# NRI: FND: Collaborative Navigation, Learning, and Collaboration in Fluids with Application to Ubiquitous Marine Co-Robots

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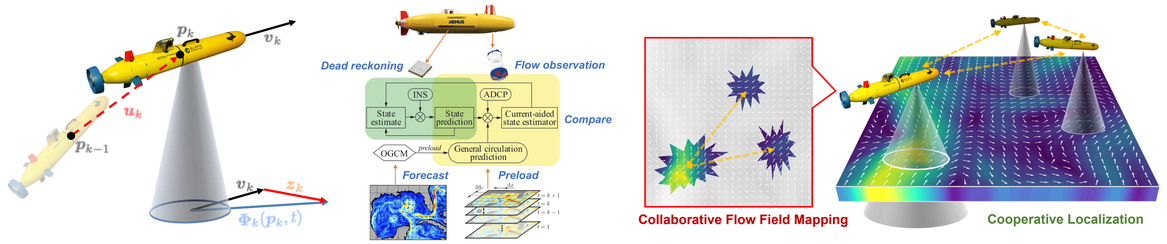
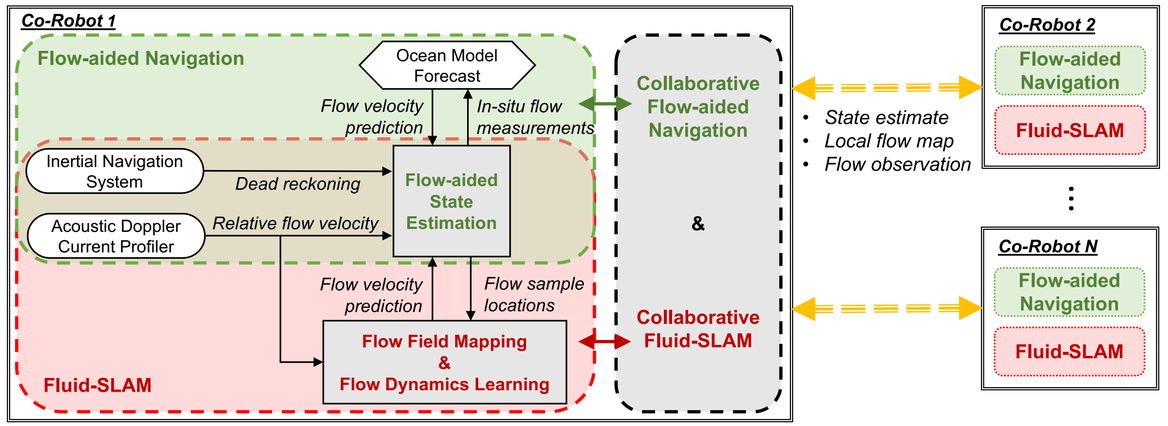
Robot Autonomy & Navigation Lab

**Goal: To create scalable algorithms that allow mobile underwater co-robots to persistently *navigate (localize within)* and *learn (map)* dynamic, uncertain fluid environments.**




## Challenge

- Long-term underwater navigation is challenging due to the lack of conventional localization references (e.g., GPS, static features)
- In-site sensing of subsurface ocean currents is extremely valuable
- Localization and flow mapping are coupled estimation problems
- Dynamic ocean flows are ubiquitous but challenging references

## Solution

- Flow-aided Navigation: Localize co-robots within dynamic flow maps through in-situ flow sensing and nonlinear filtering and smoothing
- Fluid-SLAM: Simultaneous flow-aided navigation and flow field mapping using data-driven feature dynamics learning, reduced order flow dynamics modeling, and dynamic compressed sensing
- Collaborative Fluid-SLAM: Cooperative localization and distributed flow sensing with multi-agent path planning in unsteady flows

## Scientific Impact

- Localization using nonlinear filtering is generalized to *dynamic maps*
- Concurrent state estimation and reference dynamics learning combines *stochastic filtering* with *data-driven dynamics learning*
- *Multi-robot dynamic compressed sensing* is significant to distributed sensing and monitoring of dynamic events with mobile robots

## Social Impact

- Novel navigation technologies for AUVs
- Richer subsurface data for ocean sciences

## Education and Outreach

- Created a graduate course on robot navigation
- Training opportunities on AUVs, DVL/ADCP, USBL

## Potential Impact

- Supported two Ph.D. students at UHM
- Trained 5 interns in Summer/Fall 2021

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