

Smart drones for innovative water monitoring within the INTCATCH H2020 project

Alessandro Farinelli

**GARDEN – Lake GARDa ENvironmental System
2nd International Scientific Workshop**

Manerba del Garda, 10 May 2018



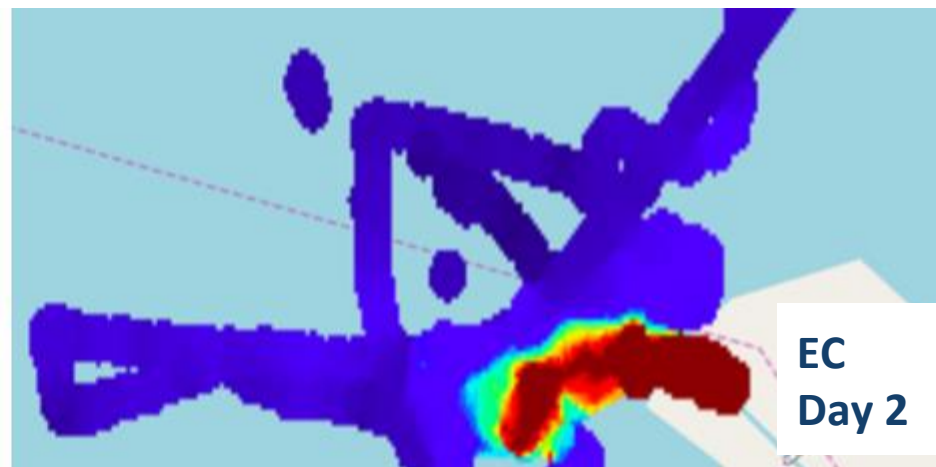
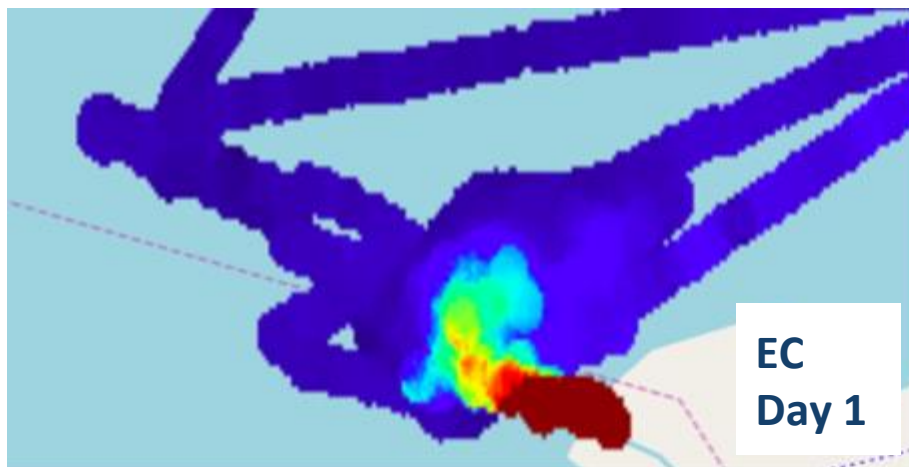
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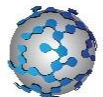
WHY ROBOTIC BOATS?

- Sensors deployed right place right time: effective decision making and management of local 'diffuse' pollution

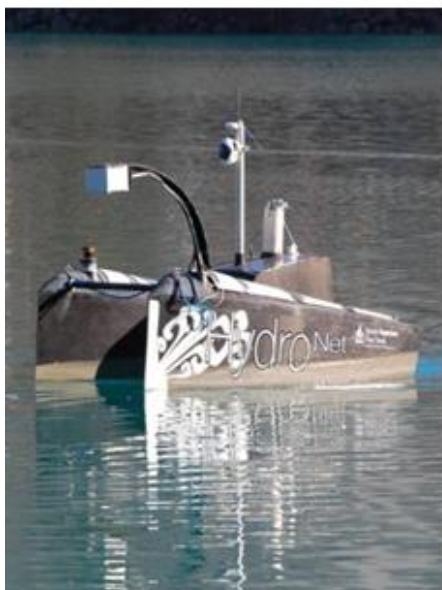


- Data captured by local stakeholders *Citizen Science*





ROBOTICS FOR WATER MONITORING



HydroNet



ARC boats



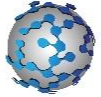
Platypus



NUSwan

- Large, expensive → small, low-cost
- Community engagement





AUTONOMOUS BOATS

in water propellers



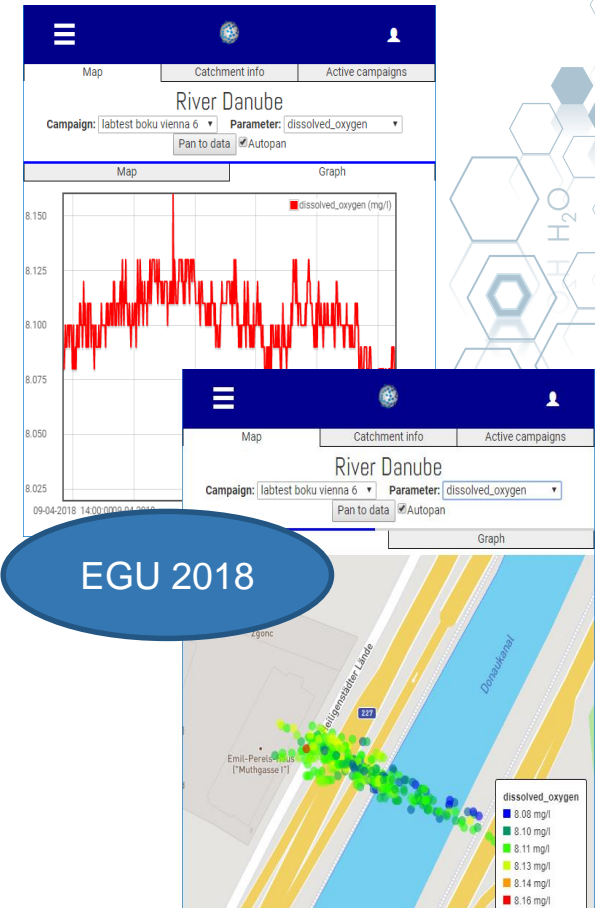
airboat



- Low-cost
- Autonomous
- Long-endurance
- Easy to deploy

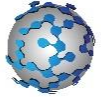


real time data visualization



EGU 2018





WHY AUTONOMY?

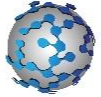
Minimize human intervention



boat

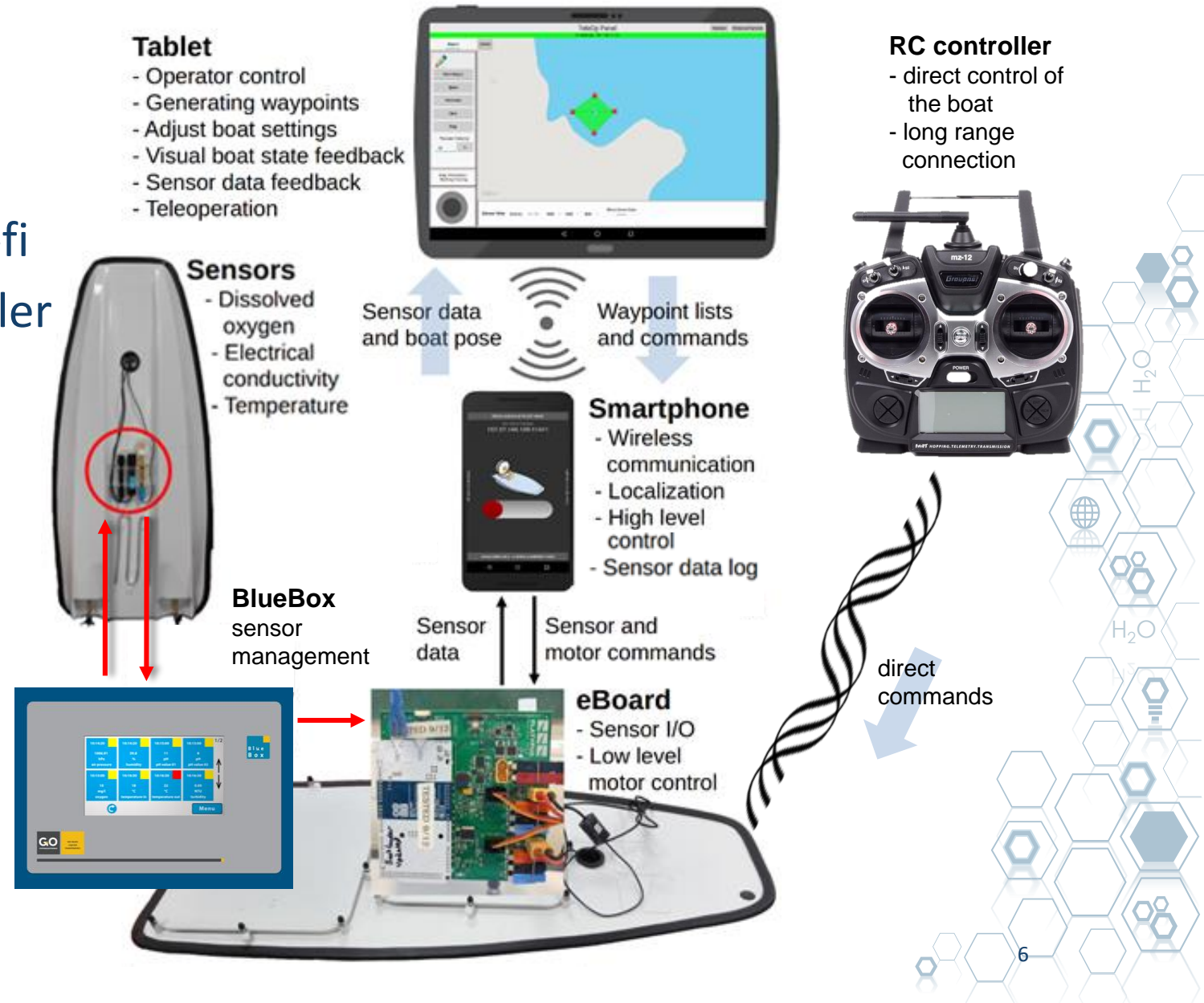
Facilitate data collection for non expert users





SYSTEM ARCHITECTURE

- The boat can be controlled by a wi-fi connected tablet or a radio controller
- The user can define a path on the tablet that the boat follows, **navigating autonomously**
- Different sensors to measure
 - electrical conductivity
 - temperature
 - dissolved oxygen





EQUIPMENT AND FUNCTIONALITIES



DO



pH



EC (T)



ISA



Chl-a

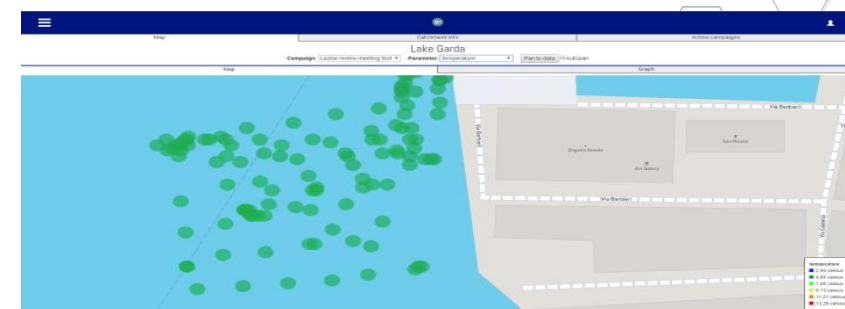
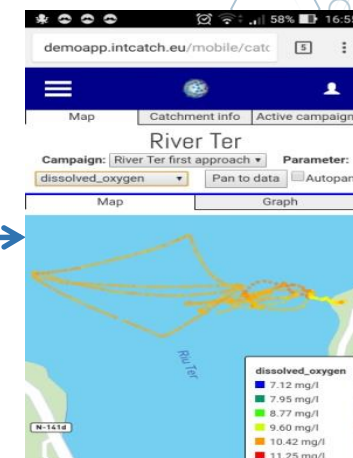


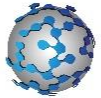
Oil/Hyd

(SAC-254,
NO_{3eq}, TOC_{eq},
DOC_{eq}, COD_{eq},
TSS_{eq}, Turb_{eq})



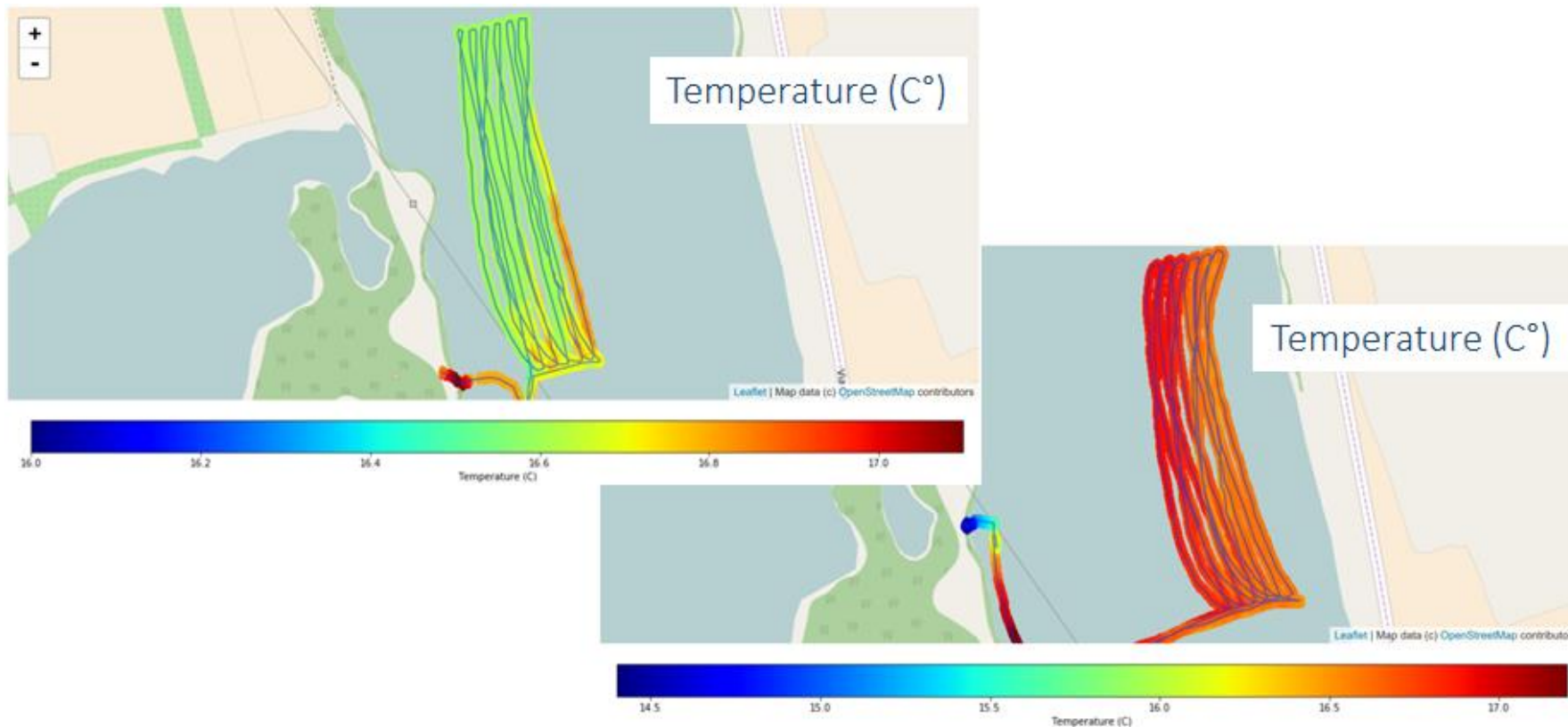
On-line data (real time)
<http://demoapp.intcatch.eu>

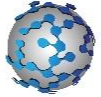




TEST DEPLOYMENT IN FISHING LAKE

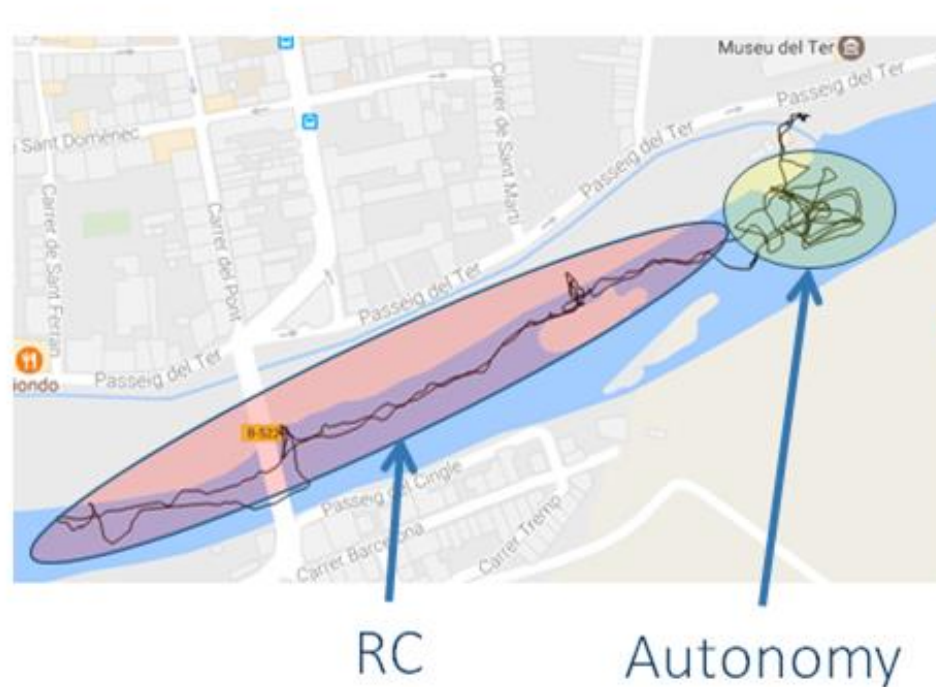
- Pre-defined path loaded to the system
- Four hours in complete autonomy (one battery switch)
- Thanks to Atlandide Fishing

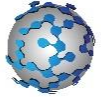




DEPLOYMENT IN RIVER TER (URBAN AREA)

Overall path length: about 1.3 km
Flow was about 1m/s
Thanks to UVIC team!



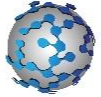


WIDE AREA MONITORING IN LAKE GARDA



<https://www.youtube.com/watch?v=oLHaSqY-egE>





INTEGRATED SAMPLING SYSTEM



Sample **based on data:**

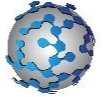
- parameter above a given threshold
- significant change of parameter
- near a GPS position
- remote command



Weight sampling device: 3 kg (water filled 5 kg)

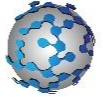
Jars: four, 500 mL each



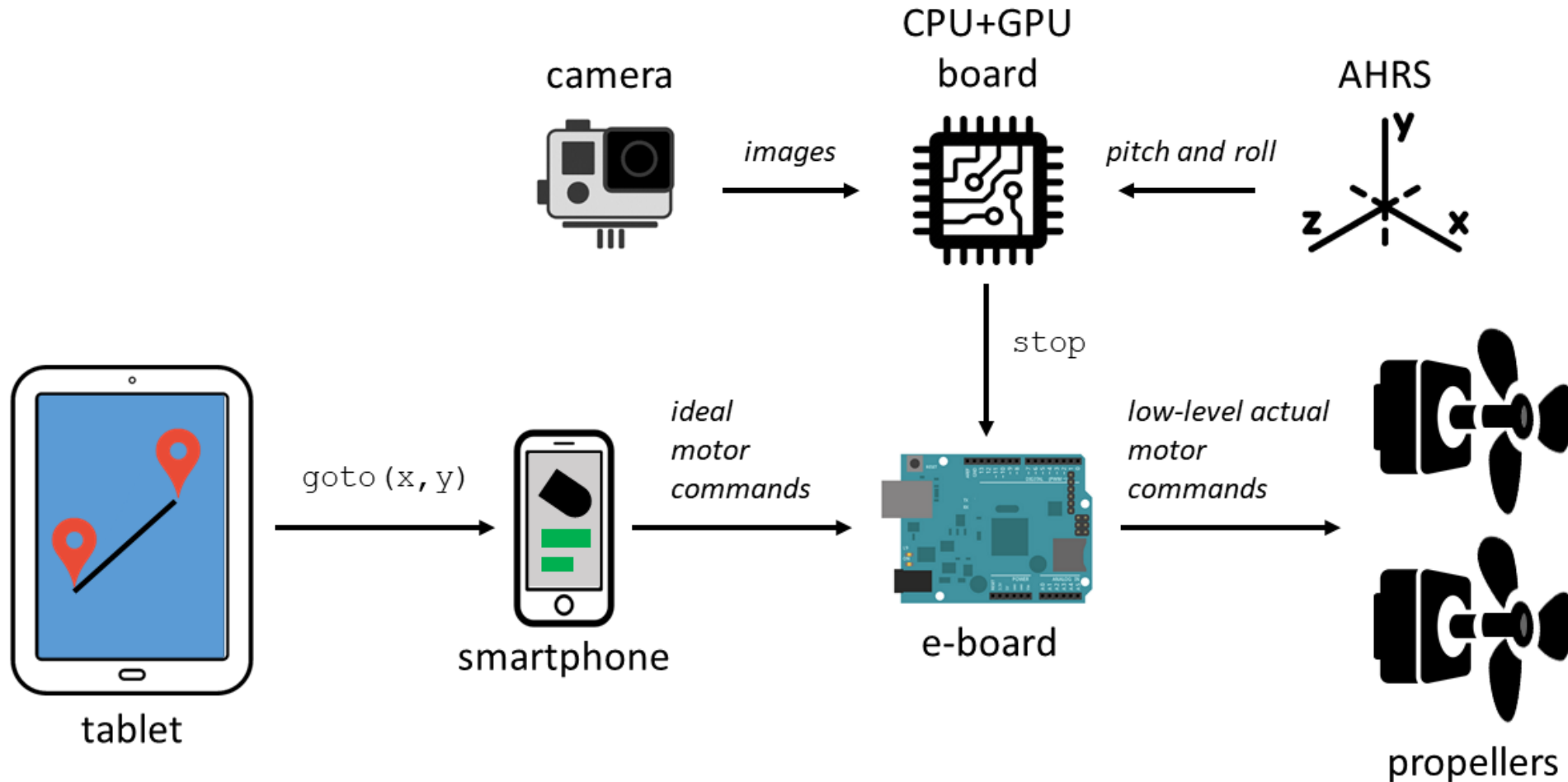


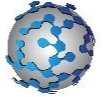
USING VISUAL INFORMATION FOR NAVIGATION



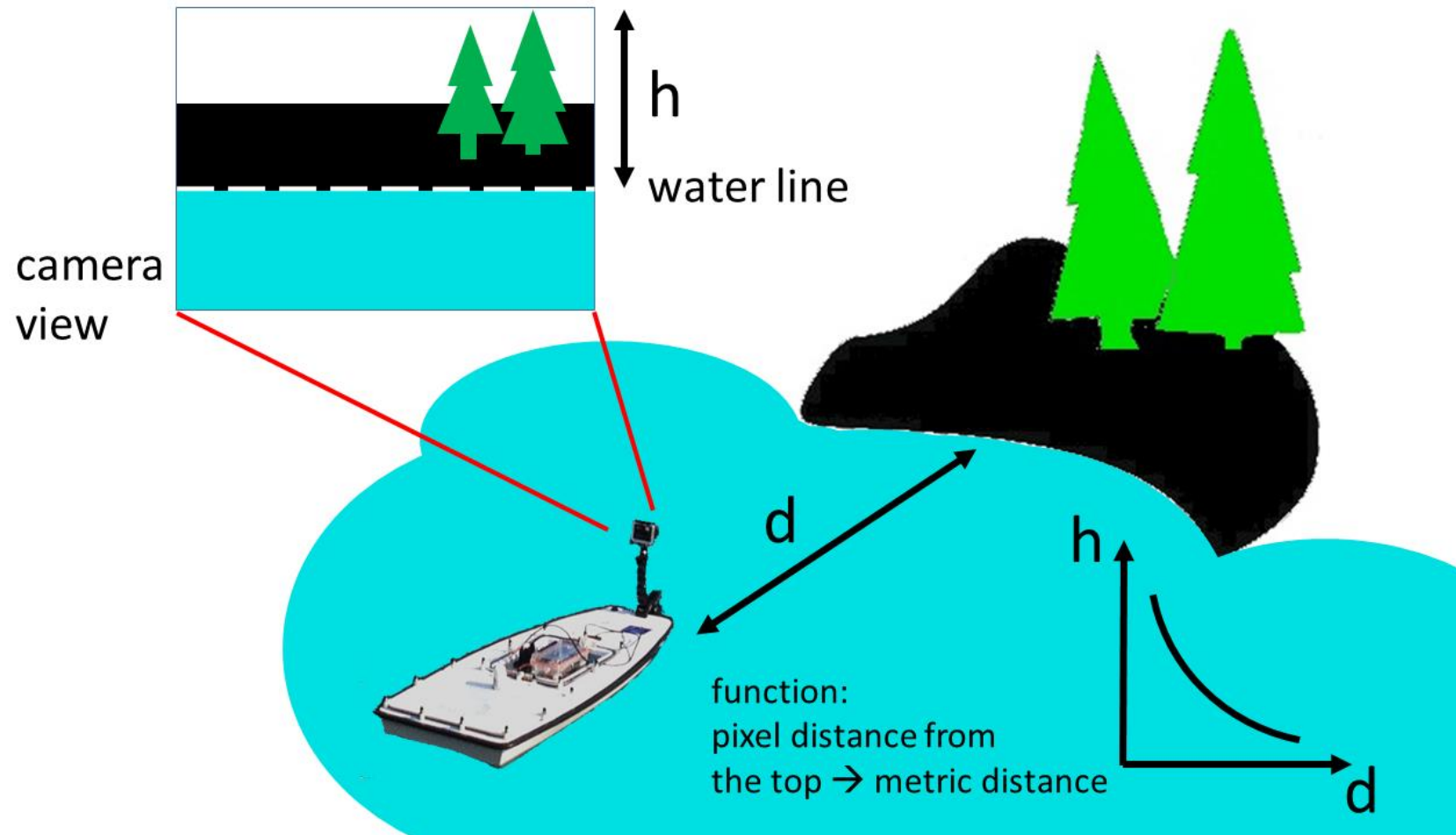


AUTONOMOUS DRIVING WITH COLLISION AVOIDANCE





WATER LINE DETECTION



VIDEO STABILIZATION

unstabilized



stabilized

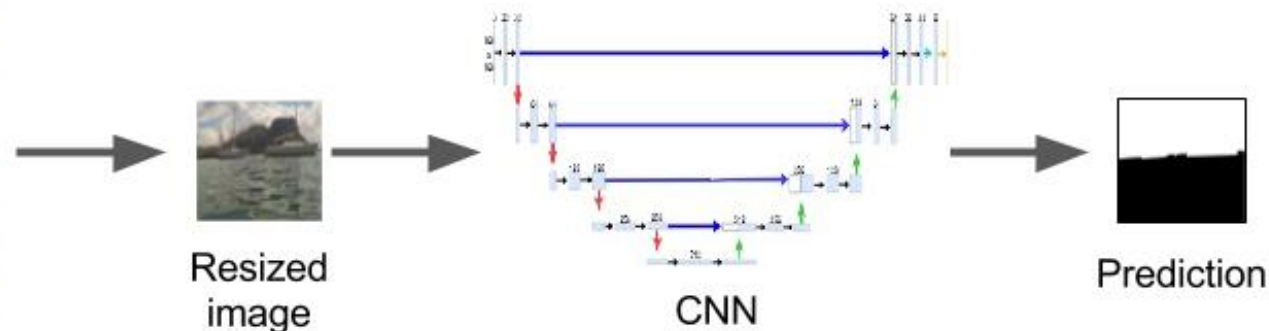




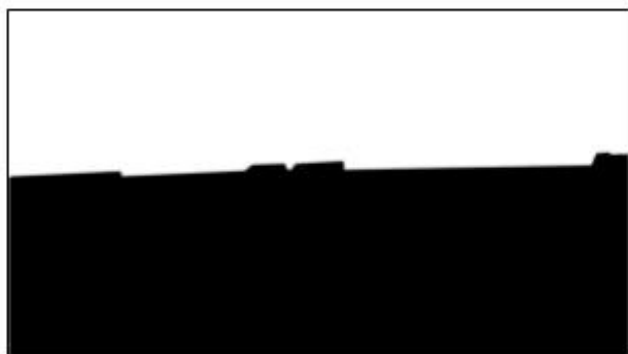
WATER LINE DETECTION PIPELINE



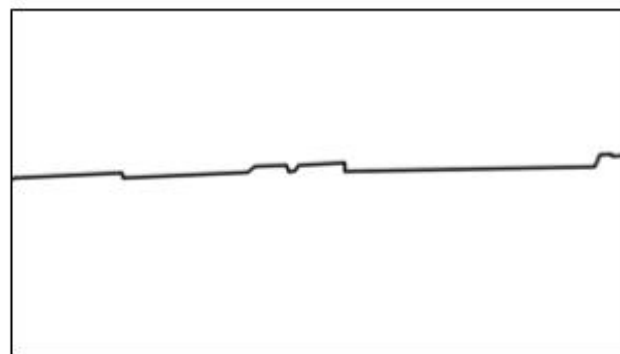
Raw image



(a) CNN feedforward prediction



Resized prediction



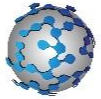
Binary Edge



RANSAC waterline prediction

(b) Waterline overlay on class mask edge pixels

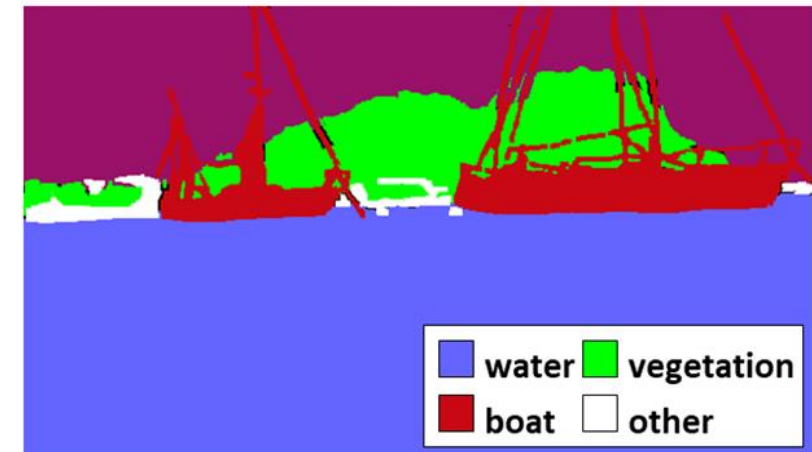




DATASET



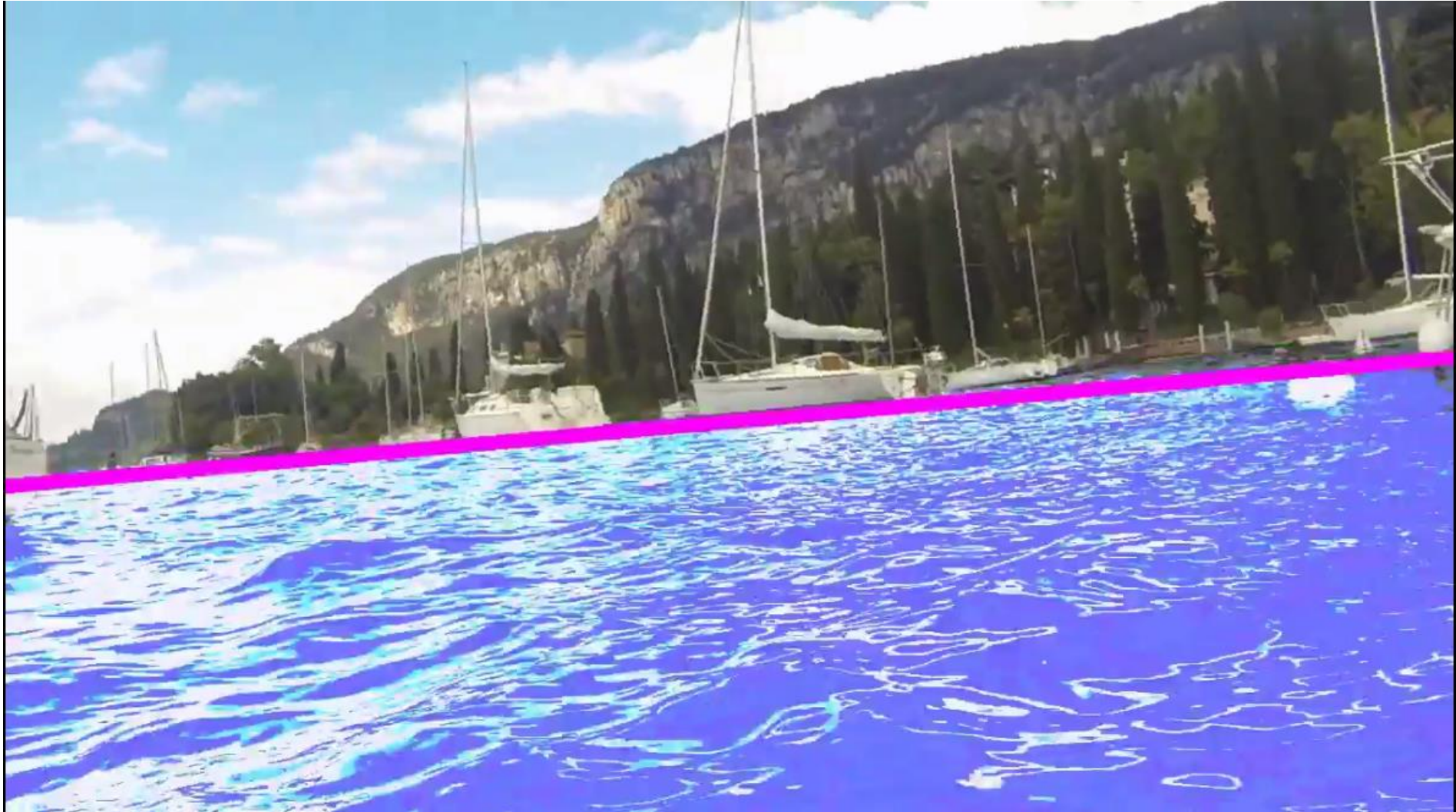
Data available at
IntCatch AI - Deep Learning Water Segmentation
<http://profs.scienze.univr.it/~bloisi/intcatchai/seg.html>



Source code available at
https://github.com/lorenzosteccanella/Intcatch_Deep_Pixelwise_Segmentation

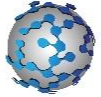


RESULTS

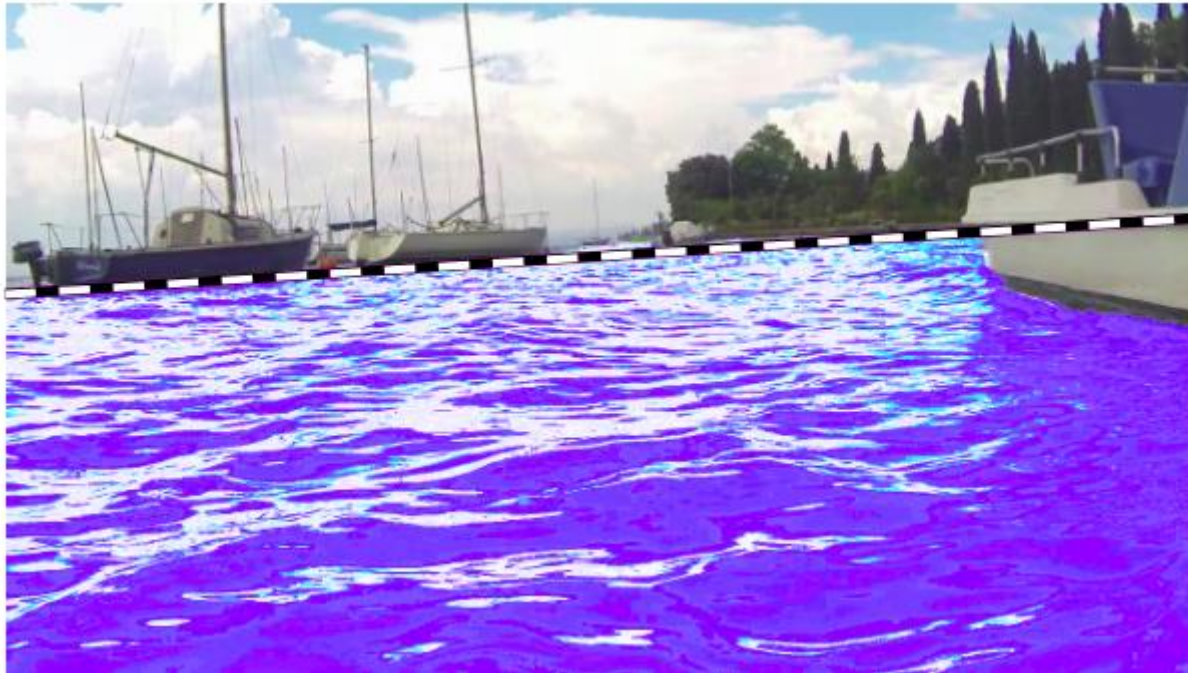


<https://youtu.be/2KHNZX7UIWQ>





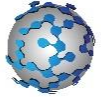
CHALLENGING SITUATIONS



The contour of a boat begins to appear and is classified correctly. RANSAC line sticks to dominant horizon line



Waterline construct breaks down completely, motivating the use of a water contour



INTERESTING DIRECTIONS

BETTER AUTONOMY

- recognize situations (e.g., upstream/downstream)
- plan in face of uncertainty (e.g., regulate speed to minimize battery usage)
- autonomous coastal navigation (based on vision)

ENHANCE DRONE EQUIPMENT

- DNA based analysis
- detecting microplastic

ENHANCE DATA VISUALIZATION

- integrate different source of information
- basic processing to better display data

Join forces to work towards
integrated systems:
joint measuring campaigns,
calibrating remote sensing,
...



AI GROUP IN VERONA

Faculty

Alessandro Farinelli
Domenico Bloisi

PhD students

Lorenzo Bottarelli
Riccardo Sartea

Alumni

Filippo Bistaffa
Masoume Raeissi

Post-Doc

Alberto Castellini

Research Fellows

Jason Blum
Matteo Murari

THANK YOU!



INTCATCH people at UNIVR

Alessandro Farinelli

Jason Blum

Domenico D. Bloisi



UNIVERSITÀ di VERONA Dipartimento di INFORMATICA

INTCATCH  2020

Special thanks to

- Lega Navale Italiana Sezione Garda
- Polizia di Stato



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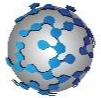
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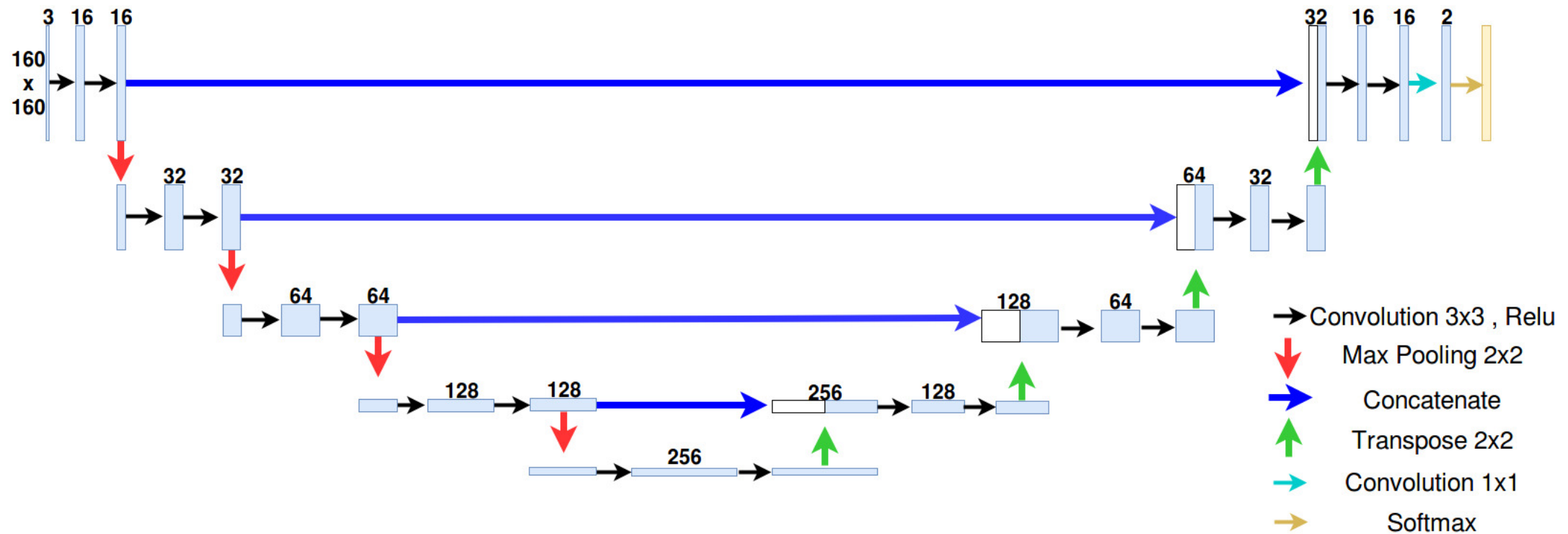


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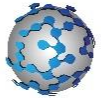
CNN ARCHITECTURE



Source code available at

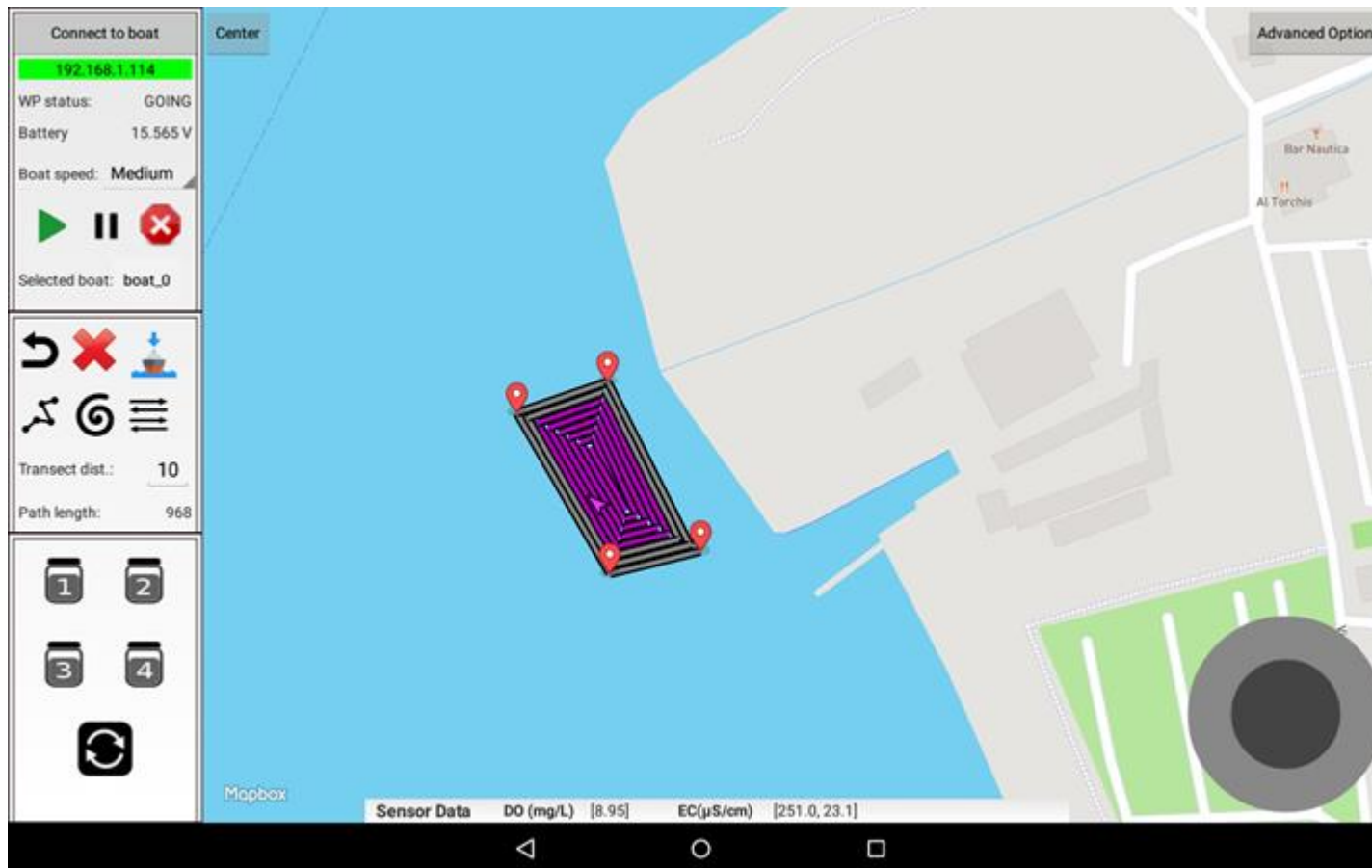
https://github.com/lorenzosteccanella/Intcatch_Deep_Pixelwise_Segmentation





USER INTERFACE AND PATH CREATION

- The tablet app generates a spiral path to collect data in the area



- Dense geo-localized data for the different parameters

