CS1951R: Intro to Robotics

Fly away with us!
Staff

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Codename: Loon
Mission: Empower every person with a collaborative robot.
Course Objectives

Each student will build and program their own small quadcopter. The course will provide basic components and a small number of replacement parts. After taking this course, students will be able to:

- Explain the space of designs for robotic communications, safety, state estimation, and control.
- Apply that knowledge to construct programs for communications, safety, state estimation, and control.
- Build, program, and operate an autonomous robot drone.

This is an overview class!
Robot/Environment Interaction

External World
Robot/Environment Interaction

Perceptual data
- Images from a camera
- Range sensor from a LIDAR
- ...

Actions
- Drive to a location.
- Pick up an object.
- ...

Observations

World Model

Actions

Control System

External World
Robot/Environment Interaction

Perceptual data
- Images from a camera
- Range sensor from a LIDAR
- ...
- Human input. e.g., “Go to the truck.”

Actions
- Drive to a location.
- Pick up an object.
- ...
- Communicative output. e.g., (“Which truck?”)
What is a robot?

• “A robot is a machine—especially one programmable by a computer—capable of carrying out a complex series of actions automatically.” (Wikipedia)

• Examples:
  - Cell phone?
  - Drone?
  - Car with cruise control?
  - Self-driving car?

• Sensors and actuators
Sensors

- Passive sensors
  - Camera
  - Odometry
  - Joint encoders

- Active sensors
  - Lidar
  - IR
  - Ultrasound
Actuators

- Electric motors
- Series elastic
- Brushless motors
Applications of Robotics
Scan the workspace with the wrist camera.
Applications of Drones
Search and Rescue

- Fly north 10 meters.
- Go to Waterman St.
- Fly a grid pattern over the Main Green.
Inspection

MAX-8 Utility UAV v1.2
Photo Mapping Package
Starting at $19,495.99

Now with improved vibration isolation for critical flight components and custom CNC mounting hardware, the MAX-8 V1.2 is even more rigid and reliable for repeated autonomous take-off-to-landing missions!
Recreation
Stanford University Autonomous Helicopter
FPV DRONE RACING
MELBOURNE, AUSTRALIA
IN 2015 WE PUT 100 DRONES IN THE SKY
Autonomous Drones

• PiDrone
  – Raspberry Pi/Python/ROS Autonomous Drone.
  – $225 in parts.
  – All autonomy on-board in Python.

Course History

- Alpha version: Fall 2017
  - Very very alpha!
- Beta version: Fall 2018 – you!
- Release: Fall 2019
  - Aiming for no enrollment limit at Brown.
  - Partnering with other institutions to launch there.
  - Aiming for online version paired with Kickstarter for anyone.
Resources

• Class website:
  – http://cs.brown.edu/courses/cs1951r/
  – Schedule, staff, hours, links.

• Duckiesky textbook:
  – Coming very soon!
  – Exercises and projects, math, explanations and diagrams.

• Duckiedrone Operations Manual:
  – Coming very soon!
  – How to use the drone. Build instructions, operation instructions, reference manual, software architecture.

• Probabilistic Robotics.
  – Actual published textbook. Great reference (and our primary resource) but focuses on ground robots.
  – Many copies around lab; you do not need a copy.

• Pidrone Github.
  – Reference code.
Projects are derived from this repository.
Master branch works/tested at all times.
The project answers are here!
Collaboration policy.
  – You can look at the answers if necessary.
  – But we recommend you do not. You will learn more if you code it up yourself.
  – You may not copy code from the repo into your project. We will use Moss; if you copy our code, we will know.
  – We will put most of the grade on short-answer questions and videos demonstrating that your drone has certain capabilities.
Projects

- Project 1: Build the drone (out next Thursday 9/13)
- Project 2: Sensors (out 10/2)
- Project 3: State Estimation with an Unscented Kalman Filter (out 10/9)
- Project 4: Proportional/Integral/Derivative (PID) Control (out 10/30)
- Project 5: Localization and Mapping (out 11/15)
Working Spaces

- Humanity-Centered Robotics Initiative
  - Maker space on the 8th floor of the Science Library.
  - Hours: am-8pm.
  - Build your drone there.
  - We have a net!
  - Flight space with or without the net.

- Brown Design Workshop (BDW)
  - “To become a member, simply come into the Brown Design Workshop, identify a Monitor (wearing an apron), and ask them to assist you in making an ID badge. It's that easy! Anyone at Brown/RISD can join.”
  - We have no formal relationship with them.

- Fly in your dorm room!
Assignments

- Assignment 0: Apply for the class.
Exams

• Midterm exam in class Thursday 10/30
• Final exam 12/17 at 2pm
Guest Lectures

- Held during the HCRI seminar slot (Thursday at 12pm-1pm.)
- Will be recorded if you can’t see it live.
- Lecture will be office hours on those days.
- Visitors:
  - Brandon Basso from Ubur on 10/25.
  - Tom Ryden, head of Mass Robotics on 11/1.
  - Prof. John Kelly from University of Toronto on 12/6
Logistics

- Lots of text-based input.
  - Screen
  - Emacs or VIM
- Lots of changing batteries and rebooting.
- Lots of crashes!
- Lots of practice.
- Our goal:
  - Be safe!
  - Have fun!
  - Learn robotics!
Video