International Workshop

«Fostering Ocean Innovations»

Naples, September 4, 2023

Marine robotics & Unmanned Surface Vehicles: what's to expect in the next decades

Massimo Caccia - CNR Institute of marine engineering

Marine robotics

- 4 segments
  - Air
  - Surface
  - Underwater
  - Sea floor



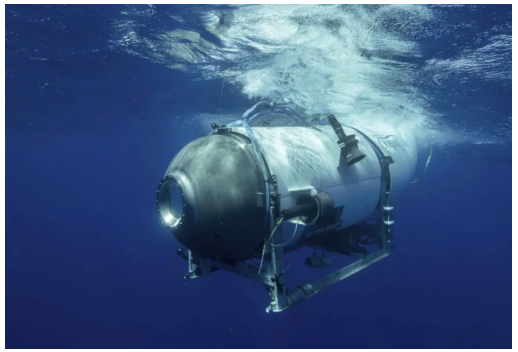




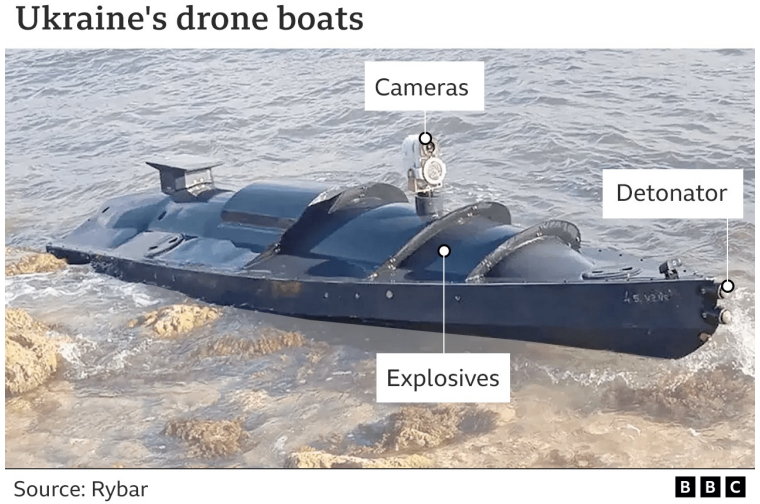
In the last months… marine robotics in the news

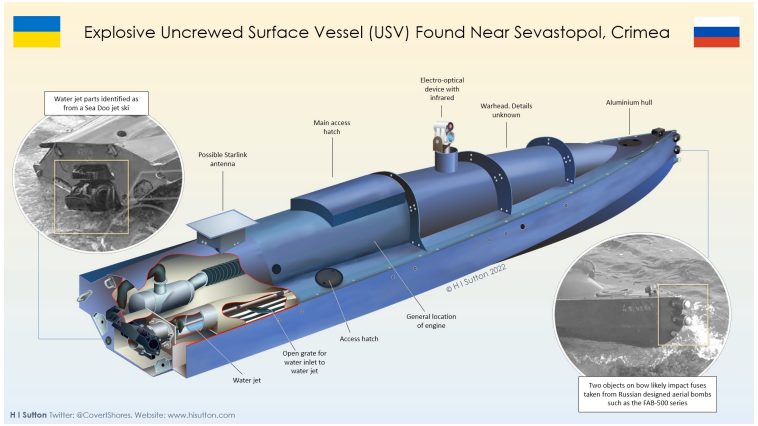
Does the Titan disaster signal the end of disruptive rapid innovation?

In a culture that has adopted the ridiculous mantra "move fast and break things," that type of arrogance can get a person far. But in the deep ocean, the price of admission is humility—and it's nonnegotiable. The abyss doesn't care if you went to Princeton, or that your ancestors signed the Declaration of Independence. If you want to go down into her world, *she* sets the rules.



And her rules are strict, befitting the gravitas of the realm. To descend into the ocean's abyssal zone—the waters from 10,000 to 20,000 feet—is a serious affair, and because of the annihilating pressures, far more challenging than rocketing into space. The subs that dive into this realm (there aren't many) are tested and tested and tested. Every component is checked for flaws in a pressure chamber and checked again—and every step of this process is certified by an independent marine classification society. This assurance of safety is known as "classing"



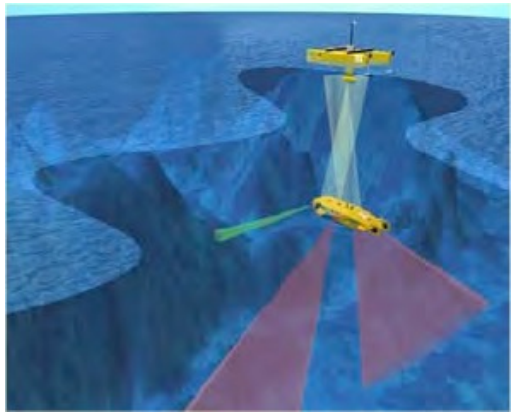


- Public **awareness** of:
  - High technological challenges in underwater environment
  - Maturity of sea drone technology : **remotely supervised ASVs**

ASVs & AOSNs

- ASVs: pioneer concepts and applications

Fig 1. MIT's *AutoCat*, circa 2000

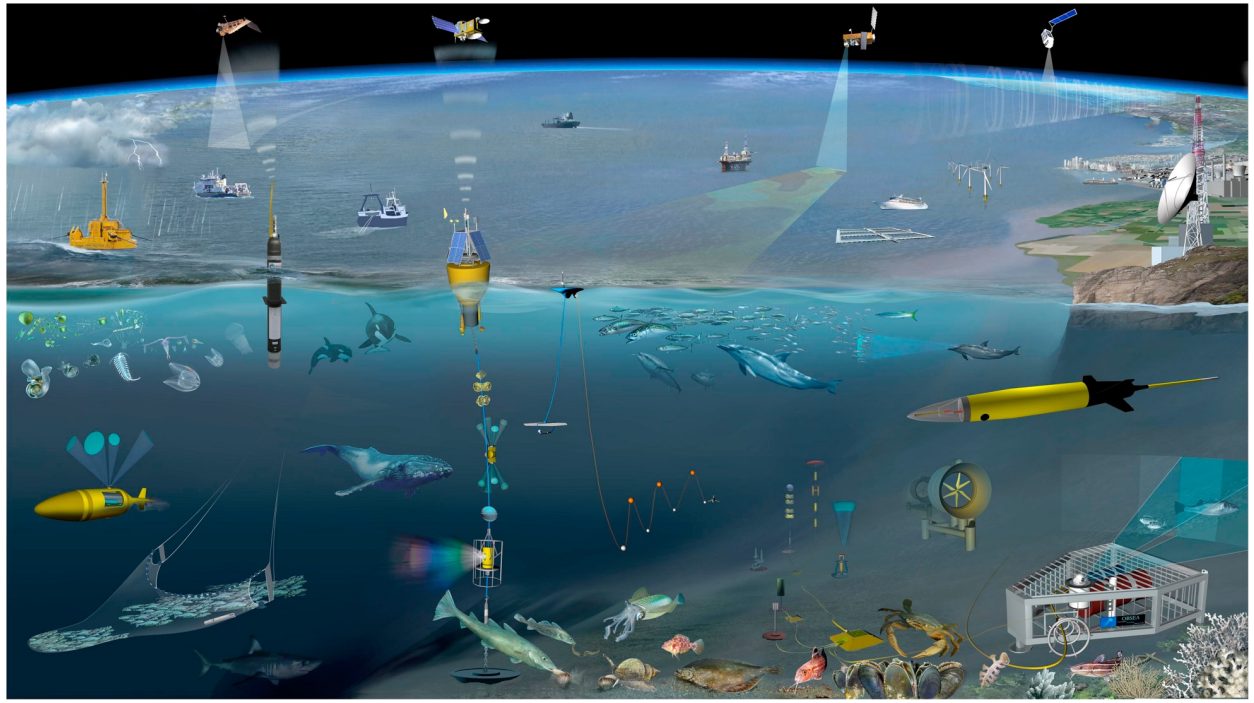


REVIEW article

Front. Mar. Sci., 08 September 2020
Sec. Ocean Observation
Volume 7 - 2020 | https://doi.org/10.3389/fmars.2020.00697

This article is part of the Research Topic
Oceanobs'19: An Ocean of Opportunity
View all 136 Articles >

Future Vision for Autonomous Ocean Observations



No ASVs in this 2020 picture

Bottlenecks

- Lack of rules for ASV operations at sea
- Reliable obstacle detection and COLREGS manoeuvres

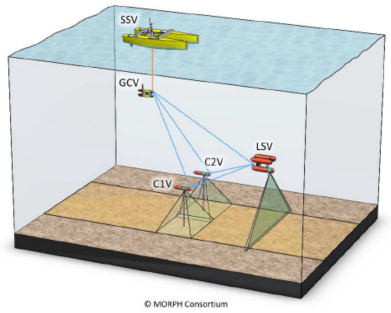
21th century research on cooperative marine robotics

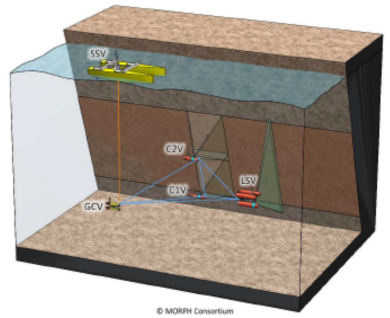
Many heterogenous autonomous vehicles working cooperatively in the same operational area

GREX

Coordination and control of cooperating heterogeneous unmanned systems in uncertain environments

MORPH





Wi MUST
Widely scalable Mobile Underwater Sonar Technology

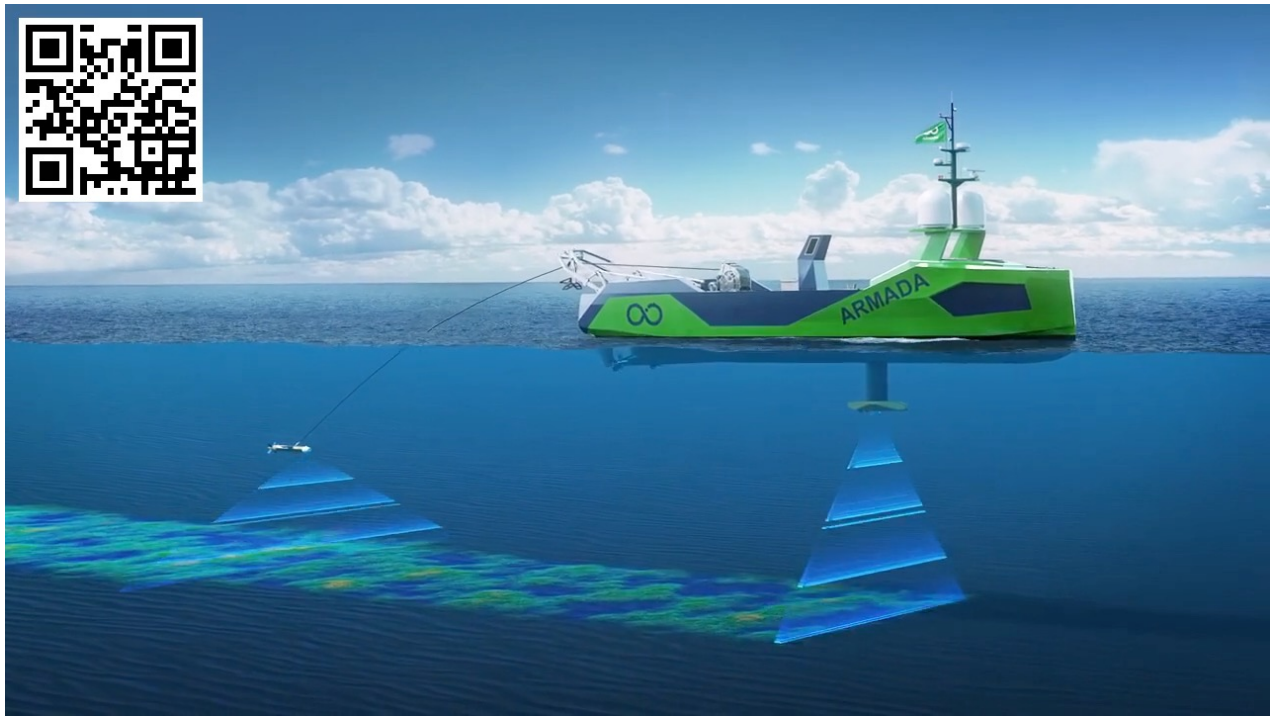
Remotely controlled global fleet of autonomous ships and robots

Challenges

- autonomous robot deployment/recovery
- underwater navigation with low logistics
  - OWTT underwater cooperative navigation
  - Comms-driven formation control
- autonomous management of tether(s) at sea

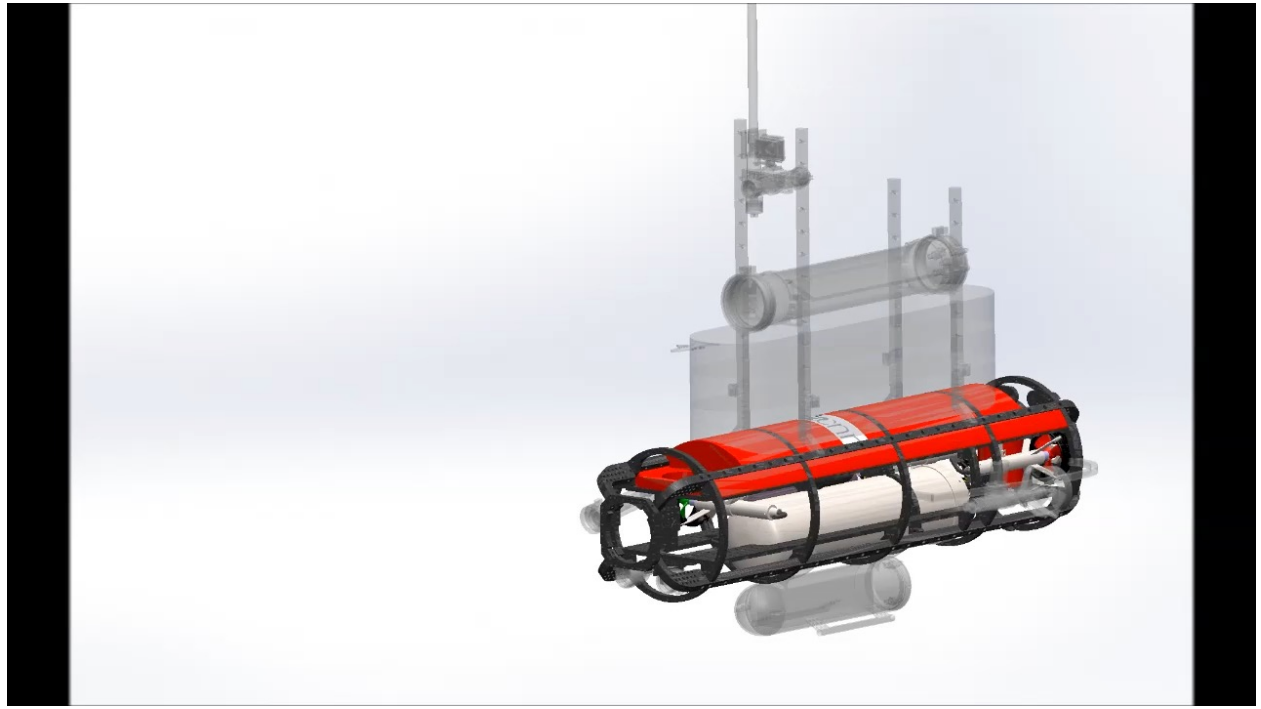
Challenges

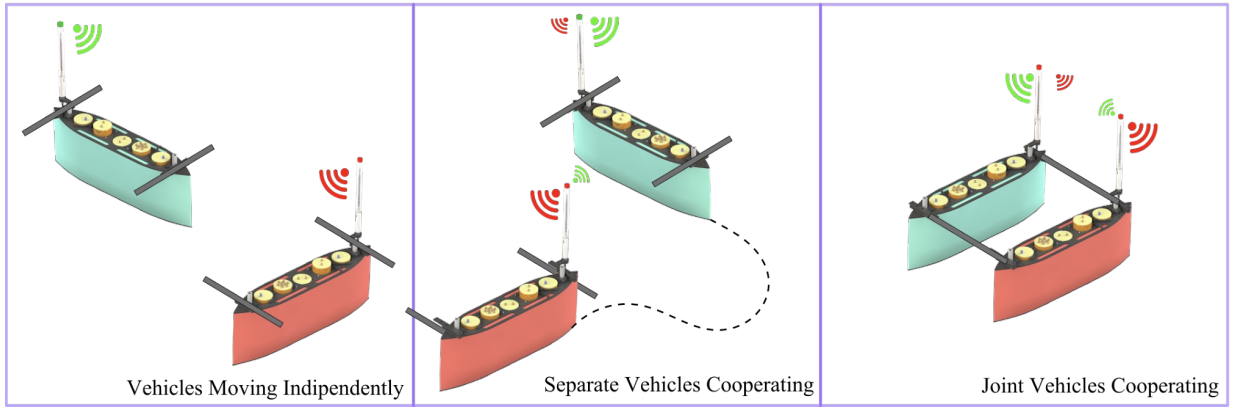
- autonomous persistent underwater systems
- green robots



Research: distributed reconfigurable modular robots

Proteus
ROV/AUV/ASSV/USV



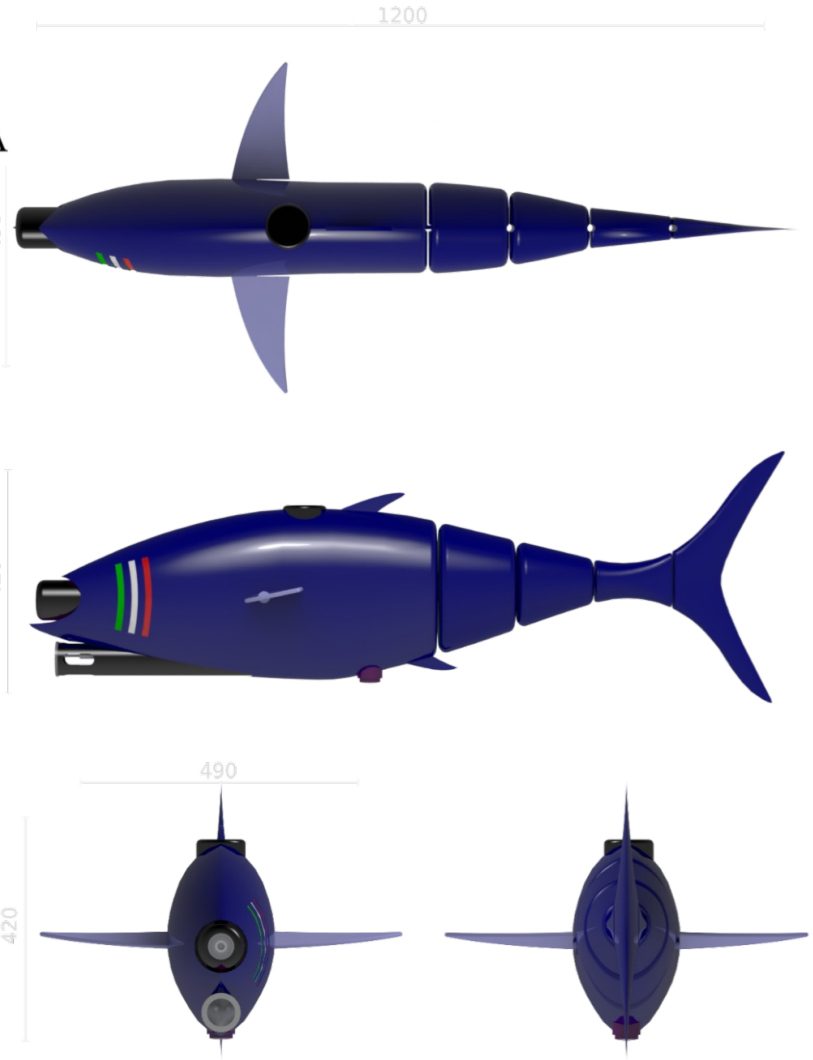


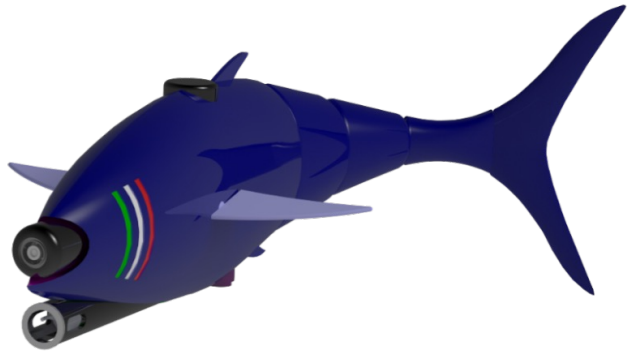
SWAMP ASV(s)

Research: bio-inspired robotics

MINISTERO DELLA DIFESA

PERSICO





INSTITUTE OF MARINE ENGINEERING

Committant: PNRM Persico

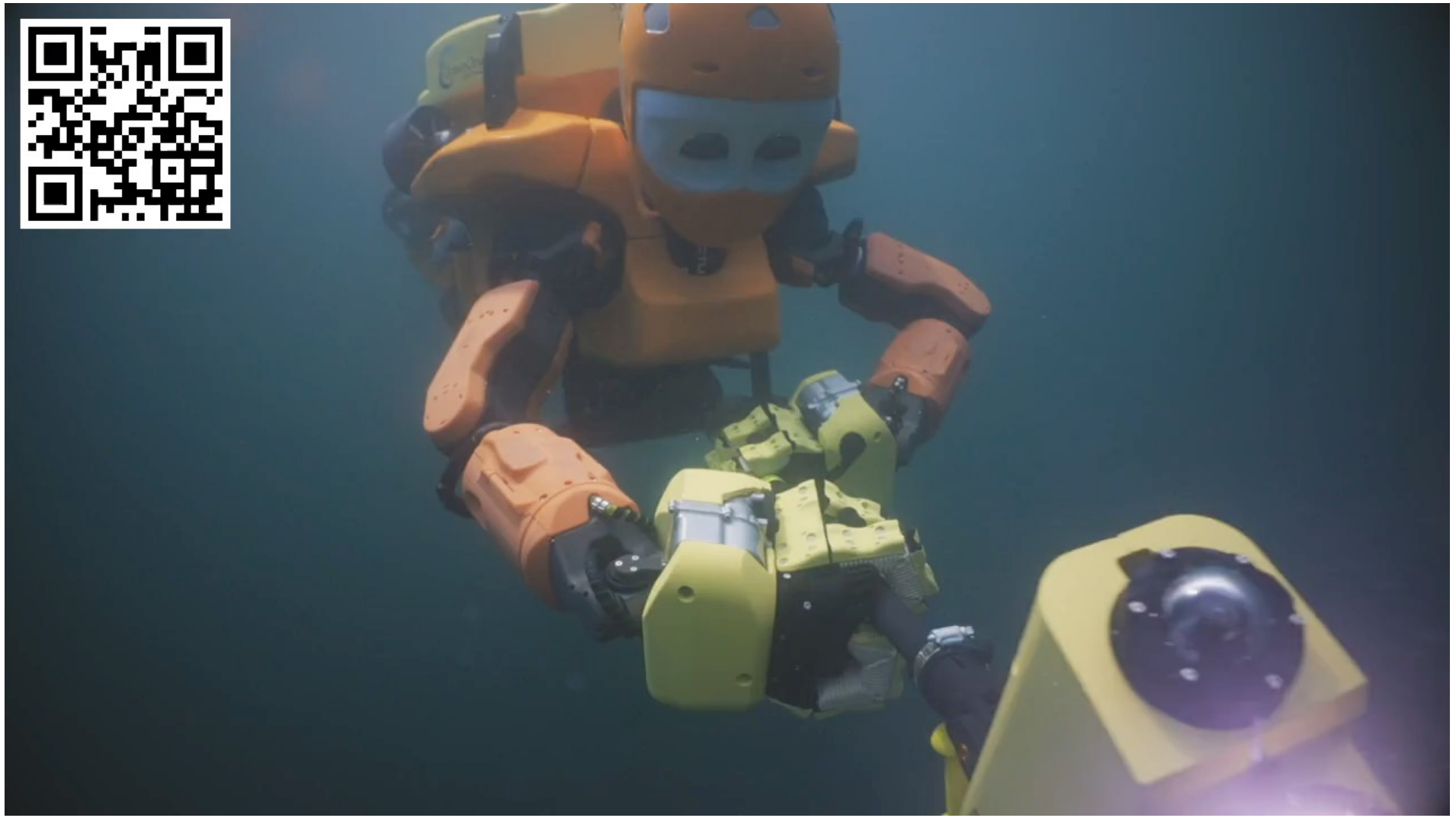
Drawing Name: Proposed solution for the concept design

Designer: CNR-INM-Uos Genova Date: 25/08/2021

Units: mm

Features		Notes and description
Main dimensions and characteristics		
Length	L	1200 [mm]
Breadth	B	490 [mm]
Height	H	420 [mm]
Main propulsion units		1 nr Biomimetic Thruster
Vertical propulsion		1 nr Swimming Bladder
Manoeuvring system		2-4 nr Fins
Maximum operating depth	D	100/200 [m]
Maximum Weight	W	40 [kg]
Design Power Consumption	P	300 [W] Li-ion Batteries
Velocity range	U	0,5 - 2 [m/s]
Standard Mission Endurance	t	12 [h] Function of average speed and sensors configuration

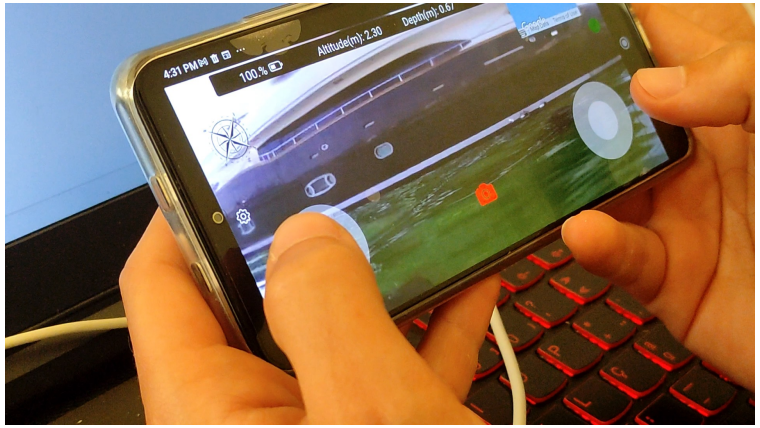
Research: underwater manipulation & haptic interfaces



Marine robotics: innovation & new markets

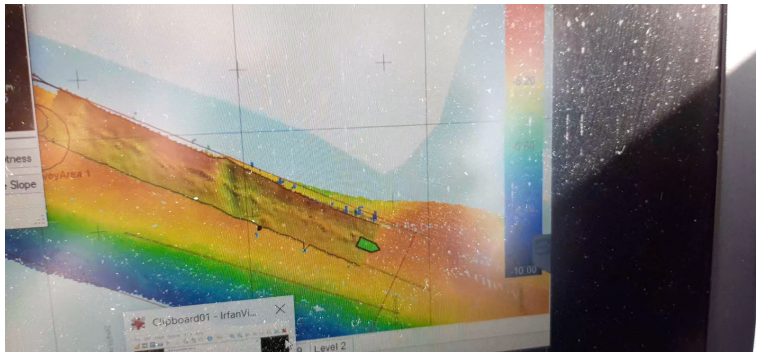
- Marine robotics for tourism, marina and leisure boats

Blu RoSES



- Marine robotics for transitional and internal waters, e.g. lagoons

Interreg Italy - Croatia InnovaMare EUROPEAN UNION



Marine robotics & Sustainability

Eco-sustainable
exploitation of coastal areas, harbours and marinas

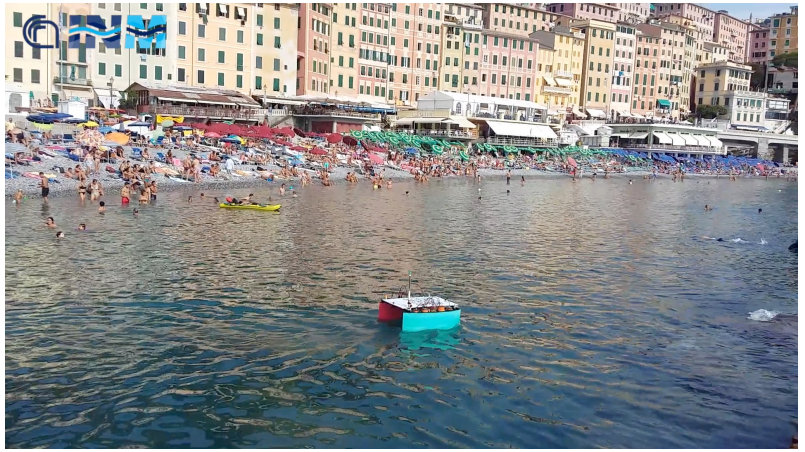
Shipyard/Yachting
Coastal tourism
Harbours & Marinas

Transitional waters
coastal areas, tidal glaciers, lagoons, swamps, rivers, lakes, harbours and marinas

Marine robotics & Sustainability

Economic	Environmental	Social
Industry	Marine science	Citizenship
Robots from *special* tools to *standard* devices	Robots from instrument carriers to services	Robots interacting with humans in their daily life
Standard procedures for system characterisation: dynamics identification, manoeuvring parameters (e.g. ITTC), quantitative performance evaluation (GEMs)	New procedures for repeatable, accurate, and adaptive in time and space data and sample collection: *robots provide detailed information on how data are collected*.	Engagement of citizens in the research process

AI-based methodologies for citizens-designed robot control



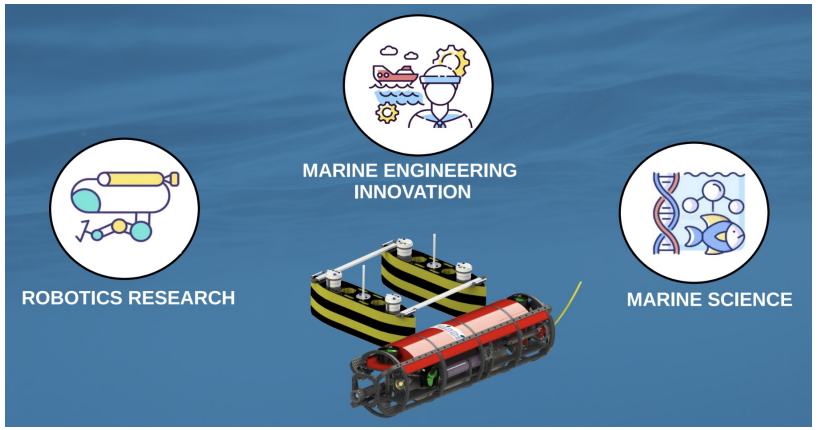
Marine robotics: change of perspective

Marine robots from tools/instrument carriers to services

Industry Marine science Citizenship	beneficiaries end-users

→ co-developers

Multidisciplinarity



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Interdisciplinarity

Marine robotics: towards a data-centric vision

Stakeholders
Industry
Marine science
Citizenship

Research
Marine engineering
Marine science
Robotics

Data-centric Vision

Digital Twin of ocean & platforms

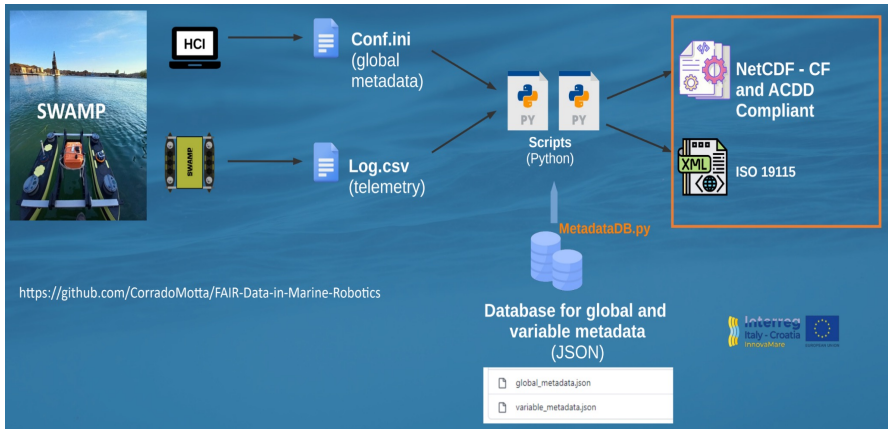
Findable
Metadata and data should be findable for both humans and computers

Interoperable
Data needs to work with applications or workflows for analysis, storage and processing

F A I R

Accessible
Once found, users need to know how the data can be accessed

Reusable
The goal of **FAIR** is to optimise data reuse via comprehensive well-described metadata



Research, innovation and human teams

Letter | Published: 13 February 2019

Large teams develop and small teams disrupt science and technology

Lingfei Wu, Dashun Wang & James A. Evans

Nature **566**, 378–382 (2019) | Cite this article

Any questions?