COMP 4500 Mobile Robotics I

Spring 2019

Instructor:	Dr. Reza Ahmadzadeh	reza_ahmadzadeh@uml.edu	DAN 313
TA:	Victoria Albanese	victoria_albanese@student.uml.edu	

Lectures: TR 2:00 – 3:15 pm in Kitson Hall, 305 NC

Websites: We will use **Blackboard** for announcements, assignments, lab submissions, and discussions

Office hours: to be posted on Blackboard

Course Description

This course covers fundamental problems and leading solutions for computer and robot perception and action from the point of view of autonomous robot navigation. Topics are approached primarily from the point of view of 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 COMP 1020 Computing II, or Co-req: EECE 3170 Microprocessor System Design I. Prior knowledge of fundamentals of linear algebra and probability is also assumed.

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
- compute mobile robot kinematics
- develop a control architecture for a mobile robotic system
- implement navigation algorithms based on sensor fusion and environment representation
- write moderately involved programs in Python to control real-time tasks with 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]. Probabilistic Robotics, *by D. Fox, S. Thrun, and W. Burgard, MIT Press, 2005.*
[2]. Introduction to Autonomous Mobile Robots, *by R. Siegwart, I. Nourbakhsh, MIT Press, 2011.*
[3]. Robotics, Vision and Control, *by P. Corke, Springer, 2011.*
[4]. Mobile Robots: Navigation, Control and Remote Sensing, *by G. Cook, Wiley-IEEE Press, 2011.*

All four books are available in digital form through online access at the Umass Lowell Library.

Assignments and Grading

Labs (11% each): There will be 5 lab assignments throughout the semester, each worth 11% of the final grade. Lab 1 will be completed individually, and labs 2-5 in pairs. Lab grades will be determined using the grading rubric provided with each lab assignment, as well as through partner peer evaluation.

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 50 points. Since almost all labs require a live demo for grading (usually done in class), please contact the 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 (7.5% each): There will be 8 quizzes throughout the semester at the beginning of class on the dates designated on the syllabus. The two quizzes with the lowest grade will be dropped, and the remaining 6 quizzes are each worth 7.5% of your final course grade. Because the lowest quizzes are being dropped, we will not be rescheduling quizzes missed due to travel, job interviews and minor illnesses. Special considerations will be made for serious or extended circumstances, please contact Dr. Reza Ahmadzadeh ahead of the quiz date to ask about special arrangements.

Extra Credit:
You may earn extra credit throughout the semester through the following:

- Make a particularly helpful or insightful Blackboard post, which is endorsed by at least one course staff. [0.2% of total grade]
- Contribute example code that does something new, interesting and/or useful, which is endorsed by at least one course staff. The code must be related to Cozmo or provide a tool usable in the course. It may be related to an assignment, but does not have to be. It must not provide a solution to an assignment. [0.5% of total grade]
- Complete the survey at the end of class. Extra credit of 0.3% of total grade if at least 85% of the class completes the survey

Partners

Beginning with Lab 2, all lab assignments will be completed in pairs. This means that on February 12th (tentative), you need to have a partner in order to receive a 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. In rare cases, we can facilitate partnering arrangements.

Cozmo Robots

Each group 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 using this spreadsheet. At the end of the semester, you are responsible for returning the robot for which

your name is listed. You will not receive a grade until you return your robot. If for any reason you start using a new robot email one of the TAs and they will update the spreadsheet.

Equipment loss/damage policy: We plan to use these robots for next semesters and you should know that if you lose or break the robot or any of its accessories you have to pay for it to avoid receiving an incomplete for the course.

Communication with Course Staff and Peers

We will be using Blackboard for course announcements, questions and discussion. Official copies of lab assignments will be available through Blackboard.

For the best and fastest response, we ask that you post your questions on Blackboard instead of sending email. If others are likely to have a similar question or benefit from the answer, make a public Blackboard 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 TA for questions.

We encourage everyone to actively contribute to discussion, answer each other's questions and generally use Blackboard as broadly as possible to make the course run smoothly. Cozmo is a rather new platform, with a frequently changing SDK, so **please check Blackboard regularly for updates**. 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. Reza Ahmadzadeh within the first week of classes.

Academic Honesty Policy: Students are expected to honor and follow all CS department and UMass Lowell policies related to academic honesty and integrity. Violators risk failing the course in addition to any actions taken by the university administration. Cheating will not be tolerated, and students who cheat risk failing the course and possible university administrative actions. Please make sure to review the UMass Lowell's Academic Integrity.

Rule of thumb: 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.

Tentative Schedule (updated on 12/28/2018)

	Date		Topic	Lab	Quiz
1	Tuesday	1/22/2019	Introduction + course logistics		
2	Thursday	1/24/2019	Perception + Lab1 checkpoint	Lab1 checkpoint	
3	Tuesday	1/29/2019	Perception		
4	Thursday	1/31/2019	Q1 + Image Processing I	Lab 1 out	Q1 (Perception)
5	Tuesday	2/5/2019	Image Processing II		
6	Thursday	2/7/2019	Image Processing III	Lab 1 due	
7	Tuesday	2/12/2019	Q2 + Pick up Robots		Q2 (Image Processing)
8	Thursday	2/14/2019	Finite State Machines + Lab 2 checkpoint	Lab 2 checkpoint	
9	Tuesday	2/19/2019	Coordinate Systems	Lab 2 out	
10	Thursday	2/21/2019	Coordinate Systems		
11	Tuesday	2/26/2019	In-class demo	Lab 2 due	
12	Thursday	2/28/2019	Q3 + Kinematics		Q3 (FSM+Coordinate Systems)
13	Tuesday	3/5/2019	Odometry		
14	Thursday	3/7/2019	Q4 + Path Planning I	Lab 3 out	Q4 (Kinematics)
15	Tuesday	3/12/2019	Spring recess		
16	Thursday	3/14/2019	Spring recess		
17	Tuesday	3/19/2019	In class-demo	Lab 3 due	
18	Thursday	3/21/2019	path planning II		
19	Tuesday	3/26/2019	path planning III	Lab 4 out	
20	Thursday	3/28/2019	Q5 + Uncertainty and intro to localization		Q5 (Path Planning)
21	Tuesday	4/2/2019	Bayes filters (Recursive state estimation)		
22	Thursday	4/4/2019	Histogram filters + particle filters		
23	Tuesday	4/9/2019	In-class demo	Lab 4 due	
24	Thursday	4/11/2019	Q6 + Monte carlo localization		Q6 (Bayes filter + particle filter)
25	Tuesday	4/16/2016	Kalman filter I		
26	Thursday	4/18/2019	Kalman filter II	Lab 5 out	
27	Tuesday	4/23/2019	Q7 + Optimization I		Q7 (Kalman filter)
28	Thursday	4/25/2019	Optimization II		
29	Tuesday	4/30/2019	Q8 + Robot Learning		Q8 (Optimization)
30	Thursday	5/2/2019	Final project In-class demo	Lab 5 due	