NRI: FND: Collaborative Navigation, Learning, and Collaboration in Fluids with Application to Ubiquitous Marine Co-Robots (CISE/IIS–2024928)

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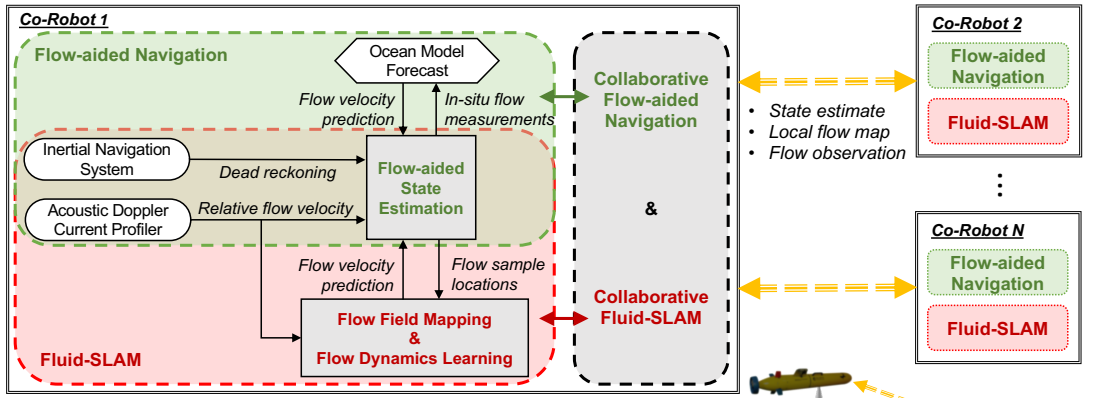
Challenge

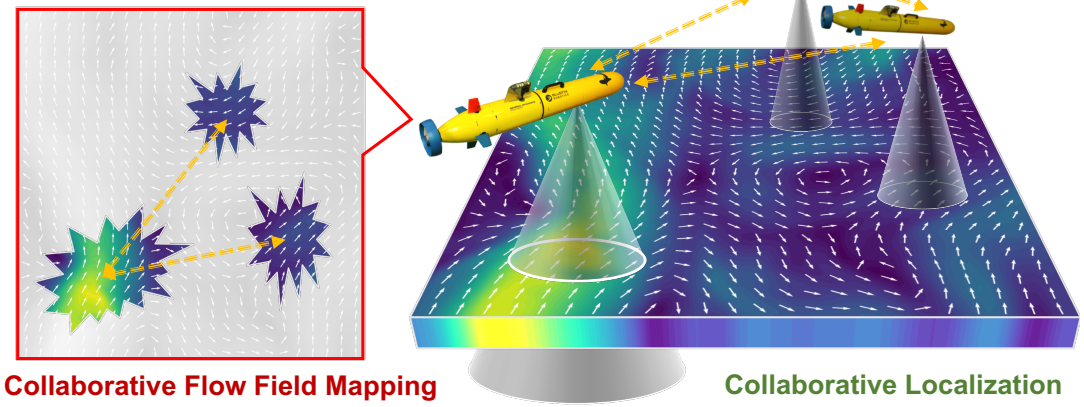
- Long-term navigation in mid-ocean is inherently challenging due to the lack of localization reference
- Our current understanding of global ocean circulation is limited by insufficient in-situ flow observations in mid-ocean

Solution

- **Flow-aided Navigation**: Localize each co-robot using background flows as localization references through *nonlinear Bayesian filtering*
- **Fluid-SLAM**: Incorporate online learning on flow dynamics using *Gaussian process regression (GPR)*
- **Collaborative Fluid-SLAM**: Enable *cooperative localization* and *distributed GPR among co-robots*

Goal: Create scalable algorithms that will enable mobile co-robots to persistently *navigate* (localize) and *learn* (map) dynamic, uncertain fluid environments.





Collaborative Flow Field Mapping

Collaborative Localization

Scientific Impact

- Nonlinear Bayesian filtering is generalizable to *state estimation in dynamic environments*
- Concurrent state estimation and GPR will contribute to solutions for *physics-informed learning under uncertainties*
- Collaborative flow dynamics learning is significant to *distributed sensing of dynamic events*

Broader Impact

- Enable distributed sensing in mid-ocean with intelligent robots
- Benefit oceanographers with richer in-situ ocean observation data
- Create STEM opportunities in robotics for Native Hawaiians