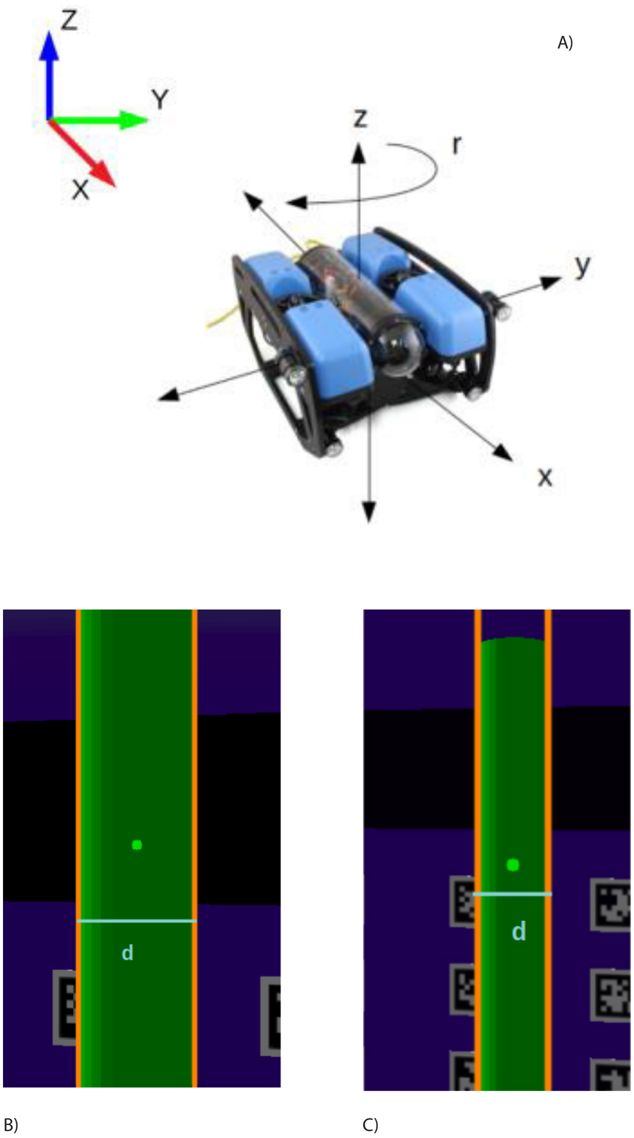
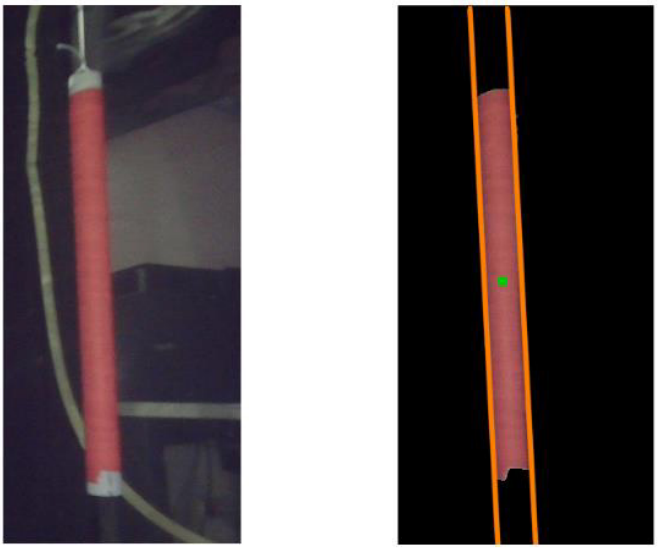


Fig 1. a) Coordinate system of the BlueROV2. b) Distance between the Hough Lines when the vehicle is closer to the object. c) Distance between the Hough Lines when the vehicle is farther from the object.

The proposed method to perform the object segmentation task consists in the implementation of a series of image processing algorithms available in the OpenCV library. Firstly, the original image is converted into the HSV color space, then the corresponding color mask is applied to cut out the object from the rest of the scene, afterwards the canny edge detection algorithm is implemented to highlight the edges of the image. To find the contours of the image and calculate its center, the moments of inertia algorithm is used and finally the Hough Lines detection algorithm is executed to find the vertical lines that can describe the sides of the object. This data then can be used as a setpoint for a controller in order to keep the vehicle at a certain distance and position with respect of the object.

The algorithm was first tested in an underwater simulation environment (UWSim) [4], and then a real-life scenario experiment was executed using a 150x150x200cm water tank, a 3.5cm diameter PVC tube covered in red tape and the BlueROV2 underwater vehicle. Preliminary results of the implementation of the algorithm in a real-life scenario can be seen in Fig.2



A)

B)

Fig 2. a) Original image. b) Proposed method, under execution in water tank conditions

REFERENCES

[1] A. Yamashita, M. Fujii and T. Kaneko, "Color Registration of Underwater Images for Underwater Sensing with Consideration of Light Attenuation," Proceedings 2007 IEEE International Conference on Robotics and Automation, 2007, pp. 4570-4575

[2] A. Peñalver, J. J. Fernández, J. Sales and P. J. Sanz, "Multi-view underwater 3D reconstruction using a stripe laser light and an eye-in-hand camera," OCEANS 2015 - Genova, 2015, pp. 1-6.

[3] P. J. Sanz, M. Vincze and D. Fornas, "Increasing underwater manipulation autonomy using segmentation and visual tracking," OCEANS 2017 - Aberdeen, 2017, pp. 1-5.

[4] M. Prats, J. Pérez, J. J. Fernández and P. J. Sanz, "An open source tool for simulation and supervision of underwater intervention missions," 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems, 2012, pp. 2577-2582.

ID32- WATER QUALITY MONITORING PROGRAM THROUGH THE KDUSTICK, A LOW-COST AND DO-IT-YOURSELF INSTRUMENT CONNECTED BY THE INTERNET OF THINGS

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Abstract
Monitoring water transparency provides an indicator of the environmental status of the water body. One parameter to estimate the water transparency is the light diffuse attenuation coefficient (Kd).

In the framework of the H2020 project MONOCLE (Multiscale Observation Networks for Optical monitoring of Coastal waters, Lakes and Estuaries), we have developed an improved version of the KdUINO (Bardaji et al., 2016) consisting of a moored instrument used to assess water transparency. This new version, the KduSTICK, estimates Kd near the surface in real-time following these specifications: cost-effective, portable, real-time monitoring and easy to use with minimal training.

This instrument transmits data by using the Internet of Things (IoT) networks. In particular, our research group participates in the initiative "The Things Network" (TTN), an IoT network based on LoRaWAN.

This device is easy to deploy and maintain, and it is suitable for citizen-science based water quality monitoring programs.

Keywords
Water quality, Do-It-Yourself, Citizen Science, Internet of Things

INTRODUCTION
The studies of light propagation and light field characteristics are crucial for understanding many physical and biological processes in the water bodies, depending on solar radiation[1], such as phytoplankton dynamics and surface bloom [2] or eutrophication [3]. This radiation at the sea surface is conventionally measured as downward planar irradiance at specific wavelengths (λ), Ed(λ). The attenuation of this quantity with depth (z) can be described by the diffuse attenuation coefficient Kd(z,λ)[4]. This parameter is of particular interest in water quality monitoring programs because it represents a suitable proxy of water transparency [5], and it is related to light penetration and availability in aquatic systems [4] [6]. It is especially relevant in coastal areas and lakes strongly affected by human activities.

Satellite-based ocean colour sensors have been used to map optical properties of the ocean such as Kd(z, λ). Approximately 90% of the diffuse reflected light from a water body comes from a surface layer of water within a depth of 1/Kd [7]. Therefore, Kd is an essential parameter for remote sensing reflectance of ocean colour from satellites. With an increase in remote sensing data availability over the past decade, there has been a rise in the in situ data available for calibration and validation of satellite measurements [8]. However, the current satellite measurements for monitoring coastal and inland waters are still evolving and remain challenging because of the spatial scales that satellite measurements represent [9]. To improve data coverage in these zones, in situ irradiance measurements are still required.

Furthermore, growing worldwide needs to explore cost-effective data acquisition to generate knowledge for sustainable natural resource management. This need to develop novel approaches for monitoring environmental data is reflected in citizen science's recent growing attention [10]. One of these in-situ sensor systems is the low cost and DIY (Do-It-Yourself) moored system KdUINO, which allows measuring the diffuse attenuation coefficient parameter (Kd) [11].

The participation of citizen scientists in water quality monitoring complements traditional monitoring methods. Besides, it has other potential advantages such as lowering monitoring costs, significantly increasing data coverage, increasing social capital, enhancing support for decision-making, and enhancing the potential for knowledge co-creation [12].

INSTRUMENT DESIGN AND CONNECTIVITY
Within the framework of H2020 MONOCLE project, our group is redesigning the KdUINO to retrieve Kd from near-surface measurements. The new KdUINO, called KdUSTICK, is a watertight transparent tube of 1.5 m. of height and a diameter of 4 cm. Some light measurement sensors are located at different positions inside the tube. The tube also contains a low-cost and low-power microcontroller with integrated Wi-Fi and Bluetooth to control the sensors. The microcontroller receives the data from the sensors and stores it in a memory card. The KdUSTICK is placed vertically in the water column, and it floats like a buoy. Most of the tube is submerged, but there is a small part that remains outside the water. The sensors can measure light at different depths because of the transparency of the tube.

To estimate Kd, the KduSTICK measures the light intensity in the PAR (Photosynthetically Active Radiation) band at several depths in the water column. Using the linear regression of such measurements, Kd is retrieved applying the Beer-Lambert law on the light measurements (Fig. 1).

The KdUSTICK transmit data using the Internet of Things (IoT) networks, such as LoRaWan and Sigfox [13]. In particular, our research group cooperate with the initiative "The Things Network" (TTN). This community network allows devices to connect to a decentralized open-source network to exchange data between applications based on LoRaWAN.

The new KdUINO instrument has been designed to connect to TTN nodes, bringing public coverage over the coast where the TTN is (Fig. 2).

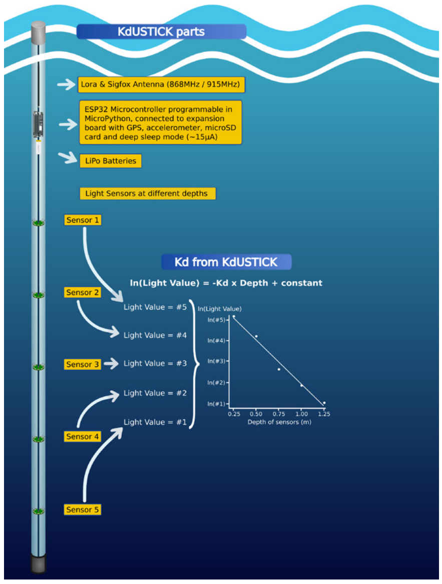

Fig. 1. Schematic of the KdUSTICK design, illustrating all its parts and demonstrating how it calculates Kd.

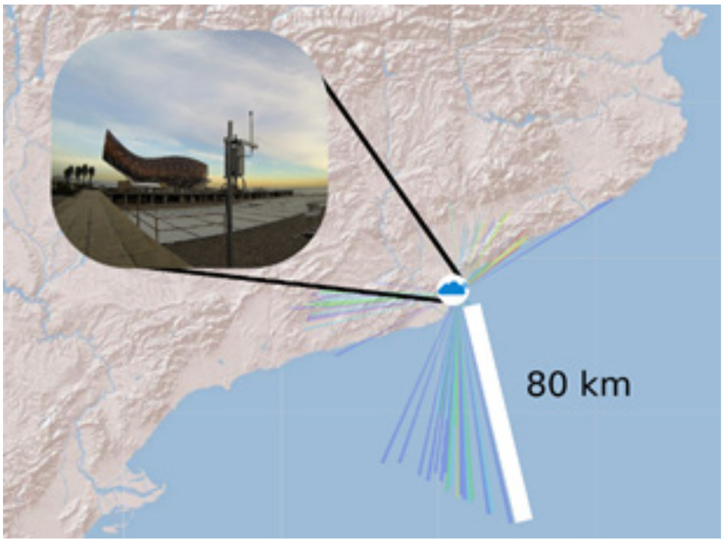

Fig. 2. The instrument transmits data using the Internet of Things networks. 80 km towards the Mediterranean Sea are covered with the TTN antenna installed at the Institute of Marine Sciences.

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The work of Raul Bardaji is supported by the CSIC Intramural Project EMSO – Laboratorios Submarinos Profundos.

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REFERENCES

[1] Mobley, C.D.; Chai, F.; Xiu, P.; Sundman, L.K. Impact of improved light calculations on predicted phytoplankton growth and heating in an idealized upwelling-downwelling channel geometry. Journal of Geophysical Research: Oceans 2015,120, 875–892.

[2] Horion, S.; Bergamino, N.; Stenuite, S.; Descy, J.P.; Plisnier, P.D.; Loiselle, S.A.; Cornet, Y. Optimize dextraction of daily bio-optical time series derived from MODIS/Aqua imagery for Lake Tanganyika, Africa.Remote Sensing of Environment 2010, 114, 781–791.

[3] Cairo, C.T.; Barbosa, C.C.F.; de Moraes Novo, E.M.L.; do Carmo Calijuri, M. Spatial and seasonal variation in diffuse attenuation coefficients of downward irradiance at Ibitinga Reservoir, São Paulo, Brazil.Hydrobiologia 2017, 784, 265–282.

[4] Mobley, C.D. Light and water: radiative transfer in natural waters; Academic press., 1994.

[5] Sarangi, R.; Chauhan, P.; Nayak, S. Vertical diffuse attenuation coefficient (Kd) based optical classification of IRS-P3 MOS-B satellite ocean colour data. Journal of Earth System Science 2002, 111, 237–245.

[6] Wang, M.; Son, S.; Harding Jr, L.W. Retrieval of diffuse attenuation coefficient in the Chesapeake Bay and turbid ocean regions for satellite ocean color applications. Journal of Geophysical Research: Oceans 2009, 114.

[7] Lee, Z.; Carder, K.L.; Arnone, R.A. Deriving inherent optical properties from water color: a multiband quasi-analytical algorithm for optically deep waters. Applied optics 2002, 41, 5755–5772.

[8] Topp, S.N.; Pavelsky, T.M.; Jensen, D.; Simard, M.; Ross, M.R. Research trends in the use of remote sensing for inland water quality science: Moving towards multidisciplinary applications. Water 2020, 12, 169.

[9] Tyler, A.N.; Hunter, P.D.; Spyrakos, E.; Groom, S.; Constantinescu, A.M.; Kitchen, J. Developments in Earth observation for the assessment and monitoring of inland, transitional, coastal and shelf-sea waters. Science of the Total Environment 2016, 572, 1307–1321.

[10] Njue, N.; Kroese, J.S.; Gräf, J.; Jacobs, S.; Weeser, B.; Breuer, L.; Rufino, M. Citizen science in hydrological monitoring and ecosystem services management: State of the art and future prospects. Science of the Total Environment 2019, 693, 133531.

[11] Bardaji, R.; Sánchez, A.M.; Simon, C.; Wernand, M.R.; Piera, J. Estimating the underwater diffuse attenuation coefficient with a low-cost instrument: The KdUINO DIY buoy. Sensors 2016, 16, 373.

[12] Ho, S.Y.F.; Xu, S.J.; Lee, F.W.F. Citizen science: An alternative way for water monitoring in Hong Kong. Plos one 2020, 15, e02383.

[13] CSIC (2019, Feb 22). "Internet of Things for the study of the marine ecosystem", Consejo Superior de Investigaciones Científicas, last accessed 2021, 29 April. https://rdcsic.dicat.csic.es/en/recursos-naturales-2/121-projects/488-internet-of-things-for-the-study-of-the-marine-ecosystem

ID33- DYNAMIC ANALYSIS OF A PENDULUM-TYPE WAVE ENERGY CONVERTER FOR OCEANIC DRIFTERS BY MEANS OF A 4 DOF MODEL

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Keywords
Lagrangian drifter, Wave Energy Converter (WEC), Pendulum, OrcaFlex

ABSTRACT
Drifters are Lagrangian instrumentation widely used in oceanography and climate research. They are designed to obtain data from oceans by passively following the water currents. They provide information about the ocean surface such as currents or water temperature. One of the main challenges faced at drifter's design is their autonomy [1]. The battery exchange is not possible because of the excessively high cost, both from the economic and the environmental point of view. Therefore, some studies tried to deal with this issue by embedding a wave energy converter (WEC) on the drifter: the waves motion is used to generate power through an inner mechanism, so no battery exchange is needed.

SARTI group has been working on a double pendulum mechanism embedded

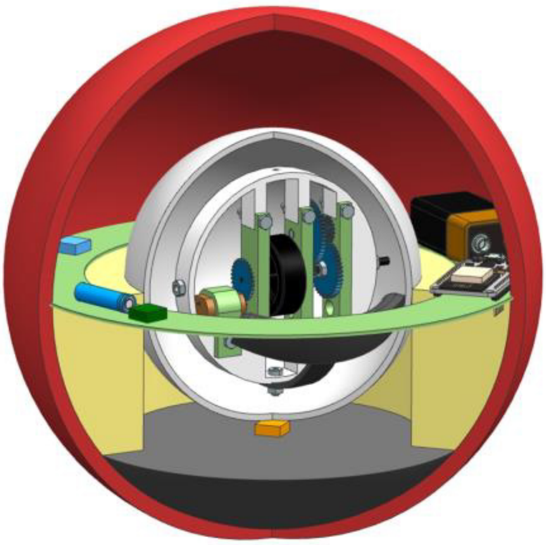

Fig. 1. Double pendulum mechanism embedded into an oceanic drifter presented at [2].

into a drifter to generate power (Fig. 1). Results obtained so far have been satisfactory, reporting a mean power of 180 uW with peaks of 2.2 mW at a sea of 1.4 meters and 0.29 Hz [2]. This result can be optimized by properly tuning the system parameters (mainly inertia properties). This tuning calls for the equations that describe the motion of the drifter in the sea and its embedded pendulum They would allow numerical simulations and optimizations prior to the actual physical construction. The goal of this paper, then, is to validate such model to study the coupled motion of a floating spherical buoy with an inner single pendulum under realistic sea conditions.

Drifters passively follow the water currents without being attached to any object. An accurate model should include the 6 degrees of freedom (DoF) (relative to the Earth) of the buoy. Also it should include 1 DoF associated to the pendulum rotation relative to the buoy. However, as a first approach, one may reduce the problem to a planar motion by just keeping 3 DoF for the buoy (the vertical translational motion, the pitch rotation and the translational motion in the direction of wave propagation) plus the pendulum rotation. Fig. 2 shows the proposed simplified model. It has been assumed that the pendulum is articulated at the buoy's geometric center (point Q). Point O is the center of mass of the buoy and point G is the pendulum's one. Z axis is always vertical and Y axis corresponds to the direction of the wave propagation. (Y, Z) are the coordinates of Q. The buoy pitch rotation around X axis is described by and the pendulum rotation by .

The validation of the model has been carried out by comparing its results with the ones obtained by OrcaFlex (Orcina), a dynamic analysis software of offshore marine systems. Both simulations use the same drifter, fluid and sea state parameters.
The model of motion of the system has been obtained using the

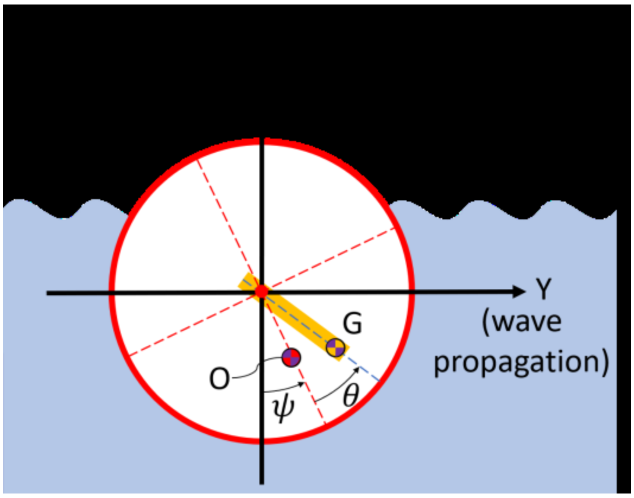

Fig. 2. 4 DoF model of the Drifter-Pendulum system.

Lagrange's equations as
where E stands for the Earth reference frame and are the generalized

$$\frac{d}{dt}\frac{\partial T_E}{\partial \dot{q}_i} - \frac{\partial T_E}{\partial q_i} + \frac{\partial U_E}{\partial q_i} = F^*_{q_i} \quad , \quad \dot{q}_i = \dot{y}, \dot{z}, \dot{\psi}, \dot{\theta}$$

forces associated with the sea-buoy interaction. This interaction may be reduced to a resultant wrench about Q with two force components (in the Y and Z directions) and one moment component (in the X direction). The small size of the drifter, with a radius of just 10 cm, allows to neglect this moment in a first approach. The fluid forces are modelled through Morrison equations [3] and Airy's wave theory [4].

The equations of motion have been numerically integrated with the fixed-step 4th-order Runge-Kutta algorithm. The sea state has been described as the superposition of two Airy waves with amplitudes Hw1=1.5m, Hw2=0.3m; periods Tw1=8s, Tw2=3.5s and wavelengths Lw1=100m, Lw2=19m. Fig. 3 shows the resulting time evolution of the drifter's 4 DoF obtained with OrcaFlex (dashed line) and through the analytical model (continuous line).

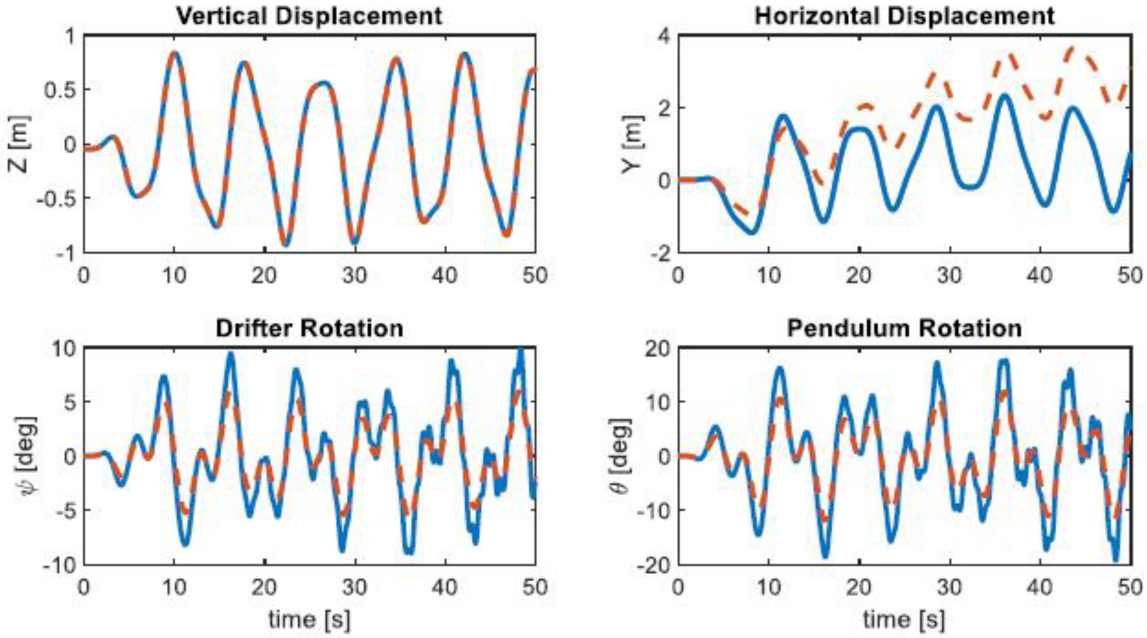

Fig. 3. Time evolution of the drifter's 4 DoF obtained by OrcaFlex simulation (dashed orange line) and by the analytical **model** (continuous blue line).

The vertical motion of the buoy's center (O) obtained through the analytical model matches with that given by Orcaflex showing an error lower than 1.5%. As for the horizontal displacement and the orientation angles (,), both OrcaFlex and the analytical simulation shows the same qualitative tendency with quantitative discrepancies. The lower amplitude values of and from OrcaFlex compared to those obtained through our model is directly related with neglecting the dissipative moment associated with the sea-buoy interaction. The higher drift of the buoy obtained with OrcaFlex is related to a different modelling of the interaction between the waves and the sea bottom. In Orcaflex, the model considers a nonsymmetric velocity profile, whereas the Morrison equations that we have implemented do not consider this phenomenon.

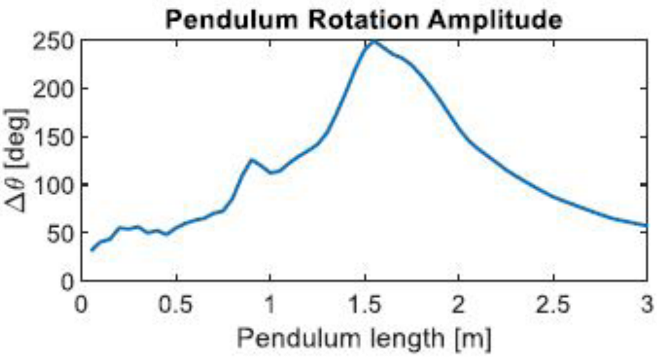

Fig. 4. Pendulum's rotation amplitude depending on its length.

As a first optimization step, we have run several simulations covering a large range of pendulum lengths (from 0.05 m to 3 m) aiming to maximize the pendulum rotation . The buoy's radius has been always two times the pendulum length while its mass has been increased to maintain the drifter's submerged volume. As does not depend on the pendulum's mass, it was kept fix during the optimization. Results are shown in Fig. 4. The maximum amplitude for is obtained at a pendulum's length of 155 cm. This is not a possibility as the common buoy's radius is around 10 cm. For this reason, a more complex pendulum's optimization is needed. Next steps include looking into the possibility of using a reduced-gravity solution or an Npendulum [5].

REFERENCES

[1] R. Lumpkin, T. Özgökmen, and L. Centurioni, "Advances in the Application of Surface Drifters," Ann. Rev. Mar. Sci., vol. 9, no. 1, pp. 59–81, 2017.
[2] M. Carandell, D. M. Toma, M. Carbonell, J. del Río, and M. Gasulla, "Design and Testing of a Kinetic Energy Harvester Embedded into an Oceanic Drifter," IEEE Sens. J., 2020.
[3] J. R. Morison, J. W. Johnson, and S. A. Schaaf, "The Force Exerted by Surface Waves on Piles," J. Pet. Technol., 1950.
[4] Z. Demerbilek, "Water Wave Mechanics," in Coastal Engineering Manual, vol. Part II, 2008.
[5] F. E. Dotti and J. N. Virla, "Nonlinear dynamics of the parametric pendulum with a view on wave energy harvesting applications," J. Comput. Nonlinear Dyn., 2021.

ID34- SPIRAL INERTIAL MICROFLUIDICS FOR SIZE BASED MICROALGAE SEPARATION

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Abstract
The identification of toxic microalgae is essential for the sustainable management of activities, such as aquaculture, being also relevant for environmental monitoring and marine research purposes [1]. For these reasons, there is an increasing demand for in situ, reliable, portable, autonomous, low-cost and of easy operation technologies and devices able to detect early signs of potential toxic algal populations within the context of long term monitoring programmes. To this aim, a multisensory platform for in-situ phytoplankton quantification and taxonomic identification designed for underwater deployment and based on lab-on-chip (LoC) technology has been developed. It combines flow cytometry with optical and electrical measurements. The separation of microalgae based on cell size prior to analysis is key to reduce the complexity and heterogeneous nature of seawater samples while also offering a degree of distinction between taxonomic groups. This work investigates and develops a simple inertial microfluidic device based on a spiral microchannel that achieves size-based separation of microparticles/cells. The theoretical principle of their separation was analysed trough numerical simulations and experimental tests were also performed. Using a 5-loop spiral (300 µm width and 100 µm height), 20 µm and 40 µm polystyrene (PS) microparticles were successfully separated for a flow rate of 2000 µl/min, showing its potential for microalgae size-based separation. Furthermore, the simple structure and high throughout makes this technique suitable for integration in LoC devices [2, 3].

Keywords
Spiral Inertial Microfluidics, Microalgae Sorting.

NUMERICAL SIMULATIONS
Microparticles separation in a spiral microchannel were simulated in COMSOL Multiphysics to examine the influence of inertial microfluidics on microparticles trajectories. The simulated spiral has five turns with channel dimensions of 300 µm width and 100 µm height with a fully developed flow rate of 1000 µl/min. Figure 1 shows the results obtained in the simulations, where a separation between 20, 30 and 40 µm particles can be observed.

EXPERIMENTAL RESULTS
In experimental tests, a 5-loop spiral 300 µm width and 100 µm height of and four outlets was fabricated in PDMS (figure 2). 20 µm and 40 µm PS microparticles were chosen to test the separation capabilities of the designed spiral. A good separation between the selected particles was achieved for 2000 µl/min, with particles of different sizes exiting through different outlets.

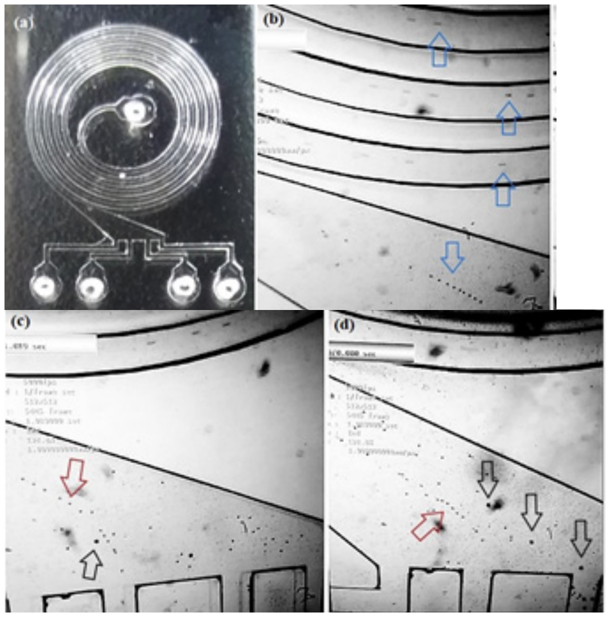

Fig 2. Experimental results: (a) PDMS spiral with four outlets; (b) Microparticles (blue arrows) being transported and focused at the microchannels for a flow rate of 1000 µl/min; (c) 20 µm (red arrow) and 40 µm particles (black arrow) both exiting through the same outlet for a flow rate of 1000 µl/min; (d) 20 µm (red arrow) and 40 µm particles (black arrow) with separated trajectories exiting through different outlet for a flow rate of 2000 µl/min.

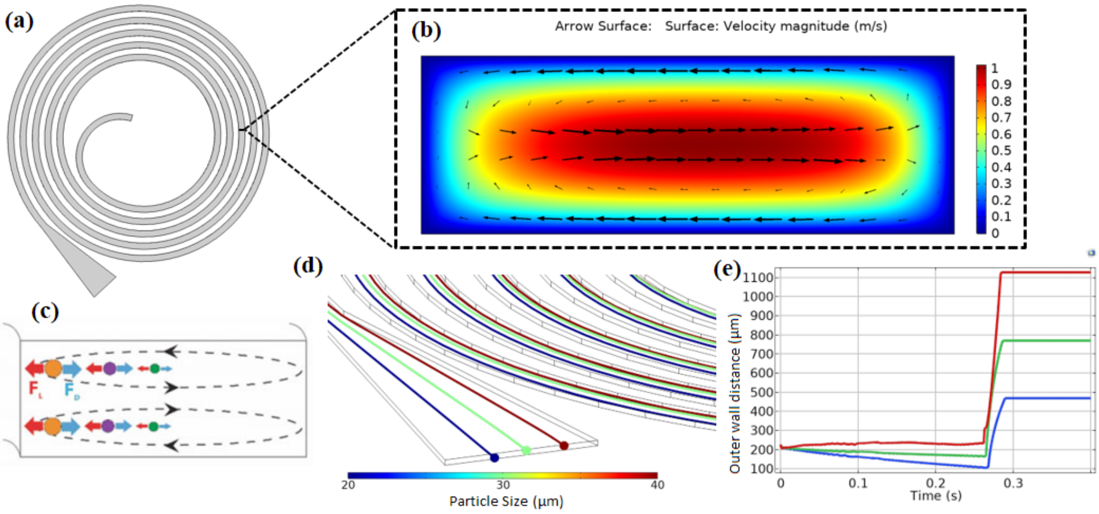

Fig 1. Numerical simulation results: (a) spiral geometry used in the simulations; (b) Dean vortices formed at the microchannel cross-section; (c) schematic representation of the equilibrium position of particles resulting of the interaction between the net lift force (FL) and the Dean drag force (FD) adapted from [2]; (d) particles (20, 30 and 40 µm) trajectories and final positions at the outlet and (e) plot of the particles distance to the outer wall of the microchannel (y-axes) as they travel from the inlet to the outlet.

ACKNOWLEDGMENTS
This work was supported by Fundo Europeu de Desenvolvimento Regional (FEDER) through Programa INTERREG V-A Espanha-Portugal (POCTEP) 2014-2020, Project 0591_FOODSENS_1_E and by the projects UIDB/04436/2020 and UIDP/04436/2020. V.H. Magalhães thanks the FCT for the PD/BD/150581/2020 grant.

REFERENCES

[1] Lassus, P.; Chomérat N.; Hess, P.; Nézan E., Toxic and harmful microalgae of the World Ocean, International Society for the Study of Harmful Algae/ Intergovernmental Oceanographic Commission of UNESCO, Denmark, 2016.
[2] Liu, N.; Petchakup, C.; Tay, H.; Li, K.; Hou H., Spiral Inertial Microfluidics for Cell Separation and Biomedical Applications, Applications of Microfluidic Systems in Biology and Medicine, Tokeshi, M., Springer, Singapore, 2019.
[3] Kuntaegowdanahalli, S.; Bhagat, A.; Kumar, G.; Papautsky, I.; "Inertial microfluidics for continuous particle separation in spiral microchannels", Lab Chip, vol. 9, pp. 2973–2980, 2009.

ID35- LanderPick, a Remote Operated Trawled Vehicle to Cost-Effectively Deploy and Recover Lightweight Oceanographic Landers

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Abstract
LanderPick project consists of the design of a cost-effective system for deploying and picking-up lightweight oceanographic landers, not provided with recovery elements, but having a structure that facilitates their hitching (a capture mesh). The LanderPick vehicle prototype is a Remote Operated Trawled Vehicle (ROTV) specifically designed to operate a mechanical release that allows the placement at the sea bottom of landers carried as a payload, as well as their recovery by means of a triple hook. The vehicle mostly depends on the ship positioning system but has small propellers to aid in the final precision approach manoeuvres. First sea trials of the system in April 2021 are described.

Keywords
Landers, ROTV, sea-floor characterization, environmental monitoring

MOTIVATION
LanderPick concept is motivated by the need of sustaining oceanographic equipment, measuring continuously for prolonged periods, on the seabed. Recent technological developments in the form of remotely operated vehicles (ROVs), towed instruments, or even human-occupied submersibles have improved our capability of observing the seafloor. However, the only way to monitor the conditions of such inaccessible habitats between costly time-spaced ship cruises is by leaving autonomous systems at place. Landers are a generic name for modular structures, equipped with various sensors, which are positioned directly on the seabed to operate autonomously for a defined timeframe. The international community seeks new technological developments to improve the trade-off between spatial and temporal coverage of seafloor observation, bridging the gap between the large spatial but lack-of temporal coverage of ROV-like systems versus the large temporal but lack-of spatial coverage of individual landers [1]. Arrays or fleets of low-cost landers are a promising approach.

The use of lander systems is far from new. Examples of the use of deep landers date back to the mid-20th century [2]. The main drawback of medium-long term landers is the deployment and picking-up system. If a lander is to be abandoned for a prolonged period, it is not possible to leave a surface recovery buoy since it would be dragged by storms and/or could interfere with fishing and navigation. Other systems based on the release of an expendable ballast force to enlarge the lander and require expensive components. This fact prevents the deployment of several landers simultaneously with a reasonable cost, which is necessary to characterize a region.

II. LANDERPICK VEHICLE PROTOTYPE DEVELOPMENT AND FIELD TESTS
LanderPick underlying idea is to deploy and recover lightweight oceanographic landers aided by a specific trawled vehicle. Such idea arose from a accident during a ROV dive in 2014, when the umbilical cable connecting the ROV to its TMS (Tether Management System) caught on a rock and broke off, resulting in the loss of the ROV at a depth of 480 m. ROV operators desperately devised a rescue operation consisting of attaching a hook to the TMS and, relying solely on the dynamic positioning of the ship, it was possible to recover the ROV bringing it back on-board. From this experience, it was inferred that (i) if the ROV had had a mesh on top, the recovery manoeuvre would had been relatively easy and, as a consequence (ii) picking structures from the bottom aided by a trawled vehicle is achievable.

Based on this premise, a first LandrPick vehicle prototype was constructed in autumn 2020 and first field tests took place in winter-spring 2021. LanderPick vehicle is based on the principles of positioning and navigation of the ROTV Politolana developed at the Spanish Institute of Oceanography [3], combined with the capabilities of a Drop-Cam (underwater image-based deployment system). The LanderPick is operated through a standard coaxial electromechanical cable allowing real-time control from the vessel. Its main gadget is a mechanical release (an MR5000B model by InterOceans Systems), and navigation is aided by spotlights, laser pointers, a high definition camera with the ability to operate in low lighting conditions and small positioning propellers. It carries batteries instead of being powered through the cable, thus minimizing interference with the communication modems. Current prototype is devised to operate down to 2000 meters. A mini-fleet of 5 landers were manufactured, 4 were provided with low-cost instruments and one included standard oceanographic sensors plus a lapse-time image system. Landers for hard-bottom, away from trawlling fishing grounds, are cylindrical like rosette samplers. Landers for sites where trawling is a concern are truncated cone-shaped. Figure 1 shows the system at work.

CONCLUSIONS
Though some technical issues should still be fixed, the first LanderPick field tests were successful, allowing 6 deployments and 3 recoveries that demonstrated the system viability and cost-effectiveness. The LanderPick can be operated from regional mid-sized vessels equipped with standard cables, allowing to conceive (i) monitoring systems based on the simultaneous deployment of several landers with a contained cost and (ii) experiments associated with deep habitats such as coral reefs in which it is necessary to locate landers with great precision.

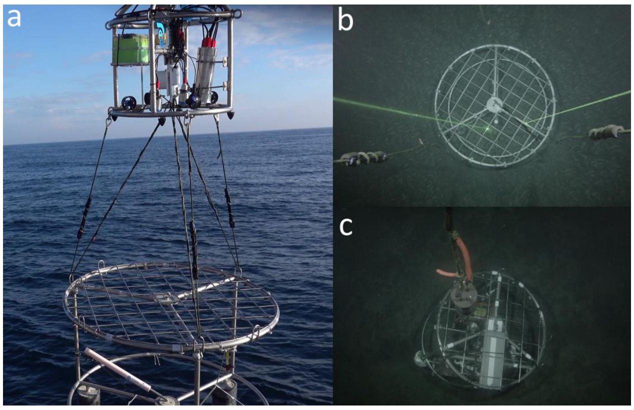

Fig 1.LanderPick vehicle in action, southern Biscay April 2021. a) The Landerpick ready to enter the water with a modestly equipped lander as a payload (include a tilt-current-meter, Lowell instruments TCM-3 and a thermometer, RBR SoloT). b) The lander just after being released on the seafloor of La Gaviera canyon axis at 801 meters depth. c) A fully equipped lander after being hooked by the LanderPick at Le Danois Bank summit (521 m depth).

ACKNOWLEDGEMENTS
This work has been developed in collaboration with the Biodiversity Foundation of the Ministry for Ecological Transition and Demographic Challenge, through the Pleamar Programme co-financed by the European Maritime and Fisheries Fund

REFERENCES
[1] Brandt, A.; Gutt, J.; Hildebrandt, M.; Pawlowski, J.; Schwendner, J.; Soltwedel, T.; Thomsen, L., "Cutting the Umbilical: New Technological Perspectives in Benthic Deep-Sea Research.", J. Mar. Sci. Eng.,vol 4, 36 2016.
[2] Guennegan, Y. and Rannou, M, "Semi-diurnal rhythmic activity in deep-

sea benthic fishes in the Bay of Biscay.", Sarsia, vol. 64, 1-2, pp. 113-116, 1979.
[3] Sánchez, F. and J.M. Rodríguez, "POLITOLANA, a new low cost towed vehicle designed for the characterization of the deep-sea floor", Martech 2013, 5th International Workshop on Marine Technology. SARTI, 2013

ID36- DEVELOPMENT OF A LOW COST, SELF-CONFIGURING ADCP AND INTEGRATED DEPLOYMENT AND RECOVERY SYSTEM

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2 Nortek Group. Oslo. Norway

Abstract
Here we present the development of a short range (0.5 to 20 m), low cost (< USD 5,000), three-beam, 1 MHz acoustic Doppler current profiler called the Nortek ECO. The system employs a robust wideband velocity measurement technique where the only required user inputs are: 1) when deployment should start, 2) how often to sample, and 3) what is the water type. The hardware is highly portable, measuring only 130 mm tall by 85 mm in diameter and weighing 1.0 kg in air. It communicates externally with Bluetooth Low Energy technology and is powered by an embedded smart Li-Ion battery that is charged by induction. Three independent activation methods are implemented, including Near-Field Communication, and all communication controlled via a platform-independent Progressive Web App. Coupled with the ADCP is a deployment and recovery system allowing for single person operation at depths up to 50 m. Discussion of the system concept and design are presented, including sample data. This is an example for preparing the full paper that is identical with the extended summaries format. It must be written in Times New Roman.

Keywords
Portable ADCP, Shallow Water, Low Cost.

ID37- IMPROVING VISUAL ODOMETRY FOR AUV NAVIGATION IN MARINE ENVIRONMENTS

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Abstract
Visual odometry is usually integrated in the localization and control modules of underwater robots, combined with other data coming from diverse instruments and sensors, such as, Doppler Velocity Logs (DVL), pressure sensors or inertial units, to compute the vehicle motion and pose by means of death reckoning. Dead reckoning is subject to cumulative drift, and, in underwater scenarios is specially affected by the challenging structures, color textures and environmental conditions (currents, haze, water density, salinity, wind, etc...), increasing the need of specific improvement or adjustment to this media. This article presents preliminary results of an evolution of the well known VISO2 stereo odometer, modified in order to improve its performance when run online in marine scenarios, and from a moving Autonomous Underwater Vehicle (AUV) equipped with cameras pointing downwards to the sea bottom.

Keywords
Visual Odometry, Underwater Robots, Marine exploration.

INTRODUCTION AND OVERVIEW
Visual Odometry can be an important element to improve the navigation of mobile robots. However, if its quality is inadequate due to, either the software itself or the difficulties inherent to the environment, these motion estimates can be more damaging than helpful. In the last years, several visual odometers, such as VISO2 [1], FOVIS [2] or the ORB tracker [3], have shown high accuracy in the velocity computation as well as minimal accumulated drift, when used in terrestrial or aerial robots. However, the application of these odometers in marine sites with cameras pointing to the sea bottom questions their suitability in this media. Although Wirth et al showed the advantages and good results of VISO2 in front of FOVIS, experiments were done in very controlled underwater scenarios. Negre et al [4] showed the improvement of underwater visual SLAM in certain marine sites when using VISO2 instead of the ORB tracker, and Bonin et al [6] determined that SIFT feature detection and tracking outperformed the tracking of other types of visual features in marine areas colonized with seagrass, in terms of number of inliers between consecutive and loop-closing images. The VISO2 stereo feature tracker is circular, bucketed, and based on minima and maxima of a blob and corner filter responses, concatenated with the comparison of Sobel filter block responses. According to [6], this strategy is clearly inadequate to detect and track features in marine images with extremelly irregular and complex textures (seagrass combined with stones, algae, peebles and sand). Furthermore, VISO2 was tested on a terrestrial vehicle, with a camera facing ahead and smooth motion and minor rotations or changes on scale in consecutive frames. Contrarily to the latter original VISO2 assumption, images of the sea bottom are usually taken with the camera lens axis perpendicular to the vehicle logitudinal axis, when the vehicle is moving at a constant height. This situation can generate changes in scale, if the navigation altitude is not strictly constant due to the hysteresis in the height controller, or intense rotations in consecutive frames when the underwater vehicle modifies its heading in surveying operations.

In the context of the regional (DETECPOS-PRD2018/34) and national (TWINBOT-DPI2017-86372-C3-3-R) projects, one or several robots need to move over marine areas of special ecological interest, mostly colonized with seagrass, for observation, inspection or intervention. In order to complement the self-motion estimations computed from the onboard sensors, the original VISO2 stereo odometer has been integrated in the vehicle control architectures and tested in the natural marine environments where the underwater vehicles have to operate. Results have been dissapointing, motivating an improvement of the VISO2 stereo odometer to be applied in this kind of situations. To this end, we have replaced the VISO2 original circular feature detection and tracking module by a new one based on SIFT features, and left intact the rest of the algorithm. Although SIFT features need more time to be computed, the slow velocity and dynamics of the AUVs make the online execution of this new visual tracker, at 2.5 fps, completely viable. To assure a minimum number of robust trackable SIFT features between consecutive images, the new versions of the VISO2 (VISO2-SIFT) odometer have been tested activating and deactivating the bucketing process that is executed after the circular feature tracking task. VISO2- SIFT has been integrated in a ROS [7]-wrapper and soon will be available for the scientific community.

EXPERIMENTAL SETUP AND PRELIMINARY RESULTS
Preliminary experiments have been done running the ROS-wrappers of the original [8] and modified versions of VISO2 during the reproduction of ROS bagfiles grabbed from our Sparus AUV in marine areas located in the south of Mallorca. The payload of the Sparus carried a stereo rig pointing downwards, with the lens axis perpendicular to the vehicle longitudinal axis, a DVL, a pressure sensor, an inertial unit, an ecosounder also pointing downwards, and the mobile part of an USBL acoustic modem. All data given by all these sensors were recorded during the mission in ROS bagfiles format, to be reproduced off-line.

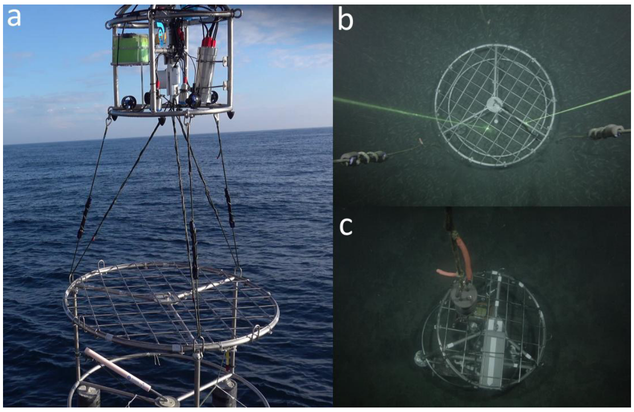

Fig 1.LanderPick vehicle in action, southern Biscay April 2021. a) The Landerpick ready to enter the water with a modestly equipped lander as a payload (include a tilt-current-meter, Lowell instruments TCM-3 and a thermometer, RBR SoloT). b) The lander just after being released on the seafloor of La Gaviera canyon axis at 801 meters depth. c) A fully equipped lander after being hooked by the LanderPick at Le Danois Bank summit (521 m depth).

The navigation module of our Sparus II implements a double stage Extended Kalman Filter (EKF) that integrates the data of all mentioned sensors, plus the absolute vehicle position given by the USBL head to the mobile acoustic modem installed in the AUV, to provide reliable vehicle motion estimates and absolute poses with respect to the North-East-Down (NED) origin of the mission. The data used for the experiments are: the stereo images at 2.5 fps, the vehicle altitude and the output of the aforementioned vehicle navigation EKF, as the ground truth. Figure 1 shows several images recorded by the robot during the mission, and Figure 2 shows the vehicle trajectory, obtained integrating the odometry given by the original VISO2 stereo odometer, the VISO2-SIFT, and the VISO2-SIFT but with the feature bucketing deactivated. Although the reconstruction of the vehicle global pose from the successive odometries usually entails drift, in this case, the improvement of the global odometric trajectory with VISO2-SIFT, in translation and orientation, with respect to the original VISO2, and compared to the ground truth is clear. Since the ground truth trajectory is refered to the NED origin, but the odometric trajectories are refered to the first grabbed image, the reference frames of all trajectories have been unified by means of the corresponding transforms. Ongoing work includes the integration of VISO2-SIFT in the AUV navigation filter, and the calculation of quantitative results, such as the absolute point-to-point errors with respect to the grount truth and comparisons using different feature detectors and/or other odometers such as the ORB tracker.

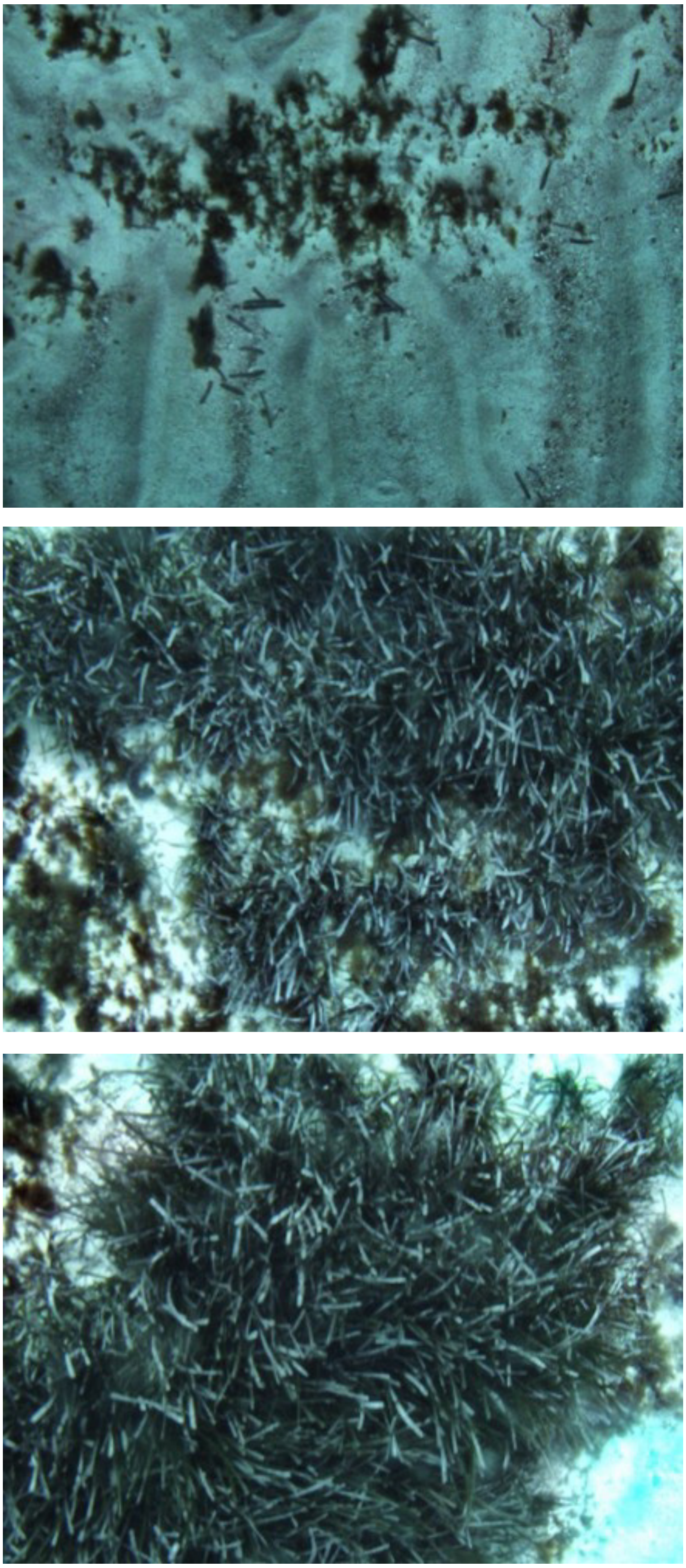

Figure 1. Some images extracted from the dataset of Portals Vells.

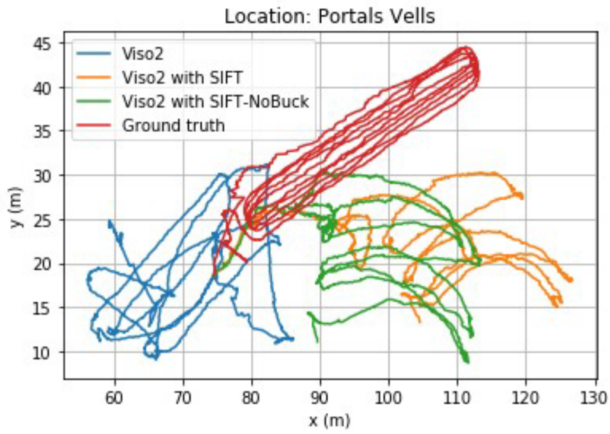

Figure 2. Trajectories estimated integrating the visual odometry obtained by different means.

REFERENCES

[1] Andreas Geiger and Julius Ziegler and Christoph Stiller (2011). StereoScan: Dense 3d Reconstruction in Real-time. Proceedings of the IEEE Intelligent Vehicles Symposium. Badem-Badem (Germany).
[2] Huang, A.S.; Bachrach, A.; Henry, P.; Krainin, M.; Maturana, D.; Fox, D.; Roy, N. Visual Odometry and Mapping for Autonomous Flight Using an RGB-D Camera; Robotics Research; Springer: Cham, Switzerland, 2017; Volume 100, pp. 235–252.
[3] R. Mur-Artal, J. M. M. Montiel and J. D. Tardós, "ORB-SLAM: A Versatile and Accurate Monocular SLAM System," IEEE Transactions on Robotics, 2015.
[4] S. Wirth, P. L. Negre, and G. Oliver, "Visual odometry for autonomous underwater vehicles," in Proceedings of the IEEE Oceans, Bergen, Norway, 2013.
[5] P. L. Negre, F. Bonin-Font, G. Oliver. Cluster-Based Loop Closing Detection for Underwater SLAM in Feature-Poor Regions. In IEEE International Conference on Robotics and Automation (ICRA), Stockholm (Sweeden), 2016.
[6] F. Bonin-Font, G. Oliver. Hacia la Navegación Visual de un Vehı culo Autónomo Submarino en Areas con Posidonia Oceanica. In Revista Iberoamericana de Automática e Informática Industrial, Elsevier, vol. 15, no. 1, 2017.
[7] Stanford Artificial Intelligence Laboratory et al. (2018). Robotic Operating System. Retrieved from https://www.ros.org.
[8] Stephan Wirth. Viso2_Ros, a ROS wrapper for libviso2. Retrieved from http://wiki.ros.org/viso2_ros

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ID38- EMSO ERIC'S AUTHENTICATION AND AUTHORIZATION INFRASTRUCTURE

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Abstract
A fundamental component of the EMSO ERIC cyber-infrastructure that integrates multiple ocean variables from EMSO ERIC regional facilities is its data management platform. The EMSO data management platform transition to pre-production enabled the deployment of EMSO ERIC data services based on harmonization, widely used specifications, and FAIR principles. It establishes an appropriate workflow for taking stewardship of every stage of the data lifecycle on an architecture based on robustness and fault tolerance, including redundancy and failover capabilities, scalability, and security. This work presents EMSO ERIC's authentication and authorization infrastructure, which provides security and accountability and enables personalized services.

Keywords
EMSO ERIC, Authentication, Authorization, Cybersecurity

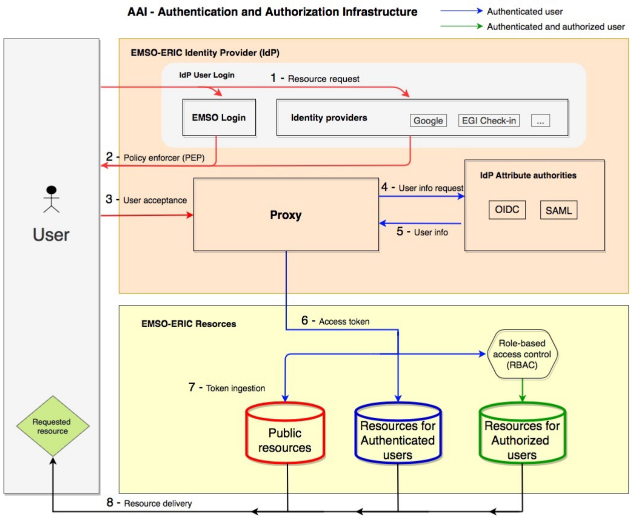
INTRODUCTION
The European Multidisciplinary Seafloor and water-column Observatory (EMSO) [1] aims to explore the oceans and explain the driving factors and the effects of changes in the broader earth systems, focusing on climate change, warning signals of biodiversity loss and ecosystem impact, and geo-hazards. A fundamental component of the EMSO cyberinfrastructure that integrates multiple ocean variables from EMSO regional facilities is its data management platform.

EMSO engaged with European Grid Infrastructure (EGI) to develop an initial data management platform as part of the EMSODEV H2020 project. The European Open Science Cloud (EOSC) Early Adopters Programme supported the transition of the EMSO data management platform to pre-production and provided critical components within the EOSChub project and its partners for the deployment of EMSO ERIC data services, including the EMSO ERIC Authentication and authorization Infrastructure (AAI). This transition enables data and services to be harmonized and standardized across EMSO observatories. It also increases its interoperability with the marine subdomain according to FAIR principles as part of the ENVRI-FAIR H2020 project, ultimately delivering EMSO ERIC added value data services via the EOSC marketplace impacting different communities. The EMSO ERIC AAI has been developed in coordination with environmental research infrastructures. Its current implementation is based on the AARC blueprint architecture [2]. It focuses on authentication and authorization and integrates EOSC services such as the EGI Check-in service.

TECHNICAL ARCHITECTURE
The EMSO ERIC regional facilities typically provide data following an open-access approach; however, access to data services that may be resource-demanding requires authentication to share resources effectively. Furthermore, heavyresource consuming services such as the EMSO ERIC virtual research environment, dynamic data product generation, and specialized dashboards require authorization for system protection. As a result, our general strategy consists of using authentication for advanced features while non-authenticated users can access essential services under certain constraints (e.g., number of concurrent requests). Furthermore, it provides security and accountability and enables the implementation of personalized services such as custom environments.

Different design choices were studied to provide a flexible and low-maintenance cost solution, including the EGI check-in service. While this service allows federating different identity providers, including the EMSO ERIC identity provider, EMSO ERIC has adopted the AARC blueprint architecture for flexibility (e.g., a user can choose the preferred identity provider) and enabling the federation within ENVRI-FAIR.

The overarching architecture of the EMSO ERIC AAI is illustrated in Figure 1. The implemented AAI solution is used in employing the single sign-on scheme in accessing different EMSO ERIC data services without re-entering authentication.



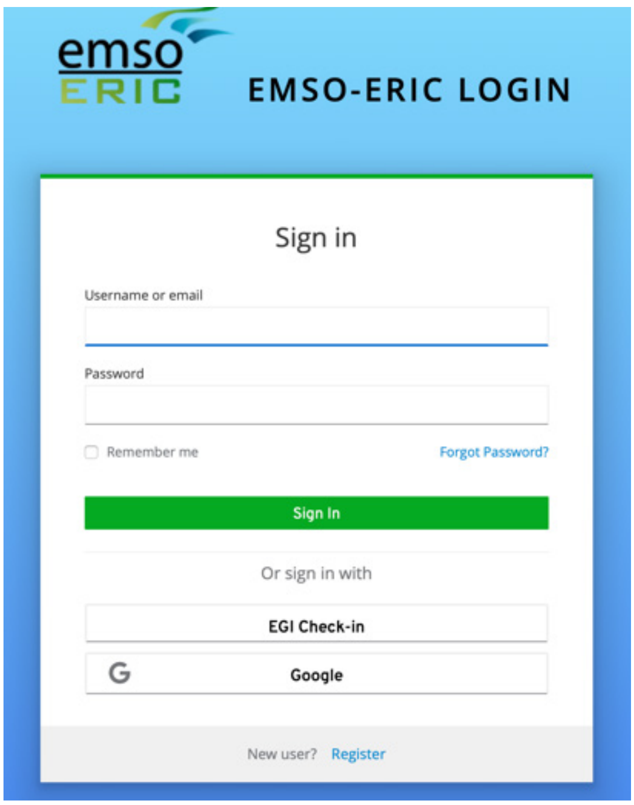


Figure 1. EMSO ERIC AAI block diagram architecture (left). Login interface with EGI Check-in integration (right).

KEY SERVICES

The EMSO ERIC data management platform API, a RESTful web service tool, allows programmatic access to EMSO ERIC data within its data management platform. Users or third-party repositories can use it via machine-to-machine interfaces. In addition to facilitating data discovery, access, and download, it enables building tools, including data portals, dashboards for data visualization, data product generation, etc. The current implementation based on the Swagger opensource framework provides a set of basic endpoints (or operations) and uses authentication for a subset of functions and administrative processes.

The EMSO ERIC data portal provides access to EMSO ERIC data with a focus on essential ocean variables. It offers open access to a description of the different observatories, pointers to existing data and meta-data sources, and an overview of visualizations. The data portal also serves as the interface for users to request access to advanced features such as a virtual research environment based on Jupyter.

ACKNOWLEDGMENTS

This work is supported by the European Union's Horizon 2020 research and innovation Programme under grant agreement 824068, by the CSIC Intramural Project EMSO-Laboratorios Submarinos Profundos,and it is sponsored by EGI and the EOSC-hub H2020 project with the dedicated support of the CESGA and RECAS-BARI providers.

REFERENCES

[1] J. J. Dañobeitia, S. Pouliquen, T. Johansen, A. Basset, et al., "Towards a comprehensive and integrated strategy of the European Marine Research Infrastructures for Ocean Observations," Front. Mar. Sci. 7:180. doi: 10.3389 fmars.2020.00180.

[2] AARC Blueprint Architecture 2019 (AARC-G045), published 2019-11-06. DOI: 10.5281/zenodo.3672785.

ID39- COMPARISON OF THE ELECTROLYTIC, ULTRASOUNDS AND CHEMICAL CLEANING IN CORRODED NAVAL STEEL

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** Correspondence: rosa.devesa.rey@cud.uvigo.es*

Abstract
Oxygen, salt and water are key factors affecting metal deterioration and leading to corrosion in a marine environment. Prolonged corrosion may compromise the use of the materials and this may have an important economic consequence, since the cost derived from its prevention may be much greater than the manufacture or acquisition cost itself. Moreover, acquisition of new pieces may be more expensive than the cost of the cleaning procedure and there may be also discontinued pieces. However, restoration is necessary to prolong the life cycle of different equipment or instruments.

This work compares qualitatively the advantages and disadvantages of three cleaning methods: electrolytic, ultrasonic cleaning and cleaning with commercial chemicals that are commonly used on boats. Materials employed were probes artificially corroded in the laboratory, as well as real parts of boats of the Spanish Naval Academy. Electrolytic cleaning was carried out by placing samples in a solution at 1% NaOH, with a graphite electrode and a current of 0,5 to 2,5 A. Ultrasound was applied at 37 kHz, time treatments varying between 10 min and 1 h 15 min, and 2,5 g of Ultrasonic A degreaser. Chemical cleaning was carried out with Minea Ferronet, a commercial solution, with a high deoxidation, degreasing and descaling power.

A summary of the results obtained can be observed in Illustrations 1-2.Electrolytic method showed high efficiency to clean metal probes, regardless of the initial corrosion. Promising results were obtained either with laboratory probes and real pieces, characterized of more complex geometries.

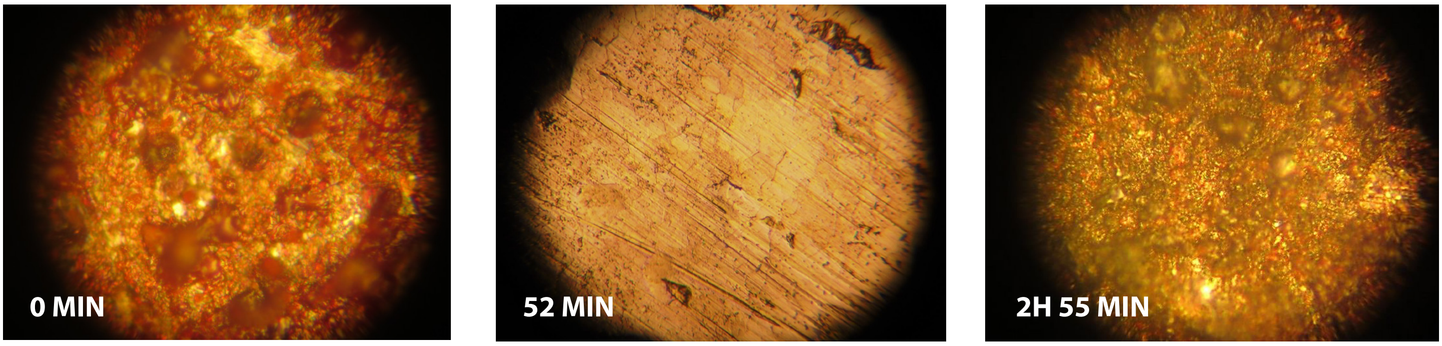

Illustration 1. Electrolytic cleaning significantly removed corrosion from the original probes (left) after 52 min and 2 h 55 min.

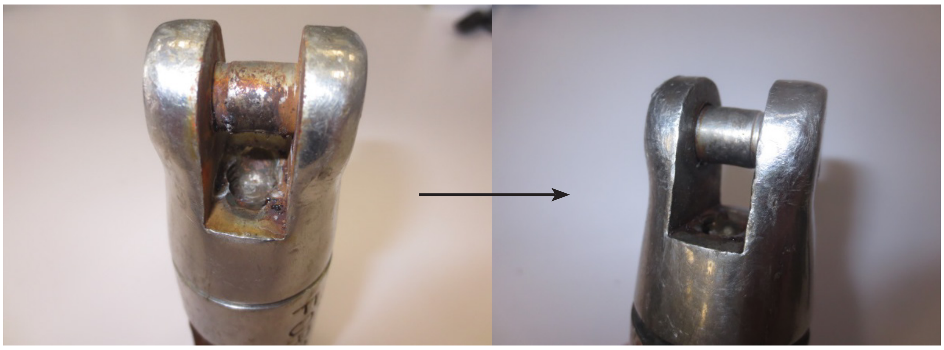

Illustration 2. Electrolytic cleaning was also applied to pieces of boats of the Spanish Naval Academy.

Keywords
Electrolysis, corrosion, metals, oxidation, restoration.

ID40- ANALYSIS AND EVALUATION OF CORROSION IN NAVAL STEELS

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Abstract
The corrosion of steel due to seawater is a problem faced by all ships. In this work it has been analyzed two of the variables that most influence the degradation process of carbon steels in marine environments (pH and chloride concentration), as well as the galvanic couple, which arises when two metals of different potential make contact. The study was carried out with two types of steel (S275JR and S235JR) and 15 different environments were analyzed (Fig. 1).

The progression of corrosion was evaluated in two ways: i) by measuring the mass variation due to the corrosion phenomenon, which was subsequently used to determine the kinetics of the reaction, and ii) visually, by using free software ImageJ. The combined effect of the three variables was analyzed using the Statistics software, performing a factorial analysis in order to obtain response surfaces and their corresponding predictive equations, which allow predicting the effect of corrosion. Finally, in order to observe the differences between the model obtained and the degree of actual corrosion, both steel types were subjected to the effect of seawater from the dock of the Naval Academy.

Figure 1. Experimental setup in laboratory.

Results of the study showed a loss of 0,1 g a week, influenced by the chloride concentration and the acid environment (Fig. 2). From the data obtained, predictive equations were formulated and compared with experiments in laboratory. After 3 weeks of corrosion induced in laboratory, a deviation of 6,74% between the real and predicted mass of probes was observed for steel S275JR and 1,35% for steel S235JR, which evidence the accuracy of the experiments carried out and gives a valuable tool in order to predict effects of corrosion. Corrosion kinetics showed a degradation of 0,3 mm/year and predictive equations showed a deviation lower than 7% in both steels when compared with experiments in laboratory.

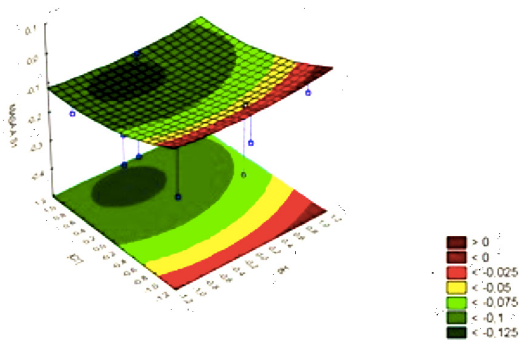

Figure 1. Surface response shows mass loss in steel probes after 1 week of exposure to acid and chloride environment.

Keywords
Corrosion, steel, seawater, vessel, factorial design.

ID41- UNCREWED SURFACE VEHICLES (USV): FROM SURVEY TO SHIPPING

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Abstract
Autonomy and unmanned systems have evolved significantly in recent decades, becoming a key routine component for various sectors and domains as an intrinsic sign of their improvement, the ocean not being an exception. This paper shows the transition from the research concept to the commercial product and related services for Uncrewed Surface Vehicles (USV). Note that it has not always been easy in most cases due to limitations on the technology, business, and policy framework sides. An overview of current trends in USV technology looking for a baseline to understand the sector where some experiences of the authors are shown in this work. The analysis presented shows a multidisciplinary approach to the field. USV's capabilities and applications today include a wide range of operations and services aimed at meeting the specific needs of the maritime sector. This important consideration for USV has yet to be fully addressed, but progress is being made to best contribute, among others, to the development and consolidation of the European Research Infrastructure (RI) on Marine Robotics (EUMR) where USV should play a key role.

Keywords
ASV, USV, Robotics, Research Infrastructure, Ocean Observing

INTRODUCTION
As a key element of exploration, commerce and war, ships have always involved engineering solutions to difficult problems and talented humans to build and operate them. Nowadays there are many small and medium-size uncrewed boats in routine-use paving the way toward fully autonomous vessels as ultimate step in this sector. Many institutions, universities and companies have begun developing Uncrewed Surface Vehicles (USV) aiming to cover a wide range of applications and services, evolving rapidly. With growing worldwide interest in commercial, scientific, and military issues associated with both open-ocean and shallow waters, there has been a corresponding growth in demand for the development of more complex USV with advanced guidance, navigation, and control (GNC) functionalities. The development of fully-autonomous USV is underway aiming to minimize both human control needs and the effects to the effective and reliable operation from human errors. USV are defined as unmanned vehicles which perform tasks in a wide range of environments without any human intervention with highly nonlinear dynamics. With the inclusion of a more robust, commercially available and affordable navigation equipment (GPS, IMU, etc.), wireless telemetry systems, "blue" power sources and trending intelligent-analytics technologies (Artificial Intelligence, etc.) the applications range for USV has significantly increased and improved in key marine and maritime domains and sectors.

USV-TECHNOLOGY: DEVELOPMENTS AND MILESTONES
After clearly experimental beginnings with limited capabilities in terms autonomy, endurance, payload, power outputs, etc., in recent years significant progress has been made in all USV subsystem components (hull and structural elements, propulsion and power system, GNC, telemetry, payloads, data management and ground station), enabling USV a leading commercial technology solution in several applications and services (some on a routine basis) beyond the military and research. The initial reference on the path to autonomous ships is technical. The core technologies that enable uncrewed vessels has come about largely due to developments in other fields. Improved USV capabilities allow to undertake missions both in coastal and open-ocean areas for long periods of time due to a more efficient power and propulsion systems based in some cases on renewable energy sources (solar, wind, waves). State-of-the-art broadband telemetry systems enable remote real-time operation and decision-making by the operator. In parallel with the mechanical and electronic system architecture improvements for USVs, software advanced rapidly as well, with special focus on autonomous navigation methods and techniques in compliance and contribution to ocean digitalization and e-navigation framework initiatives. Considering hull dimension and propulsion system as classification factors, several flag-ship developments through last decade have been released (Fig. 1) highlighting Sailbuoy tested as pre-commercial solution at PLOCAN open-ocean observatory in 2012; Wave Glider robust enough to complete a crossing of the Pacific Ocean from California to Australia or successfully accomplish routing transects across the Macaronesia region by PLOCAN; AutoNaut performed trials at PLOCAN testy-site waters for marine mammal monitoring; C.-Enduro; the Saildrone able to perform long-range missions such circumnavigate the Antarctica and ATL2MED being PLOCAN an active member in the second one providing its test-site facilities for launching and initial field validations; DriX with specific applications on survey-services for industry; Mayflower expecting to sail between Plymouth-Cape Cod (MA, USA); Sphyrna hat focusses on passive acoustic monitoring applications; Data Explorer; XO-450 for energy and seabed mapping commercial survey services; SeaTrac; S10-submaran as hybrid concept able to both sail the ocean surface and glide the water-column as underwater vehicle. All of them are fully or partially powered by endless ocean-energy sources. In parallel, half-way to autonomous ship concept, developments such Sea-KIT; Ocean Infinity have also been released for specific seabed-mapping and survey-services in industry applications at ocean-basin level worldwide. These developments, many of them already commercial, have demonstrated that specialty USV could withstand the harsh ocean environment for extended periods and their software and systems were reliable enough for extended voyages and missions.

Fig 1. USV technologies currently available for operation

AUTONOMOUS VESSELS: THE ULTIMATE STEP TOWARDS SHIPPING 4.0 IMPLEMENTATION

We are nowadays facing a step further towards a new paradigm associated with cyber-physical systems, big data and autonomy as part of Shipping 4.0 and Digital Ocean international trends and strategies. Efforts in transport cost reduction, the global need of minimize emissions and the demand for improving safety at sea are three base reasons on why autonomous shipping is under consideration and early stages of implementation. The development and future implementation of vessels as MASS (Maritime Autonomous Surface Ship) will represent an inflexion point for the paradigm shift in the industry and maritime shipping system as a whole. Industries related to high specialized technology base sectors such autonomy and automation, unmanned operations, big data, artificial intelligence, machine learning, enterprise-grade connectivity and analytics will be essential. Although some regulatory aspects of manned vessels may be compatible with unmanned vessels, such as certain clauses of the International Safety Management (ISM) Code, there is a need for specific international regulations taking into account the characteristics of unmanned vessels as well. As ultimate regulator responsible for the COLREGs, the International Maritime Organization (IMO) in 2017 agreed to include marine autonomous surface ships (MASS) in agenda and started with a scoping exercise to determine how the safe, secure and environmentally sound operation of MASS might be introduced in IMO policies and rules.

Level	Description
1	Ship with automated processes and decision support
2	Remotely controlled ships with seafarers onboard
3	Remotely controlled ships without seafarers onboard
4	Fully autonomous ships

Table 1. MASS Levels of Control according to IMO's regulatory scoping exercise from 2018

CONCLUSIONS

In this paper, a global vision of the USV sector has been shown from the experiences of the authors in PLOCAN. A detailed analysis about the present and future of this sector has been depicted. An especial emphasis has been done in showing the interdisciplinary nature of the field, involving technological, commercial and regulatory aspects. The technological developments presented include a multidisciplinary set of state-of-the-art: sensors and systems for positioning, navigation, control, telemetry, propulsion, route planning, as well as specific tools for supervision and situational awareness operations, being key the inclusion of the AI techniques. IMO is developing a global regulatory framework for MASS implementation in coming years.

REFERENCES

[1] Liu, Z., Zhang, Y., Yu, X. and Yuan, C., "Unmanned surface vehicles: An overview of developments and challenges", Annual Reviews and Control, vol. 41, pp.71-93, 2016.

[2] Kim, M., Joung, T-H., Jeong, B. and Park, H-S., "Autonomous shipping and its impact on regulations, technologies and industries", Journal of International Maritime Safety, Environmental Affairs and Shipping, vol.4 (2), pp. 17-25, 2020.

[3] IMO, "Regulatory scoping exercise for the use of maritime autonomous surface ships (MASS)", MSC 99/5/12, 2018.

[4] Polvara, R., Sharma, S., Wan, J., A. Manning, A. and Sutton, R., "Obstacle avoidance approaches for autonomous navigation of unmanned surface vehicles", The Journal of Navigation, vol. 1(1), pp. 241 – 256, 2018.

ID42- MOODA: THE MODULE FOR OCEAN OBSERVATORY DATA ANALYSIS AND HARMONIZATION

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Abstract
The development of straightforward tools in data analysis plays a significant role in the available accumulative data from marine observatories. A large number of different variables recorded with different formats in marine observatories require methodologies that allow analysis and integration of these data automatically. In this paper, we present the MOODA open-source Python package, which provides an extensive range of procedures for harmonization and analysis of data from marine observatories, including feature extraction, quality control, filtering features, and visualization tools. We present the key aspects of the design and implementation of the package (mooda v1.x). MOODA is an integral component of the European Multidisciplinary Seafloor and water-column Observatory (EMSO) data management platform to harmonize and manage data from the different marine observatories. MOODA's dynamic development model based on user feedback achieves a continuous enhancement and integration of the library.

Keywords
Python, data science, data harmonization, EMSO ERIC

INTRODUCTION
The European Multidisciplinary Seafloor and water-column Observatory (EMSO) European Research Infrastructure Consortium (ERIC) [1] is a large-scale, distributed, marine Research Infrastructure (RI). EMSO ERIC consists of ocean observation systems for long-term, high-resolution, (near) real-time monitoring of environmental processes, including natural hazards, climate change, and marine ecosystems. EMSO ERIC observatory nodes are at key environmental sites across European seas, from the North Atlantic, through the Mediterranean, to the Black Sea. To analyze and harmonize the data from the different observatories, we developed MOODA, the Module for Ocean Observatory Data Analysis.

MOODA is a Python library that facilitates data access, transport, and analysis by the scientific community and stakeholders. Some of MOODA's features are:

- Direct data access with sophisticated query capabilities
- Data filtering methods based on metadata information
- Complex visualization tools
- Summary reports of the validated data generated from a specific query, including event annotations
- Specific data analysis tools for different scientific disciplines

We have added algorithms to open and analyze data from European and International marine data sources (e.g., EMODnet, Copernicus CMEMS, NSF Ocean Observatories Initiative [2,3], Ocean Networks Canada) and raw data from oceanographic instrumentation. MOODA is open source, adaptable, and scalable, which allows contributions from researchers and developers from all the disciplines associated with the marine observatories. In this contribution, we present the code package design and its main characteristics.

MOODA FEATURES
MOODA consist of a set of modules. These modules are classified into tree types:

Analysis modules. Libraries that contain a set of functions and classes for processing and analyzing data. For example, mooda.WaterFrame.min(parameter), that returns the minimum value, time and location (if the information is available) of the input parameter.

Input/output modules. Modules that contain a set of subclasses for reading data from a particular marine observatory or instrument. Module functions consist of translating the input observatory data to the standardized data frames (i.e., WaterFrames) for more accessible analysis. E.g., mooda.read_nc(), that allows to open datasets from a NetCDF.

Plot modules. Modules that contain a set of classes and functions to create plots. For example, mooda.WaterFrame.plot_timeseries(parameter), that makes a plot of the input parameter with a trace of the values of the time series and a shadow trace of the standard deviation of the values (see Figure 1).

A differential issue between the MOODA package and other existing data analysis packages, which adds significant value, is the integration of data quality control management. The MOODA package generates data quality control flags based on the QUAL - GTSPP data quality codes [4] and OceanSites quality control flags [5].

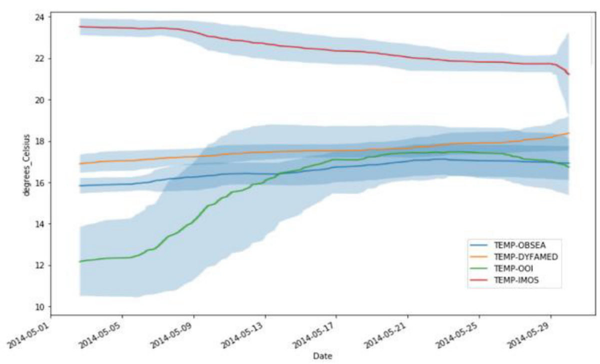

Figure 1. Example of plot generated with mooda.WaterFrame.plot_timeseries()

MOODA can be downloaded and installed with the popular Python package management system "pip" by using the command "pip install mooda" or using the source code available in Github [6].

CONCLUSIONS
MOODA is an open-source Python library that implements a wide range of marine data analysis functionalities. The library is useful to open, manage and analyze data from files and data sources from in-situ oceanographic data sources (e.g., EMODnet, Copernicus CMEMS, NSF Ocean Observatories Initiative, Ocean Networks Canada) raw data from oceanographic instrumentation. The package design and implementation model is adaptable and scalable, allowing continuous user input and contributions.

ACKNOWLEDGMENTS
This work is supported by the CSIC Intramural Project EMSO – Laboratorios Submarinos Profundos and EMSO ERIC.

REFERENCES
[1] J. J. Dañobeitia, S. Pouliquen, T. Johansen, A. Basset, et al., "Towards a comprehensive and integrated strategy of the European Marine Research Infrastructures for Ocean Observations", Front. Mar. Sci. 7:180. doi: 10.3389/fmars.2020.00180.

[2] L. M. Smith, J. A. Barth, D. S. Kelley, A. Plueddemann,I. Rodero, G. A. Ulses, M. F. Vardaro, R. Weller, "The ocean observatories initiative", Oceanography 31(1), 16–35(2018).
[3] I. Rodero, M. Parashar, "Architecting the Cyberinfrastructure for National Science Foundation Ocean Observatories Initiative (OOI)", 7th International Workshop on Marine Technology : MARTECH 2016. "Instrumentation viewpoint". Vilanova i la Geltrú: SARTI, 2016, p. 99-101.
[4] QUAL - GTSPP data quality codes - https://www.nodc.noaa.gov/GTSPP/document/codetbls/gtsppcodes/gtspp_qual.html
[5] OceanSites data format reference manual - http://www.oceansites.org/docs/oceansites_data_format_reference_manual.pdf
[6] MOODA GitHub web site - https://github.com/rbardaji/mooda

ID43- DEVELOPMENT OF A CITIZEN MONITORING PROGRAM FOR THE BARCELONA COASTAL WATERS: THE SCIENTIFIC PATÍ VELA (PATI CIENTIFIC)

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Abstract
The first results of the PATI CIENTIFIC project are presented. This is a collaborative project funded by a Barcelona Institute of Culture's grant for research and innovation under the 2019 Barcelona Science Plan. The main objective of this project is to develop a monitoring program for the coastal waters of Barcelona through a small-sailboat fleet of the traditional and sustainable Patí de Vela (sailing skate). This pleasure boat is to become a scientific sailing skate. This fleet will acquire the essential oceanographic variables along the Catalan coast, which will be incorporated and accessible in a web platform. We present the initial adaptations done to the Patí de Vela to have an onboard platform holding the scientific instruments (sensors and devices) for sampling the Barcelona coastal waters. These adaptations allow the systematic measurements of the essential physical and biogeochemical variables. These data, which will allow detecting variations along the coast, hence identifying potential sources of contamination and also providing the necessary knowledge of natural and anthropogenic seasonality, and will be freely available on a web platform. The PATI CIENTIFIC project will increase our knowledge of the coastal waters of the Barcelona coast, encouraging participation in sea monitoring activities and increasing social awareness on the need to love and protect our oceans.

Keywords
Coastal research platform, Barcelona coast, recreational sailing, sustainable platform, citizen initiative, ocean awareness, ocean monitoring.

INTRODUCTION
Our knowledge of the ocean has improved drastically during the last decades, particularly thanks to remote sensing from satellites and a fleet of underwater instruments (Argo floats, http://www.argo.net/ and EMSO ERIC, http://www.emso.eu) present in all the oceans far from the coast. Paradoxically, the available amount of data for the coastal ocean has experienced a very slow increase. However, accurate observations of the coastal oceans are required to understand how these regions evolve due to natural, and very particularly, anthropogenic effects.

Barcelona's climate is conditioned by the Mediterranean Sea, which acts as a natural regulator to prevent extreme weather conditions. Further, the surrounding sea provides natural resources for local fisheries and a gathering space for local people and visitors, for recreational and social activities. Despite its relevance, the Barcelona marine environment remains very poorly sampled. Apart from the water quality control carried out in summer [1]-[2], only a systematic year-long offshore sampling along one line normal to the Somorrostro Beach has been regularly maintained since 2002 [3]-[4] These data, which are available on the ICM's webpage [5], have been used to produce a substantial number of publications [6]-[8].

In order to address this lack of observations, here we propose to take advantage of a traditional and fully sustainable recreational boat widely used on Barcelona's coast and nearby: the sailing skate (Patí de Vela). It is a wooden sailing boat that was born on the beaches of Badalona and Barcelona in the 1920's because of the need for swimmers to pass over the polluted near-shore waters. It is a lightweight one-person catamaran with a single Marconi sail and no boom. This boat has the peculiarity of not having a rudder nor a centreboard. The steering is only controlled using the bodyweight of the crew member and the tension in the sail.

OBJECTIVES
Our main objective is to create the first prototype of the scientific Patí de Vela to sample the Barcelona coastal waters using relatively cheap sensors to help answer scientific questions such as: How healthy is the Barcelona coastal ocean? How intense rainy events modify the offshore water quality? How are the temperature and salinity evolving? The second objective is to create a small fleet of sailing skates that can routinely monitor the coastal waters, encouraging citizens to produce reliable scientific knowledge and effectively incorporating the oceans into Barcelona's collective imaginary.

Throughout the process, outreach and communication activities will be held, especially among university students and schools and civil associations from the coastal neighbourhoods, as well as together with other citizen sailing initiatives.

RESULTS
We present the adaptation of the first prototype of the Scientific Patí de Vela (Fig. 1, Left) such that it can hold all the scientific instruments onboard and tow a net to remove floating debris. Some essential ocean variables (e.g. temperature and salinity) are sampled in the surface and sub-surface layers (max: 30 m depth). The data is acquired from a designed and tested prototype of a low-cost instrumented oceanographic platform.

We will show the first observations taken with the scientífic Patí de Vela from a coastal zone between Hotel Vela and Forum, which is about 4-5 km long and between 0.4 and 2.4 km wide (Fig. 1, Right).

All data will be freely available thanks to the development of an open-access interactive web where data will be incorporated and retrieved.

Fig. 1. Left: Preliminary sketch illustrating some modifications that will be done to the scientific Patí de Vela, including the incorporation of several sensors and sampling devices. Right: Schematics of the area of study. The triangles indicate the hydrographic stations monthly sampled by the Institut de Ciències del Mar (only stations 1.1, 1.2, 1.3, 1.4 and 1.5 are currently maintained). The dotted line illustrates a possible track for one single Patí de Vela. The white circles point at potential reference locations along the coast. The red star indicates the location of the boat yard, in the Club Patí Vela Barcelona premises.

ACKNOWLEDGEMENTS

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The work of Carlos Rodero is supported by the H2020 Project MONOCLE (grant agreement No 776480).

REFERENCES

[1] ACA, "Qualitat de les aigües de bany", Agencia Catalana de l'Aigüe, last accessed 1 August 2019. http://acanet.gencat.cat/scripts/platges/menu.asp
[2] BCN, "Bany i Platges", Ajuntament de Barcelona, last accessed 1 August 2019. https://www.barcelona.cat/ca/que-pots-fer-a-bcn/banys-i-platges
[3] ICM, "Estació Litoral de Barcelona", Institut de Ciències del Mar, last accessed 1 August 2019. http://coo.icm.csic.es/site-page/stations#Barcelona-ELB
[4] ICM, "PUDEM SOS Application", Institut de Ciències del Mar, last accessed 1 August 2019. http://ide.cmima.csic.es/sos-js/web/examples/sos-app-test.html
[5] ICM, "Coastal Ocean Observatory", Institut de Ciències del Mar, last accessed 1 August 2019. http://coo.icm.csic.es/
[6] Arin, L., J. Guillén, M. Segura-Noguera, M. Estrada, "Open sea hydrographic forcing of nutrient and phytoplankton dynamics in a Med. coastal ecosystem", Est. Coastal Shelf Sci., vol. 133, pp. 116-128, 2013.
[7] Romero, E., F. Peters, L. Arin, J. Guillén, "Decreased seasonality and high variability of coastal plankton dynamics in an urban location of the NW Mediterranean", J. Sea Res., vol. 88, pp. 130-143, 2014.
[8] Guillén, J., L. Arin, J. Salat, P. Puig, M. Estrada, A. Palanques, G. Simarro, J. Pascual, "Coastal oceanographic signatures of heat waves and extreme events of dense water formation during the period 2002-2012 (Barcelona, NW Mediterranean)", Scientia Marina, vol. 82, pp. 189-206, 2018

ID44- IMPLEMENTATION OF A LOW-COST ULTRA-DENSE TIDE GAUGE NETWORK IN THE BALEARIC ISLANDS

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Abstract
The VENOM project has developed an unprecedented ultra-dense low-cost, and yet reliable, tide gauge network around the Balearic Islands to understand the very nature of the spatial variability of coastal sea level at different time scales, from sub-hourly processes (e.g., meteotsunamis), to seasonal and interannual variability.

Keywords
Tide Gauge, Sea Level, Meteotsunami, Arduino, Mediterranean Sea

INTRODUCTION

Sea level variability is used as an indicator of various short-term and long-term oceanographic processes, such as tsunamis or the sea level rise caused by global warming. Sea level is currently monitored mainly by satellite altimetry and tide gauges, which provide data at different time scales with different spatial resolutions. Despite the extensive network of instruments available, there are still some important limitations for the monitoring of coastal sea level. The tide gauge network is sparse and unevenly distributed, and high frequency data (< 1 hour) is often not available. Furthermore, satellite altimetry measurements are obtained along tracks which can be separated up to 300 km. Also, the validity of altimetry measurements close to the coast is limited and in certain regions may not be representative of the coastal processes.

The mail goal of the VENOM project is to better understand the spatial variability of coastal sea level at different time scales, from sub-hourly processes (e.g., meteotsunamis), to seasonal and interannual variability. In order to cover the short spatial scales associated with the high frequency variability, the project has extended the existing sea level measurement network around the Balearic Islands in the framework of the Western Mediterranean. Namely, we have deployed a new, ultra-dense network of low-cost, and yet reliable, tide gauges.

TIDE GAUGE DEVICES

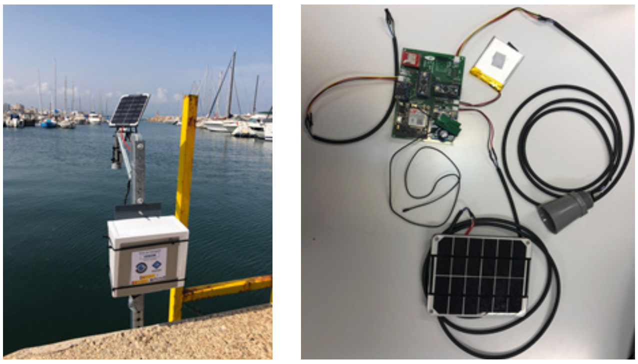
The low-cost tide gauges (Fig. 1) have been developed in the Arduino environment. They consist of an acoustic sensor coupled to a datalogger that registers data at 60 second intervals on a local SD, and that communicates through a GPRS link with a web database at selected intervals. Instruments are solar-powered, so they can be installed almost everywhere. A graphic dashboard allows the monitoring of the network (including the battery status), as well as real-time data visualization. A comparison between a low-cost tide gauge deployed side-by-side with a Puertos del Estado tide gauge (Palma) shows a RMS error of 0.4 cm for hourly data and 0.6 cm for data recorded every minute.

THE ULTRA-DENSE TIDE GAUGE NETWORK

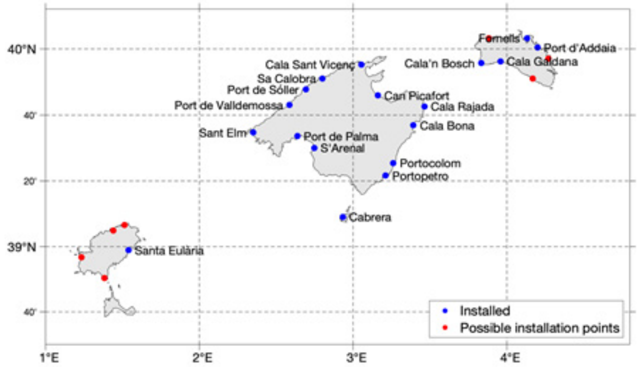
Currently, 19 instruments have already been installed all around the Balearic Islands (12 in Mallorca, 4 in Menorca, 2 in Cabrera and 1 in Eivissa, see Fig. 2) at distances of approximately 10-30 km. Additional sensors like atmospheric pressure or air temperature sensors have also been attached to some of the tide gauges. In the near future, 4 more instruments will be deployed. Their location has been chosen in such a way as to complement the 14 instruments run by other institutions (5 by Puertos del Estado, 5 by SOCIB, 3 by Ports de les Illes Balears and 1 by IEO).

CONCLUSIONS

The preliminary results of this network are very promising, as the instruments have already measured regional phenomena such as meteotsunamis and downbursts that are currently being analyzed. Our expectation is that with the addition of this new low-cost tide gauge network, it will be possible to achieve an unprecedented advance in understanding the spatial variability of coastal sea level.



'Fig 1.' Low-Cost tide gauge (left) device and Arduino-based data logging circuit board (right).



'Fig 2.' Tide gauge network locations operated by the VENOM project (blue) and future installation points (red).

AKNOWLEDGMENTS

This work is funded by the Spanish Government (Ministerio de Ciencia, Innovación y Universidades) through the coordinated project VENOM (PGC2018-099285-B-C21 and PGC2018-099285-B-C22). We acknowledge the support and collaboration of the Demarcación de Costas and Ports de les Illes Balears, for granting us permission to install the tide gauges. We also thank Puertos del Estado, SOCIB, Ports de les Illes Balears and IEO for the availability of their tide gauge data.

ID45- AUTONOMOUS PORTABLE MODULE FOR CONTINUOUS ANALYSIS OF OCEANOGRAPHIC VARIABLES ALONG COASTAL TRANSECTS

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Abstract
Eutrophication risk determination requires a continuous acquisition of nutrient data to establish environmental trends. In the context of the MarRISK project, a portable module has been designed to autonomously measure inorganic nutrients together with other parameters such as temperature and salinity along coastal transects.

Keywords
Inorganic nutrients, autonomous analyses, WIZ probe, eutrophication, coastal risks.

OCEANOGRAPHIC MODULE DESCRIPTION
Eutrophication is associated with adverse effects in coastal ecosystems. This environmental problem implies an accelerated proliferation of opportunistic microbial and macroalgae communities, altering the trophic structure of the marine ecosystems and deteriorating water quality. Consequently, nutrient enrichment risk negatively affects the marine ecosystem services [1, 2]. Particularly, in the Galicia-North Portugal Euroregion we have identified coastal risks such as eutrophication, ocean acidification and algal blooms regime alterations and all of them directly affect supporting and provisioning services.
In order to establish the trend of environmental indicators related to the eutrophication risk in a specific area, it is essential a continuous acquisition of nutrient data [3]. Most of nutrient probes are commonly used for fixed and floating platforms [4], but it requires having an available infrastructure and constant maintenance. In the EU MarRISK project [5], a portable module has been designed for continuous analysis of several parameters along transects on board opportunity vessels.

Our module, integrated by a WIZ nutrient probe, a SBE45 thermosalinograph and a GPS system, Fig 1(a), is activated manually by a single user only to start and to stop it. All these instruments are mounted on a pumping circuit collecting sea-surface waters. Temperature and salinity analyses are in continuous mode. Nutrients probe is programmed for sequential measurement of nitrate+nitrite and phosphate every 40 min. Seawater sample is pumped with a peristaltic pump into a flexible bag before entering in the WIZ nutrient-analyser. The sample is previously filtered by passing it through a 0.1 micron-filtration unit. When the multi parameter analysis is finished, the filter and pumping circuit washing is activated by turning the pump in reverse mode.

The WIZ probe is based on the automated micro-Loop Flow Reactor technology (patented by Systea S.p.a., Italy) and it is composed of an analytical unit and a reagent canister, Fig 1(b). Nitrate and nitrite are measured by UV-photoreduction, phosphate method is based on phosphomolybdate formation and ammonium is determined by OPA fluorimetric method. The main advantages of WIZ are the low reagents consumption, in the order of µL, and the analysis of nitrate+nitrite, nitrite, phosphate and ammonium using one single unit.

Nutrient results of WIZ probe and FUTURA autoanalyzer, based on segmented flow analysis, were also compared. Our multi-parameter module has been tested in several campaigns on board R/V Mytilus and Tyba III (BDRI, O Grove), showing that it is a powerful tool for biogeochemistry studies in coastal areas.

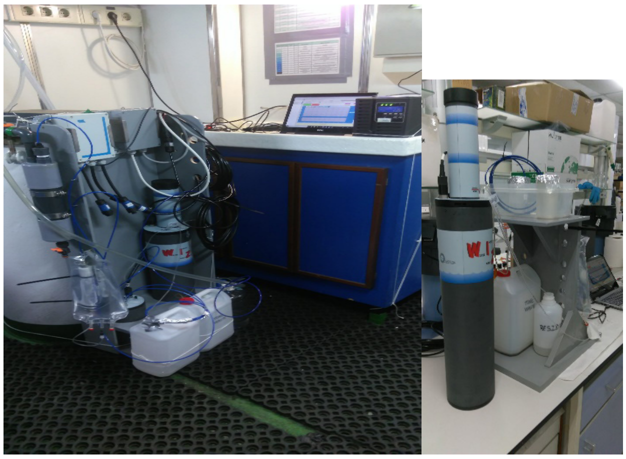

Fig 1. (a) WIZ probe-thermosalinograph-GPS module on board; (b) WIZ probe calibration in the laboratory.

REFERENCES
[1] Ferreira JG et al. "Marine Strategy Framework Directive, Task Group 5 Report Eutrophication", 2011.
[2] Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Current States and Trends. Island Press, Washington, 2005.
[3] EEA. Digest of EEA indicators. Technical report, 8/2014. European Environment Agency, 2014.
[4] Bodini S et al. "Automated micro Loop Flow Reactor technology to measure nutrients in coastal water: state of the art and field application". IEEE Oceans'15 Conference, Genova (Italy), 2015.
[5] EU MarRISK project: "Adaptación costera ante el Cambio Climático: conocer los riesgos y aumentar la resiliencia". 0262_MarRISK_1_E, Spain-Portugal (POCTEP).

ID46- USING WIZ PORTABLE MODULE TO ANALYSE EUTROPHICATION RISK LEVELS IN THE NW IBERIAN COAST

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Abstract
A portable module has been used to measure inorganic nutrients on the NW coast of the Iberian Peninsula during summer of 2019. The results allow us to know the variability of nutrient concentration and study the potential risk of eutrophication.

Keywords
Eutrophication, WIZ probe, nitrate, phosphate, inorganic nutrients

INTRODUCTION
Marine eutrophication is a process that results from the increase of nutrients, mainly nitrate and phosphate in seawater. Eutrophication damages marine ecosystems by promoting blooms of microbial communities (some of them toxic) that lead to an increase in total organic matter and in oxygen demand. In marine environment, nitrate and phosphate come from subsurface nutrient-rich waters, and also from agriculture via river runoff and wastewater [1].

The NW coast and adjacent shelf of the Iberian Peninsula constitute the most important upwelling region in Europe [2]. In the Northern Hemisphere, upwelling processes occur mainly during summer, when northerly winds blow over the shelf. These winds push away surface water close to the coast and cause subsurface water to rise. As it rises, this deeper nutrient-rich water reinforces primary production [3]. If the primary producers are not effective enough, high concentration of nutrients could stay in surface layers, causing a potential risk of eutrophication.

In this study, surface concentrations of nitrate and phosphate were measured during summer months on the NW Iberian coast (shelf and inner bays). The main goals are to analyse nutrient concentration variability and perform an assessment of the potential risk of eutrophication.

METHODS
Surface seawater samples were collected on different days in August and September 2019 (Fig. 1A) and analysed on board the opportunity vessel Tyba III (BDRI, O Grove). Nitrate and phosphate concentrations were measured using a portable WIZ nutrient probe (Bastero et al 2021, MarTECH workshop). To consider the effect of upwelling events on nutrient concentration, we used data of the Upwelling Index (UI) obtained from the INTECMAR database.

RESULTS
Surface nutrient concentrations along the NW Iberian coast increase from offshore to the shelf and from the shelf to the inner bays (Fig. 1a). The time variability of the nutrient concentrations followed UI variability, with higher concentrations observed during upwelling events (Fig. 1a, b). The highest concentrations in the sampling period were measured in September, and result from the persistent upwelling events that occurred during this month (Fig. 1b). Considering the eutrophication level ranges proposed by the Environmental European Agency (EEA, [4]), the nutrient concentrations observed show that the study area was in low risk of eutrophication during the sampling period. Nevertheless, some local sites with high vulnerability (medium and high levels of eutrophication) were detected (Fig. 1c, d).

REFERENCES

[1] Malone TC, Newton A, "The Globalization of Cultural Eutrophication in the Coastal Ocean: Causes and Consequences", Frontiers Marine Science, vol. 7, Article 670, 2020.
[2] Fraga F, Upwelling off the Galician Coast, Northwest Spain, In: Richardson FA (ed). Coastal upwelling. American Geophysical Union, Washington DC, pp. 176-182, 1981.
[3] Castro CG, Perez FF, Alvarez-Salgado XA, Fraga F, "Coupling between the thermohaline, chemical and biological fields during two contrasting upwelling events off the NW Iberian Peninsula", Continental Shelf Research, vol. 20, pp.189-210, 2020.
[4] EEA, Nutrient enrichment and eutrophication in Europe's seas. Moving towards a healthy marine environment. European Environment Agency, 14/2019.

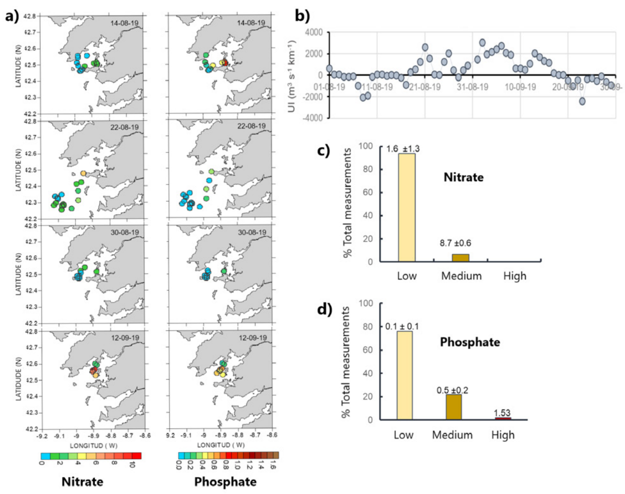

Figure 1. a) Nitrate and phosphate concentrations, b) Upwelling Index (UI), and Eutrophication risk levels for c) nitrate and d) phosphate.

ID47- THE WAVY DRIFTERS – SENSOR AND DATA VALIDATION

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Abstract
The WAVY family of drifters, developed in the EU H2020 project MELOA, range from small drifters suitable for beach and surf zone studies to somewhat larger drifters, tailored for coastal and long-term open ocean observations, and consists of five members, namely the WAVYs Basic (WB), Littoral (WL), Ocean (WO), Ocean-plus (WP) and Ocean-Atmo (WA). The WB and WL are currently at TRL 8, having been validated and used in real operational environments in a series of demonstrative use cases; the WOs are currently at TRL6 and undergoing use cases designed to bring them to TRL8. This paper presents the latest work done in the validation of three capabilities of the drifters: tracking of the ocean's surface currents; measurement of wave parameters and measurement of sea surface temperatures.

Keywords
Ocean currents, Ocean waves, Sea Surface Temperature, Ocean observation, Lagrangean current meters, surface drifters, near real-time in-situ data, data validation.

INTRODUCTION
Project MELOA (Multi-purpose/Multi-sensor Extra Light Oceanography Apparatus) developed a family of low-cost, easy-to-handle, wave resilient, multi-purpose, multi-sensor, extra light surface drifters for use in all water environments, the WAVYs. Their main attributes are the small size and low weight, optimized buoyancy to reduce the wind "sail effect" and minimized pendular motion, to keep the internal antennae as much as possible above water.

The research and development focused on achieving sturdiness of the casing, to allow applications in rough environments, such as the surf zone and rugged littorals; the implementation of an inertial motion sensor (IMU), to compute wave parameters, and finally energy harvesting, for extended battery life at sea. Other challenges were addressed as well, such as resistance to shock, balance between autonomy and weight, placement of the required antennae versus the desired behaviour of the spherical drifter (minimizing the wind exposed surface), electromagnetic interference between components, balance of on-board computing power and data storage capacity, development of communication protocols and other minor issues.

The following sections cover recent achievements in the validation of data along three main features: tracking of surface currents; measurement of waves; measurement of near-surface sea temperatures.

OBSERVATION OF SURFACE CURRENTS
The ability of the WAVY drifters to correctly track surface currents has been demonstrated many times during the field campaigns carried out in the MELOA project. Figure 1 illustrates the trajectories observed by WL in the nearshore and coastal waters off Portugal and at a beach in Vilanova i la Geltrú, Spain, as seen in the WAVY Operation Software, the tool developed to manage campaigns and deployments and available to all users. Other field tests currently ongoing use fixed ADCP to measure surface velocities that are then compared to those observed by the drifters in the vicinity.

OBSERVATION OF OCEAN SURFACE WAVES
This is done by processing the accelerations measured by the on-board IMU. Three main types of validation experiments have been performed in multiple occasions: 1) direct comparison with other wave sensors (DataWell Waveriders and upward looking ADCPs with surface following mode); 2) validation in a Ferry Wheel used for Waverider calibration and 3) validation in a wave tank under controlled and known wave fields. Figure 2 shows examples of wave parameters (left) and the spectrum (right) measured against a Waverider and in a wave tank (the Lir NOTF in Cork, Ireland); in this latter case, the drifters were moored with a very light configuration but, nonetheless, their behaviour is affected by it. The wave extraction algorithm used in MELOA shows a good ability to depict the waves observed in situ.

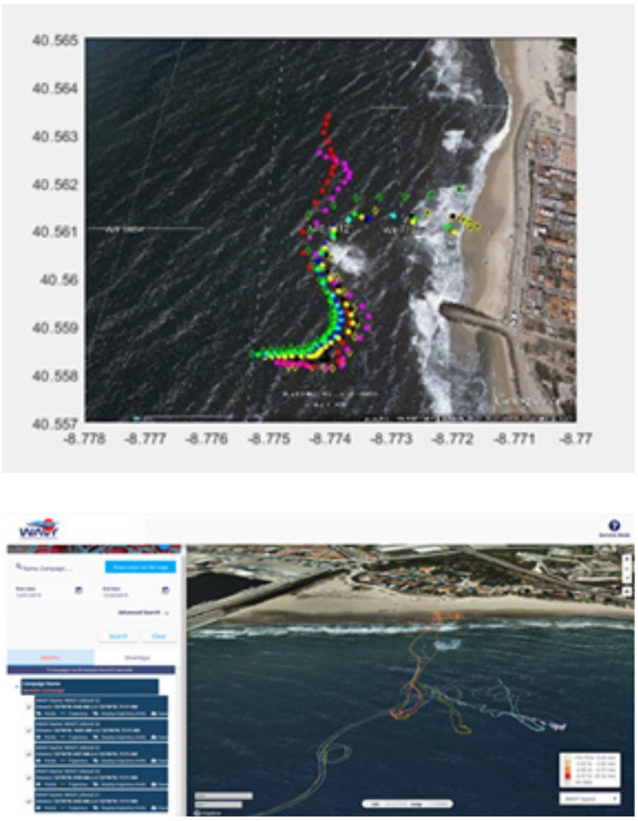
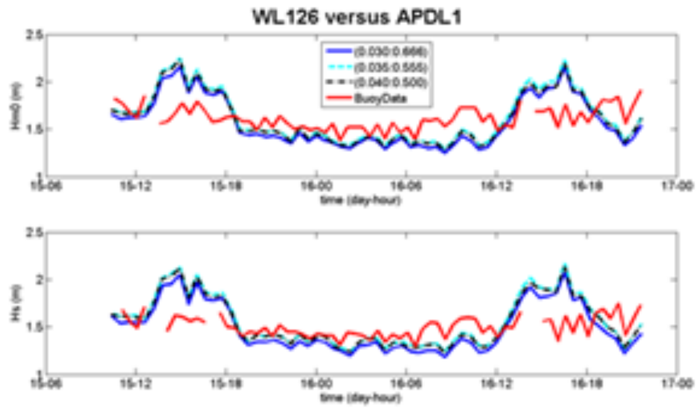


Fig 1. Trajectories of WL in a beach in Portugal, 2019 (left) and in Vilanova i la Geltrú, Spain, 2019 (right). The dots shown in the left correspond to successive positions of the drifter and depict wave-induced currents. The drifters shown on the right were launched from the beach by beachgoing citizens. Regular lines further offshore are trajectories of a RIB after recovery of the drifters.



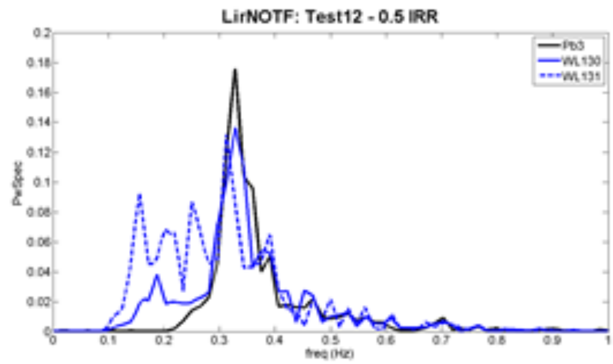


Fig 2. Example of wave parameters as measured by WLs, compared against a Waverider (left) and in controlled conditions (wave test tank, right), showing low frequency effects of the mooring used to keep the drifter on station, possibly (under investigation).

OBSERVATION OF SEA SURFACE TEMPERATURES (SST)

Observations of SST are done by the on-board thermistors. Sensor validation is achieved through calibrated temperature baths and field experiments. One such campaign was carried off the Portuguese West coast with a WB. Figure 3 shows results obtained in the latter case, clearly capturing the good response of the sensor when the drifter was placed in the water (~14:07) and then later removed (~14:50). Work is ongoing to obtain more validation data and fine-tune the calibration procedure for the thermistors.

ACKNOWLEDGMENTS

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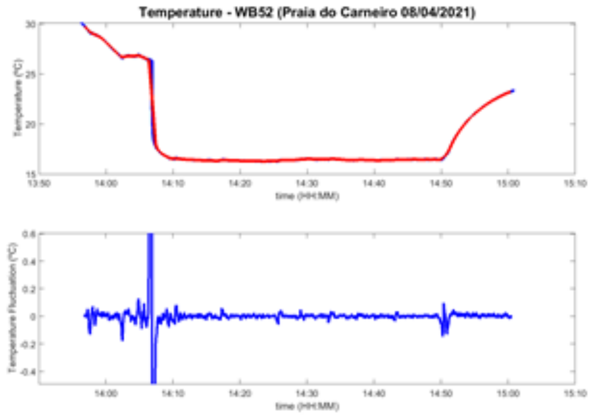

Fig 2. Example of wave parameters as measured by WLs, compared against a Waverider (left) and in controlled conditions (wave test tank, right), showing low frequency effects of the mooring used to keep the drifter on station, possibly (under investigation).

ID48- TIDAL PROPAGATION AND FREQUENCY RESPONSES IN THE GUADALQUIVIR ESTUARY

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Abstract
The Guadalquivir River is dominated by the tidal flows coming from the Gulf of Cadiz, being the semidiurnal oscillation the most relevant in the area. Tidal constituents in the estuary are especially sensitive to variations in frequency due to tidal friction and resonance balance, and fluctuate with other harmonic components. In this study both sensitive analyses have been covered, providing an assessment of the frictional interactions between tidal constituents.

Keywords
Guadalquivir Estuary, tidal resonance, tidal amplitude, semidiurnal constituents.

THE GUADALQUIVIR ESTUARY
The Guadalquivir Estuary opens into the Gulf of Cadiz (SW, Spain), where tidal oscillations are semidiurnal with a tidal range between 2 and 3.5 meters. Tide in the estuary is imported from the ocean and, as a consequence, the fluctuations of the water column thickness along the river are mostly determined by the tidal amplitudes, being the atmospheric components (wind and pressure) and anthropogenic-controlled discharges the following phenomena in importance. Within the estuary, energy is dissipated by friction. The bottom stress (higher friction), acts drawing out tidal propagation, causing lower incoming velocities into the river. Reports in literature show a considerable balance between the convergence of the channel, friction effect in the estuary and tidal reflection in Alcalá del Río dam, located ~100 km upstream [1].

TIDAL REGIME IN THE AREA
Tidal behaviour in the estuary is addressed according the same procedure as in oceanic studies, by means of the harmonic analysis. Among the astronomic constituents, the most important are semidiurnal, primarily M2 (main lunar constituent), which accounts for the major part of the explained variance in the estuary, and secondarily S2 (main solar constituent) and N2 (lunar elliptic). Diurnal constituents, K1 (lunar declination) or O1 (main lunar diurnal), may also be identified in the estuary, but they are an order of magnitude less than the mesotidal flow.

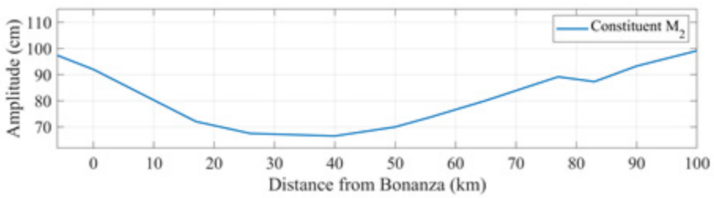

Fig 1. Profile of M2 amplitude (cm) along the Guadalquivir Estuary.

Focusing on the semidiurnal components, their amplitude profiles tend to be characterized by a notorious V-shape pattern along the whole estuary, which is particularly noticeable in the case of M2, achieving maximum amplitudes of around 1m in the mouth and head of the estuary, and minimum values of around 0.7m in the middle portion of the estuary (Figure 1). There is agreement in the literature that points at friction as the main process for the M2 amplitude damping in the middle estuary [2]. Another cause to this effect can be ascribed to the M2 behaviour as a stationary wave with resonant behaviour [3]. Considering both effects jointly, the frictional bottom layer would tend to balance the tidal amplification due to a likely resonance, thus preventing the channel from being purely resonant.

DEFINITION OF NUMERICAL EXPERIMENTS
Tidal resonance occurs when tidal frequency (ω_F) matches the natural oscillation frequency (ω_0) of a semi-enclosed body of water. To investigate the resonant frequency ω_0, a set of experiments that use a fictitious tidal constituent of predetermined frequency (which changes from an experiment to the other) and the same amplitude has been run, and the response at the estuary's head has been analysed. On the other hand, with the purpose of providing an explanation to some peculiar spatially-dependent features of tidal oscillation in the estuary, a simulation forced by M2 and S2 uniquely has been run. A second simulation that switched off M2 constituent was then run and the spatial patterns of S2 in both simulations have been compared in order to assess the frictional interactions between tidal constituents. A three-dimensional (3D) model (DELFT3D) has been used as the numerical tool.

REFERENCES
[1] M. Díez-Minguito, A. Baquerizo, M. Ortega-Sánchez, I. Ruiz and M. Losada, "Tidal wave reflection from the closure dam in the Guadalquivir estuary", Coastal Engineering, 2012.
[2]. H. Cai, M. Toffolon, H. H. G. Savenije, Q. Yang and E. Garel. "Frictional interactions between tidal constituents in tide-dominated estuaries". Ocean Sci., 2018.
[3] O. Álvarez, B. Tejedor and J. Vidal (s), "La dinámica de marea en el estuario del Guadalquivir: un caso peculiar de «resonancia antrópica»", Física de la Tierra, 13,11-24, 2001.

ID49- PHOTOGRAMMETRY IN MARINE SCIENCE

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Abstract
Photogrammetry is one of the oldest but constantly evolving branch of computer vision. The main concept behind it is based on obtaining three-dimensional coordinates of a real word object from a series of pictures of it, collected from different locations. The outcome is a three-dimensional model of the object, on which any kind of virtual manipulation and quantitative measuring can be carried out. Several examples of both aerial (based on aerial photographs) and close-range (based on standard close-distance pictures) photogrammetry applications to different fields of marine science, are described, promoting the use of this technique as an undeniable aid for oceanographers, marine geologists and biologists.

Keywords
Photogrammetry, Image processing, 3D models.

PHOTOGRAMMETRY
Photogrammetry is the science of obtaining quantitative information about surface and volume of an object, from a series of pictures of it. The basic concept is the known pinhole camera model [1], which describes the mathematical relationship between the three-dimensional coordinates of a point in the exterior (real world) space and its projection on the bi-dimensional plane of the camera sensor in the interior space. This model is sophisticated by accounting lens geometry and distortion (camera calibration) that affect the accuracy of the previous transformation. For a given camera location, a line of sight (ray) to the target point is drawn and, if the same point is seen from other camera locations, the intersection of these multiple rays determines the three-dimensional position of the point (triangulation, [2]). This technique is iterated through a generally large number of pixels recorded in multiple neighbor images, with a recursive approach aimed at minimizing errors, and a three-dimensional point cloud is obtained. Eventually, the object shape can be reconstructed by interpolating the point clouds on a triangular mesh, usually by means of a Poisson Surface Reconstruction algorithm [3], to obtain a complete texturized 3D model.

AERIAL AND CLOSE-RANGE PHOTOGRAMMETRY
Two different approaches of the photogrammetric technique are widely employed in environmental science. The aerial photogrammetry is based on the pool of aerial images collected along predefined tracks with a high degree of overlap among neighbor images. The outcomes are typically 3D terrain models employed in topography, civil engineering and coastal/land management. On the other hand, close-range photogrammetry relies on images collected by standard cameras, with typically inclined orientation, surrounding the object. Archaeology, medicine, mechanic engineering and morphometry are only few of the fields where this technique is successfully applied. The main difference with the previous method is the lack of information on the camera location and orientation, which is provided by the aircraft in the aerial counterpart. This implies the lack of a real-word scale, which however can be inferred by adding scaled references in the scene.

APPLICATIONS TO MARINE SCIENCE
Different examples of applications of both aerial and close-range photogrammetry are presented in this work, all sharing the common field of marine science and technology. Drone-based aerial photogrammetry is proposed as a technique to improve the quality of the sites mapping in coastal management. Marine coastal evolution after storm events, morphology inspection of riverine margins and even the combined use of shallow bathymetric survey and high resolution photogrammetric coastal mapping are presented (Fig.1). On the other hand, a successful example of application of close-range photogrammetry to the digitalization of the Marine fauna collection of the Spanish Institute of Oceanography, is also described. A bunch of unique specimen of abyssal fishes, included a rare dicephalus blue shark (Prionace glauca), have been digitalized providing a unique way of handling, measuring and analyzing the samples with no further need of physical contact with them (Fig.1).

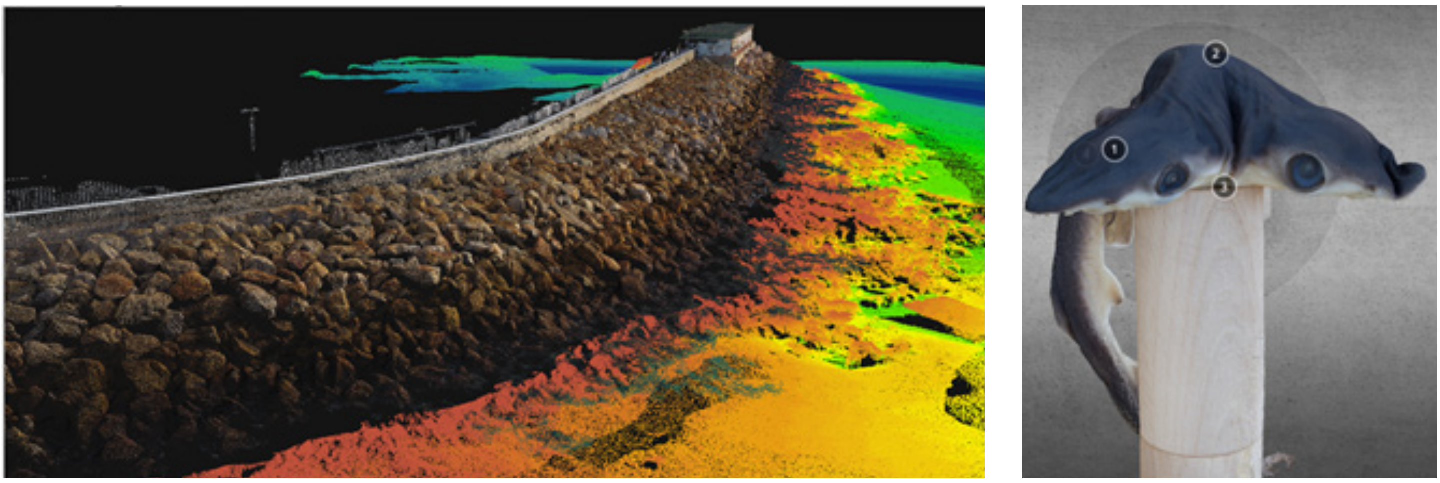

Fig 1. Combined bathygraphy and aerial photogrammetry of Tarifa Port (left) and 3D model of dicephalus Prionace glauca (right).

PHOTOGRAMMETRIC SPHERE

One of the main bottleneck factors in close-range photogrammetry is the uniformity of lighting and pictures scale. The quality of the 3D output model strictly depends on the coherence of paired targets (neighbor pictures pixels), which in turn is directly correlated to the strength and position of the light source and the distance of the camera to the subject. Keeping them constant during the survey may result very hard and the successful completion of the model may be compromised. In order to solve these issues, the photogrammetric sphere is proposed. It consists on a spherical lattice structure, hosting an array of digital cameras and multiple lighting LED rings, capable of simultaneously shooting several pictures of the object located in the center, so guaranteeing coherent lighting and precise photographs dimensions.

REFERENCES

[1] Forsyth, D. A., Ponce, J. (2012). Computer Vision - A Modern Approach, Second Edition. Pitman. ISBN: 978-0-273-76414-4.

[2] Schenk T. (2005) Introduction to photogrammetry. Department of Civil and Environmental Engineering and Geodetic Science, The Ohio State Universitiy, Columbus, p 95.

[3] Michael Kazhdan, Matthew Bolitho, and Hugues Hoppe. 2006. Poisson surface reconstruction. In Proceedings of the fourth Eurographics symposium on Geometry processing (SGP '06). Eurographics Association, Goslar, DEU, 61–70.

ID50- COMPARING MESH-FREE AND MESH-BASED NUMERICAL METHODS TO DEAL WITH SLOSHING TANK PROBLEMS

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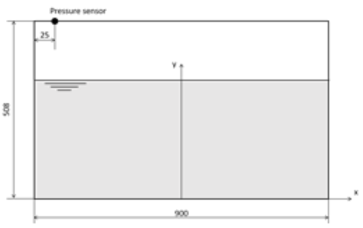
Sloshing is a highly nonlinear movement that can lead to dynamic loads on tanks. These loads can affect, for example, Liquefied Natural Gas (LNG) vessels by modifying the movement of ships on waves. This is a key point in the design of anti-roll tanks used to damp the roll movement of ships. The coupling effect between sloshing and motions of ship can be analysed by means analytical, experimental and numerical methods. Analytical and experimental methods have some drawbacks as, for example, the simplification hypothesis of the analytical methods make that only simplified models can be analysed and the experimental methodologies need from expensive experimental facilities that limit the number of cases. Numerical methods are a good option to overcome these drawbacks. The numerical methods can use two different methodologies: mesh-free and mesh-based methods. The mesh-based methods discretise the domain of study using fine meshes to study, for example, the propagation of waves. These methods usually require expensive mesh generation and have severe technical challenges associated with the implementation of conservative multi-phase schemes. Free surface elevation is obtained by using volume of fluid methods (VOF). The mesh-free methods discretise the fluid domain using particles. Then, these methods analyse the flow by following the fluid particles. The mesh-free methods allow overcoming part of the drawbacks that characterise the mesh-based schemes, despite their usually bigger computational cost. Methods such as Smoothed Particle Hydrodynamics (SPH) and the particle finite element method (PFEM) are examples of mesh-free schemes. In SPH no special tracking is used to detect the free surface and the domain is multiply-connected due to the Lagrangian nature the method. Consequently, large deformations of free surface can be efficiently treated since there is no mesh distortion, making SPH an ideal technique to study highly non-linear phenomena. González-Cao et al. show in [1] a comparison of this two methodologies applied to fluid-structure interaction (FSI) problems. The authors compare the results of the propagation of regular waves and their impacts on a static vertical wall of a structure with a cantilever slab using the mesh-free method DualSPHysics [2] and the mesh-based method IHFOAM [3]. In this work the authors aim to extend the previous comparison studies focused on the interaction of fluid with static structures to moving bodies by comparing the results obtained in physical tests (reference data) of a sloshing tank with the numerical results obtained using DualSPHysics and OpenFOAM. The analysed case is a SPHERIC Benchmark Test Case 10 (https:// spheric- sph. org/ tests/ test- 10), consisting of a sloshing tank of 900 mm × 508 mm with an initial water level equal to 355.3 mm. Figure 1 shows a scheme of the experimental set-up. Reference data (experimental) of the time series of pressure of the impacts in the roof of the tank (see Figure 1) was obtained from [4-7]. The time series of pressure obtained with DualSPHysics, OpenFOAM along with the experimental data are depicted in Figure 2. The numerical results are quite similar to the reference solution.

This work shows that mesh-free methods have achieved the required level of maturity to reproduce sloshing problems, attaining a level of accuracy and efficiency similar to mesh-based methods.



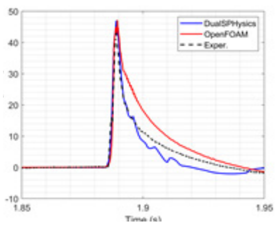


Fig. 1. Scheme of the experimental setup.

Fig. 2. Time series of pressure obtained with DualSPHyics (blue line), OpenFOAM (red line) and in the experimental tests (black dashed line).

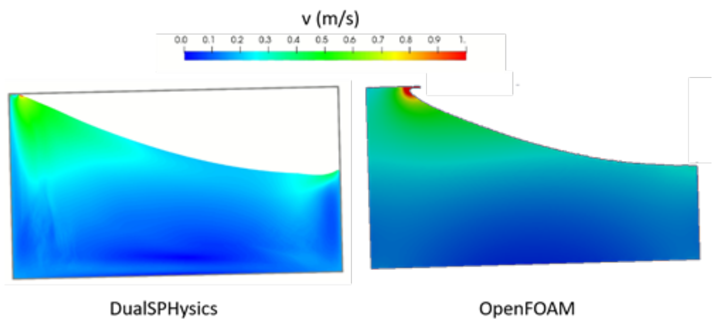


Fig. 3. Snapshot of the numerical simulations of the sloshing tank carried out with DualSPHysics and OpenFOAM.

REFERENCES

[1] J. González-Cao, C. Altomare, A.J.C. Crespo, J.M. Domínguez, M. Gómez-Gesteira and D. Kisacik, "On the accuracy of DualSPHysics to assess violent collisions with coastal structures", Computer and Fluids, vol. 179, pp. 604-612, 2019.
[2] J.M. Domínguez, G. Fourtakas, C. Altomare, R.B. Canelas, A. Tafuni, O. García-Feal, I. Martínez-Estévez, A. Mokos, R. Vacondio, A.J.C. Crespo, B.D. Rogers, P.K. Stansby, M. Gómez-Gesteira. "DualSPHysics: from fluid dynamics to multiphysics problems". Computational Particle Mechanics, 2021. DOI:10.1007/s40571-021-00404-2. [3] P. Higuera, J.L. Lara, I.J. Losada, "Three-dimensional interaction of waves and porous coastal structures using OpenFOAM®. Part I: Formulation and validation", Coastal Engineering, vol. 83, pp. 243-258, 2014.
[4] L. Delorme, A. Colagrossi, A. Souto-Iglesias, R. Zamora-Rodríguez, and E. Botia-Vera, "A set of canonical problems in sloshing. Part I: Pressure field in forced roll. Comparison between experimental results and SPH," Ocean Engineering, vol. 36, no. 2, pp. 168–178, February 2009.
[5] A. Souto-Iglesias, E. Botia-Vera, A. Martin, and F. Pérez-Arribas, "A set of canonical problems in Sloshing. Part 0: Experimental setup and data processing," Ocean Engineering, vol. 38, 16, pp. 1823-1830, 2011. DOI.: https://doi.org/10.1016/j.oceaneng.2011.09.008.
[6] A. Souto-Iglesias, E. Botia-Vera, G. Bulian (2011, June). Repeatability and Two-Dimensionality of model scale sloshing impacts. In International Offshore and Polar Engineering Conference (ISOPE). The International Society of Offshore and Polar Engineers (ISOPE).
[7] E. Botia-Vera, A. Souto-Iglesias, G. Bulian, L. Lobovský (2010). Three SPH Novel Benchmark Test Cases for free surface flows. In 5th ERCOFTAC SPHERIC workshop on SPH applications.

ID51- MELOA CATALOGUE, GEOPORTAL AND DATA SERVICES: A MODERN APPROACH FOR A MARINE IN-SITU MEASUREMENTS SPATIAL DATA INFRASTRUCTURE AND DATA SERVICES

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INTRODUCTION
The MELOA project (https://www.ec-meloa.eu/) proposes to develop a low-cost, easy-to-handle, wave resilient, multi-purpose, multi-sensor, extra light surface drifter for use in all water environments, ranging from deep-sea to inland waters, including coastal areas, river plumes and surf zones.

Given the low influence of wind upon the drifters' displacements, MELOA will provide a cheap effective way to monitor surface currents and surface dynamic features anywhere in the World Ocean. Through equipping the drifters with thermistors at two different levels, the possibility is open for monitoring "near-skin temperature" and near-surface

A complete Software Ecosystem is developed in MELOA to transmit the measurements from the WAVY drifters' sensors via GPRS or satellite communications (Argos), or Wi-Fi for the raw log files through a Mobile Application (WavyHub); manage the test campaigns and launches and curating the data through the WAVY Operation Software; generate the Data Products in CSV and O&M formats through the L1 Processor; and disseminate and make the data openly accessible through the Catalogue, Geoportal and Data Services.

MELOA CATALOGUE
The MELOA Catalogue (http://catalogue.ec-meloa.eu/) solution is based on CKAN, a tool for making open data systems, by helping the management and publish of data collections. It is used by national and local governments, research institutions, and other organizations who collect lots of data. Once the data is published, users can use its faceted search features to browse and find the data they need, and preview it using maps, graphs and tables - whether they are developers, journalists, researchers, NGOs.

The main purpose of the Catalogue is to enable search and discovery of the data and metadata from the observations of the WAVYs in order to enable federation and data sharing with other data catalogues and communities such as GEOSS or Copernicus. Currently, MELOA data is also available through the NextGEOOS Catalogue (https://catalogue.nextgeoss.eu/) which is harvesting the metadata directly from the MELOA Catalogue.

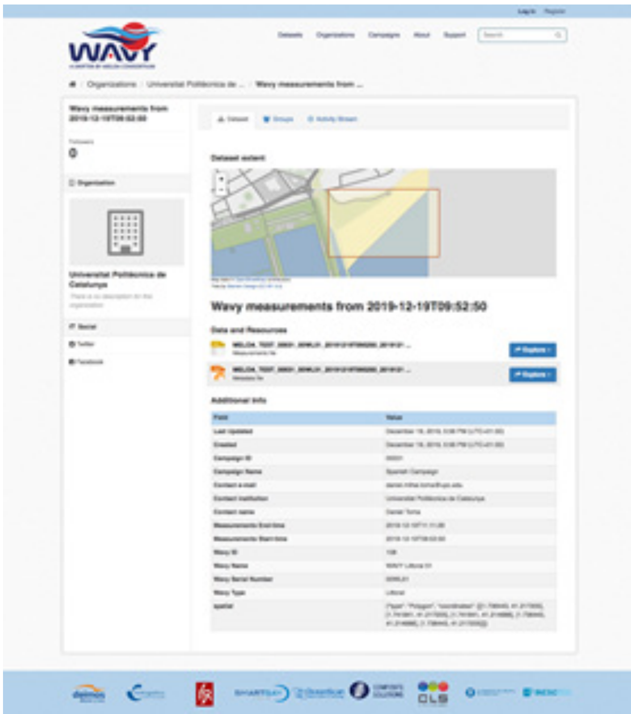
MELOLA GEOPORTAL
The MELOA Geoportal (https://geoportal.ec-meloa.eu) is an online, map based, data visualization tool for the public data stored in the WAVY's online Catalogue.
The main purpose of the MELOA Geoportal is to enable end-users the exploration and visualization of WAVYs data in an easy-to-use way, targeting diverse audiences: From marine scientists to citizens and general public. The usability and user experience have been one of the main objectives to be addressed, bringing user experience research methods to the design process to provide a user-centered perspective during software development.

The data visualization technology is based on Vector Tiles, enabling visualization details up to the individual measurement level and dynamic data management such as filtering and spatial aggregations.

MELOA DATA SERVICES
MELOA provides the following OGC Web Services to access the data, focused on interoperability:

- Web Map Service (WMS): is a standard protocol for serving georeferenced map images over the Internet.
- Web Feature Service (WFS): provides an interface allowing requests for geographical features across the Web using platform-independent calls.
- Sensor Observation Service (SOS): This standard defines a Web service interface which allows querying observations, sensor metadata, as well as representations of observed features in an interoperable way
- SensorThings API: Provides an easy, flexible and efficient way access WAVY data and metadata compliant with the O&M data model. Although it has better performance and it is more user-friendly than SOS, its data model is less restrictive, resulting in weaker semantic relationships.

In addition to these services focused on interoperability, MELOA's software ecosystem includes a developer-friendly query language, based on GraphQL to facilitate the development of apps and other services, by combining different service endpoints and tailoring them to developers' needs. GraphQL provides a complete and understandable description of the data, delivering interlinked resources with a single request and making it easier to evolve and maintain APIs over time.



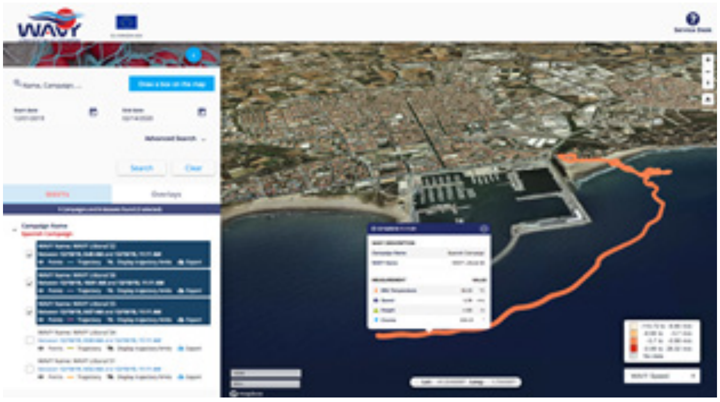


Fig 1. MELOA Catalogue & Geoportal

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SARTI

EMODnet European Marine Observation and Data Network

emso ERIC

IEEE Oceanic Engineering Society

OBSEA EXPANDABLE SEAFLOOR OBSERVATORY