

Wet Wet Wet and Under Pressure: Underwater Sensor Simulation

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WET WET WET

the greatest hits



Wet Wet Wet



Queen and David Bowie: Under Pressure

Wet Wet Wet and Under Pressure?

“The ocean is the most important frontier that we have left.”

~ David Packard, MBARI Founder



Monterey Bay Aquarium
Research Institute

MBARI's goal is to advance marine science and engineering to understand our changing ocean

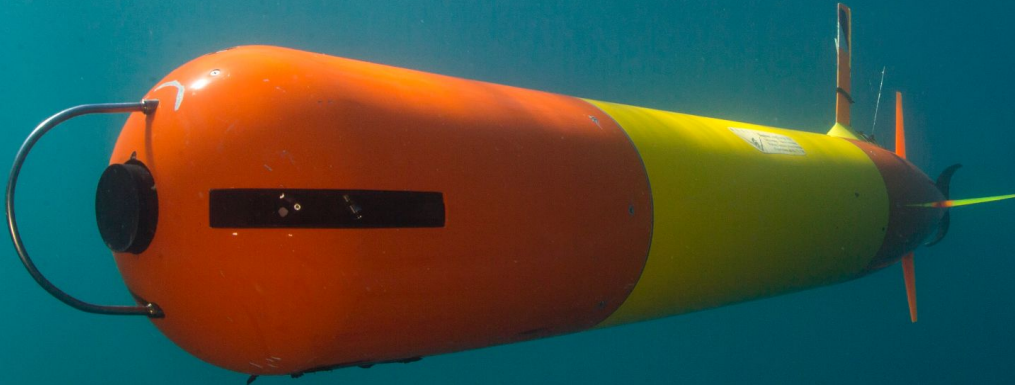
Getting observations at scale and with sufficient resolution is challenging and cost prohibitive...

MBARI/WHOI Rhodamine dye release experiment, 2019. PI: Amy Kukulya, Brett Hobson. Photo: Todd Walsh, MBARI

Underwater robots for oceanographic research

Tethys-class Long-Range AUV

High-endurance data collection platform



Underwater robots for oceanographic research



<https://www.mbari.org/at-sea/vehicles> Photo: Kip Evans

What time is it? It's Maritime (in Ignition and Gazebo)

Environment:

Buoyancy, currents, bathymetry, turbidity

Controls:

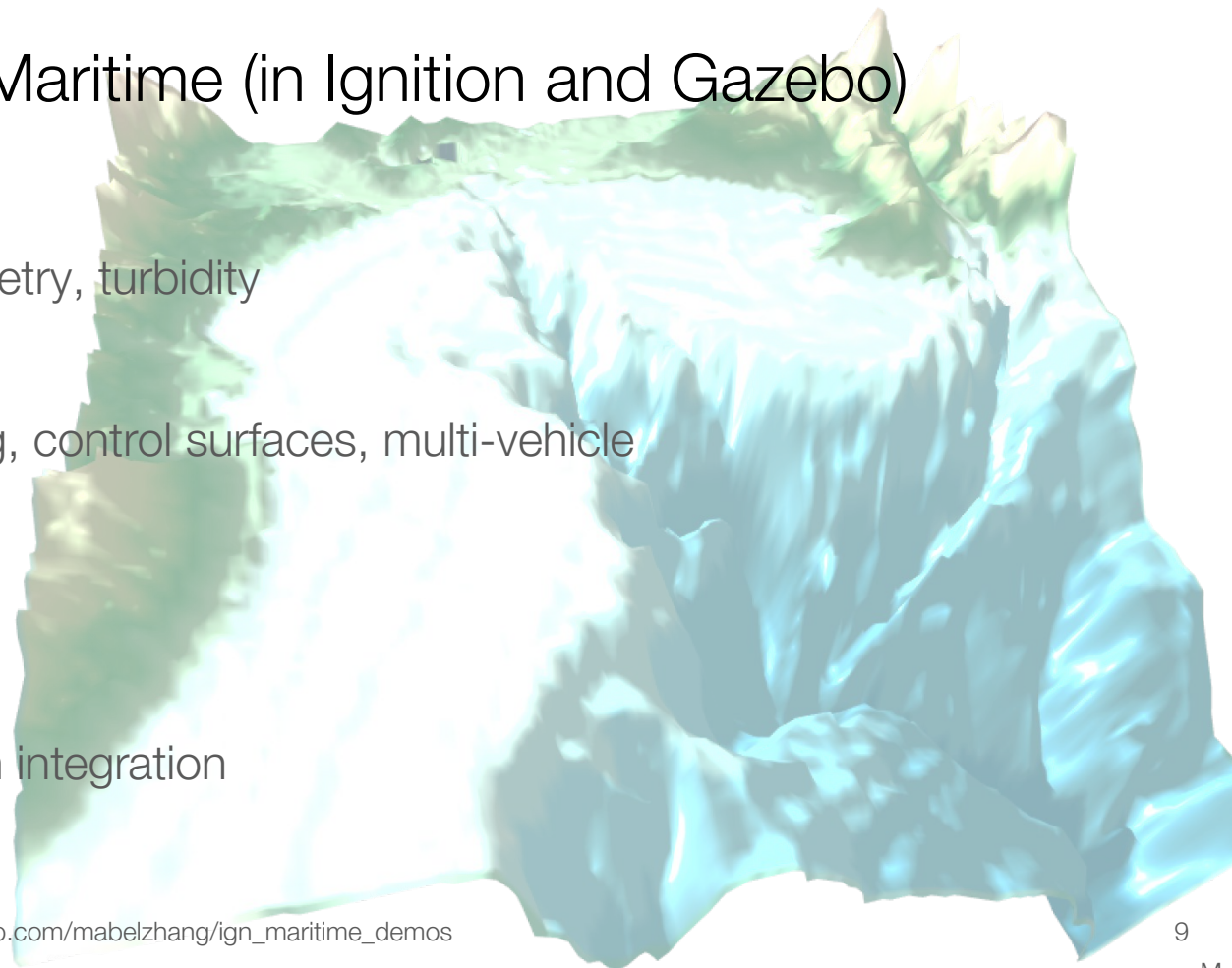
Hydrodynamics, lift and drag, control surfaces, multi-vehicle

Sensors:

Acoustics, water properties

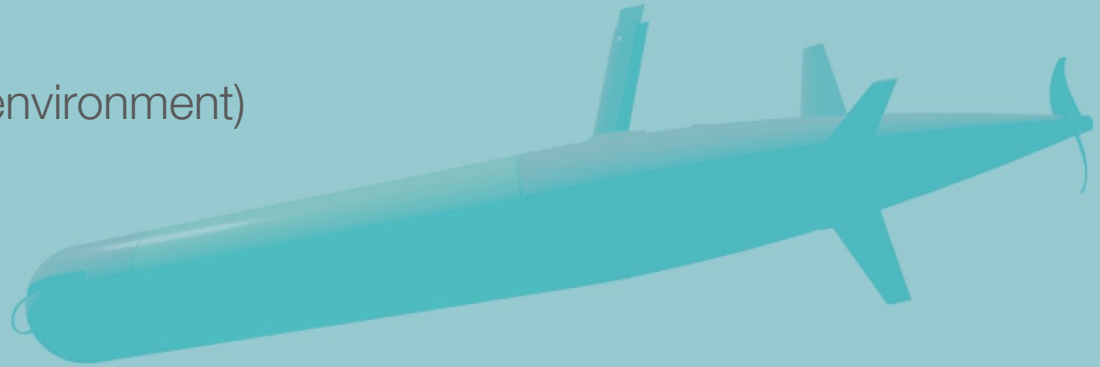
Experiments:

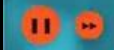
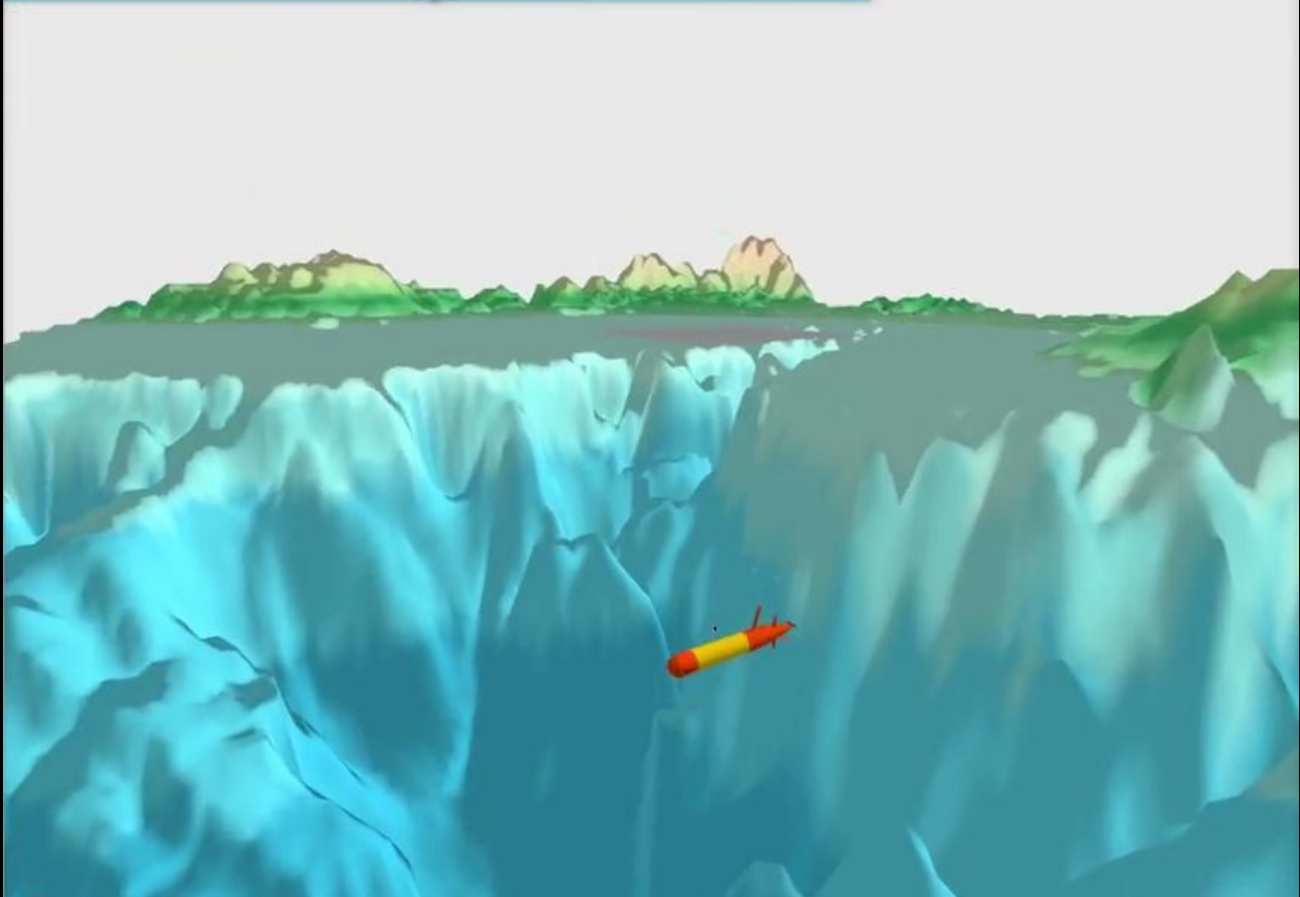
Faster than realtime, mission integration



Robot, Out of the Blue

(Video demo: Robot and environment)



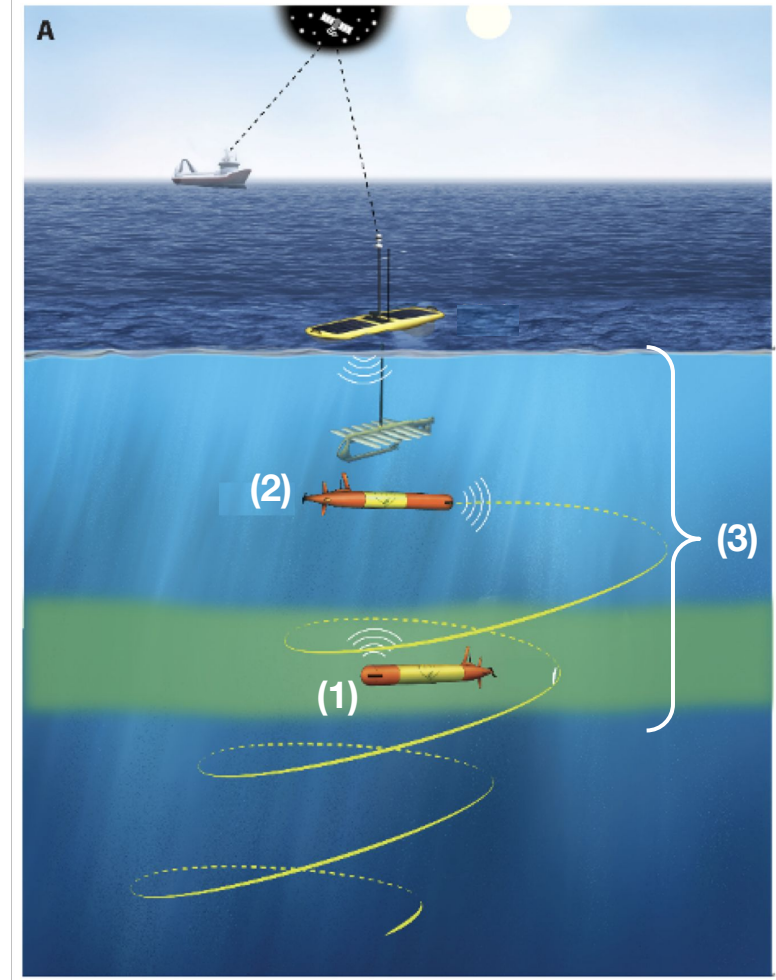


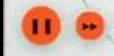
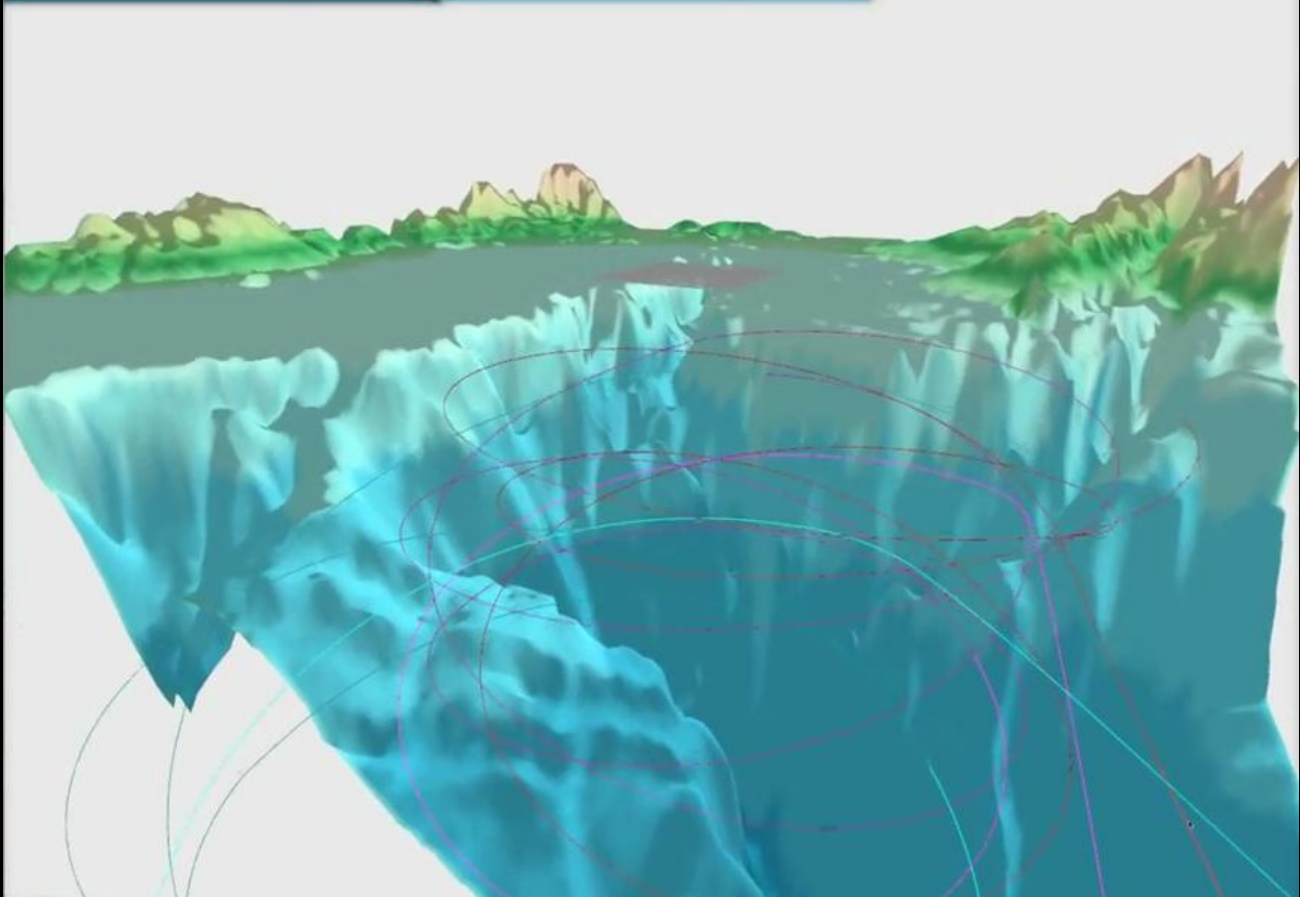
Mobile ocean observatory

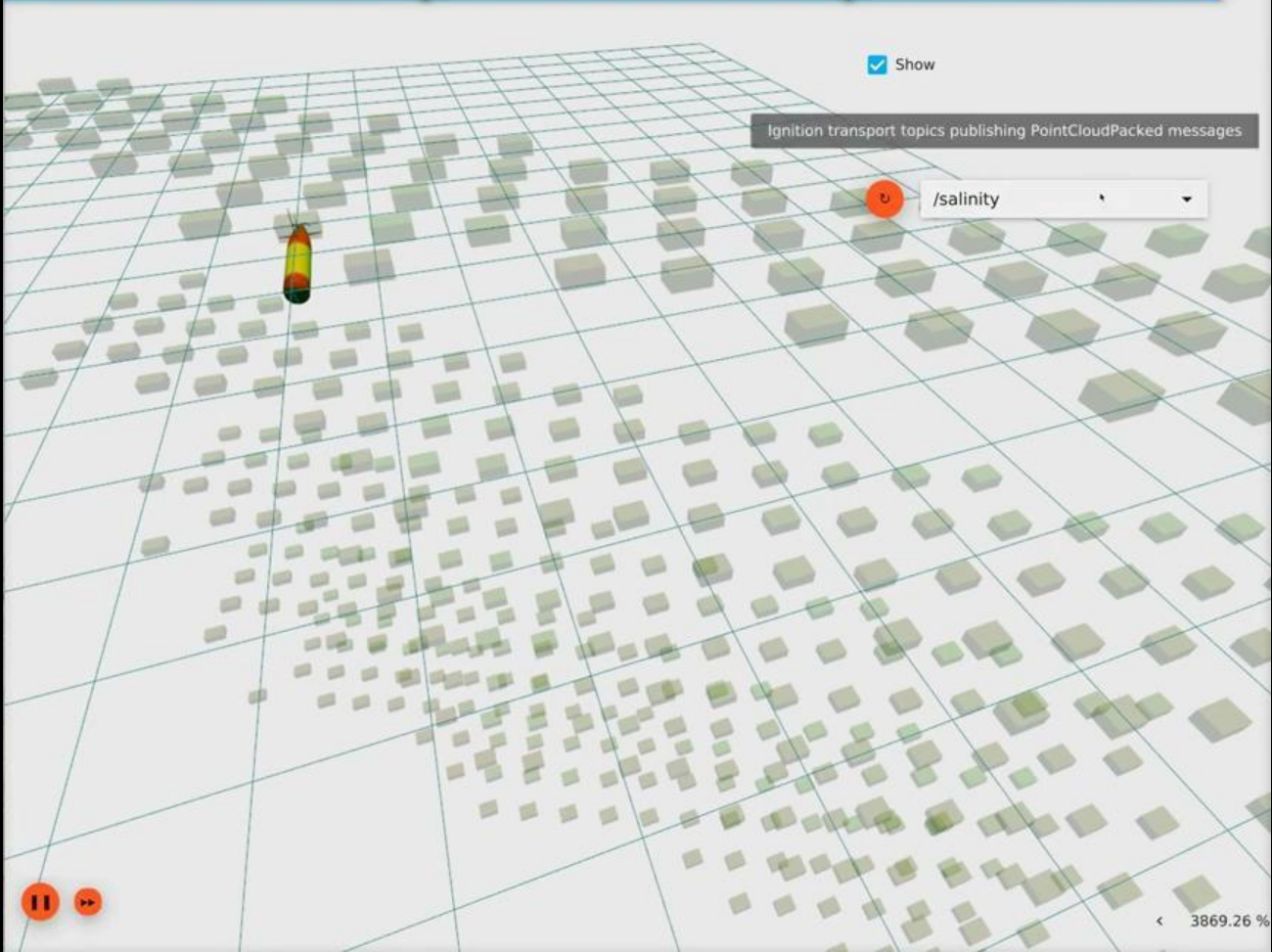
Collaborative autonomous water sampling

1. Sampling AUV autonomously locates and tracks a feature of interest (e.g., chlorophyll max) and acquires water samples
2. Sentinel AUV follows AUV1 and vertically profiles neighboring waters to capture contextual oceanographic data
3. Inter-vehicle acoustic comms support localization using range/bearing and command + data relay to/from shore

Zhang, Yanwu, et al. "A system of coordinated autonomous robots for Lagrangian studies of microbes in the oceanic deep chlorophyll maximum." *Science Robotics* 6.50 (2021), DOI: 10.1126/scirobotics.abb9138

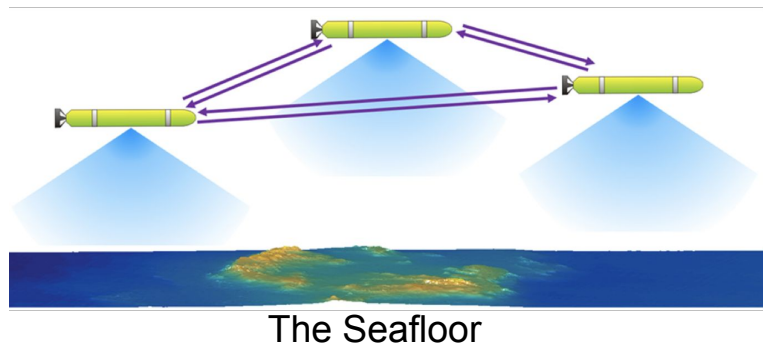






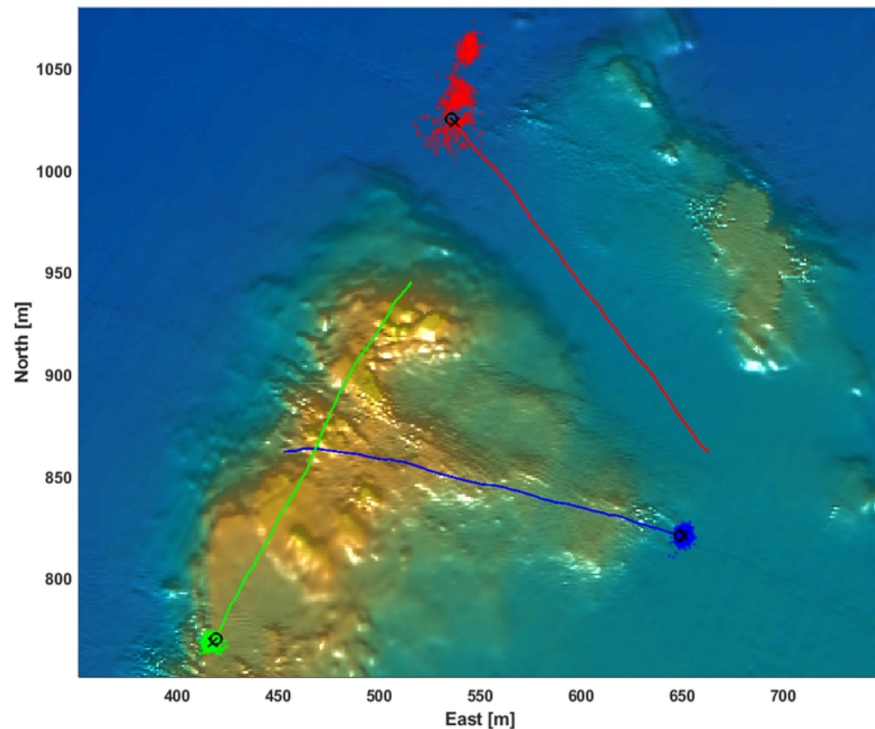
Collaborative Multi-Robot Localization

Terrain Relative Navigation (TRN)



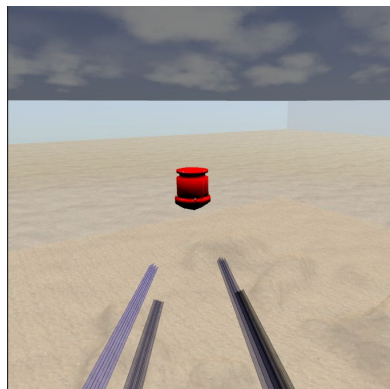
AUVs can use Doppler Velocity Loggers (DVLs) to sense their altitude and resolve their position by comparing with elevation maps.

TRN localization solution improves by fusing in measurements from multiple vehicles



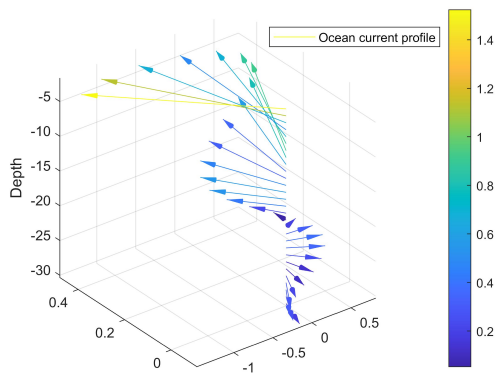
A. Wiktor and S. Rock, "Collaborative Multi-Robot Localization in Natural Terrain,"
IEEE ICRA, 2020, doi: 10.1109/ICRA40945.2020.9197576

Can You Hear Me Now?



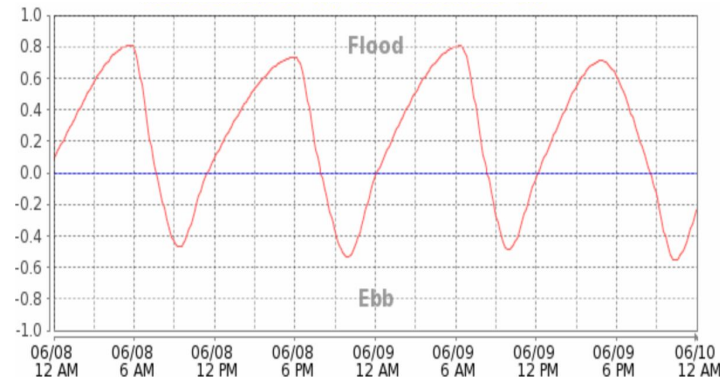
DVL from uuv_sim

+



Stratified ocean current

+



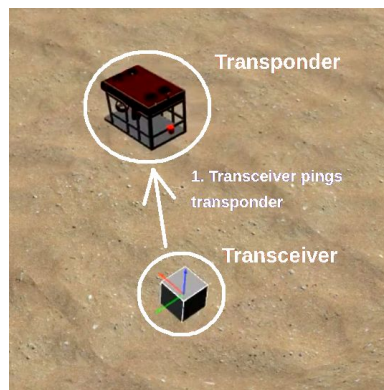
Tidal oscillation

DAVE Doppler Velocity Log

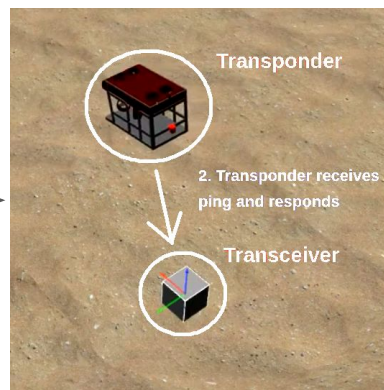
DAVE Ultra-Short Baseline

Upcoming:

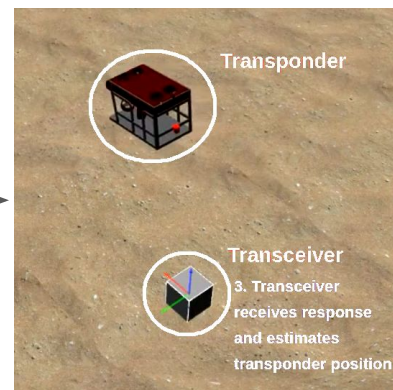
DVL + bathymetry +



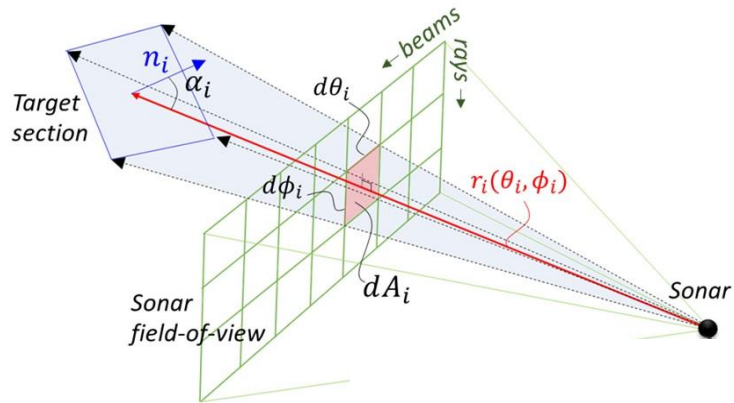
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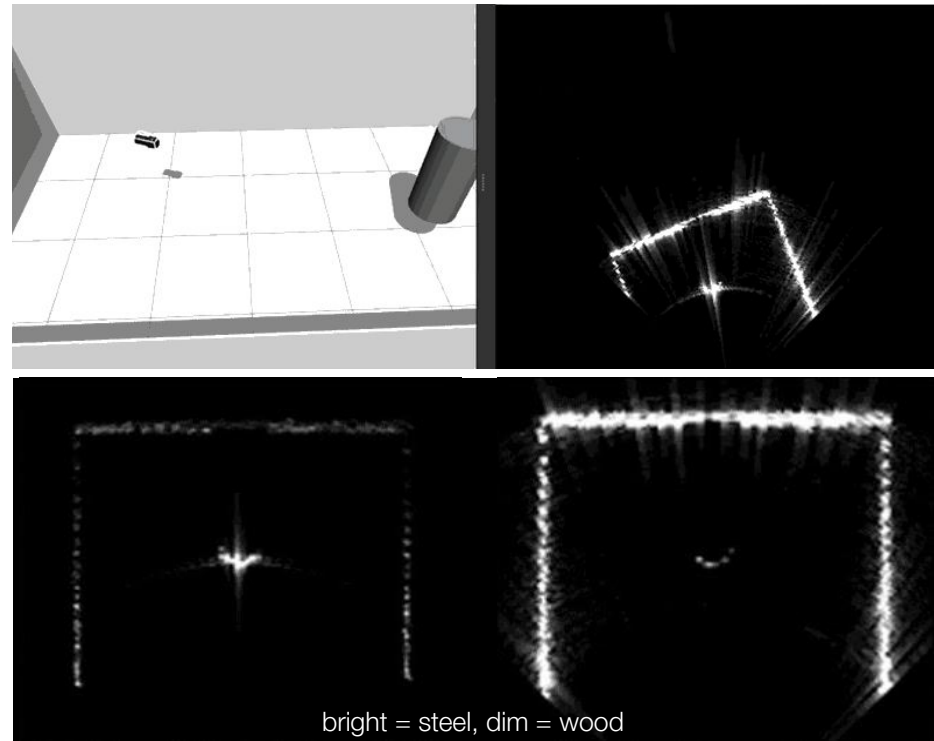
Looking Forward, Beaming



DAVE multibeam forward-looking sonar

Models beam-level physical acoustics:
scattering, noise, reflectivity, material

Real-time with CUDA GPU



Thank you.



ignitionrobotics.org
(maritime landing page coming soon)
github.com/osrf/lrauv (public soon)



mbari.org



github.com/Field-Robotics-Lab/dave



Arjo Chakravarty



Carlos Agüero



Louise Poubel



Open Robotics

the David & Lucile Packard
FOUNDATION



Monterey Bay Aquarium
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