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Enabling Real-time Dynamic Control and Adaptation of Networked Robots in Resource-constrained and Uncertain Environments

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Motivation

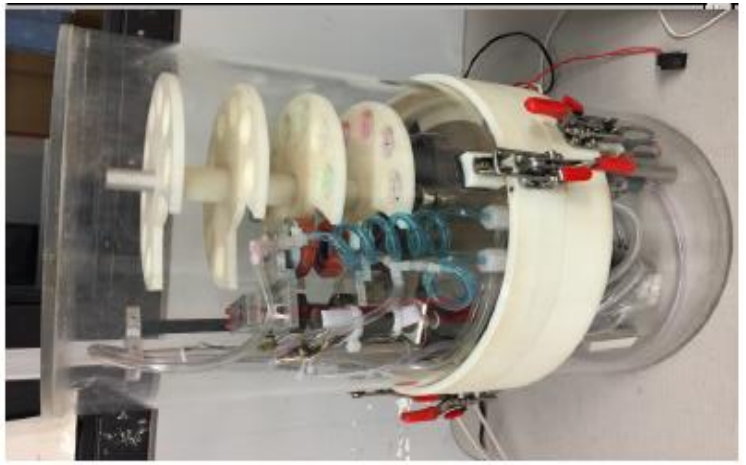
- **Near-real-time water-quality monitoring of physical variables**
- **Optimal decisions and timely closed-loop solutions**

Goal

- **Design a Cyber Physical System (CPS)** where drones and autonomous underwater robots can identify in near real time *Regions of Interest (RoIs)* and collect biosamples from them
- Perform in-situ transformation of the measurements/raw data into valuable information and then into knowledge through *collaborative information fusion* and *integration*
- Solve the problem of uncertainties (*model*, *resource*, and *data*) that arises in in-situ processing of data from sensors in any CPS
- Provide greater autonomy, robustness, and cooperation in CPSs while improving on their scalability, reliability, and timeliness in comparison to traditional sensing systems

Research Tasks

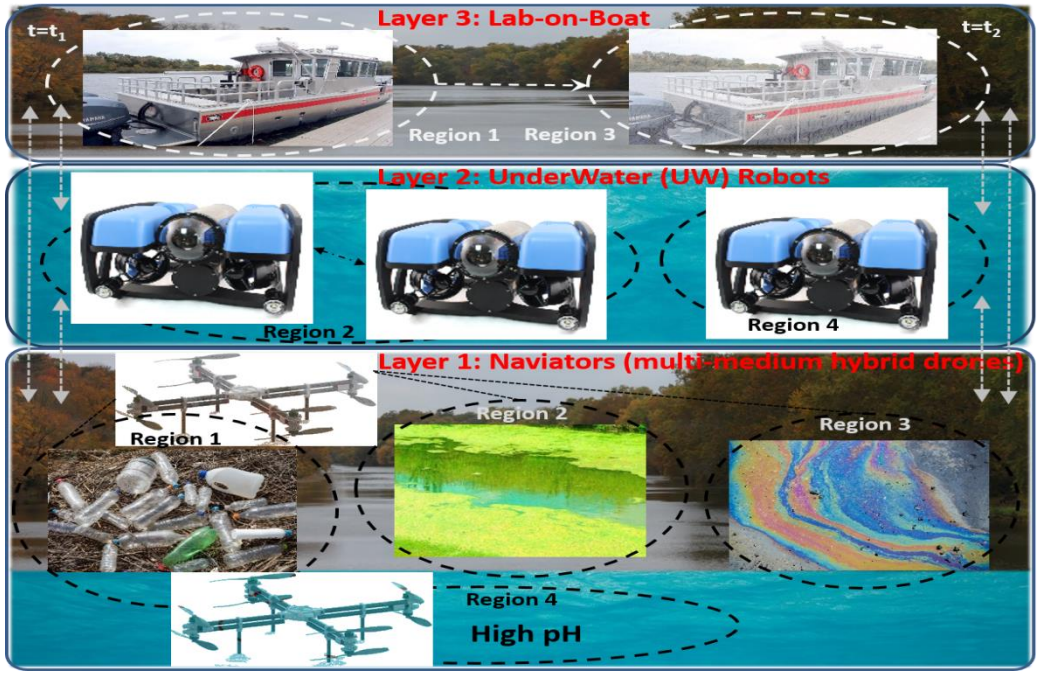
- **Task 1:** achieve dynamic collaboration between local and cloud resources
- **Task 2:** handle model uncertainties in the local resources
- **Task 3:**
  - **(i)** develop a biosampler, i.e., a "lab-on-robot"
  - **(ii)** optimize the Rutgers Naviator's current hybrid air/water multirobot platform/propulsion system
- **Task 4:** perform integrated field testing on the Raritan River, NJ
  - **(i)** to validate our algorithms
  - **(ii)** to analyze their scalability (from an economical and feasibility perspective)
  - **(iii)** to assess their performance confidence/accuracy



Prototype of the on-board biosampler

The recent version of our Rutgers Naviator

Methodology: A Three-layer CPS Sensing Architecture



- **Layer 1:** multi-medium drones (Rutgers Naviators), with *narrow-spectrum sensing* capabilities but with *fast moving* and quick triage abilities
- **Layer 2:** autonomous underwater robots with *narrow spectrum sensing* but with *high temporal- and spatial-resolution* capabilities
- **Layer 3:** few Lab-on-Boats with *broad and accurate spectrum sensing* capability but *slow moving* and low spatial- and temporal-sensing resolution

Thank you!

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