UNIVERSITY OF SOUTH CAROLINA

CSCE 574 ROBOTICS

Introduction

Ioannis Rekleitis

Why Robotics?

- Manufacturing
- Labor shortage (agriculture, mining)
- Point where computers fast/cheap
- Automation of cars→more cars on highways
- To reach areas where no human can go

Present Everywhere

- **At home**
- On the road
- In the sky (drones)
- In the fields
  (agricultural robotics)
- In resource utilization
  (ROV in the oil industry)
- Along power lines
- In Hospitals
- Education
- In Factories
- In Warehouses
- In Space

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QUADH2O MULTIROTOR

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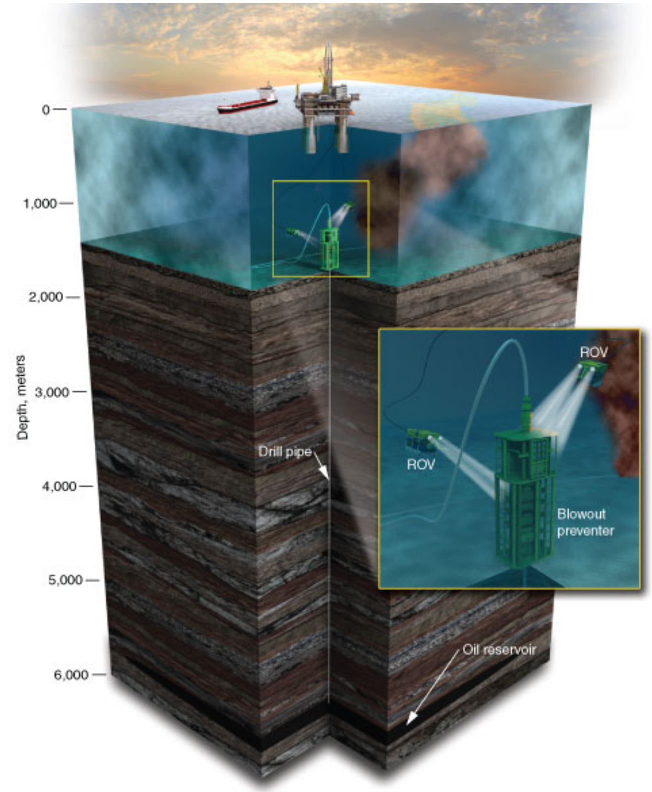

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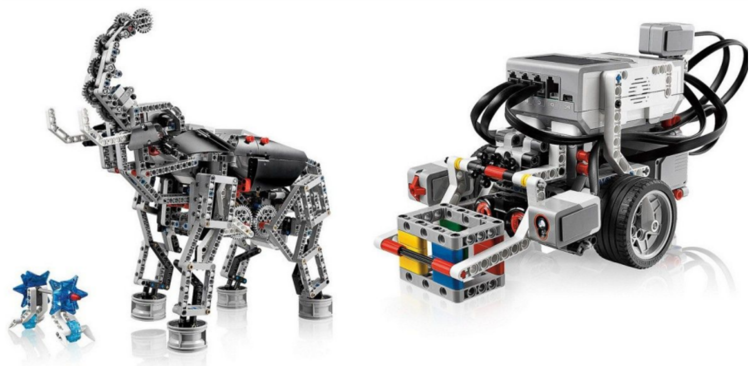

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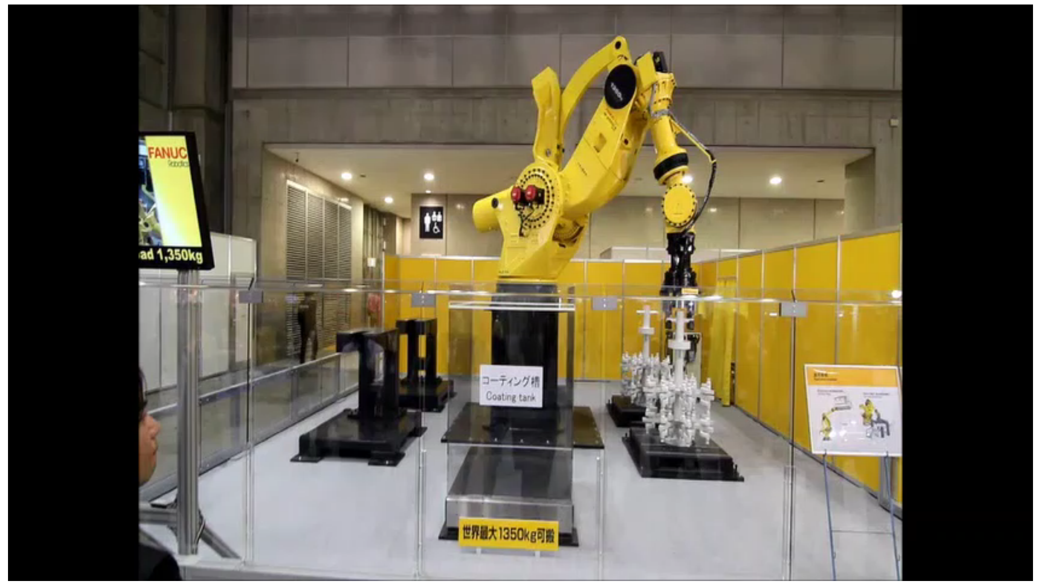

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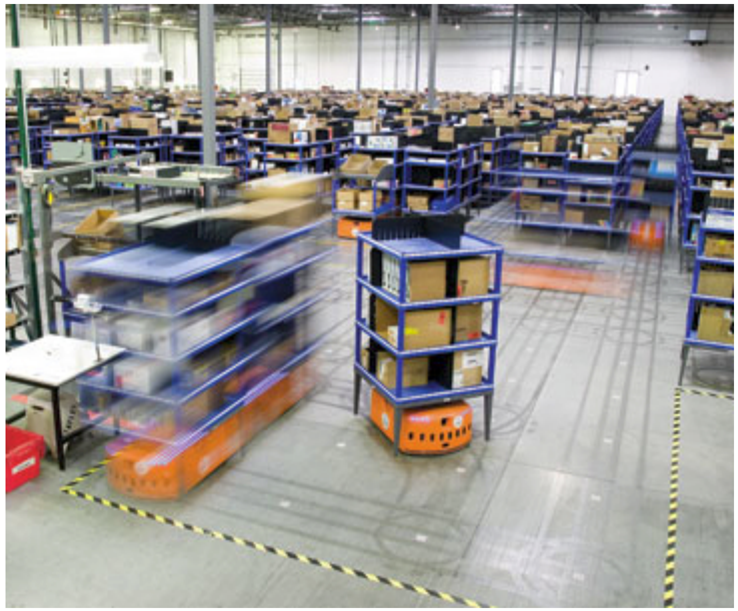
Amazon bought Kiva for $775M



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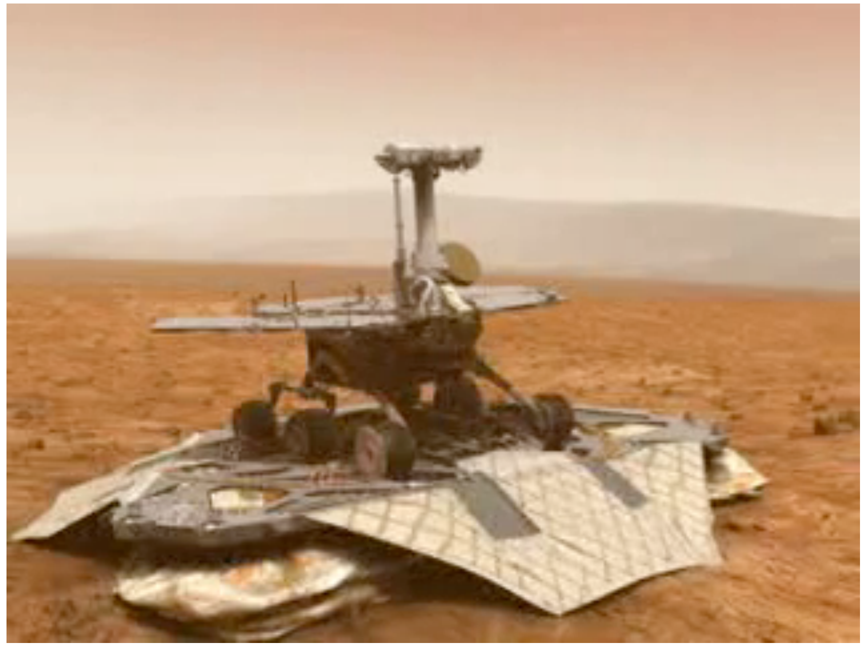


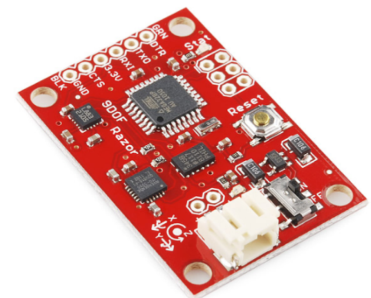
Robotic technology becomes affordable

TurtleBot 2

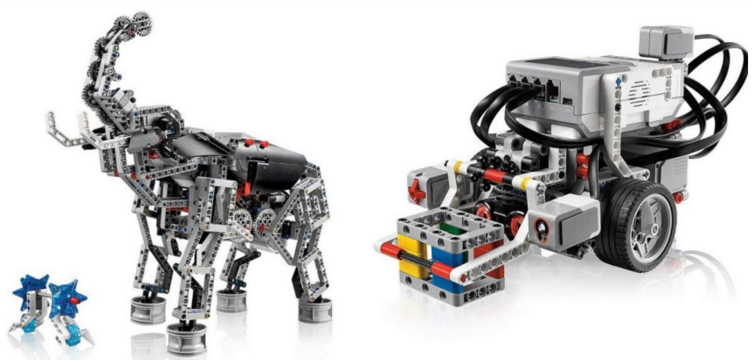
AR.DRONE

Kinect

IMU

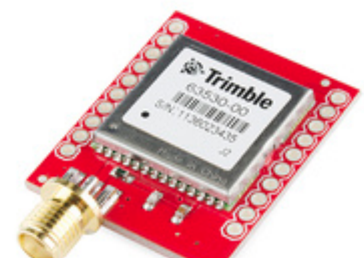


Raspberry Pi



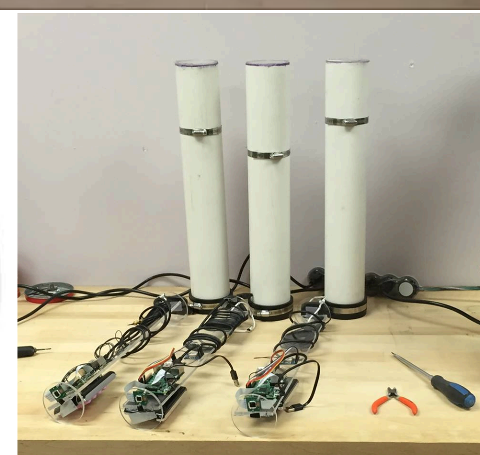
Lego Mindstorm

GPS



Robotics at USC

Courses	Professors
CSCE 274	Dr. O'Kane
CSCE 574	Dr. Beer
CSCE 774	Dr. **Rekleitis**



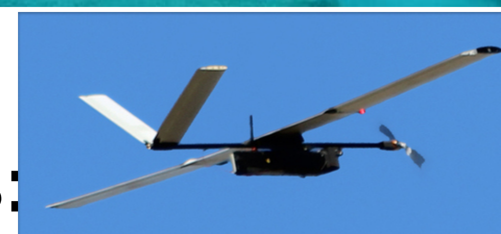
Recent Funding:

- **NSF CRI II-New**: Acquisition of a Heterogeneous Team of Field Robots for Coastal Environments
- **PI: I. Rekleitis.**
- CoPIs: J. Beer, J. O'Kane
- Funding: 520,000$ for 3 years

Several **Surface Vehicles**

2 **Aqua** u/w vehicles

Aerial Vehicles:
2 fixed wings
2 quadrotor



Autonomous Field Robotics Lab

Autonomous Field Robotics Lab

Philosophy

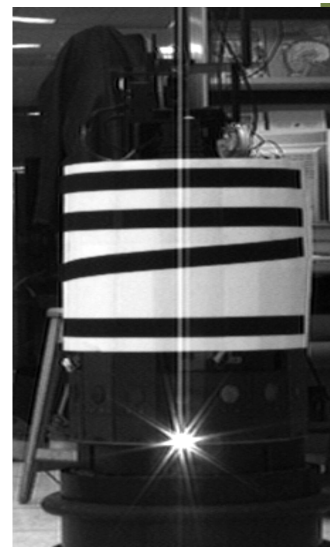
Develop algorithms for robotic applications

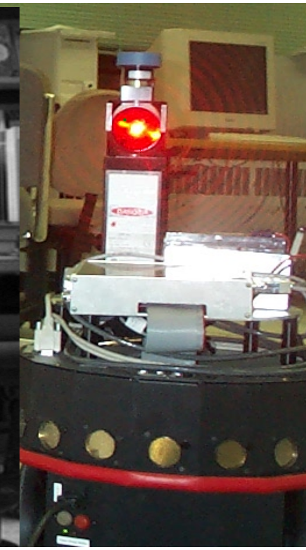
Deploy algorithms on fielded robots

(Aerial, ground, surface, and/or underwater)

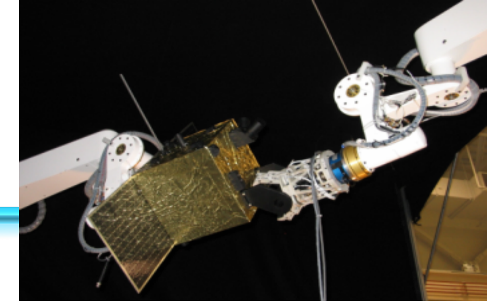
Evaluate performance of the deployed robots

Past Projects





Past Projects

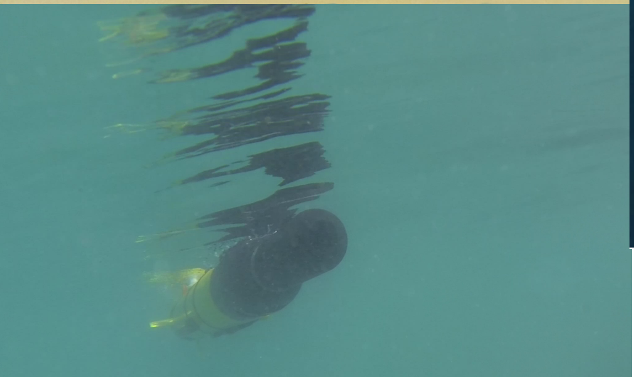


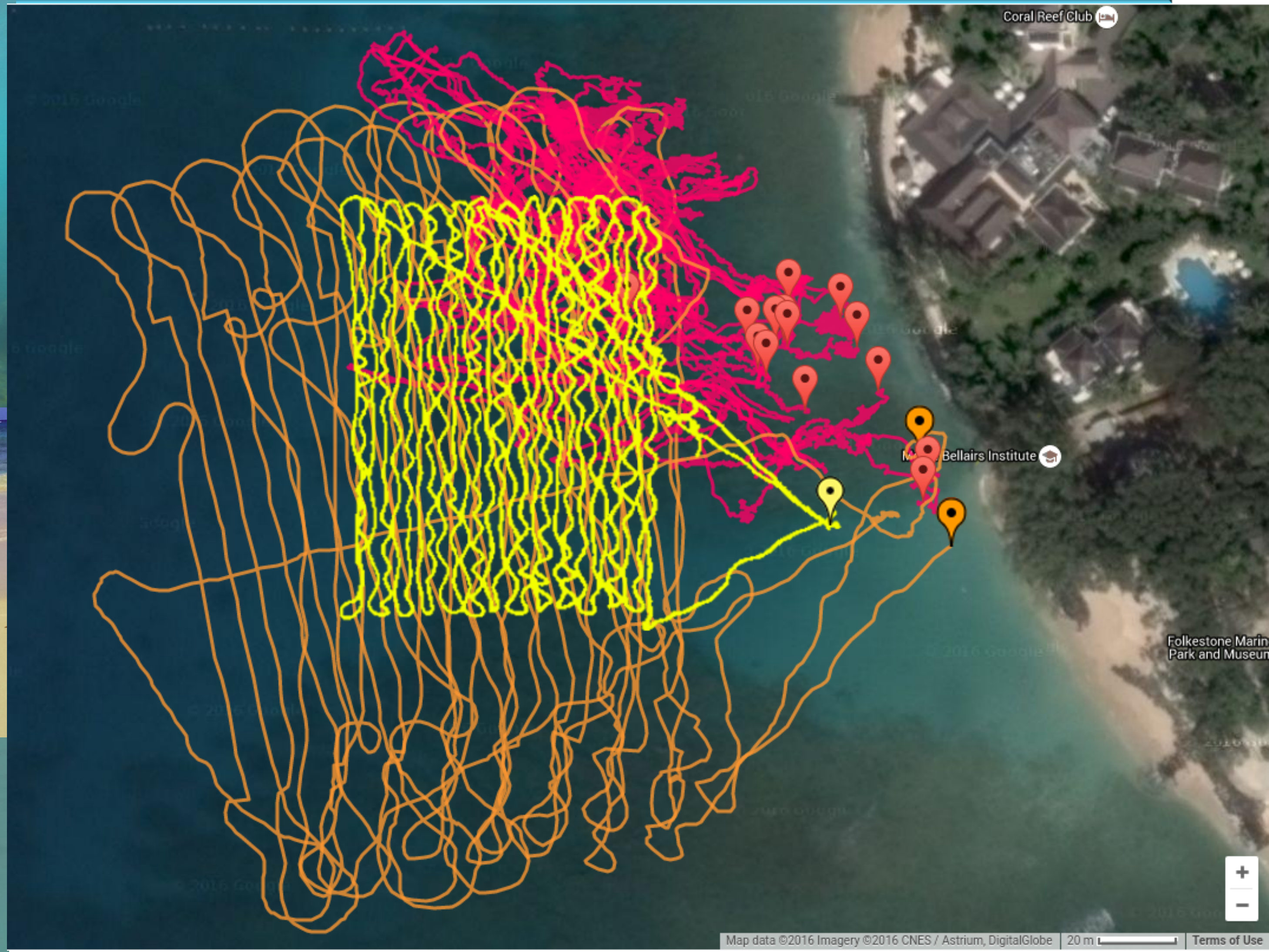
Aerial Robotics

Cooperative Localization

- Inferring relative pose
- Using vision only
- Bearing only data

Coral Reef Monitoring by Heterogeneous Robots

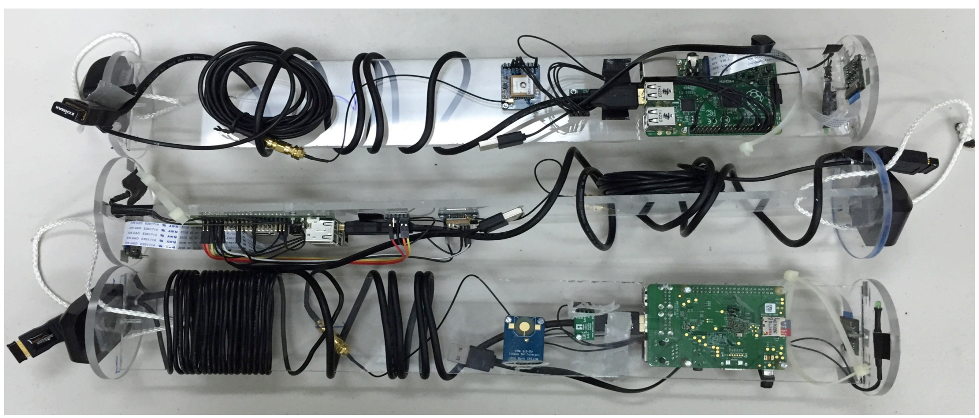




Marine Robotics

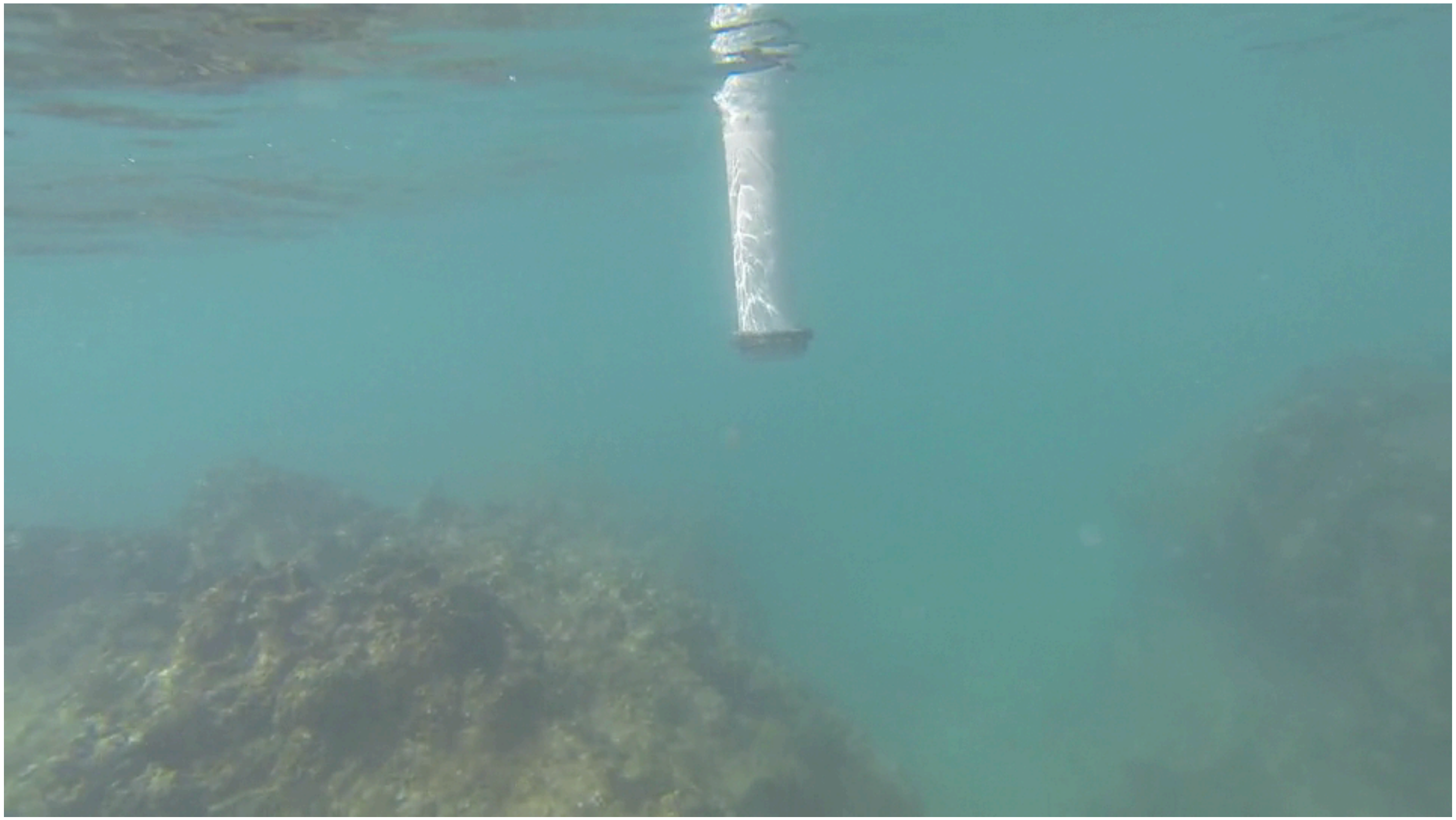
Capstone Project: Drift Nodes

- Measure Lagrangian current characteristics, marine life, salinity, turbidity, etc.
- Improve estimation accuracy



Marine Robotics: Drift Nodes

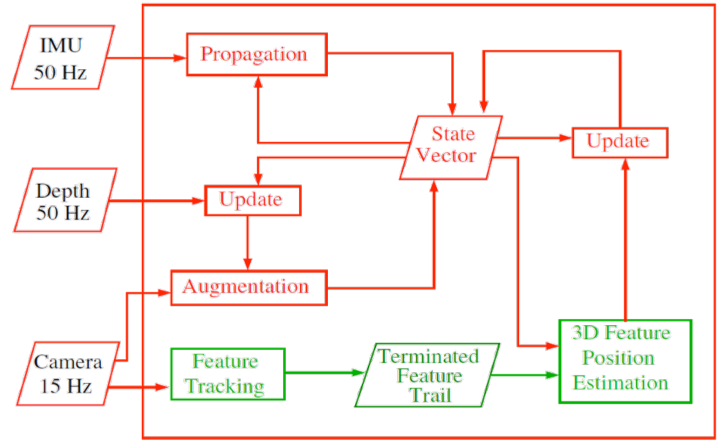
- Monitor, shallow coral reefs.
- Improve estimation accuracy



Marine Robotics

Underwater Situational Awareness

- Vision-INS State Estimation
- Path Planning
- Mapping



Shipwreck Mapping

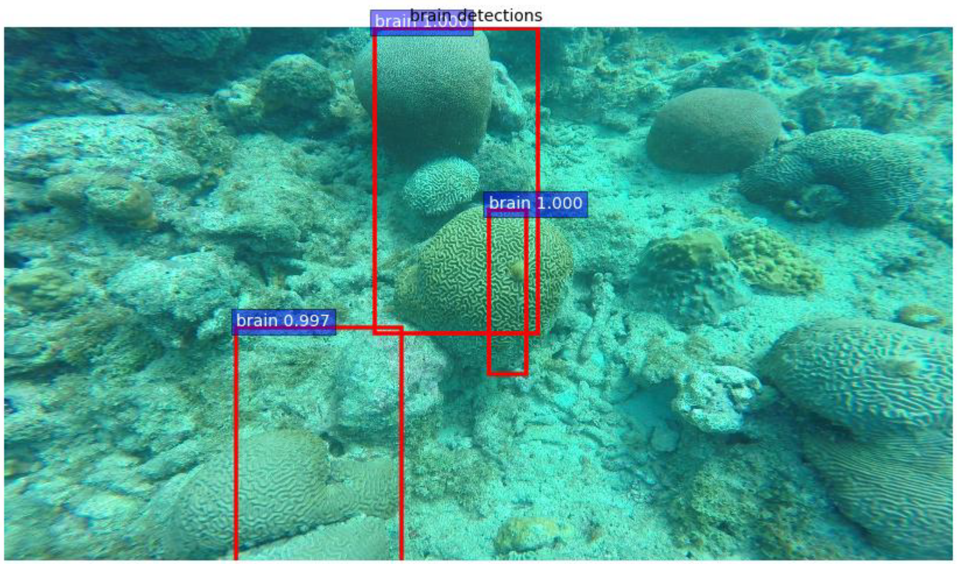
Shipwreck Mapping

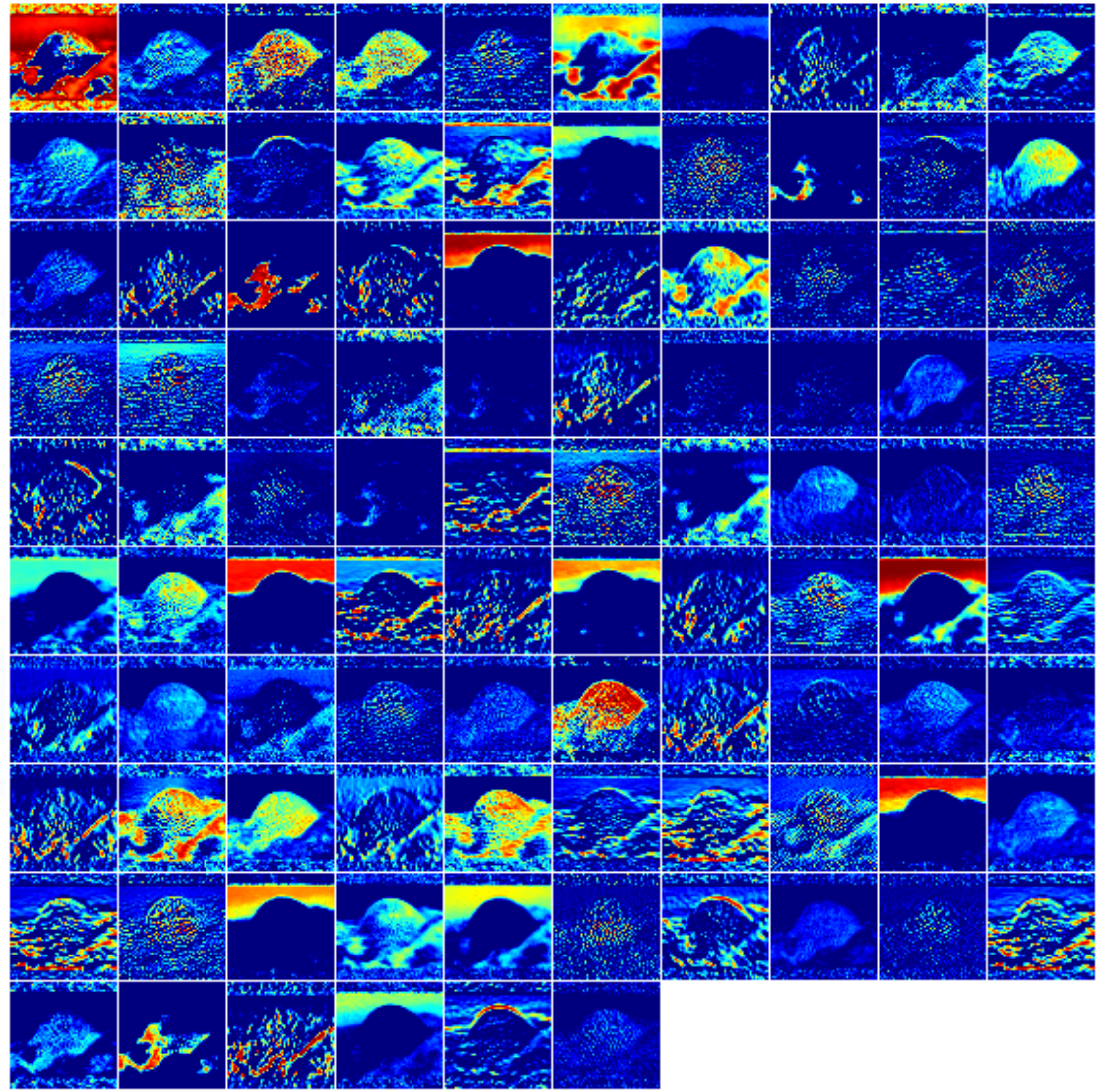
Robot's Eye View

Underwater Cave Mapping

Shallow Coral Classification using Deep Learning

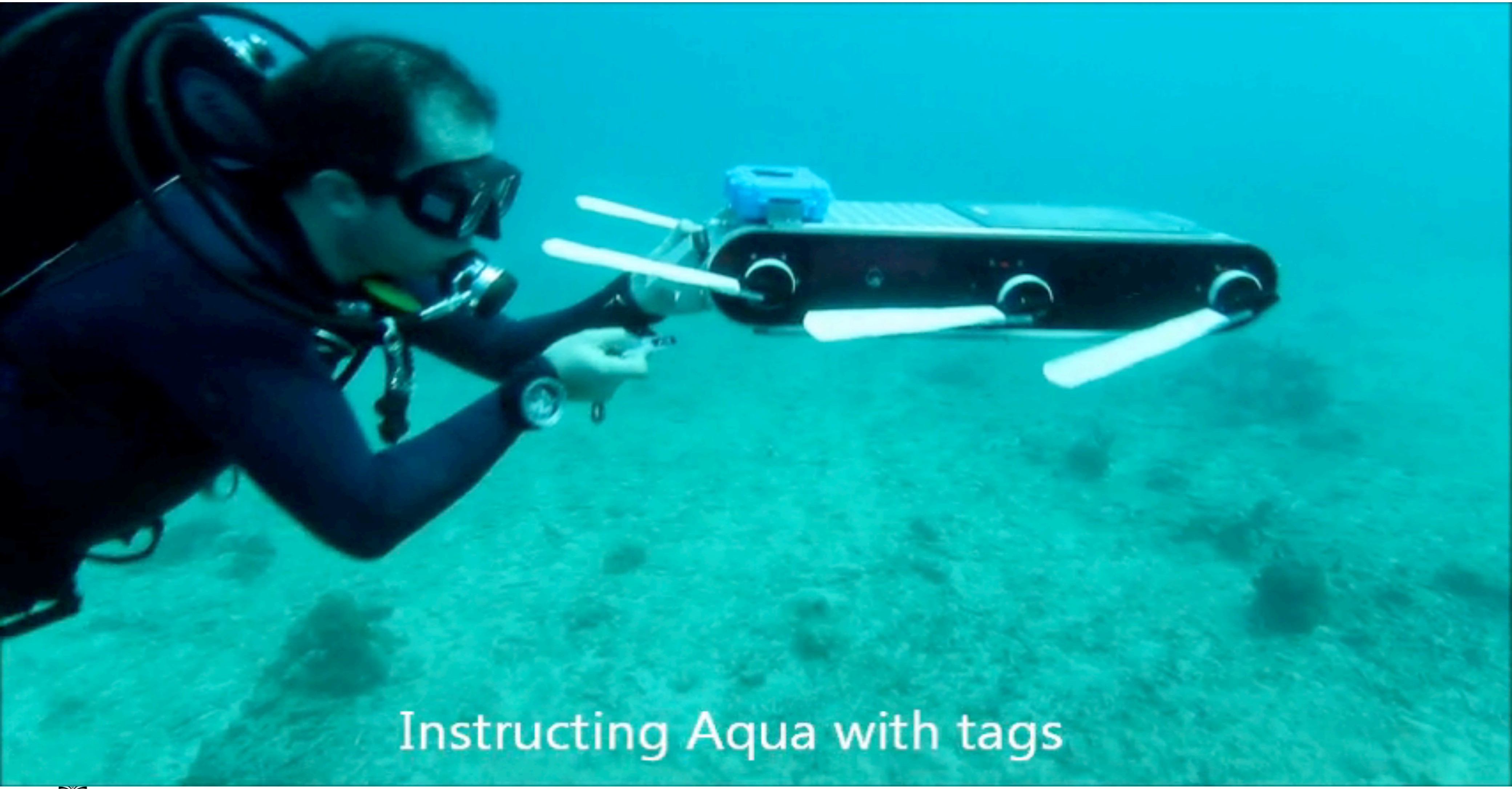
- Using a CNN





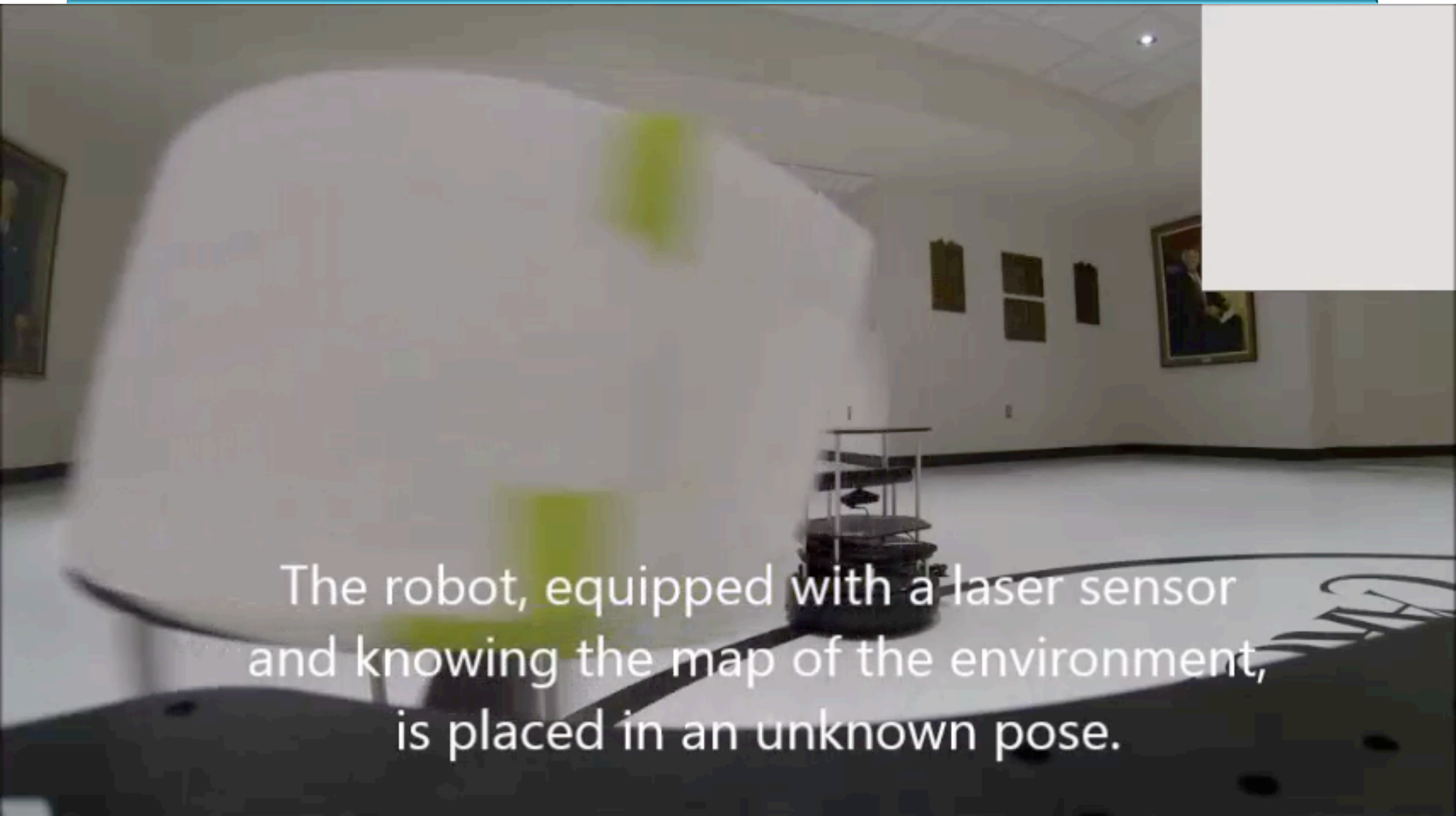
Marine Robotics:

HRI with limited bandwidth

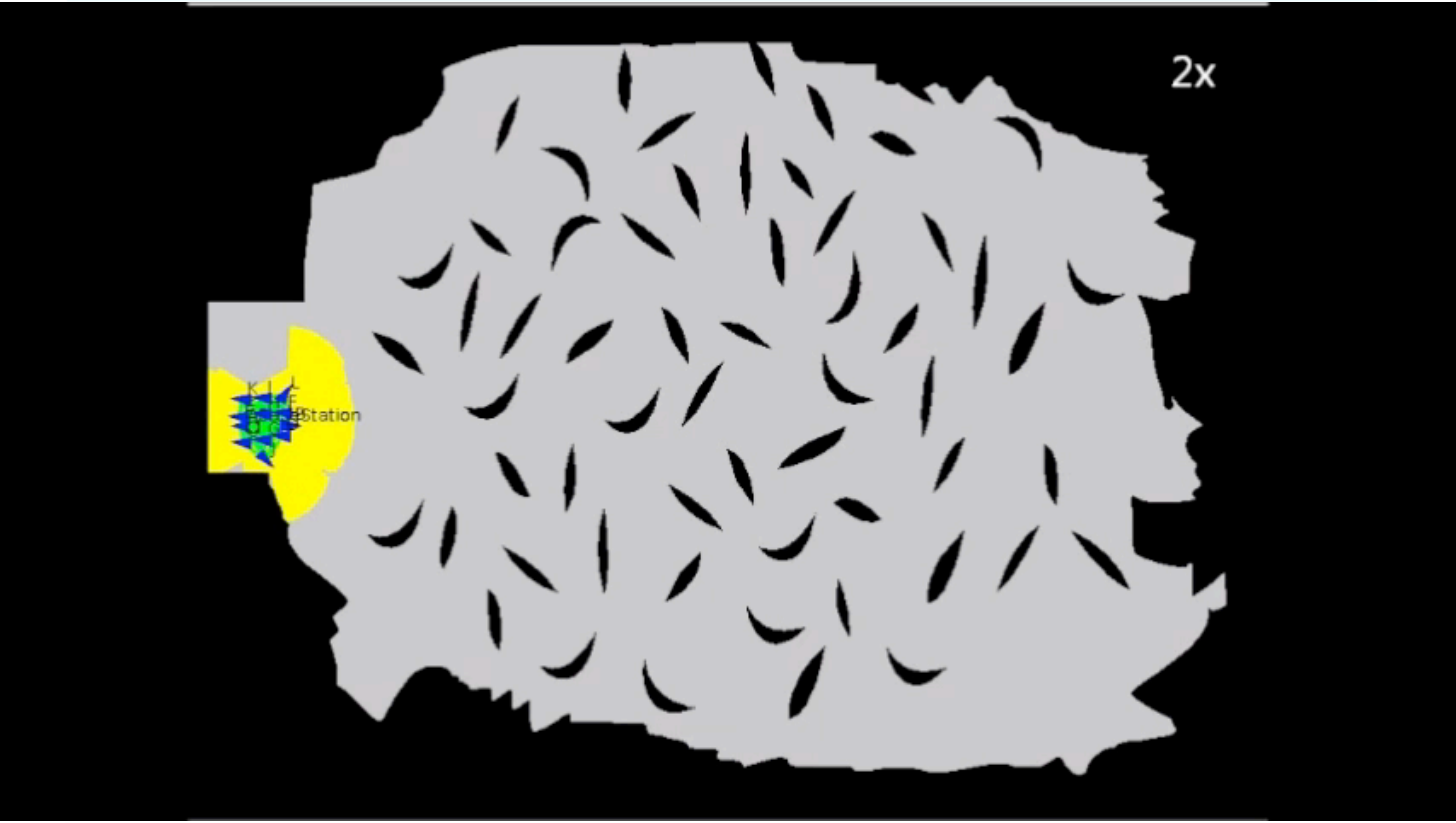


Current work in indoor Robotics

Indoor: Localization with dynamic obstacles



Indoor: Communication Constrained Exploration



Syllabus

Week 01: Syllabus presentation, Round Table, Introduction, History of Robotics. ROS
Week 02: Actuators. Locomotion. Sensor (Tactile, Range Finders, GPS, IMU, Position Encoders).
Week 03: Reactive Path Planning. Potential Fields. State Estimation, Bayesian Filtering
Week 04: Particle and Kalman Filters
Week 05: Exploration, HRI
Week 06: Mapping: Metric Maps, Topological Maps, hybrids
Week 07: Visibility Graphs, Bug Algorithm, Generalized Voronoi Graphs, Atlas.
Week 08: Break
Week 09: Semantic hierarchy of spatial representations. Configuration Space, PRMs
Week 08: Architectures.
Week 09: Coverage, Multi-Robot Coverage
Week 10: Presentations
Week 11: Presentations
Week 12: Sensor (Vision).
Week 13: Presentations
Week 14: Review of Material
Week 15: **Final**

Evaluation

- 5 Homeworks, 10% each: 50%
  - First two individual
  - Last three 50% team, 50% individual
- Final Examination: 30%
- Midterm: 20%

Homeworks/Projects

- Using ROS
- Using Simulations
- Using sensor data from real robots
- Using real robots (TurtleBot 2)

Contact

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- http://www.cse.sc.edu/~yiannisr/574/2016Fall/
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- **Office hours**: 3A54 – Mon/Wed 10:30-11:30
  and by appointment