CS 780/880 Intro to Mobile Robotics, Spring 2018

Lectures: MW 12:40 pm - 2:00 pm, Kingsbury N113
Lab: W 4:10 pm - 6:00 pm, Kingsbury N242

Instructor: Prof. Momotaz Begum, mbegum@cs.unh.edu
Office hours: M-W: 11:00 AM to 12:00 PM or by appointment, Kingsbury N215A

Lab assistant: Estuardo R Carpio-Mazariegos, erp48@wildcats.unh.edu
Office hours: TBA

Course Description

This course will introduce the foundational theory and practices in mobile robotics. The following topics will be covered

1. Robot kinematics: Linear algebra, coordinate transformation, wheeled locomotion
2. Robot control architecture: Hierarchical paradigm, Behavior-based control, Hybrid paradigm
3. Robot perception: Common sensors (odometry, sonar, laser, depth, camera) and sensor processing
4. Probability theory: Axioms, Discrete and continuous random variables, Joint probability, Bayes theorem, Normal distribution and its properties
5. Robot vision: Fundamentals of image processing and computer vision for robotics
6. Robot navigation: Obstacle avoidance, path planning, robot localization using Kalman filter and particle filter, SLAM

Laboratory sessions will be directed towards real-world implementation of learned knowledge on a Turtlebot (http://www.turtlebot.com/). Hands-on experience from the labs will contribute to the final project.

Assignments, Exams, Project: There will be three homework assignments, three quizzes, seven labs, and one final project. There is no final exam in this course.

Labs: Lab grade will be based on lab assignments, reports, and performance in the lab. The final project is a part of the lab.

Grades: Assignments: 20%
Quizzes: 45%
Lab assignments, reports, and performance: 15% (undergraduate) 10% (graduate)
Final project: 20% (undergraduate) 25%(graduate)

a) Presentation: 5
b) Demo: 10 (15)

c) Report: 5

Programming: Python/C++/Matlab and Robot operating system, ROS (Matlab is compatible with ROS).

Reference: There is no designated textbook for this course. The instructor will provide all required materials. However, materials covered in lectures has significant overlap with the following books (available in the library):

- Introduction to Autonomous Mobile Robots, by R. Siegwart, I. R. Nourbakhsh, MIT Press, 2011.
- Principles of Robot Motion, by H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki and S. Thrun, The MIT Press, 2005
- Introduction to AI Robotics, by R. R. Murphy, The MIT Press, 2000
- Computational Principles of Mobile Robots, by G. Dudek and M. Jenkin, Cambridge University Press, 2000
- Probabilistic Robotics, by S. Thrun, W. Burgard, and D. Fox, The MIT Press, 2005

A Tentative Schedule

The schedule will be adjusted frequently based on the progress of the class. The instructor reserves all rights to change the lecture topics, exam dates, and due dates for labs/homework assignments during the semester.

	Event		Topic
Week 1	Lecture 1		Course and people Introduction, ROS
	Lab 1		
Week 2	Lecture 2		Linear Algebra I
	Lecture 3		Linear Algebra II
	Lab 2		
Week 3	Lecture 4		Robot Kinematics I: Fundamentals of locomotion, wheel geometry and kinematic constraints
	Lecture 5		Robot Kinematics II: Differential drive robot I
	Lab 3		
Week 4	Lecture 6		Robot Kinematics III: Differential drive robot II
	Lecture 7		Robot Kinematics IV: DDR: kinematic modelling
	Lab 4		
Week 5	Lecture 8		Sensors for mobile robots I (sonar, laser, and misc)
	Lecture 9		Path Planning: configuration space
	Lab 5		
Week6	Lecture 10		**Quiz # 1 (Lectures 1 to 7)**
	Lecture 11		Path Planning: Combinatorial (visibility graph, cell decomposition , Voronoi diagram)
	Lab 6		
Week 7	Lecture 12		A* Search/Search algorithms -Project
	Lecture 13		Probability theory I
	Lab 7		
Week 8			
Week 9	Lecture 14		Probability theory II
	Lecture 15		Robot/Computer Vision I
	Lab 8		**Project**
Week 10	Lecture 16		Robot/Computer Vision II
	Lecture 17		Robot/Computer Vision III
	Lab 9		**Project**
Week 11	Lecture 18		Robot/Computer Vision IV
	Lecture 19		Obstacle avoidance I (Bug1 and Bug2)
	Lab 10		**Project**
Week 12	Lecture 20		**Quiz# 2 (Lectures 8-18)**
	Lecture 21		Obstacle avoidance II (potential field method and vector field histogram)
	Lab 11		**Project**
Week 13	Lecture 22		Mapping and Exploration: Frontier-based
	Lecture 23		Robot Navigation I (Bayes Filter)
	Lab 12		**Project**
Week 14	Lecture 24		Robot Navigation II (Kalman Filter)
	Lecture 25		Robot Navigation III (KF and Particle filter)
	Lab 13		**Project**
Week 15	Lecture 26		Robot Navigation IV (Particle Filter)
	Lecture 27		Robot Navigation V (PF)
	Lab 14		**Project demo and presentation**
Week 16	**Lecture 28**		Robot Navigation VI (PF)
			Quiz #3 (Lectures 19-28)