



UNIVERSITY OF
SOUTH CAROLINA

CSCE 574 ROBOTICS

Introduction

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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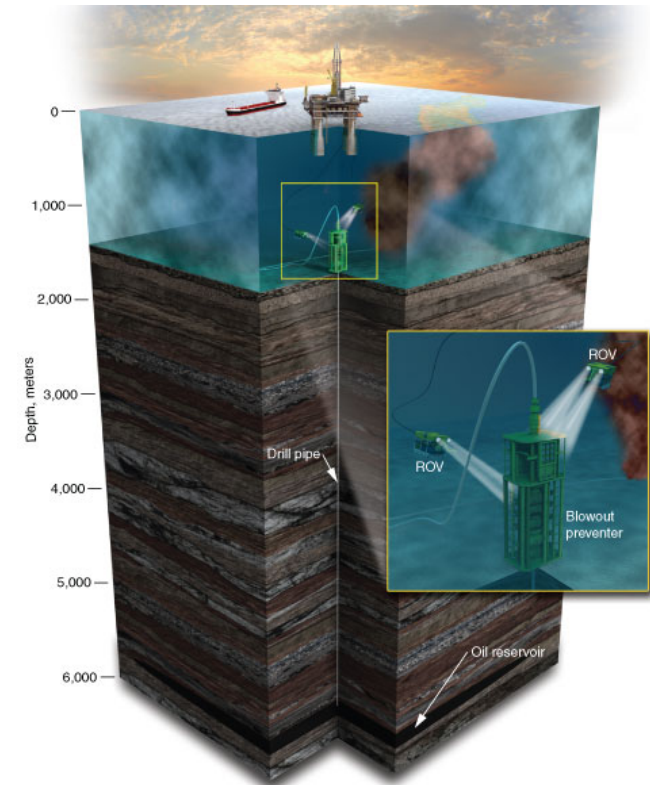
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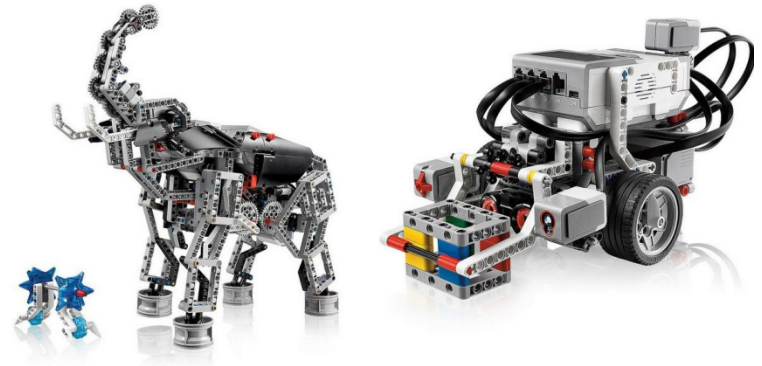
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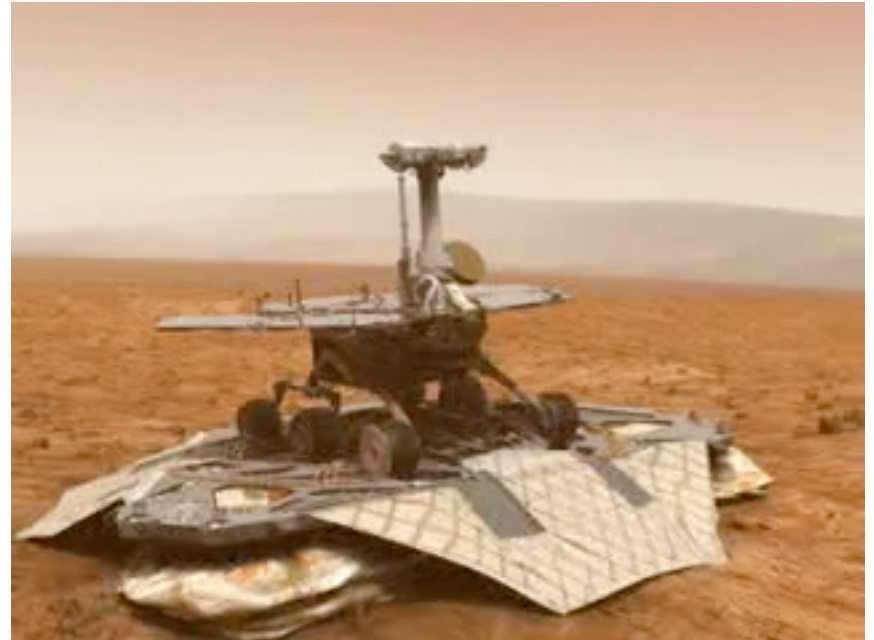
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Amazon bought Kiva for \$775M



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Robotic technology becomes affordable

TurtleBot 2



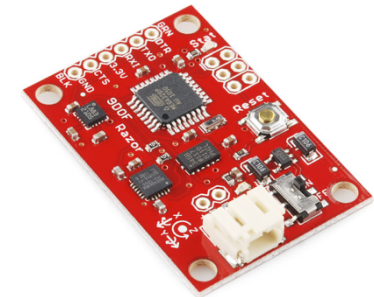
AR.DRONE



Kinect



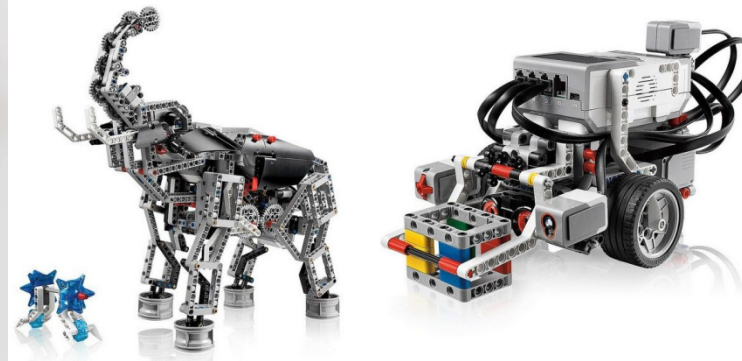
IMU



Raspberry Pi



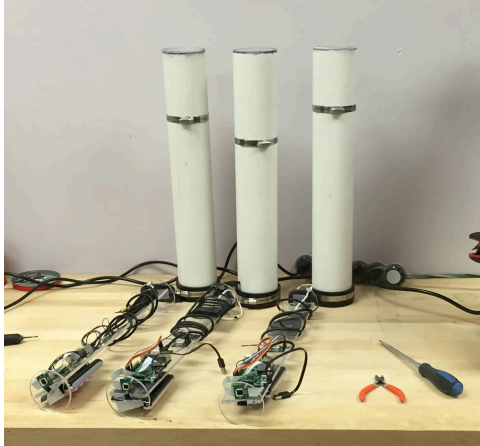
GPS



Lego Mindstorm

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



**Develop
algorithms for
robotic
applications**

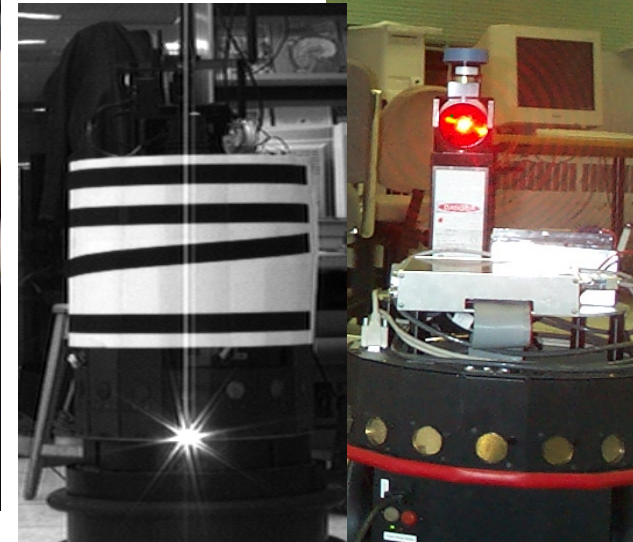
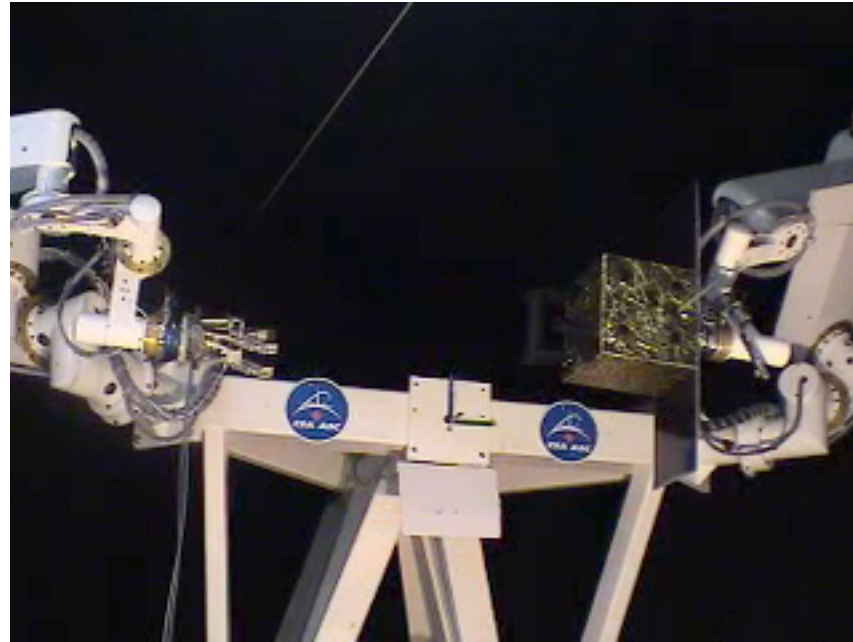
Philosophy

**Evaluate performance
of the deployed robots**

**Deploy algorithms on
fielded robots**
(Aerial, ground, surface,
and/or underwater)

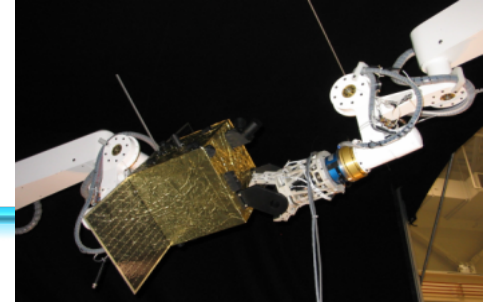


Past Projects





Past Projects



**Complete Optimal Terrain Coverage
using an Unmanned Aerial Vehicle**

Anqi Xu
Chatavut Viriyasuthee
Ioannis Rekleitis



The MARE ASV serves as a surface relay station
between the Unicorn UAV and the Aqua AUV





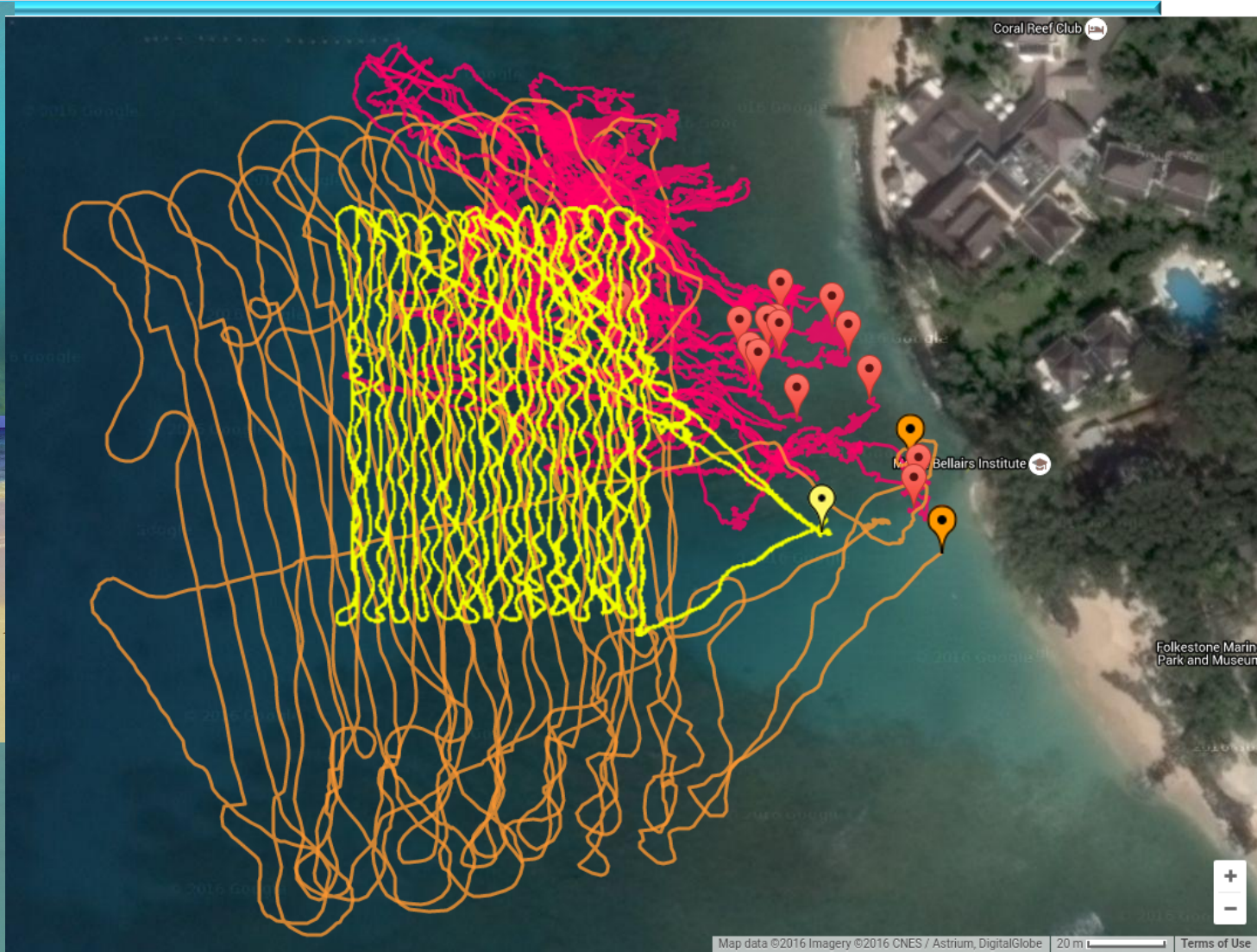
Aerial Robotics

Cooperative Localization

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



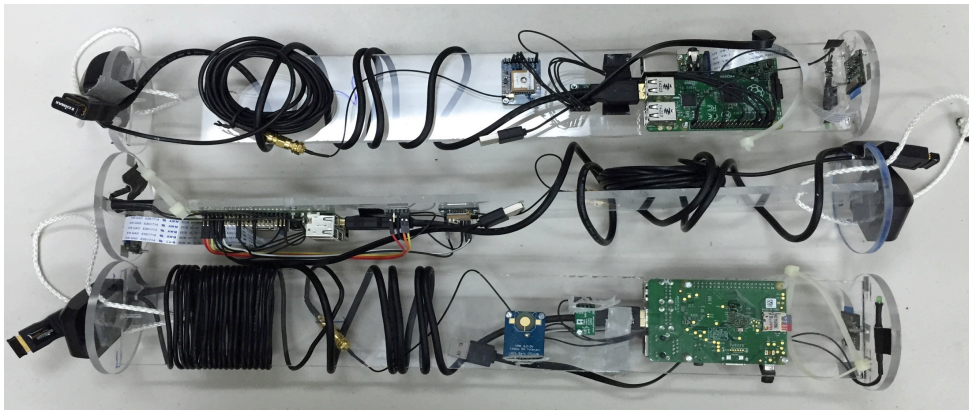
Coral Reef Monitoring by Heterogeneous Robots



Marine Robotics

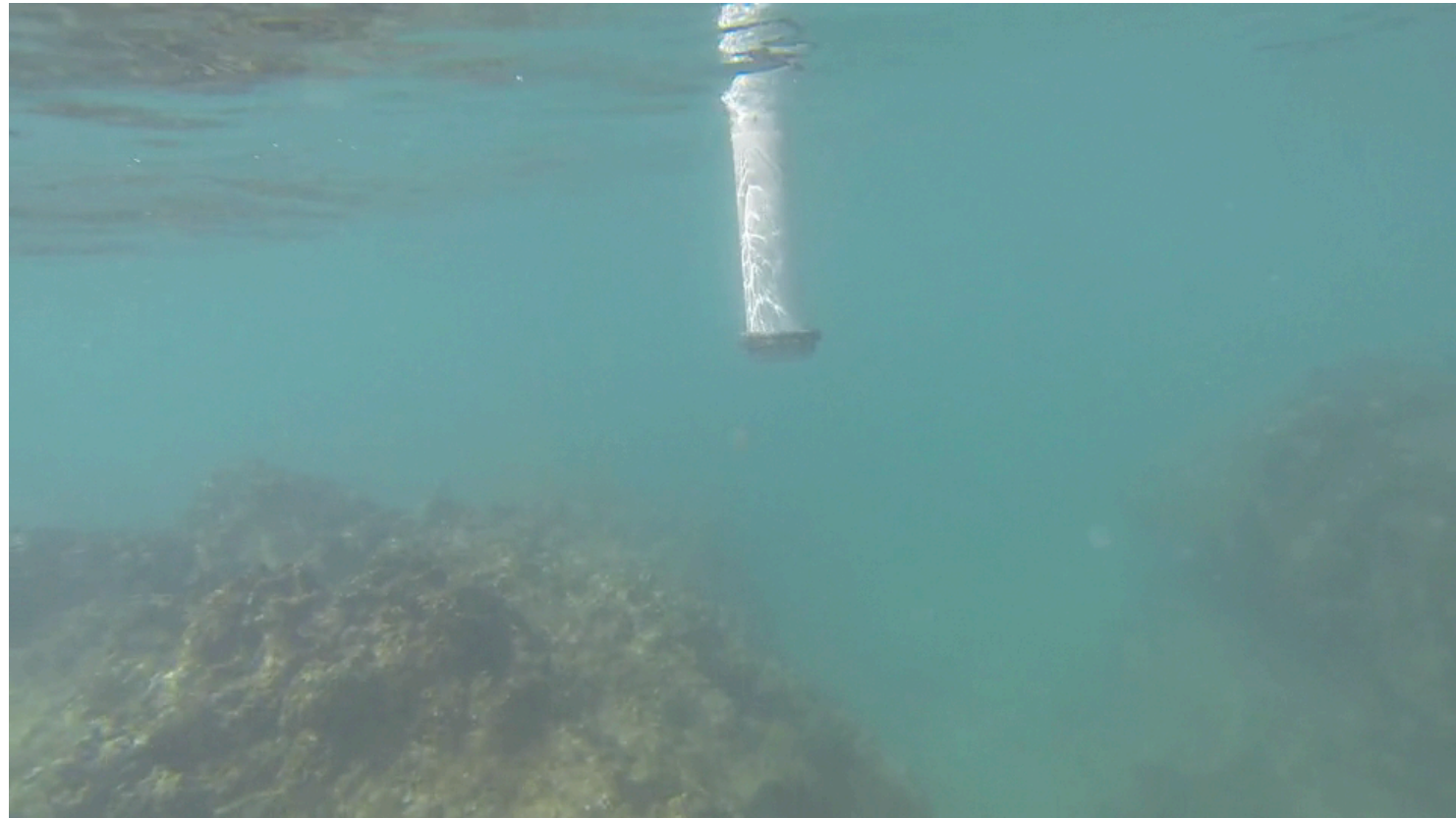
Capstone Project: Drift Nodes

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



Marine Robotics: Drift Nodes

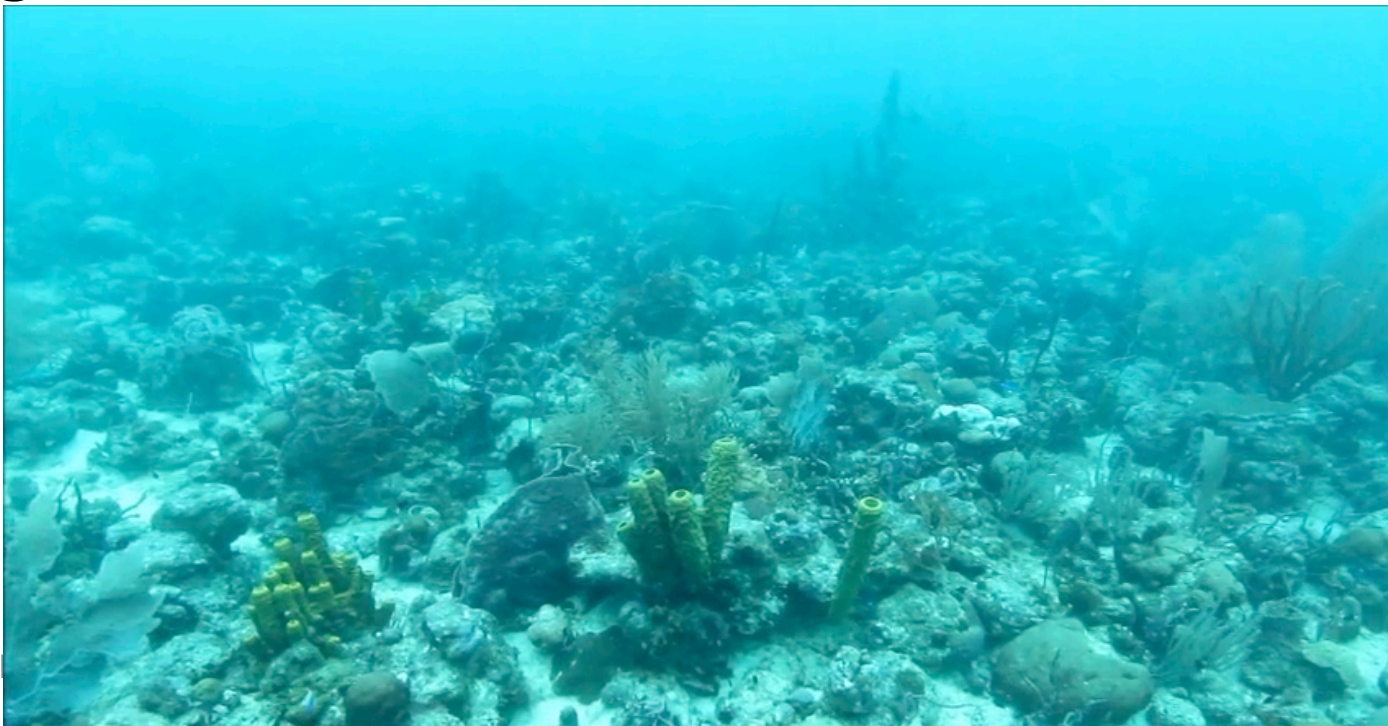
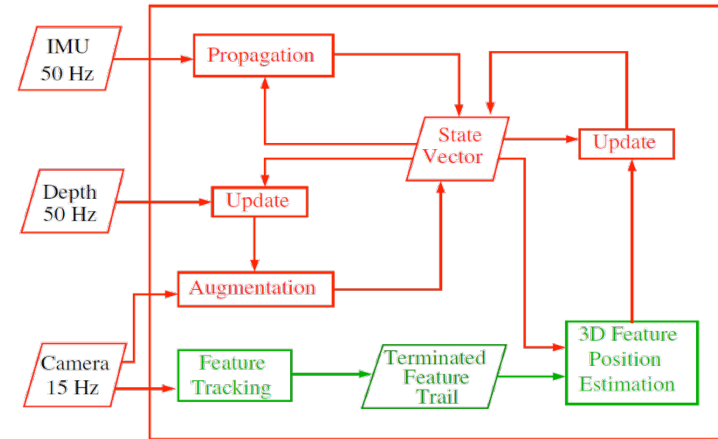
- Monitor, shallow coral reefs.
- Improve estimation accuracy



Marine Robotics

Underwater Situational Awareness

- Vision-INS State Estimation
- Path Planning
- Mapping



Shipwreck Mapping



Shipwreck Mapping

Robot's Eye View



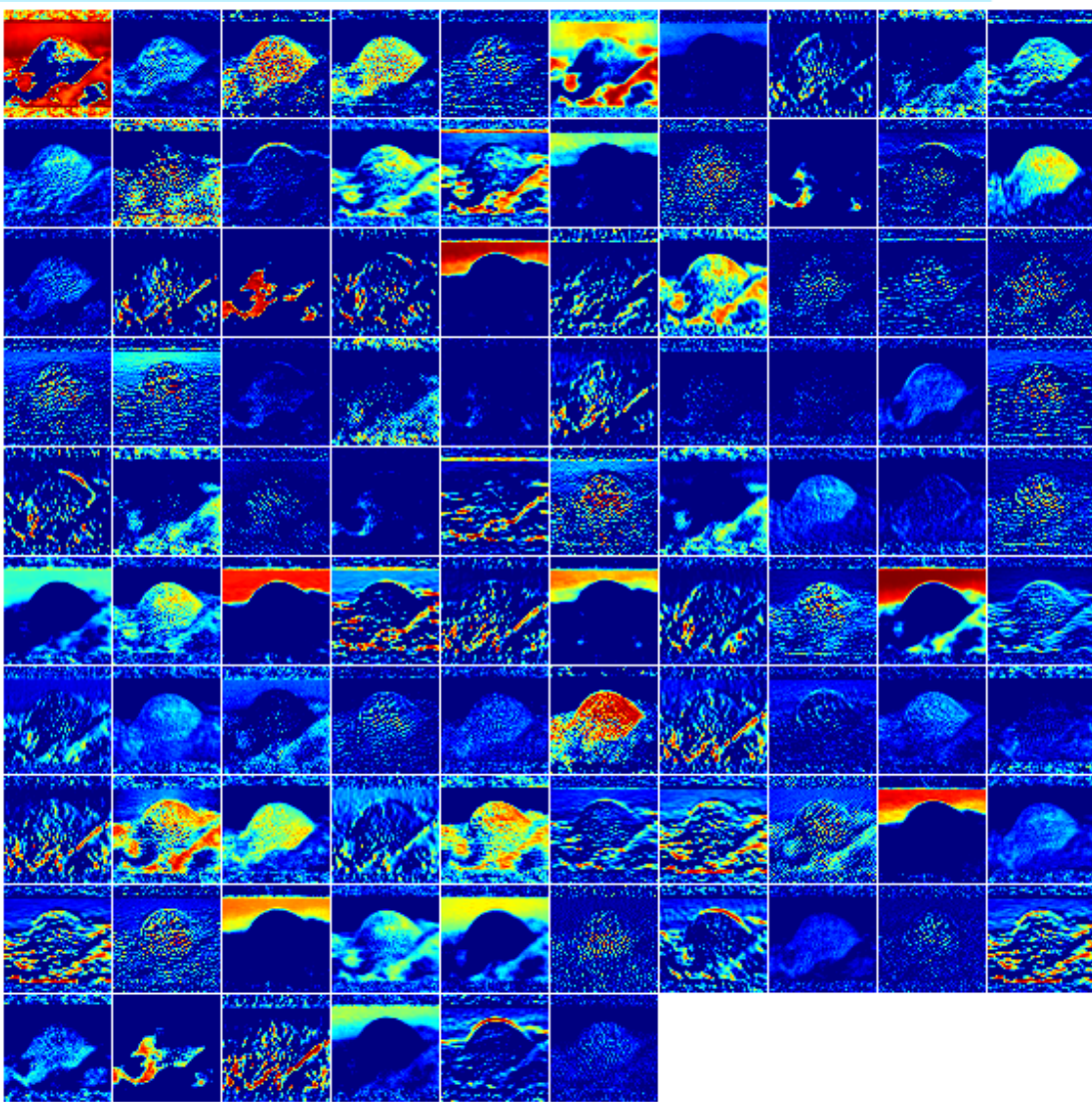
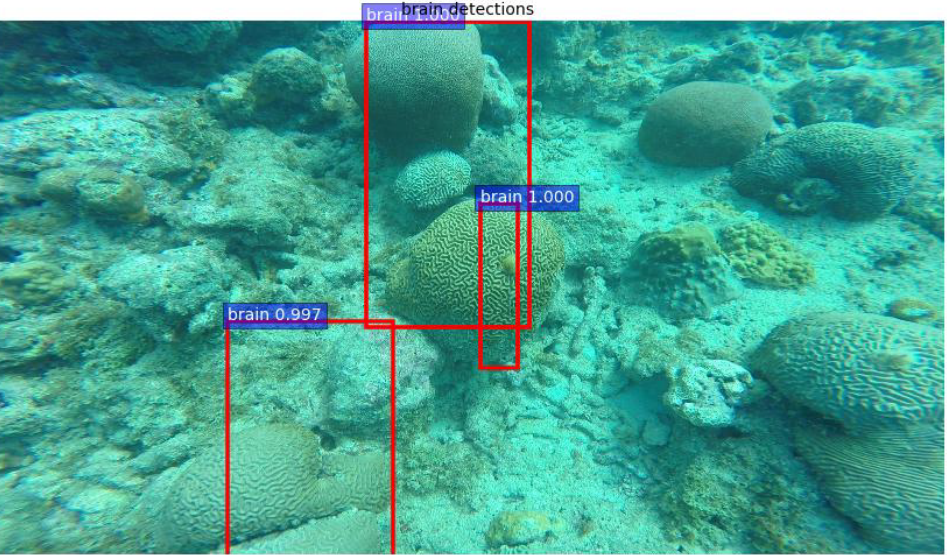
Underwater Cave Mapping

Cave Mapping using Stereo Vision

Nick Weidner, Sharmin Rahman, Alberto Quattrini Li, and Ioannis Rekleitis

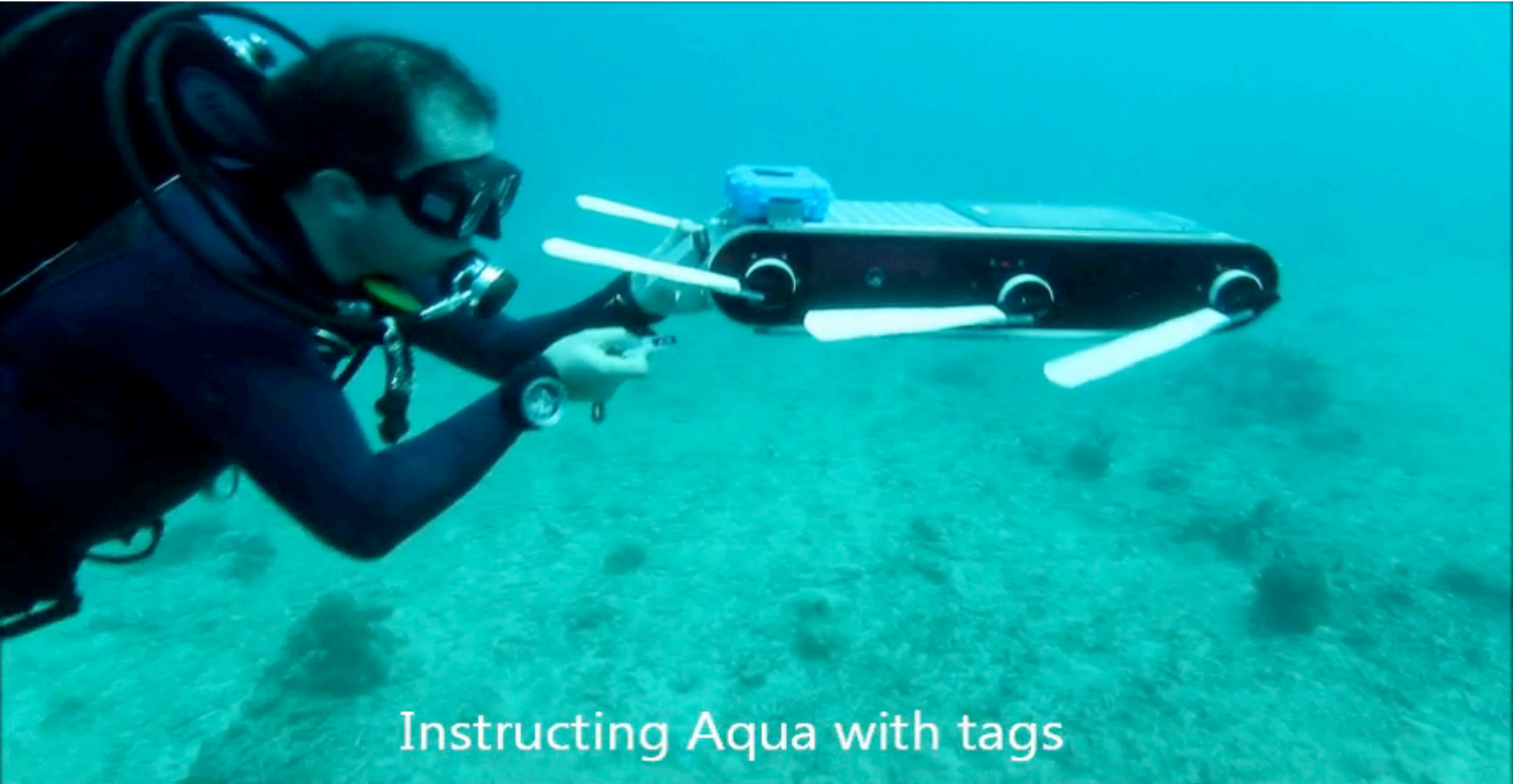
Shallow Coral Classification using Deep Learning

- Using a CNN



Marine Robotics:

HRI with limited bandwidth



Instructing Aqua with tags

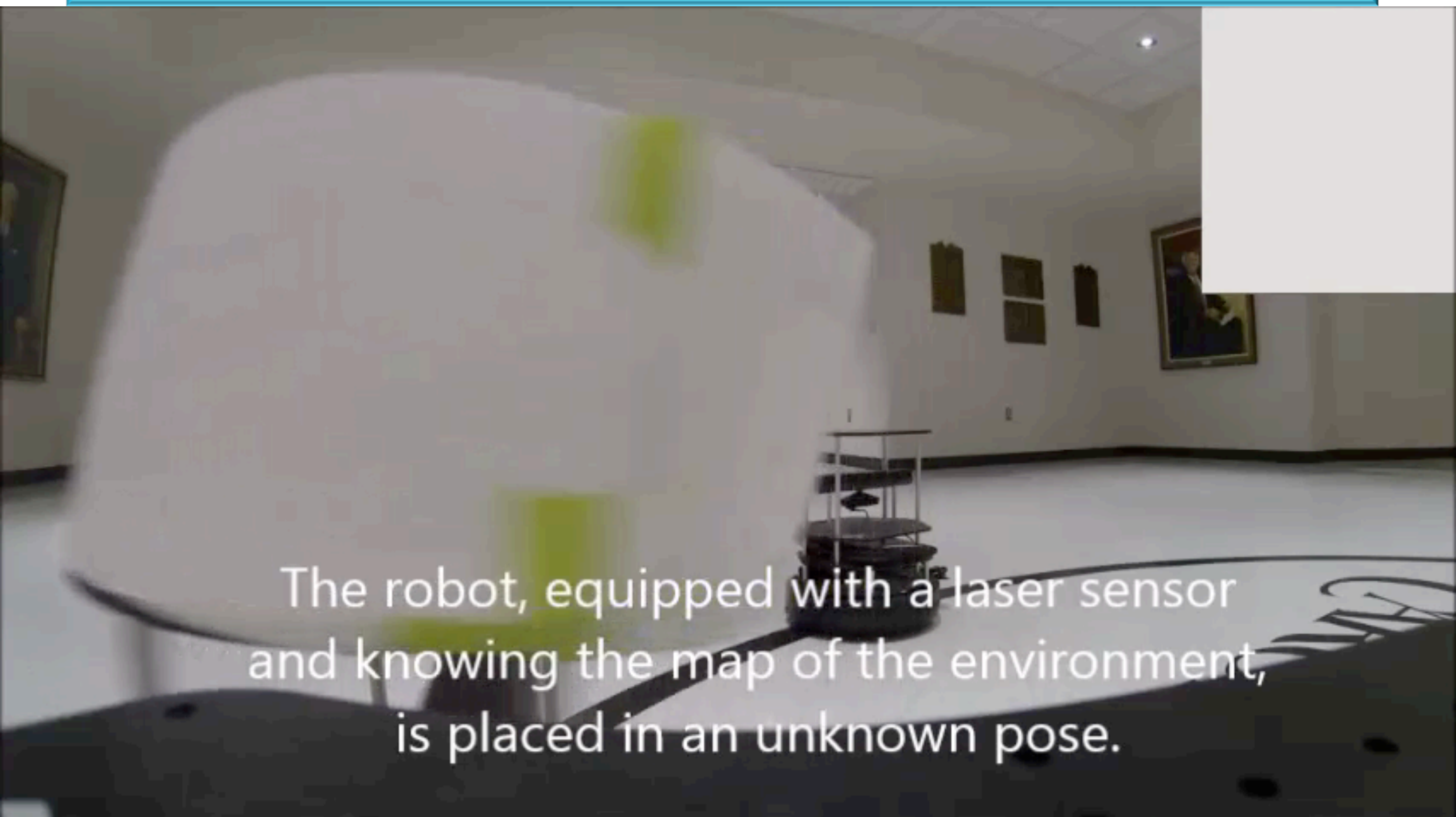
Current work in indoor Robotics

Ear-based Exploration on Hybrid Metric/Topological Maps

Q. Zhang, D. Whitney, F. Shkurti, and I. Rekleitis
School of Computer Science, McGill University

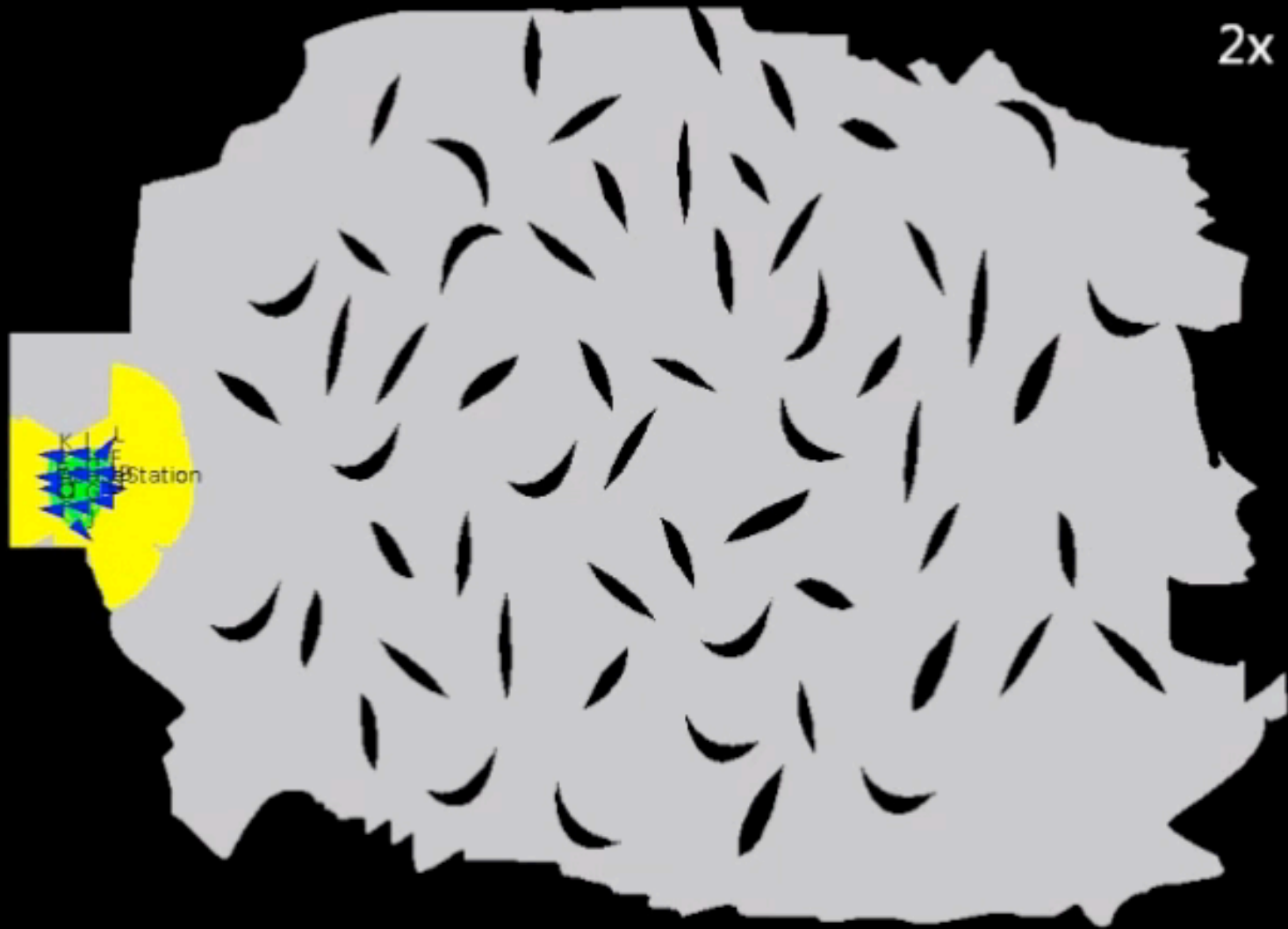


Indoor: Localization with dynamic obstacles

A mobile robot is positioned in a hallway, facing a large, white, rectangular obstacle. The robot is equipped with a laser sensor, which is visible as a green beam. The hallway has white walls, a dark baseboard, and several framed pictures. The floor is light-colored with a large, dark circular logo. The robot is on a dark surface, possibly a table or a platform.

The robot, equipped with a laser sensor and knowing the map of the environment, is placed in an unknown pose.

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/>
- **Email:** yiannisr@cse.sc.edu

- **Office hours:** 3A54 – Mon/Wed 10:30-11:30
and by appointment

