UNIVERSITY OF SOUTH CAROLINA

CSCE 274 Robotic Applications and Design
Fall 2020
Introduction

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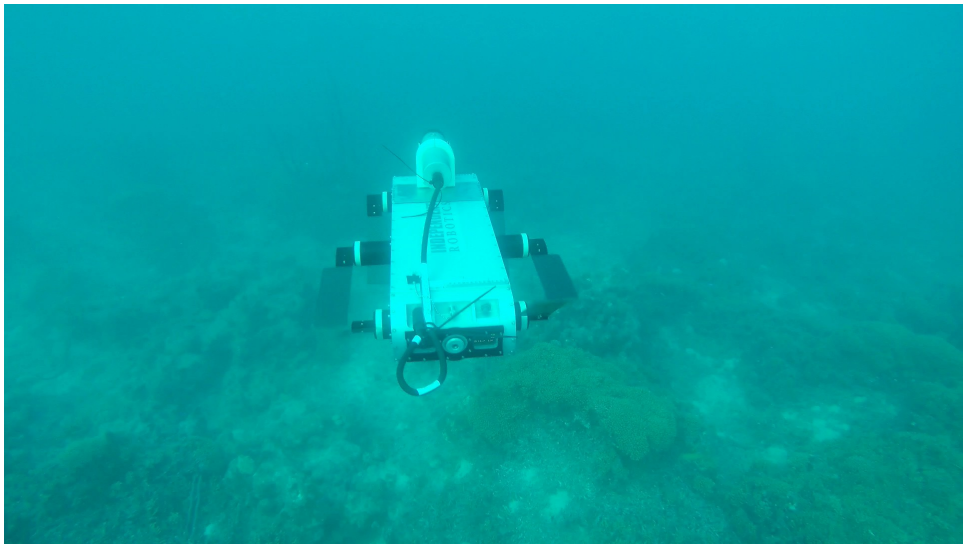
Outline

- What is a robot?
- Why robotics?
- Focus and aims of the class
- Robotics at UofSC
- Select current research
- Syllabus
- Evaluation



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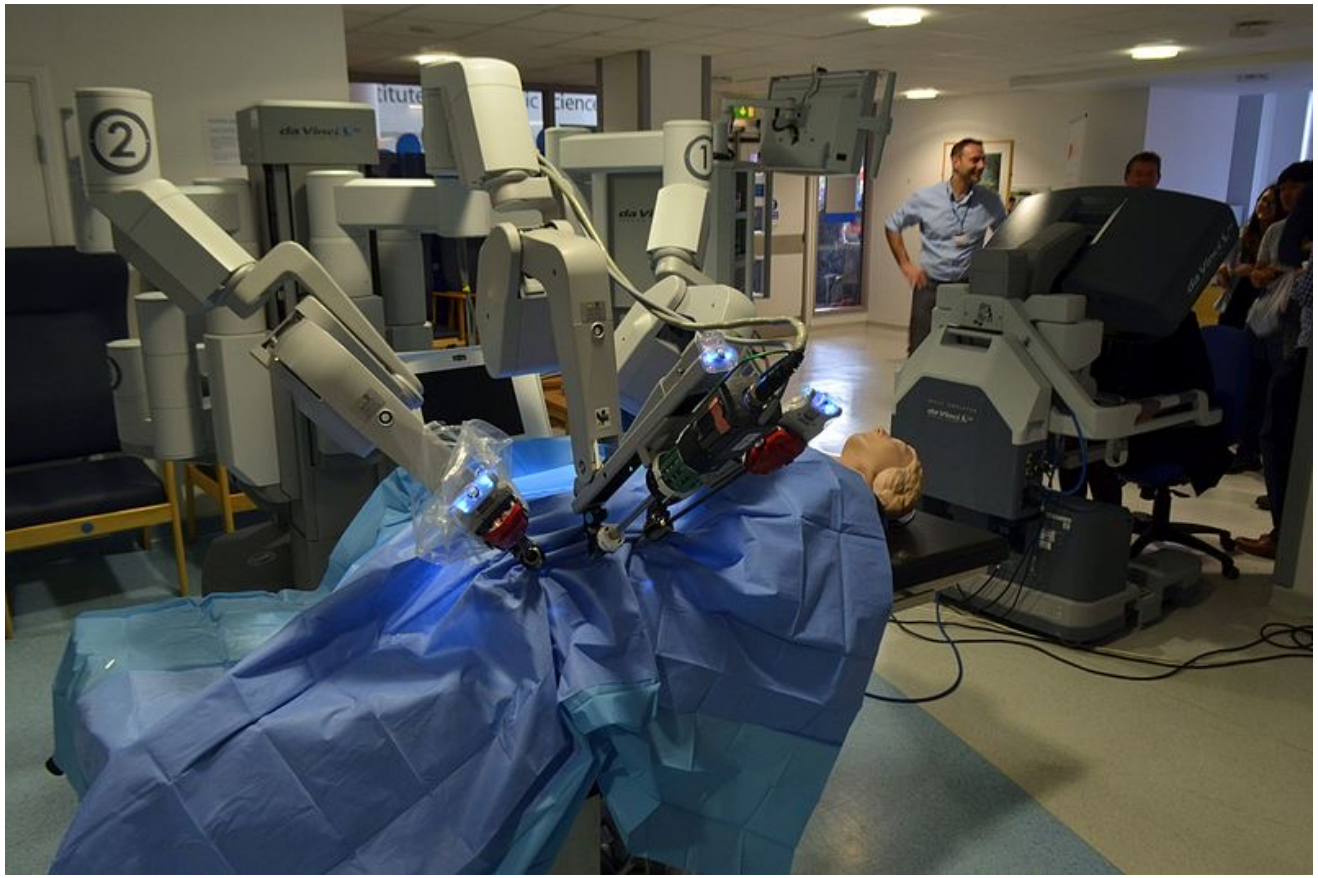

Da Vinci Surgical System – Source: wikipedia.com

What is a robot?

Google crawler – Source: culturainteractive.com

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Halo 3 – Source: telegraph.co.uk

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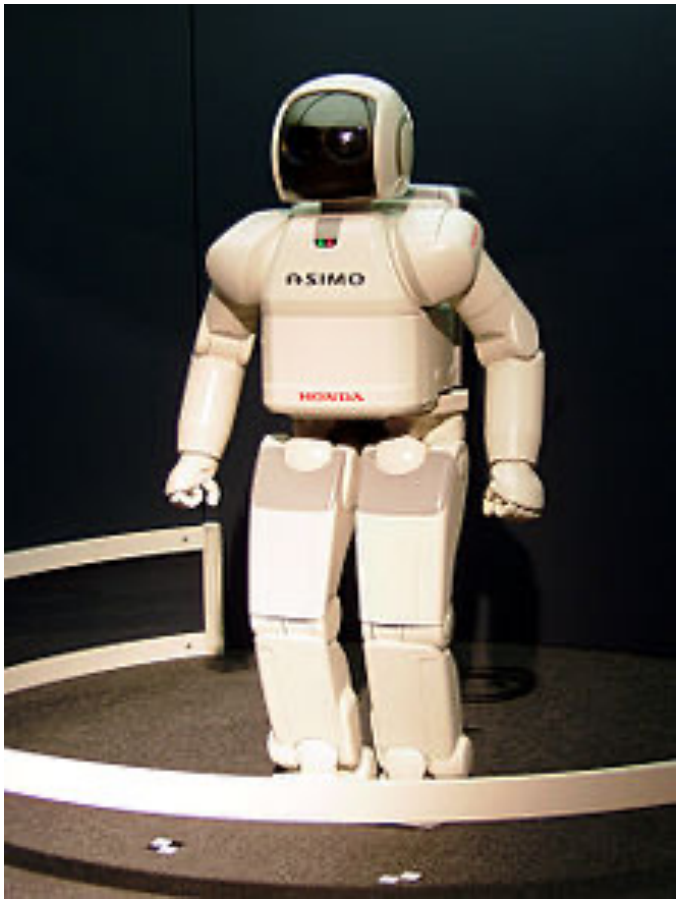

ASIMO – Source: wikipedia.com

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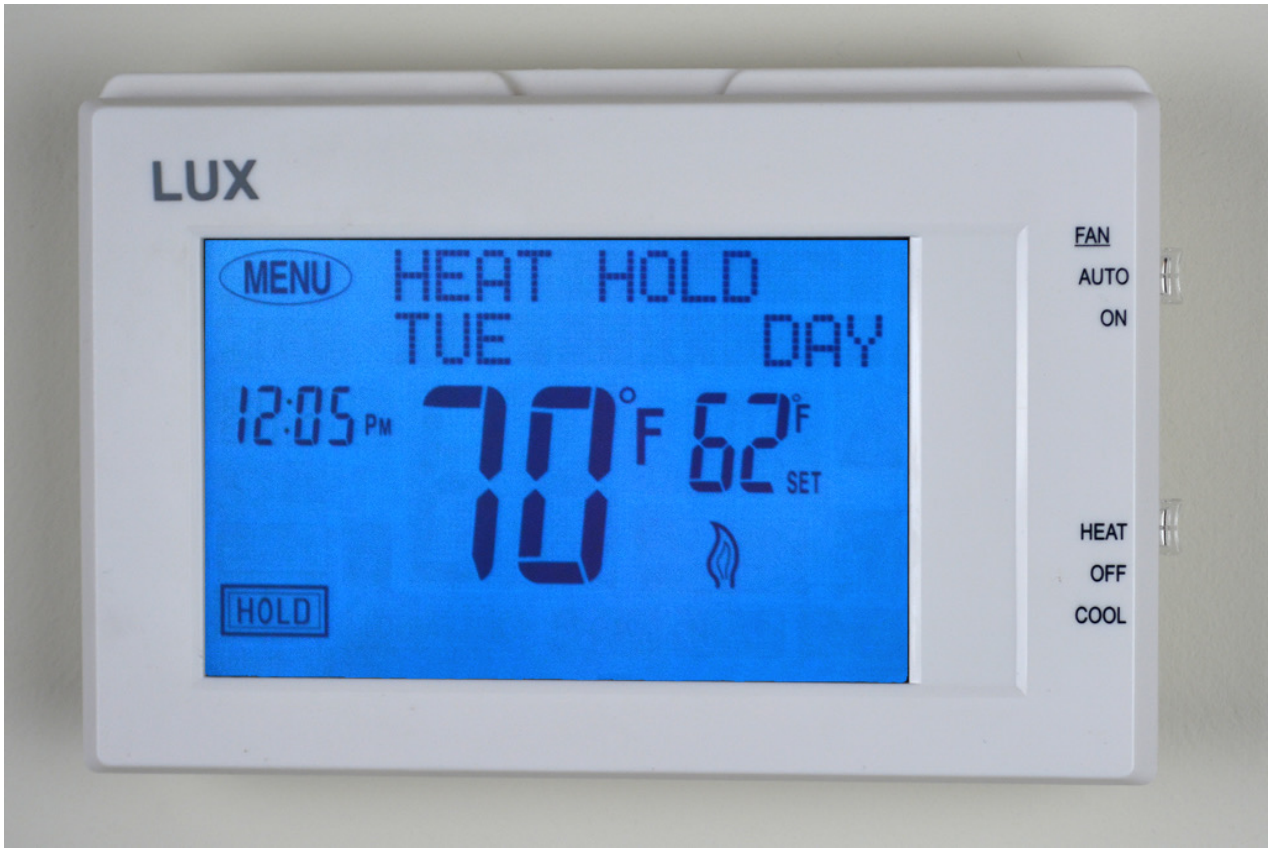
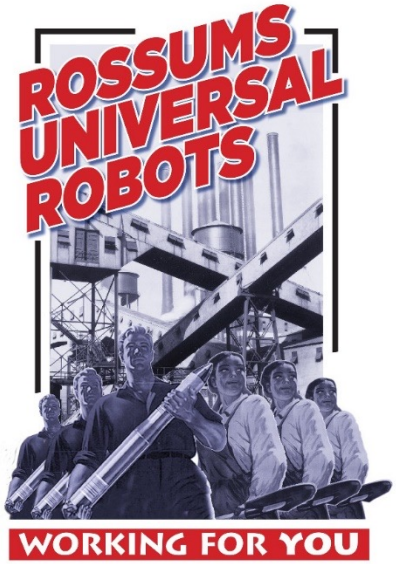


Thermostat – Source: wikipedia.com

What is a robot?

- Origin: coined by the Czech playwright Karel Capek from the Czech word for forced labor or serf in a 1920 play titled Rassum's Universal Robots (RUR)

- "A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks" – Robot Institute of America, 1979



What is a robot?

- From the book: “A robot is an autonomous system which exists in the physical world, can sense its environment, and can act on it to achieve some goals.”

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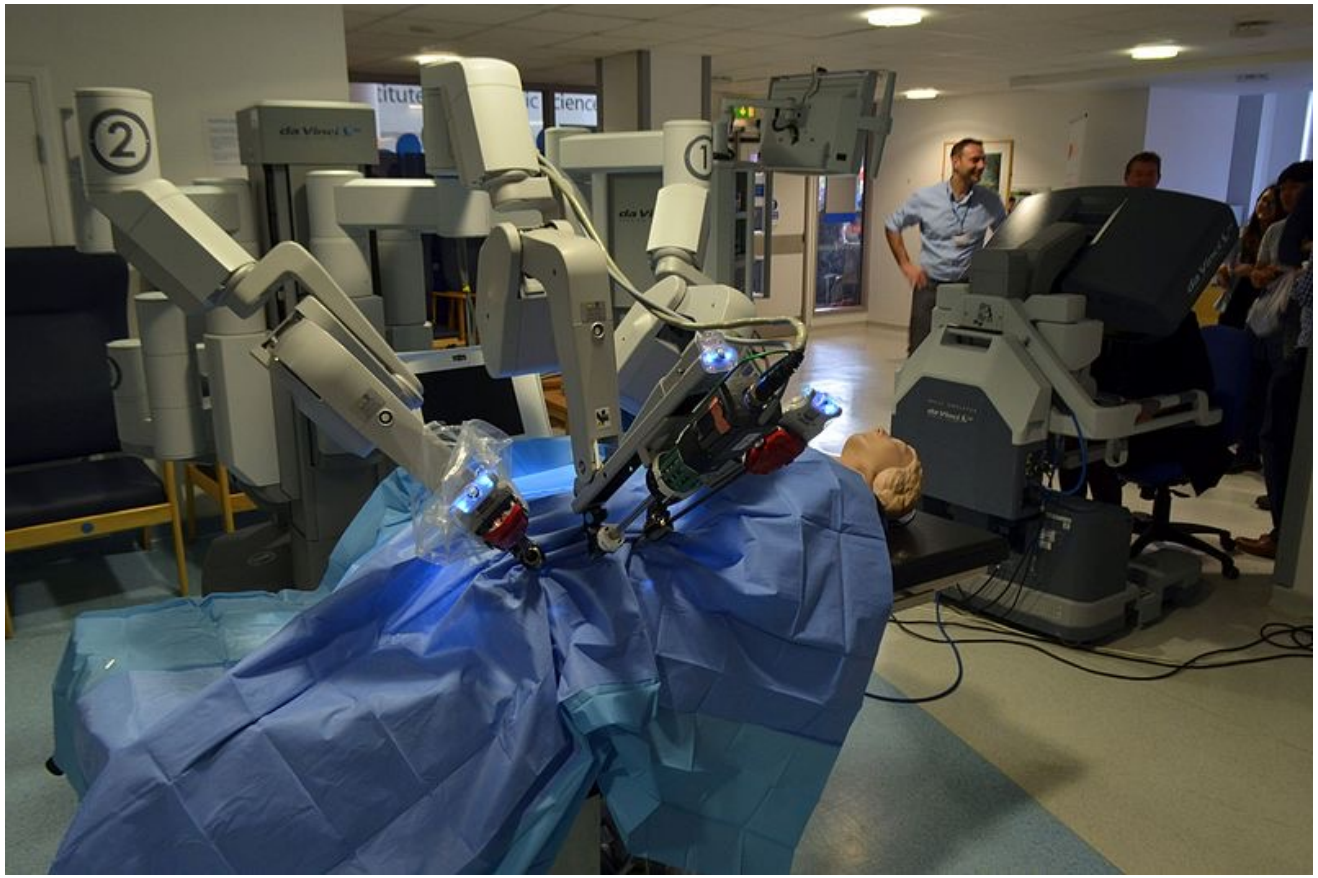

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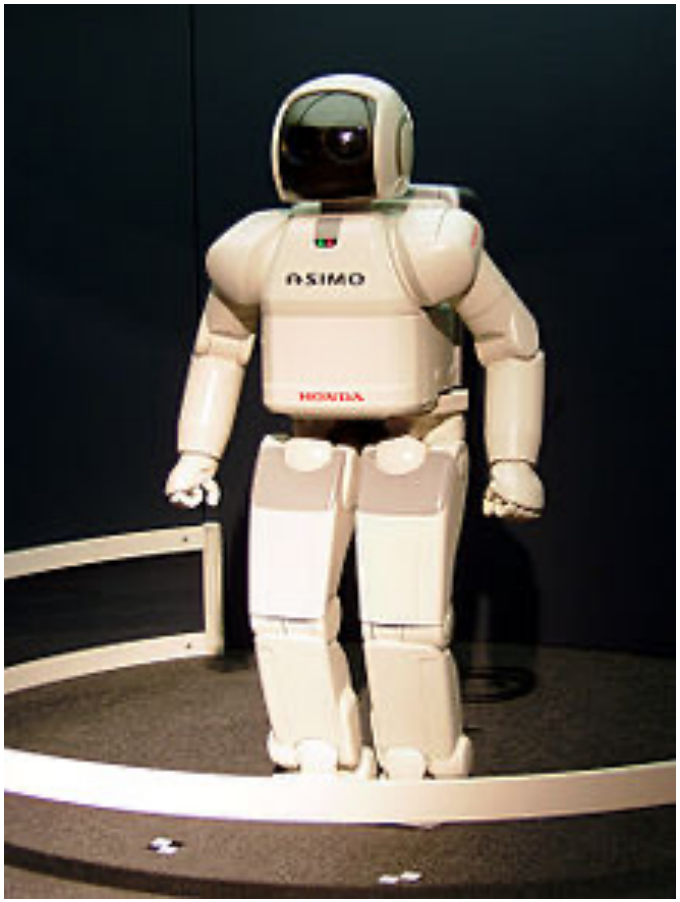

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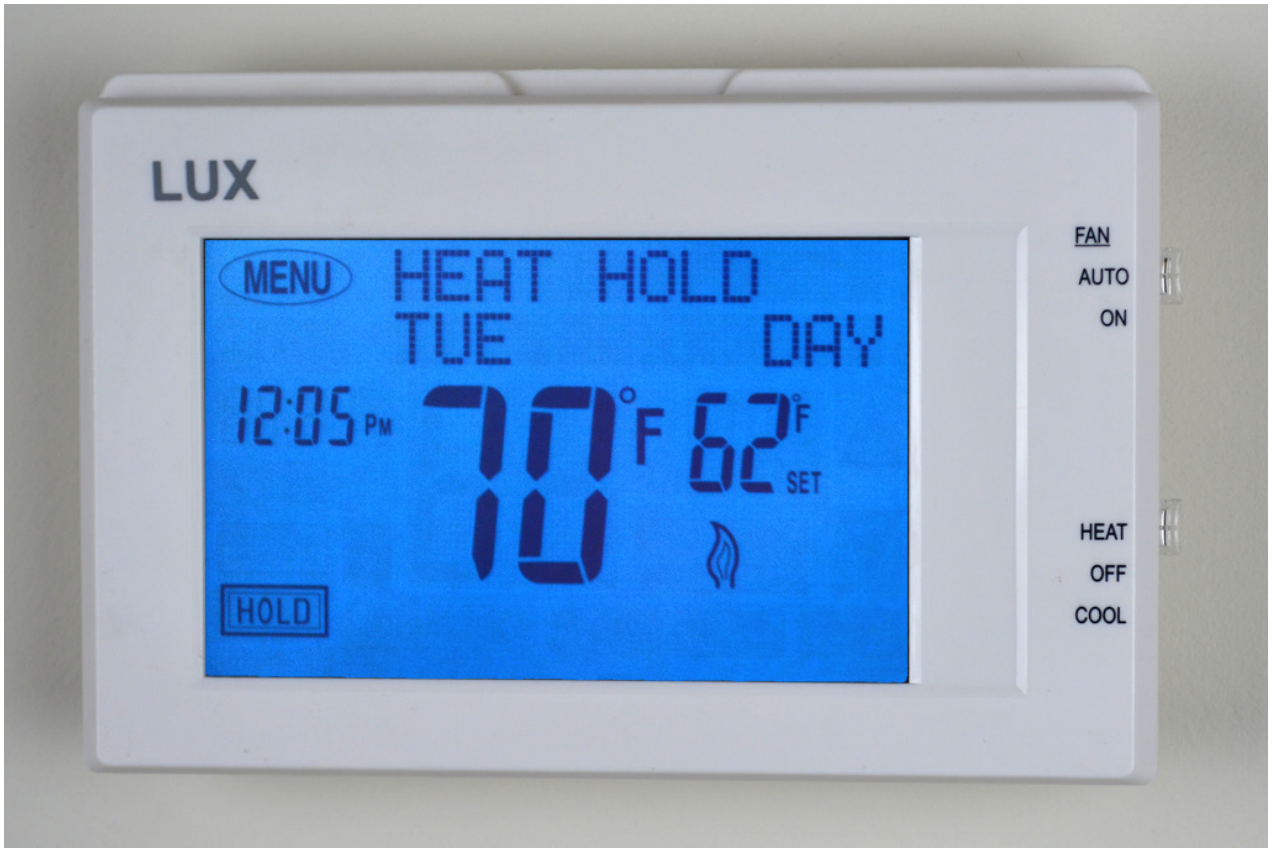

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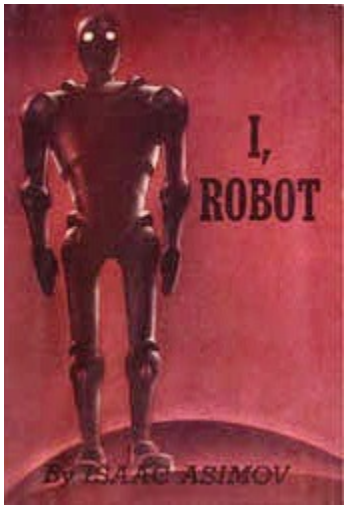
Robotics

- The term 'robotics' refers to the study and use of robots. The term was coined and first used by the Russian-born American scientist and writer Isaac Asimov



Source: wikipedia.com

- Law Zero: A robot may not injure humanity, or, through inaction, allow humanity to come to harm
- Law One: A robot may not injure a human being, or, through inaction, allow a human being to come to harm, unless this would violate a higher order law
- Law Two: A robot must obey orders given it by human beings, except where such orders would conflict with a higher order law
- Law Three: A robot must protect its own existence as long as such protection does not conflict with a higher order law.

Why robotics?

Robotics is spread everywhere!

Why robotics?

- Automation

Why robotics?

- Search and rescue in dangerous situations

Source: IEEE Spectrum

Why robotics?

- Marine exploration

Source: Stanford

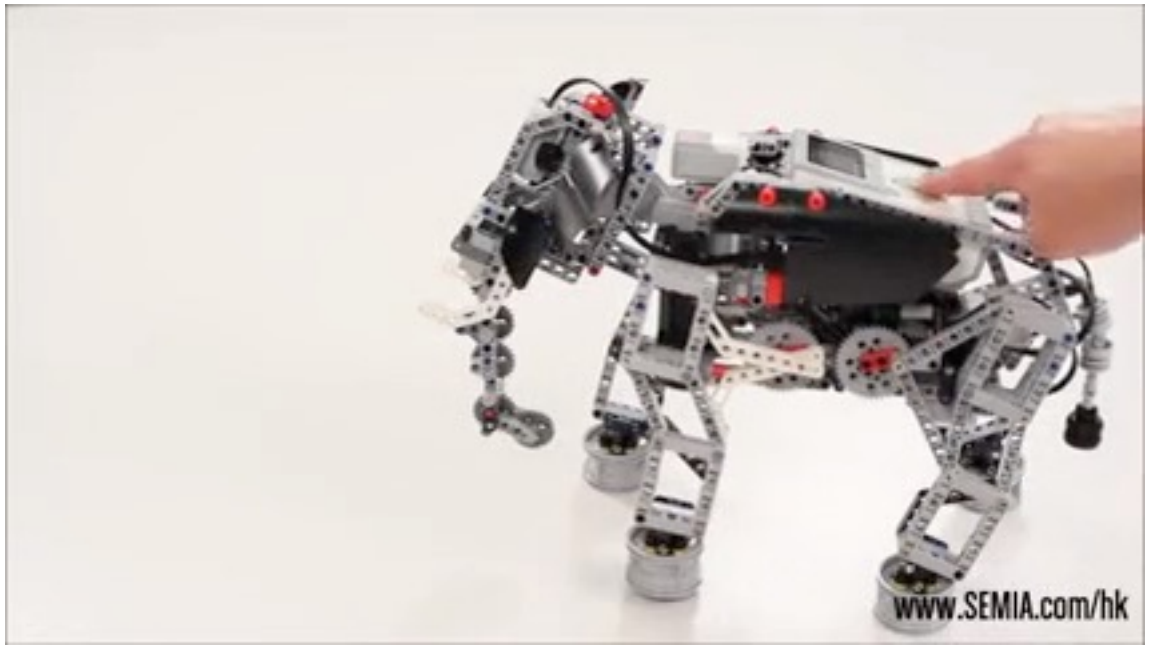
Why robotics?

- Assistive tasks

Source: Reuters

Why robotics?

- Education



Source: SEMIA

https://www.smartrobottutor.com/

Why robotics?

- Boring tasks

Source: iRobot

Why robotics?

and many more, including

- Surveillance

Knightscope K5 –
Source: knightscope.com

Why robotics?

and many more, including

- Surveillance
- Exploration (e.g., space)

NASA Curiosity – Source: wikipedia.com

Why robotics?

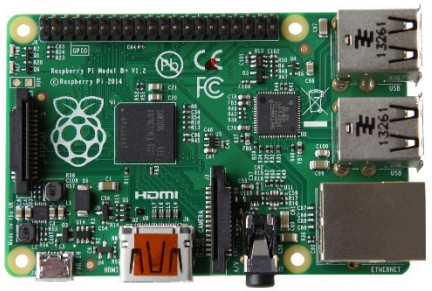
and many more, including

- Surveillance
- Exploration (e.g., space)
- …

Why robotics?

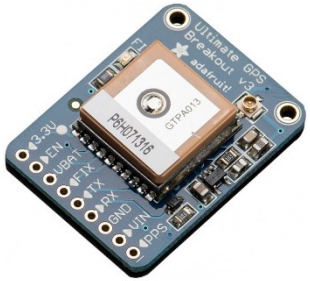
- Robotic technology becomes affordable

iRobot Create 2 – Source: irobot.com



Raspberry Pi – Source: raspberrypi.org

Microsoft Kinect –
Source: microsoft.com



Adafruit Ultimate GPS –
Source: robotshop.com

Pololu MinIMU-9 v3 –
Source: pololu.com

Why robotics?

https://get.duckietown.com/collections/frontpage/products/duckiebot-db19

https://get.duckietown.com/collections/dt-robots/products/duckiebot-db21-m

https://www.duckietown.org/research/AI-Driving-olympics

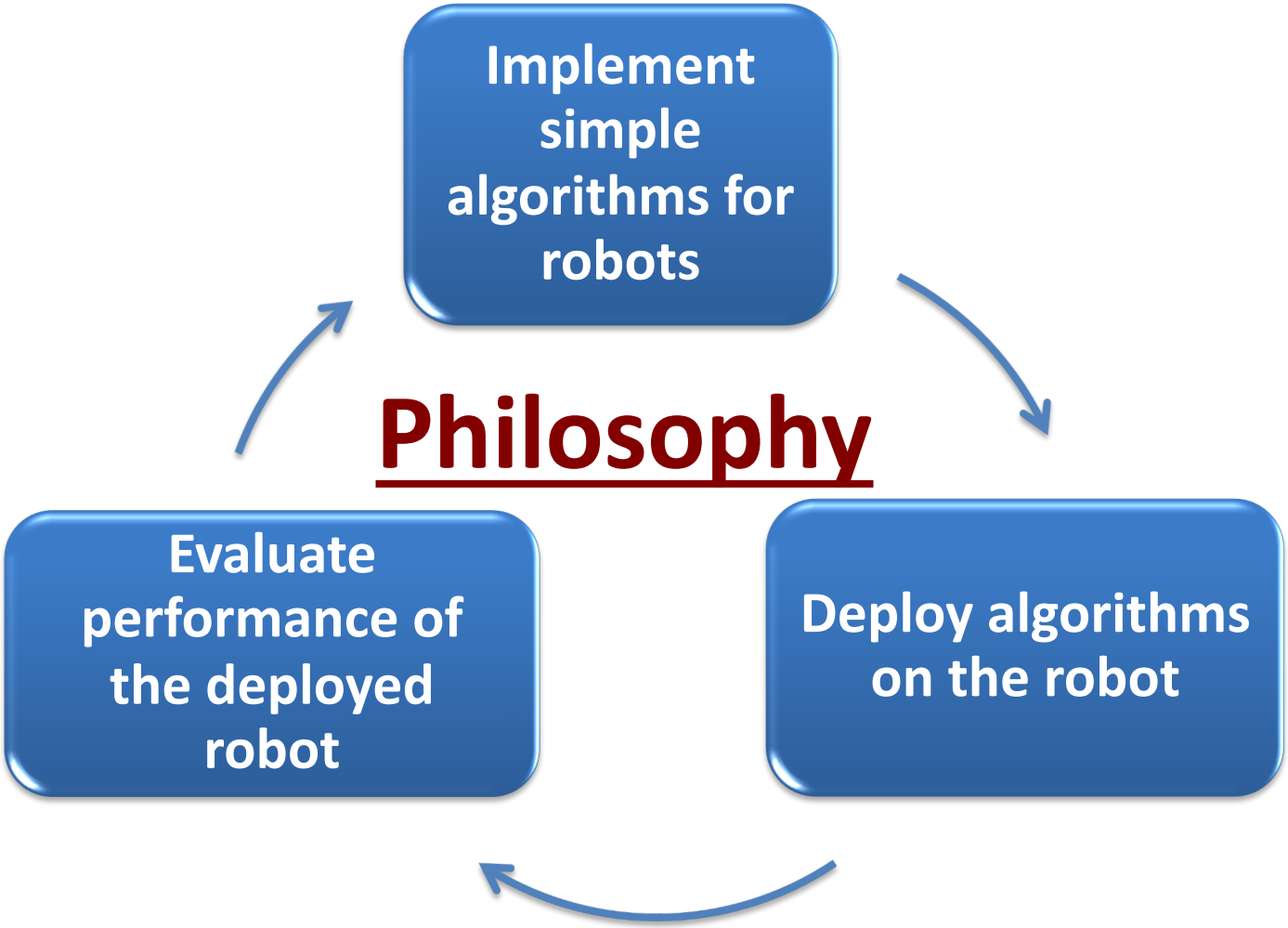
Robotics

- Robotics is a LARGE field that encompasses many disciplines, including:
  - Mechanical engineering
  - Electrical engineering
  - Psychology
  - Computing
  - …

Aims of the class

- Introducing to robotics from a computing perspective both from a theoretical and practical point of view
  - Sense and act
  - Planning

Aims of the class



Philosophy

Challenges

Source: ieee.org

Challenges

- Sensing the environment and obstacles reliably
- Planning to accomplish the task in an efficient way
- Predicting the outcome of the robot's decisions
- Ensuring the safety of the robot and the surrounding
- Reacting and recovering to unexpected events
- Keeping the expense reasonable
- …

Challenges

- Software bugs
- Hardware problems
  - Battery charge level
  - Loose wires
  - …
- Real world conditions
  - Stairs
  - Table legs
  - Glass walls
  - …

Robotics at University of South Carolina

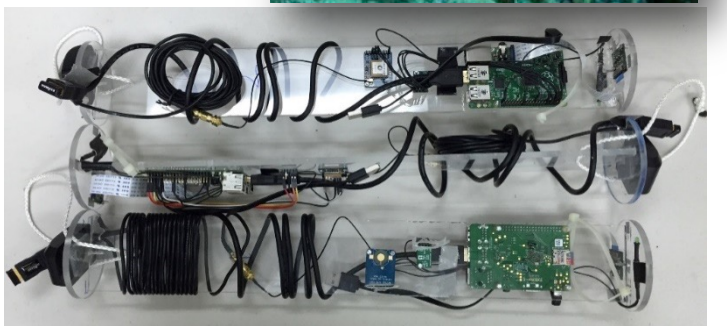
Dr. O'Kane

Dr. Vitzilaios

Dr. Rekleitis

Courses
CSCE274
CSCE574
CSCE774
CSCE790

Autonomous Field Robotics Laboratory



Contact

- Instructors:
  Ioannis REKLEITIS -- yiannisr@cse.sc.edu
  Ibrahim SALMAN -- ijsalman@email.sc.edu

- Office hours:
  Ioannis REKLEITIS: Innovation 2235 – Tue/Th 13:00-14:00
  Ibrahim SALMAN: TBD

  and by appointment. Send however an email to confirm the slot.

- Homepage
  Ioannis REKLEITIS https://cse.sc.edu/~yiannisr/
  CSCE274 page https://cse.sc.edu/~yiannisr/274/2020Fall/
- UGTA : Allison Scott

Date

- Lectures
  - Tuesdays and Thursdays
    - Section 1: 4:25 pm - 5:40 pm Swearingen 2A15
    - Section 2: 2:50 pm - 4:05 pm 300 Main B102
- Lab @ Swearingen 1D49.

Covid 19

- **"Face coverings will be required at all times inside all campus buildings, unless you are in your own residence hall room, private office or you are eating inside campus dining facilities. They are also required on shuttles, buses and other forms of university transportation."**

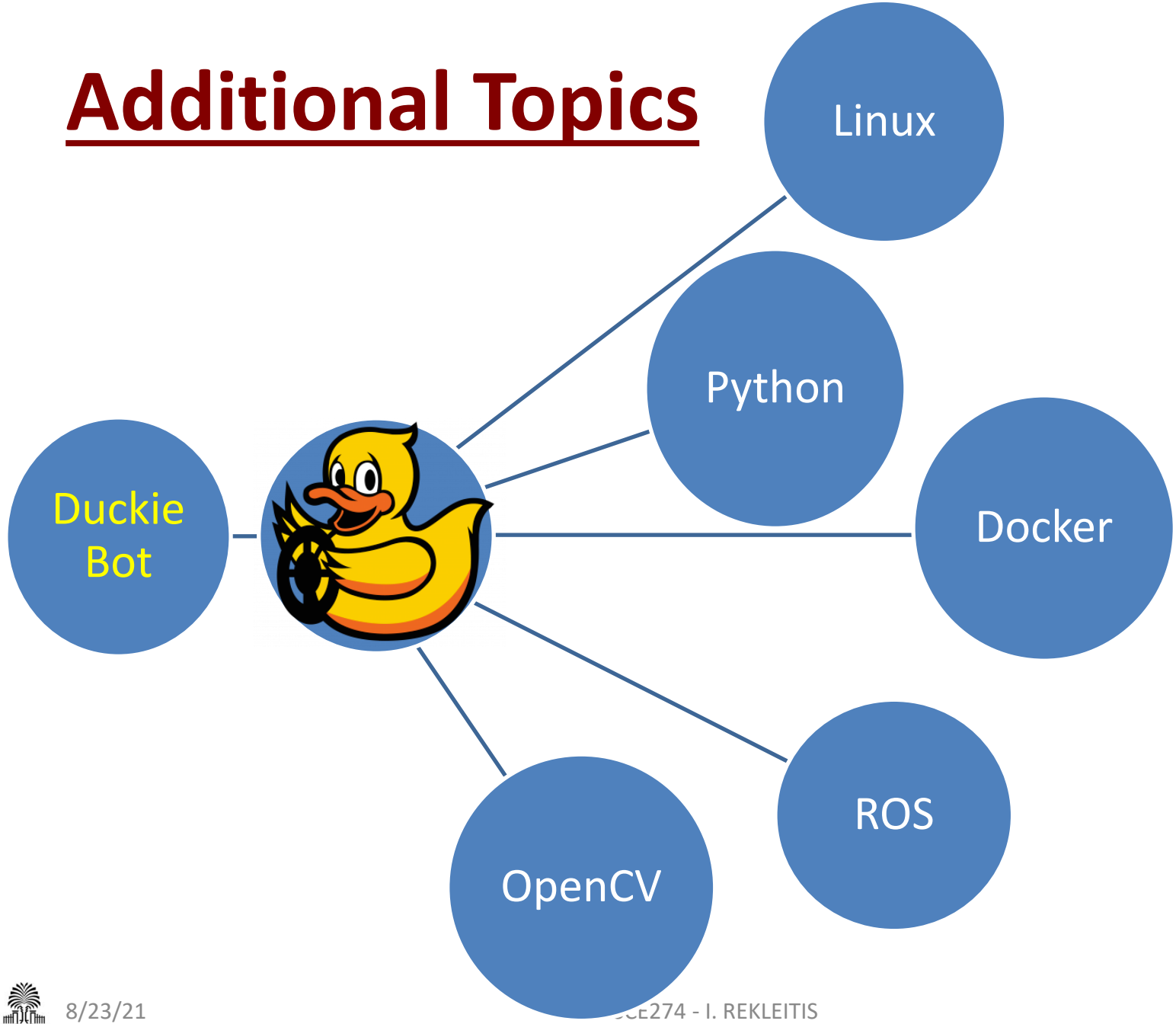
https://sc.edu/safety/coronavirus/safety_guidelines/index.php

Syllabus

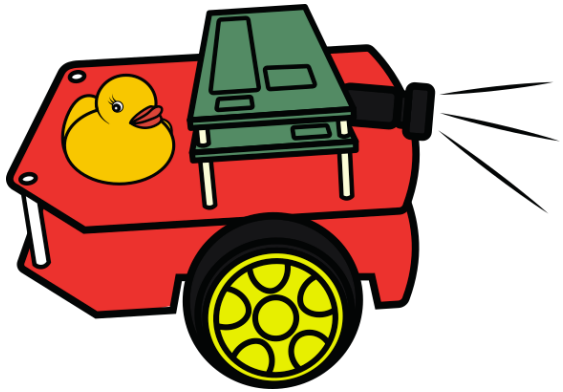
Book: Maja J. Mataric, *The Robotics Primer*. MIT Press, 2007

- Introduction
- History
- Robot Components
- Intro to h/w -- DuckieBot
- Overview of Python
- Overview of Linux
- Overview of Docker
- ROS Programming
- Robot motion -- Control
- Sensing -- Computer Vision
- Sensing -- Duckie Vision
- **Lab sessions**
- Navigation Locomotion
- Architectures/Research
- Learning in Robotics
- Deep Learning
- Ethics
- State Estimation
- Robots of the World

Additional Topics



Evaluation



- Homeworks: 30%
- Four Robot programming assignments: 40%
- One in-class tests: 10%
- Final: 20%

- **Homework assignments: *No late submissions***
- **Robot programming assignments: -10% per day for the first 3 days. Then no submission.**

- Assignments and homeworks should be submitted to the CSE Moodle server by the deadline (https://dropbox.cse.sc.edu), where grades will be posted on

Evaluation

A	>= 90%
B+	>= 87%
B	>= 80%
C+	>= 77%
C	>= 70%
D+	>= 67%
D	>= 60%
F	< 60%

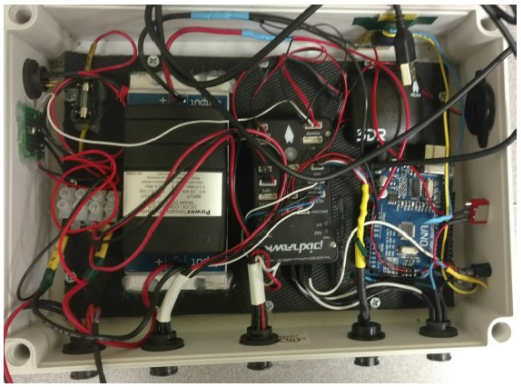
How to do poorly

Here are some habits that have correlated with poor performance in this course in the past:

- **Not starting/making progress on the programming assignments until the last minute**
- **Skipping homeworks**
- Skipping class
- Ignoring the communications from the instructor
- Not properly reading the instructions
- Ignoring the homework
- Not asking questions and interacting with the instructors

Select current research

Autonomous surface vehicles for environmental monitoring



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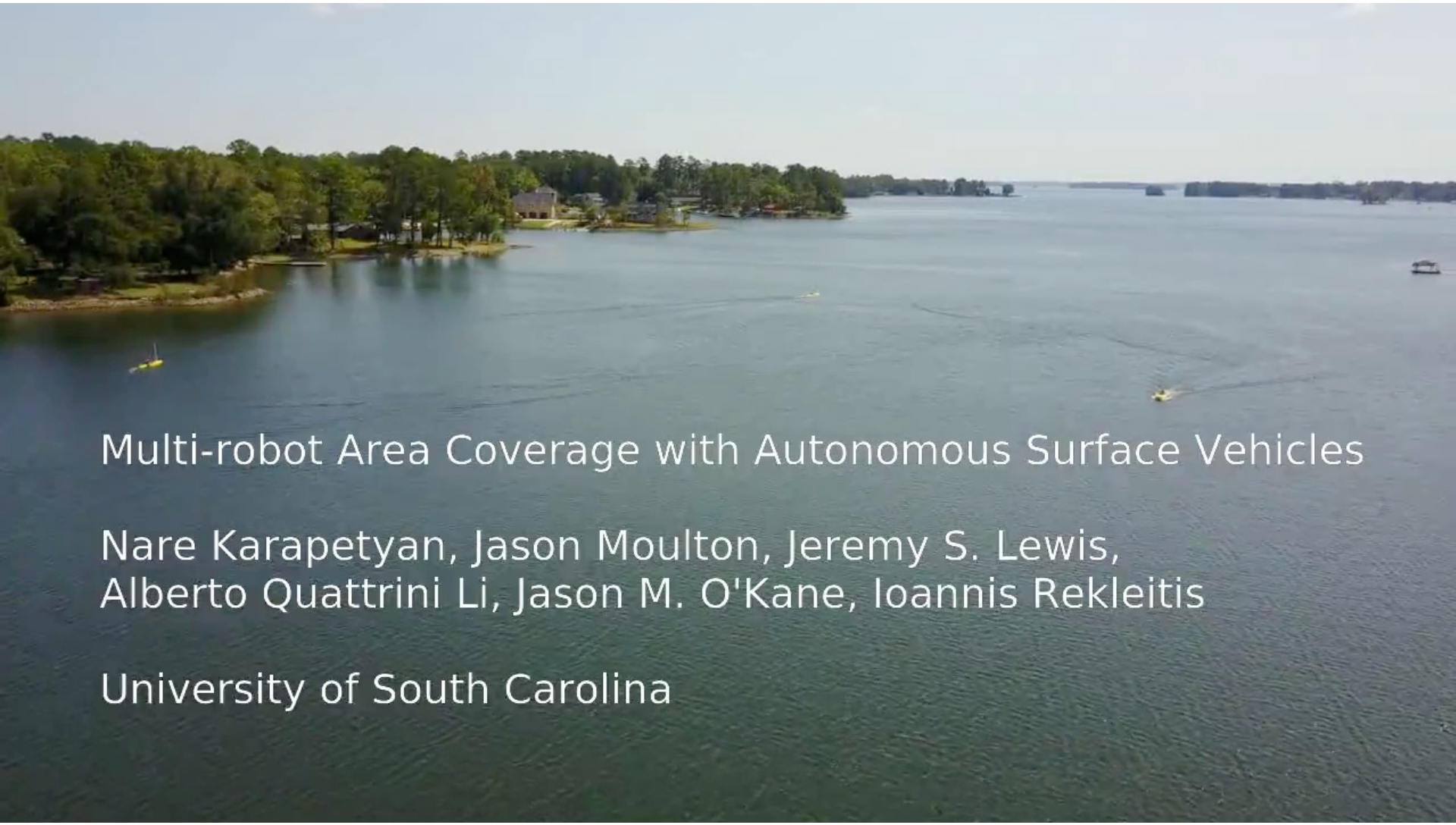
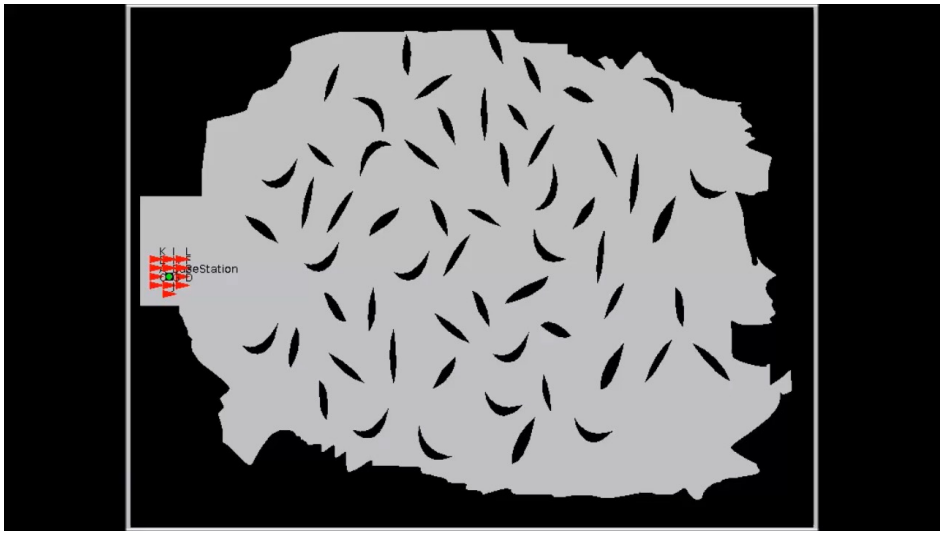
[ICRA2018]



Select current research

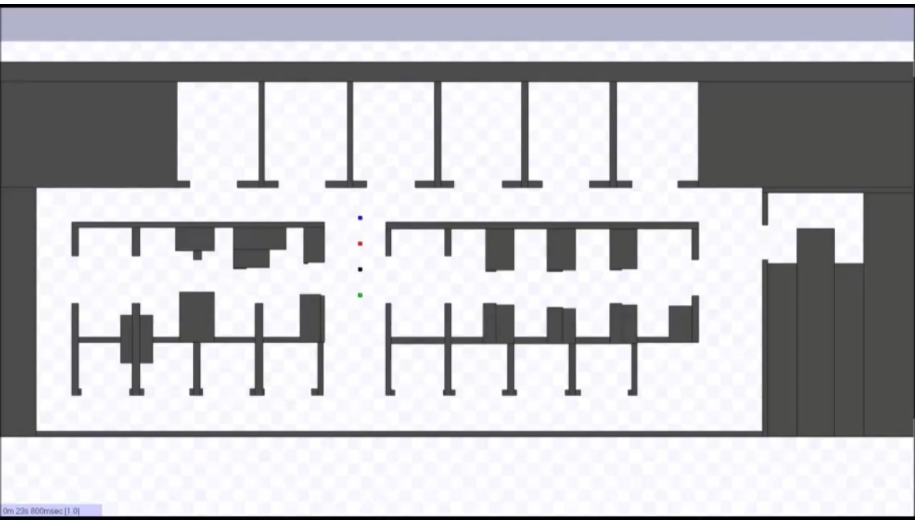
Scenario

[ICRA2016]

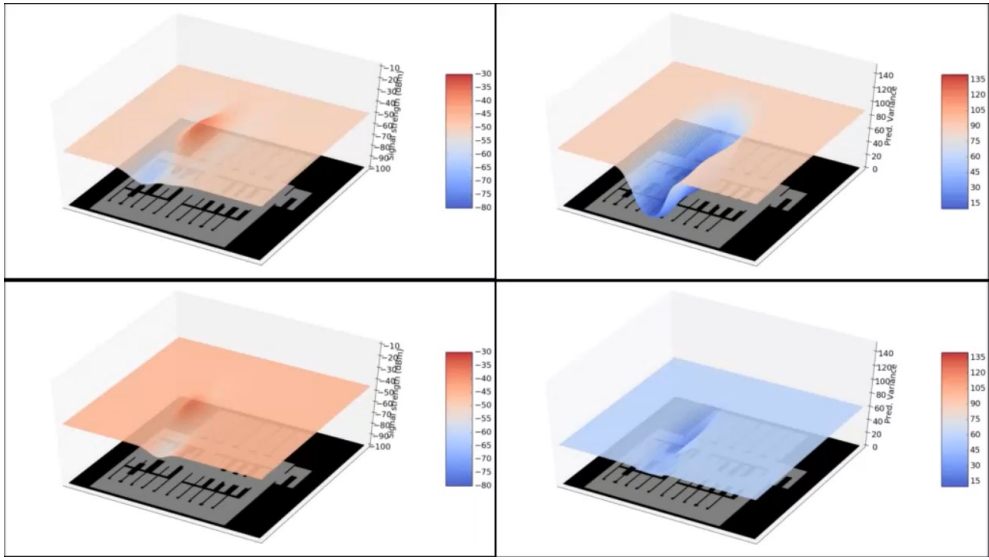


Building communication maps

Our contribution



[ICRA2017]

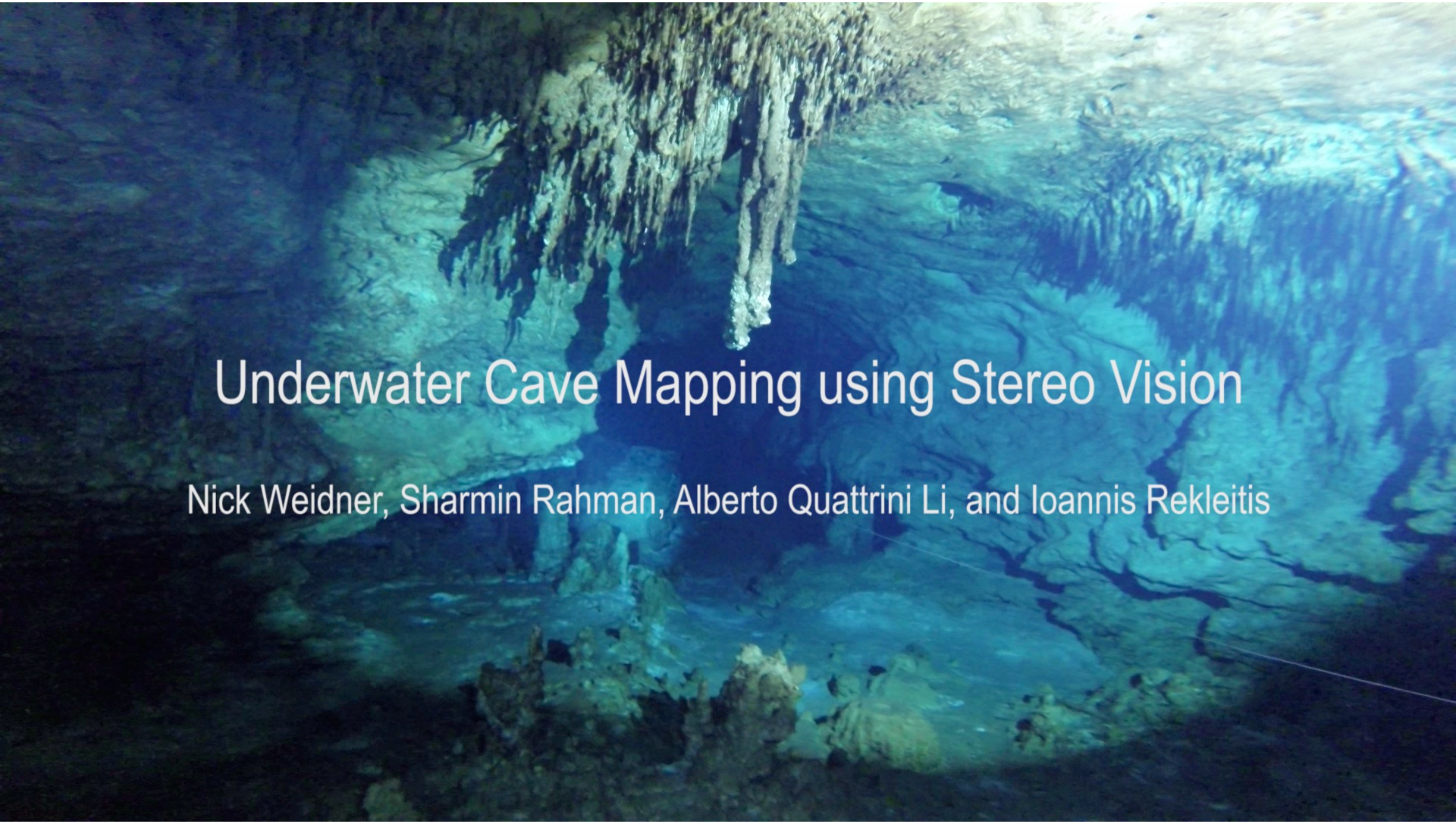


Select current research

- Environmental monitoring with heterogeneous multirobot system [CRV2017]

Select current research

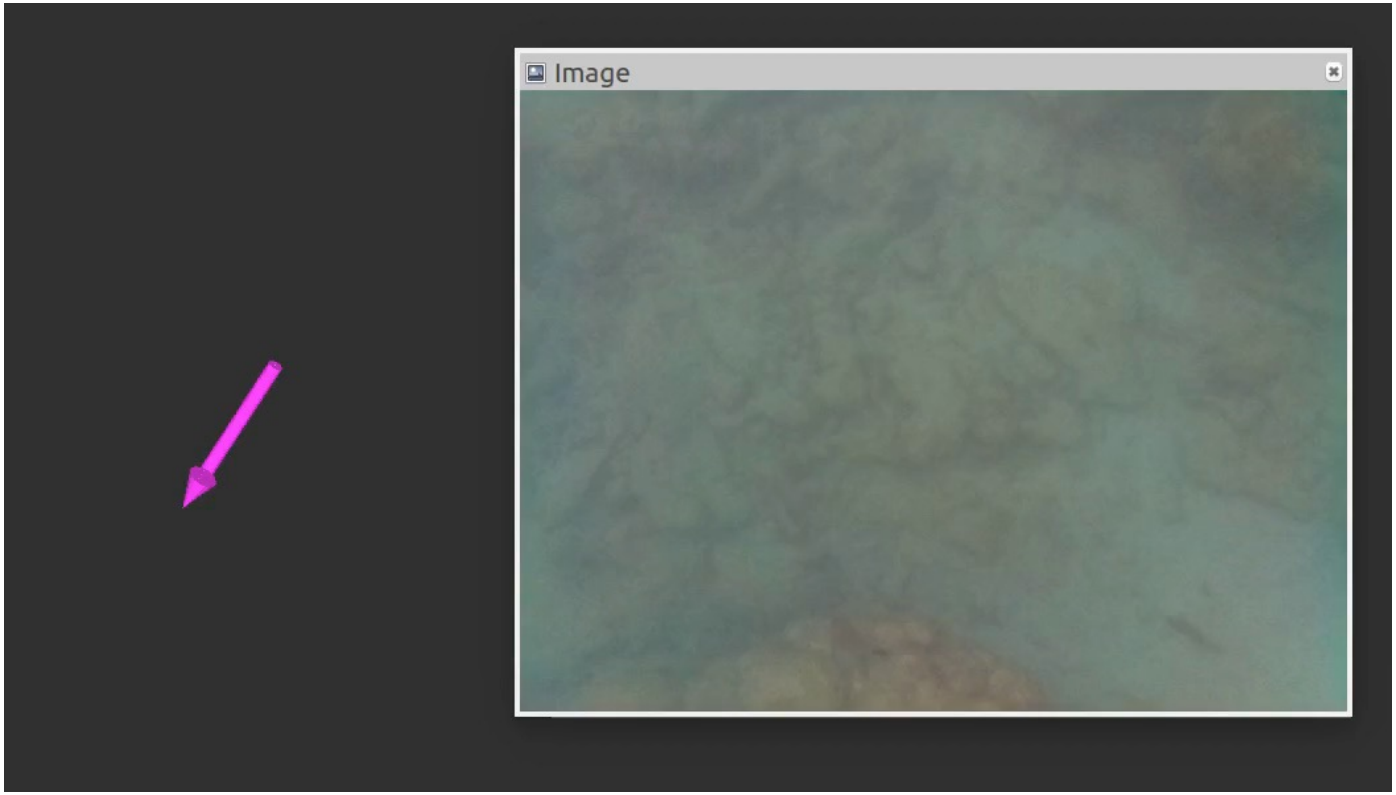
Cave mapping



[ICRA2017]

Select current research

- Coral reef monitoring



Summary

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Questions?