CSCI 445L: Introduction to Robotics

Units: 4.0
Spring 2024

Lectures: T/Th 08-09:20am (KAP 163)
Lab Sections: T/Th 10-11:50am (RTH 419)

Website: https://piazza.com/usc/spring2024/csci445l

Instructor: Erdem Bıyık
Office: PHE 214
Office Hours: Wednesdays 11:00am – 12:00pm
Contact Info: biyik@usc.edu

Course Description

This course is an introduction to robotics, focusing on basic building blocks such as motors, sensors, and algorithms. Students will get hands-on experience with building robots, integrating sensors and actuators, and developing algorithms for robot control.

It is an explicit goal of this course to advance students' critical thinking and communication skills. This is achieved through laboratories, group work, and discussions.

Course Texts and Readings

Students are expected to read the weekly reading material prior to attending lecture. This is the best way to (1) ensure you have properly understood the material, (2) follow along in the lecture, (3) get a high score in class participation, and (4) do well on the exams. Students are expected to attend lecture, as there are many insights that will be shared and discussed in class that are not on the lecture slides.

The course will use multiple texts. Assigned readings (including articles and other supplemental readings) are not optional. They are meant to help you understand the course material.
1. The main text for the course is Elements of Robotics (Mordechai Ben-Ari and Francesco Mondada), and is available for free download here: https://www.springer.com/gp/book/9783319625324
2. Planning Algorithms (Steve LaValle) is available online for free at http://planning.cs.uiuc.edu
3. Behavior Based Robotics (Ron Arkin), chapters will be posted on Piazza.
4. Introduction to Autonomous Mobile Robots (R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza, 2nd Edition) is available through the library website as an e-resource for free.

Homework

Homework is graded on a scale of 100 points each. Homework is expected to be turned in on Gradescope **by 11:59pm** on the due date. **Unless a student has obtained special permission for extraordinary circumstances, late homework assignments will be penalized, 20 points per day.**

Laboratory Component

The laboratory is an integral component of this course. It reinforces concepts discussed in lecture by giving students the opportunity to apply these concepts on hardware.

LAB ATTENDANCE IS REQUIRED. Any absences from lab must be excused in advance by the teaching staff, and arrangements must be made to make up the lab. You must come to lab prepared, having read the lab handout and reviewed the relevant topics. A pre-lab component will be due at the beginning of most labs, and will be checked by the TAs. Failure to prepare for the lab will result in a 10% deduction in your grade for that week's lab. Being >10 minutes late will also result in a 10% deduction for that week's lab.

Course Project

The course project provides students with an opportunity to incorporate all the concepts learned in class and all tools developed in lab into a final project. Details will be released towards the end of the semester.

Exams

Exams will be taken during the scheduled class time. The final exam will not be cumulative, and will focus on material covered after the midterm. The teaching staff will make every effort to return graded exams within one week of the exam date. **From the date the exams are returned, students have ONE WEEK to bring up and reconcile issues related to grading of the exam.**

Grading Breakdown

Assessment Tool (assignments)	% of Final Grade
Homework (5 problem sets)	20
Labs (including programming assignments)	30
Course Project	10
Midterm	20
Final Exam	20
Participation (in class and on Piazza)	3
TOTAL	**103**

Course Schedule

Week	Date	Topics/Daily Activities	Readings	Lab Schedule	HW	Due Date
1	Jan 9	Introduction, Defining Robotics		(no lab)	Programming Assignment 1	Jan 19
	Jan 11	Defining Robotics + Motors & Gears	EOR 1			
2	Jan 16	Actuators, Effectors, & Locomotion	EOR 5.10-12	Lab 1: Intro		
	Jan 18	Introduction to Sensors, Sonar	EOR 2			
3	Jan 23	Simple Sensors II - Encoders	EOR 5	Lab 2: Sensors	HW1	Feb 2
	Jan 25	Odometry				
4	Jan 30	Feedback Control	EOR 6	Lab 3: Odometry		
	Feb 1	Feedback and Sensor Processing				
5	Feb 6	Simple Sensors III – Optical		Lab 4: Feedback (PD)	HW2	Feb 16
	Feb 8	Complex Sensors	EOR 12			
6	Feb 13	Control Architectures		Lab 5: Feedback (PID)		
	Feb 15	Representation	EOR 3, RA 5			
7	Feb 20	Representation & Reactive Control	EOR 4	Lab 6/7: Combining Controllers		
	Feb 22	Hybrid & Behavior Based Control	EOR 4, RA 3,4,6			
8	Feb 27	Midterm		(no lab)		
	Feb 29	Particle Filter	EOR 8			
9	Mar 5	Emergent Behaviors & Group Robotics		Lab 6/7: Combining Controllers	HW3	Mar 20
	Mar 7	Multi-robot Systems	EOR 15			
10	Mar 12	Spring Recess (no class)		(no lab)		
	Mar 14	Spring Recess (no class)				
11	Mar 19	Manipulation	EOR 16.1-2	Lab 8/9: Particle Filter		
	Mar 21	Planning and Discrete Search	EOR 10			
12	Mar 26	Configuration Space Planning	SL 3, EOR 10.2	Lab 8/9: Particle Filter	Programming Assignment 2	Apr 3
	Mar 28	Potential Fields & Obstacle Avoidance	SL 5			
13	Apr 2	Sampling Based Planning	EOR 7	Lab 10: Mapping	HW4	Apr 17
	Apr 4	Task Planning				
14	Apr 9	Learning I		Project		
	Apr 11	Learning II				
15	Apr 16	Soft Robotics		Project	HW5	Apr 26
	Apr 18	Haptics				
16	Apr 23	Human-robot Interaction		Project		
	Apr 25	Guest Lecture (Elizabeth Ondula)				
FINAL	May 8	Final Exam (8am-10am)				

References:
EOR: Elements of Robots, Ben-Ari, Mondada; **RA:** Behavior Based Robotics, Ron Arkin; **SL:** Planning Algorithms, Steven LaValle

Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - *(213) 740-9355 – 24/7 on call*
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - *988 for both calls and text messages – 24/7 on call*
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - *(213) 740-9355(WELL) – 24/7 on call*
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - *(213) 740-5086*
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - *(213) 740-5086 or (213) 821-8298*
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - *(213) 740-0776*
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - *(213) 740-0411*
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - *(213) 740-2101*
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - *UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - *UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call*
Non-emergency assistance or information.

Office of the Ombuds - *(213) 821-9556 (UPC) / (323-442-0382 (HSC)*
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - *(323) 442-2850 or* otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.