NSF:NRI: FND: Extending Autonomy in Seemingly Sensory-Denied Environments Applied to Underwater Robots

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http://users.cis.fiu.edu/~jabobadi/extendingautonomy/

Enabling accurate localization and navigation using novel strategies and map representations for effective human-robot communication and targeted intelligent sampling.

Challenges: At least **40% of the world** lives in near-shore regions. Manned data collection is **inefficient, expensive, dangerous**, and often **damaging to the environment**. Traditional sensor modalities are affected in underwater localization. Overcome the **theoretical** and **technical** barriers to performing intelligent sampling in a sensory-denied, spatiotemporally dynamic environments focused on the aquatic domains.

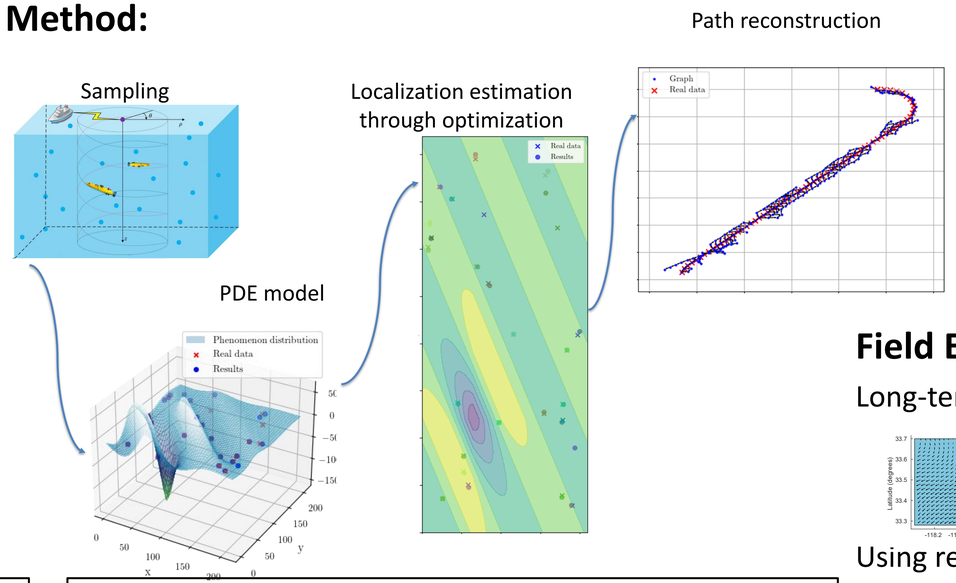
Scientific Impact: Novel strategies to perceive the surrounding environment and enable localization and navigation devoid of a geographical reference model in seemingly sensor denied, dynamically evolving environments.

Technical Approach:

1. Environment features modeled by Partial Differential Equations (transportation PDE's).
2. Estimate the robot's localization through the models and the collected data posing and optimization problem
3. Validate research outcomes through simulations and field experiments.

$$\frac{\partial f}{\partial t} + b \cdot \nabla f = g(x,t), \text{ for } (x,t) \in \mathbb{R}^2 \times (0,\infty)$$
$$f(x,0) = h(x), \text{ for } t = 0$$

Method:

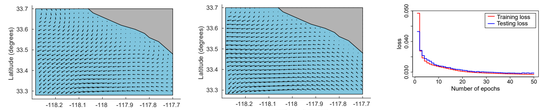


Results:

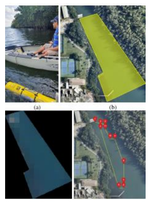
- Theoretical results bounding the error.
- Simulations using different transportation models.
- Extensible approach used to path reconstruction

Field Experiments:

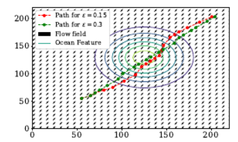
Long-term autonomy for AUV. (RA-L' 21)



Using remote sensing for prior maps. (OCEANS'22)



Learning Policies for Feature Tracking



Biscayne Bay FL

Broader Impact: High-impact applications: Scientific advances in this project will enable cost-effective data collection for many critical applications, including assessing reef ecosystem, seagrass, mangrove health, and algae bloom monitoring.

Broader Impact (Education): Research Involvement of undergraduate students and graduate students from historically underrepresented groups in cutting-edge robotics research.

Grad students: Jose Fuentes, Paulo Padrao, Cesar Rojas.

2022 NRI & FRR Principal Investigators' Meeting
April 19-21, 2022

Award ID#: 2024733