CS 3630 Introduction to Robotics and Perception

Fall 2019

Instructor: Dr. Harish Ravichandar, harish.ravichandar@gatech.edu, CCB 217

TAs: List of TAs with contact info: https://bit.ly/2GSrwMh

Lectures: TR 9:30-10:45 am in Howey Physics Building - Room L1

Websites: We will use Canvas for tracking grades and for lab submissions. All announcements, assignments and discussions will be available through Piazza at https://piazza.com/gatech/fall2019/cs3630/home

Office Hours: Calendar at https://bit.ly/2ZIBabO

Robotics Education Lab: CCB 030 (Directions at https://bit.ly/2Z635Gj)

Course Description

This course covers fundamental problems and leading solutions to autonomous robot navigation – what and how must a robot perceive the world, and how can it use that information to navigate effectively.

The only formal prerequisite is CS1332 Data Structures & Algorithms. Prior knowledge of fundamentals of linear algebra and probability is helpful, but not required. Background in AI and Machine Learning is not assumed.

The course requires access to a laptop and a mobile device (cell phone or tablet) running Android or iOS. If you don't have access to these, please contact the instructor ASAP. All programming assignments will be completed in Python.

Course Objectives

Upon completion of this course, students will be able to:

- describe and explain what robots are and what they can do
- describe mathematically the position and orientation of objects and how they move
- design a control architecture for a mobile robotic system
- implement navigation and localization algorithms based on sensor fusion and environment representation
- write moderately involved programs in Python to control a robotic system
- construct, program, and test the operation of a robotic system to perform a specified task.

References

There is no assigned textbook for this course, but material covered in lectures has significant overlap with the following:

1. *Introduction to Autonomous Mobile Robots*, by R. Siegwart, I. Nourbakhsh, MIT Press, 2011.
2. *Robotics, Vision and Control*, by Peter Corke, Springer, 2011.
3. *Mobile Robots: Navigation, Control and Remote Sensing*, by G. Cook, Wiley-IEEE Press, 2011.

All three books are available in digital form through online access at the Georgia Tech library. Relevant excerpts from various texts will also be provided on Piazza.

Assignments and Grading

Labs (10% each): There will be 6 lab assignments throughout the semester, each worth 10% of the final grade. Lab 1 will be completed individually, and labs 2-6 in pairs. Lab grades will be determined using the grading rubric provided with each lab assignment. **Late Policy:** All lab assignments are due at the time and date indicated on the assignment document. Up to two late days are allowed, but a grade penalty of 50% and 75% will be applied at the first and second day, respectively. For example, a 100-point lab completed one day late would only receive at most 50 points. Since most labs require a live demo for grading (usually done in class), please contact a TA well ahead of time to schedule a time to demo your solution if you are missing class or are making a late submission.

Quizzes (6% each): There will be 7 quizzes throughout the semester at the end of class on the dates designated on the syllabus. For each student, the quiz with the lowest grade will be dropped, and the remaining 6 quizzes will each be worth 6% of the final course grade. Because the lowest quiz is being dropped, we will not be rescheduling quizzes missed due to unexcused absences (travel, job interviews, etc.). Make-up quizzes will only be scheduled for absences approved by the Dean of Students or by special permission by the instructor.

Participation (4%): The participation grade will be based on peer review by your partner(s) at the end of the semester.

Extra Credit: You may earn extra credit throughout the semester by making a helpful contribution to the class, such as a tutorial, guide, visualization or debugging tool. This is to encourage everyone to share useful information relating to the course, particularly useful tools, libraries, or guides for overcoming common problems. Feel free to reach out to course staff if you have any questions. Extra credit will be assigned as 0.2-0.5% of total class grade, depending on the type of contribution.

Partners

Beginning with Lab 2, all lab assignments will be completed in pairs using a shared Anki Cozmo robot. **Partner arrangements are not fixed and can change throughout the semester**. In fact, we encourage anyone not satisfied with their partner to find a new partner to work with. We can try to facilitate partnering arrangements if needed.

Cozmo Robots

You and your partner will receive a Cozmo robot to use for the semester that you will return, with all accessories, at the end of the course. Each Cozmo will be numbered and we will keep track of who has which robot. At the end of the semester, you are responsible for returning the robot for which your name is listed. If you switch teams and start using a new robot, please email one of the TAs and they will update the spreadsheet.

Note that the Cozmo robots are the property of the College of Computing, and the College may charge a fee of up to $175 for the cost of the robot if it is not returned at the end of the semester.

Communication with Course Staff and Peers

We will be using Piazza for course announcements, questions and discussion.

For the best and fastest response, we ask that you post your questions on Piazza instead of sending email. If others are likely to have a similar question or benefit from the answer, make a public Piazza post. Feel free to make private posts to the course staff if your question concerns a solution, your grade, or other private information. You can also reach out to your group lead TA for questions, or reach all the course staff by emailing cs3630staff@lists.gatech.edu.

We encourage everyone to actively contribute to discussion, answer each other's questions and generally use Piazza as broadly as possible to make the course run smoothly. We recommend configuring the email settings to send new post notifications in real time, not at the end of the day.

Course Policies

The course schedule and policies mentioned in this syllabus may change at any time during the term, but all changes will be clearly documented and announced.

Student Disability Services: If you need course adaptations or accommodations because of a disability, or if you have medical information to share with the instructor, please make an appointment or stop by to speak with Dr. Ravichandar within the first week of classes.

Academic Honesty Policy: Review Georgia Tech's Academic Honor Code. Any work you present as your own should represent your own understanding of the material. When external sources were used as significant points of information (sample code, etc.), the source must be referenced in your submission. Following Georgia Tech's guidelines, all suspected cases of academic cheating will be forwarded for review by the Office of Student Integrity.

Acknowledgement

Assignments, lectures, and ideas on this syllabus are adapted from Prof. Sonia Chernova's course at Georgia Institute of Technology. I would like to thank Sonia for the helpful discussions and access to all her course materials.

Tentative Schedule

DATE	TOPIC	NOTES
Tue Aug 20	Course Introduction	
Thu Aug 22	Image Processing and Object Recognition – Episode I	
Tue Aug 27	Image Processing and Object Recognition – Episode II	
Thu Aug 29	*Go to CCB to pick up Cozmo robots*	
Tue Sep 03	Image Processing and Object Recognition – Episode III	**Lab 1 due**
Thu Sep 05	Coordinate Transforms – Episode I	*Quiz 1: Aug 22 – Sep 03*
Tue Sep 10	Coordinate Transforms – Episode II	
Thu Sep 12	Representing Uncertainty, Foundations of Localization	*Quiz 2: Sep 05 – Sep 10*
Tue Sep 17	*In-class demos*	**Lab 2 due**
Thu Sep 19	Particle Filter – Episode I	
Tue Sep 24	Particle Filter – Episode II	
Thu Sep 26	Kalman Filter – Episode I	*Quiz 3: Sep 12 – Sep 24*
Tue Oct 01	Kalman Filter – Episode II	**Lab 3 due**
Thu Oct 03	Self-Driving Cars	
Tue Oct 08	Path Planning: Representations and Fundamentals	*Quiz 4: Sep 26 – Oct 03*
Thu Oct 10	Path Planning: Search	
Tue Oct 15	*Fall Recess*	
Thu Oct 17	*In-class demos*	**Lab 4 due**
Tue Oct 22	Path Planning: Probabilistic Methods – Episode I	
Thu Oct 24	Path Planning: Probabilistic Methods – Episode II	*Quiz 5: Oct 08 – Oct 22*
Tue Oct 29	Robot Control – Episode I	
Thu Oct 31	Robot Control – Episode II	
Tue Nov 05	Potential fields, tentacles, and exploration	*Quiz 6: Oct 29 – Oct 31*
Thu Nov 07	*In-class demos*	**Lab 5 due**
Tue Nov 12	*Guest Speaker*: Prof. Mathew Gombolay	
Thu Nov 14	*Guest Speaker*: Prof. Seth Hutchinson	
Tue Nov 19	Fundamentals of SLAM	
Thu Nov 21	Robot Learning – Episode I	*Quiz 7: Nov 12 – Nov 19*
Tue Nov 26	Robot Learning – Episode II	
Thu Nov 28	*Thanksgiving Break*	
Tue Dec 03	*In-class demos*	**Lab 6 due; return robots**

in-class lab/demo session, bring robot/laptop to class