CSE 478: Autonomous Robotics

Instructor: Chris Mavrogiannis

TAs: Kay Ke, Gilwoo Lee, Matt Schmittle

*Slides based on or adapted from Sanjiban Choudhury
We will be programming RACECARS!
Big thanks to the MuSHR team!

Multi-agent System for non-Holonomic Racing

https://mushr.io

Patrick Lancaster

Johan Michalove

Matt Schmittle

Matthew Rockett

Colin Summers

... and growing!
Overview of the RACECAR

- YLidar X4
- Intel Realsense D435i
- Redcat Racing HX-5000MH-B
- VEX Bumper switch
- Nvidia Jetson Nano
- Redcat Racing Blackout SC 1/10 chassis
Where you will be by week 7!
Highlights from last year ...
... and what’s **different** this year!

1. **Updated** assignments that guide you towards the final project

2. **Higher** standards for robots - faster, more precise, more robust (RACECAR 3.0)
Objective 1

Learn algorithms for autonomous driving and implement them on the RACECAR in 11 weeks!
Objective 2

Learn a **small** set of fundamental tools that solve a **wide** range of robotics problems.
Concrete learning objectives

**Estimate state**

**Plan a sequence of motions**

**Control robot to follow plan**
## Course outline

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**Week 11, Final project**: Combine modules to navigate around a track and solve tasks!
Scope of this course

Mobile robots

Soft-Robotics

Manipulation

Humanoids

Nano-robotics
Mobile robots are exciting!

Dealing with uncertainty in the real world outside of laboratory

Old algorithms - new technology! (better compute, sensors, batteries)
Today’s objective

1. Team introductions

2. Logistics

3. Getting started
Today’s objective

1. Team introductions

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3. Getting started
Christoforos “Chris” Mavrogiannis

Postdoc, University of Washington
Personal Robotics Lab

Ph.D., Cornell University
“Motion planning for socially competent robot navigation”

Research interests:
Motion planning; Multi-robot systems; Navigation, Manipulation; Human-robot interaction.
Liyiming “Kay” Ke

PhD student on Robotics & Learning
Research on imitation learning, applied machine learning.
Currently, teaching robot to use chopsticks!

Vision

Language

Robot
Gilwoo Lee

Ph.D. student, Personal Robotics Lab

Research:

- Reinforcement Learning
- Bayes-Adaptive RL
- Autonomous Assistive Feeding
Matt Schmittle

Ph.D. student, Personal Robotics Lab

Research:
• Imitation Learning
• Corrective Feedback

MuSHR Project
Today’s objective

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Course management tools

- Website: [https://courses.cs.washington.edu/courses/cse478/20wi](https://courses.cs.washington.edu/courses/cse478/20wi)
  - one stop for all information, slides, notes, assignments
- Sign up [piazza.com/washington/winter2020/cse478](https://piazza.com/washington/winter2020/cse478)
- Piazza: [https://piazza.com/class/k3tbbeofifd6ai](https://piazza.com/class/k3tbbeofifd6ai)
  - announcements, discussions, finding teammates, contacting instructors
- Canvas: [https://canvas.uw.edu/courses/1352219](https://canvas.uw.edu/courses/1352219)
  - submitting assignments, receiving grades
Lectures / Recitations

- Lectures on Mon Wed Fri, 13:30-14:20, THO 125
  - Will introduce the topic and focus on fundamental principles, algorithms and theory

- Recitation *this* Thursday 1/9, 13:30-14:20 / 14:30-15:20, CSE1 022
  - Important!
  - Will focus on specific implementation details, hardware / software details and issues relevant to assignments / projects.
  - Rest of the quarter as needed
Deliverables/Grades

- 4 Lab assignments (60%)
  - Implementation of algorithms on the racecar
  - Demo
- 1 final project (30%)
  - Use implemented components to complete a task
  - Demo day
- Participation (10%)
  - Piazza, classroom
  - Course evaluation
Assignments

- All assignments will be done as a team of 3
- All assignments involve work with the robot
- Each team submits one writeup
- Assignments are due 11:59 p.m on Friday
- Assignments have live demos on Thursday (day before)
  - TA will test your code on the robot
  - Timeslot for each group announced on Piazza
Lab logistics

• We have a separate lab for teams to work on robots
  • CSE1 022 (Basement)
  • Card-key operated

• Each team gets a desktop (same machine for duration of class)
  • Ubuntu + Python + ROS-Kinetic pre-installed.

• Each team gets 1 racecar (same for duration of class)
When can I get a car?

- First you need to form a **team of 3**
  - Everything as a team - assignments, projects, etc
  - Team remains the *same* throughout course
  - Use Piazza to find team members
  - Send a private note to instructors with team member names
  - **Form a team by Wednesday 1/8**

- Each team will get a car during the first recitation on Thursday 1/9
Car logistics

• Please treat cars with respect.

• Do not change the passwords on the cars.

• Each team maintains own batteries - don’t use others.

• Keep your space clean.

• Robots stay in 022.
Office hours

- Come to office hours!

Office hours:
- Chris Mavrogiannis: Mondays, 11:00-noon, CSE1 436
- Kay Ke: Wednesdays, 12:30-13:30, CSE1 022
- Gilwoo Lee: Thursdays 9:00-10:00, CSE1 022
- Matt Schmittle: Fridays, 10:00-11:00, CSE1 022

For assignment-specific clarifications, it is more fruitful to talk to TAs - they worked hard to design them!
Administrative policies

- Check website/canvas for details

- Late day policy
  - Each team gets 4 late days
  - After which 10 pts deduction every day

- Collaboration policy
  - Ok to discuss with other groups, but no sharing of writeup / code
  - Ok to look at online resources (cite when you do!) but don’t use code.
  - [https://www.cs.washington.edu/academics/misconduct/]
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Knowledge survey

• We have posted a knowledge survey on the website.
  • Ubuntu / Python experience
  • Math knowledge
  • Robot experience, etc
• Not crucial to know everything in depth
• But it will help us customize the class to you
Assignment 0 out Wednesday

• Introduction to Python, ROS, Simulator & Robot
  • Introduction to ROS Tools
  • How to receive, process, and send data in ROS
  • Control the racecar in simulation
  • Interface and operate with robot (involves significant time with the robot)

• Due date: Jan 17
  • Submit write-up, data, videos
  • More details in Canvas / Piazza
• Crucial to Come to recitation on Thursday 1/8
TL;DR

- Submit knowledge survey TODAY
- Form a 3 person team by Wednesday 1/8 (send a private note to instructors on Piazza)
- Assignment 0 released Wednesday and due on 1/17.
  - Familiarize yourself with ROS
- Come to recitation on Thursday, get your robot and start working on Assignment 0.
Next lecture: Anatomy of an autonomous vehicle

Urmson et al. 2008