

Past, Current and Planned Marine Research at Padova: An Overview

Damiano Varagnolo

University of Padova & NTNU

“who is knocking at ISME’s door?”

University of Padova who?

- information engineering
- industrial engineering
- civic engineering
- geosciences
- marine biology
- various students associations

Departments and Activities, more in details

- **DEI**: robotics and control for underwater drones, augmented reality mapping, environmental measurements, underwater optical and acoustic communications, NAUTILUS student association
- **DII**: innovative boat design, “Metis vela Unipd” student association
- **DTG**: drones and automatic control
- **DICEA**: maritime constructions, wave motion study tanks, sensors for water quality
- **Geosciences** hydrology about MOSE and Venice Lagoon
- **DiBio**: aquatic biodiversity and water quality monitoring, tanks and university boat
- **BCA**: studies on sharks and cetaceans, hydrobiological Station
- **DBC**: underwater archaeology

Departments and Activities, more in details

interested in something not in this presentation?
Send an email to `damiano.varagnolo@unipd.it`!

This presentation

2.5 minutes per selected topic:

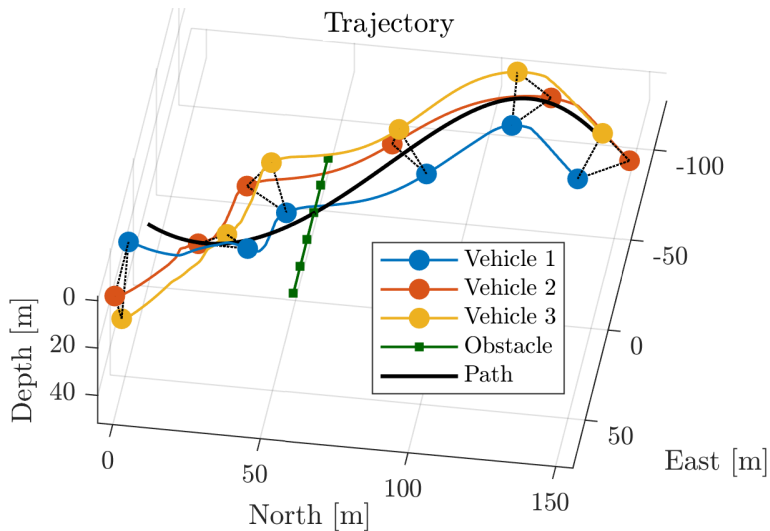
- automatic control
- robotics
- sensing systems
- telecommunications

automatic control group

Control people in Padova: what?

main topic: communication-aware GNC for surface & underwater multi-agent systems

Overarching example: formation control with obstacle avoidance



Relevant ancillary research topic

modelling and recursive system identification

“But how many vessels do you have right now at DEI?”

- one BlueROV
- one BlueBoat
- one BlueEye X3



Laddering on NTNU's infrastructure



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Contact



Martin Ludvigsen
Scientific Manager AUR-Lab



Antonio Vasiljevic
Daily Manager AUR-Lab



Live from
Trondheimsfjorden

Measurements from 90 meter,
approximately 400 meters outside
of Trondheim Biological Station

The Applied Underwater Robotics Laboratory



AURLab

a part of the NTNU SINTEF OceanLab-project

We are open for collaborations. [Just contact us!](#)



NTNU AUR-Lab





LAUV Fridtjof

A small, red and black autonomous underwater vehicle (AUV) is visible in the water, positioned to the left of the center. It has a vertical black mast with a green light and a red horizontal arm.



LAUV Roald

A larger, red and black autonomous underwater vehicle (AUV) is visible in the water, positioned in the lower center. It has a vertical black mast with a green light and a red horizontal arm, similar to the smaller one but with a more complex structure.

Current directions

- autodocking for surface vessels
- collaborative navigation for heterogeneous multi-modal networks



robotics group

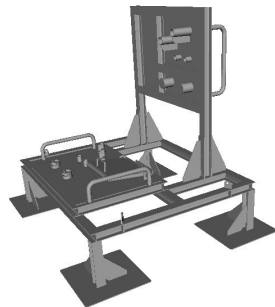
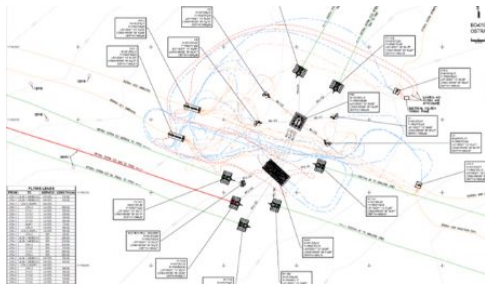
Towards Accurate 3D Positioning in Large-Scale Underwater Environments

Introduction



Goal

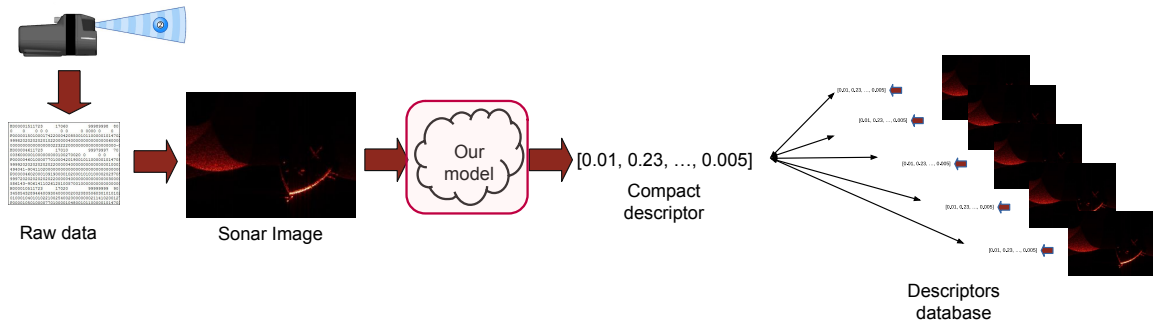
- An **underwater global positioning/SLAM system** is an essential requirement for AUVs
- We focus on **large-scale** environments sparsely populated by man-made infrastructure



Contribution 1: A synthetically trained global and compact descriptor computed on sonar images

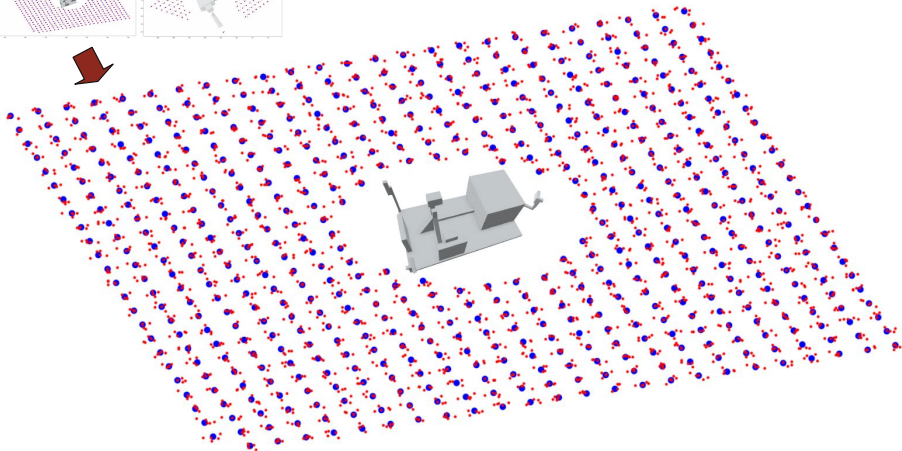
I. Donadi, E. Olivastri, D. Fusaro, W. Li, D. Evangelista, and A. Pretto Improving Generalization of Synthetically Trained Sonar Image Descriptors for Underwater Place Recognition In Proc. of the 14th International Conference on Computer Vision Systems (ICVS), September 27-29 2023

Global Descriptor



Descriptors should be similar for neighboring locations

Data Acquisition Procedure



Contribution 2: An improved real-time underwater place recognition system using learning-based descriptors

D. Fusaro, M. Mosco, W. Li, and A. Pretto Real-time Underwater Place Recognition in Synthetic and Real Environments using Multibeam Sonar and Learning-based Descriptors, 2025 IEEE International Conference on Simulation, Modeling, and Programming for Autonomous Robots (SIMPAN) - submitted

Contribution 3:

A Sonar-based AUV positioning system for underwater environments with low Infrastructure density

E. Olivastri, D. Fusaro, W. Li, S. Mosco, and A. Pretto, "A Sonar-based AUV Positioning System for Underwater Environments with Low Infrastructure Density", Workshop on Field Robotics - ICRA 2024

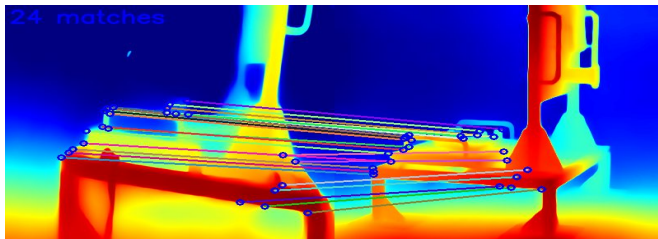
Contribution 4: An unsupervised CAD-based 6-DoF camera localization system for submarine inspections

Matching between depth maps

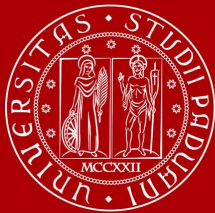
Standard matching



Matching between
depth maps



sensing group



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La tecnologia Smart Pebble e il monitoraggio dell'erosione costiera

Alessandro Pozzebon

Università degli Studi di Padova

Dipartimento di Ingegneria dell'Informazione (DEI)



L'impatto del trasporto sedimentario



Marina di Pisa, Novembre 2021

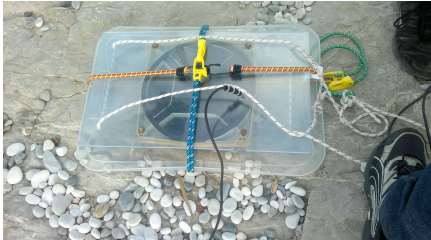


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Gli Smart Pebble



La localizzazione degli Smart Pebble





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Smart Pebble

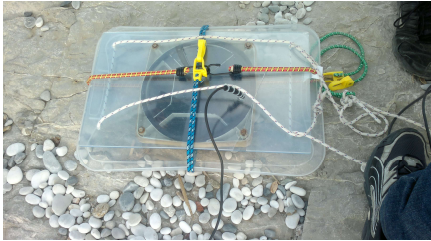
Marina di Pisa (IT)



L'abrasione dei sedimenti



La localizzazione degli Smart Pebble



telecom group

The SIGNET Underwater Communications' Team and its Spinoff Companies

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University of Padova, Department of Information Engineering



DEPARTMENT OF
INFORMATION
ENGINEERING
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The SIGNET Underwater Branch

20 years ago, a branch of the SIGNET group started research on underwater wireless networks. It has:

- more than 200 published papers
- more than 10 people involved
- various equipment (modems, drones)
- a large research lab
- facilities to support experimentation
- availability of boats of the University of Padova
- more than 15 successful research and industrial projects
- extensive experience in sea trials
- extensive experience in developing code for telecommunications
- extensive experience with embedded systems



SIGNET

<https://signet.dei.unipd.it/research/underwater-networks/>

Expertise

Software development



Linux embedded



Underwater and terrestrial networks



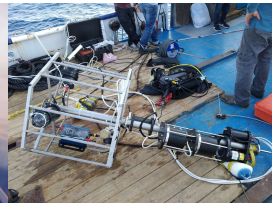
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<https://signet.dei.unipd.it/research/underwater-networks/>

Sea Trials

We performed many sea trials
(more than 20) to test our
prototypes

- NATO/CMRE, CSSN
- self-organized
- Mediterranean (Italy and Israel)
- Atlantic Ocean
- lakes/rivers
- Northern Europe (with TNO, FFI, FOI, WTD71, etc.)



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<https://signet.dei.unipd.it/research/underwater-networks/>

Michele Zorzi



Michele Zorzi
Full Professor
Dep. of Information Engineering
University of Padova
Co-founder of SubSeaPulse
and Wireless and More
michele.zorzi@unipd.it

Michele Zorzi (full professor, more than 50000 citations) has been working in uw networks since 2006 and has more than 110 research articles and proceedings on uw networks. He is often invited as keynote speaker in international conferences on uw networks and provided many seminars on this topic. He has been PI and Co-PI of more than 10 national and international projects on uw networks. He leads the signet research group, composed of more than 20 PhD students and 10 faculty. He co-founded three spinoff companies: Patavina Technologies srl, Wireless and More srl, and SubSeaPulse SRL.



SIGNET



Filippo Campagnaro



Filippo Campagnaro
Assistant Professor
Dep. of Information Engineering
University of Padova
Co-founder of SubSeaPulse
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Filippo has been working in uw networks since 2014, joined more than 15 sea trials and developed several research and industrial prototypes. He teaches advanced C++ programming at the University of Padova. Filippo led several research and industrial projects on uw networks. IEEE OES YP laureate, UN Oceans Decade Volunteer, ECOP member. Former senior software developer of Wireless and More srl, spinoff company of the University of Padova. From 2021, he works on wireless sensors for studying biodiversity and climate change in coastal areas, and recently co-founded SubSeaPulse SRL, a startup company active in this field.



summarizing

- (growing) interest for marine oriented research @ UniPD
- students associations contribute positively (*e.g., Nautilus, Metis Vela*)
- active also in outreach (*e.g., Port Days in Chioggia*)
- very keen for collaborating and helping out

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thanks!

for further questions, damiano.varagnolo@unipd.it