West Virginia University

MAE/CpE 412 Mobile Robotics

Fall 2019

Lecture: MRB 205 Time: TR 12:30 – 1:45 pm (3 Credit Hours)

OBJECTIVE: The objective of this course is to teach students key engineering topics related to the field of mobile robotics, which includes robot locomotion, sensing, navigation, planning, decision making, control, and robot systems design.

INSTRUCTOR: Dr. Yu Gu
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PREREQUISITE: Consent.

COURSE FORMAT: Lecture with laboratory. Please see the tentative course outline provided at the end of the document for additional details.

OFFICE HOURS: The instructor will keep regular office hours on Tuesday and Thursday from 11:00 am - 12:00 pm. You can also make an appointment by email or by talking to the instructor before or after the class.

TEXT: "Robotics, Vision and Control: Fundamental Algorithms in MATLAB," Peter Corke, Springer, 2011 (The book can be downloaded from Springer website for free). You may also find the following references useful:

- "*Introduction to Autonomous Mobile Robots,*" (second edition), Roland Siegwart, Illah R. Nourbakhsh and Davide Scaramuzza. Bradford Books, 2011. ISBN 0262015358.
- "*Probabilistic Robotics,*" Sebastian Thrun, Wolfram Burgard, and Dieter Fox, 2005. ISBN 0-262-20162-3.
- "*Handbook of Robotics*," Siciliano, B., & Khatib, O. (Eds.). Springer, 2016.

CATLOG DESCRIPTION: Introduction to fundamental topics in mobile robotics; methods of locomotion; common mobile robot sensors, state estimation and navigation algorithms; path planning and obstacle avoidance methods; robot decision making and control processes; and mobile robot systems design.

LEARNING OUTCOMES: By the end of this course you should have demonstrated your ability to:

- analyze the advantages and disadvantages of different mobile robot design choices.
- select and interface sensors, actuators, and microprocessors for controlling a mobile robot.
- program and debug a robot in MATLAB for navigation, control, path planning, and obstacle avoidance tasks.

- write structured technical proposals and reports.
- work effectively within an inter-disciplinary project team.

GRADING POLICY:

Homework	20%
Lab Reports	20%
Quizzes	10%
Midterm Exams	25%
Final Project	25%

Letter grades are assigned with respect to total percentages earned based upon the standard university policy described in the catalog.
(100% – 90%: A, 80% - 89%: B, 70% - 79%: C, 60% - 69%: D, <60%: F)

QUIZZES AND EXAMS: Quizzes will be given in class. The quizzes will cover lecture material, lab material, as well as required reading material. Quizzes may be unannounced and there will be no makeup quizzes. There will be two midterm exams. If you must miss an exam, you must inform the instructor before the scheduled start of the exam. Failure to do so will result in denial of the opportunity to make up the exam.

HOMEWORK: Homework will mostly be MATLAB programing assignments. Late homework will be accepted at a deduction of 15% per day.

LAB REPORTS: Lab reports must be done individually. A sample lab report will be provided with the expected format. It is STRONGLY advised that the format be followed as grading of lab reports will be strict. All lab assignments are due seven days after your lab. Any work submitted after this time will be accepted at a deduction of 15% per day. Attendance for all labs is mandatory. If you miss a lab you must make it up. This can be done during "off hours" by making arrangements with the instructor. Lab reports submitted for labs not attended will not be accepted.

PROJECT: You will be divided into teams and will undertake a final project, as specified in a request for proposal (RFP) document, which will be distributed by the instructor. The project will require you to apply the material learned in the lectures and labs, and will consist of two phases: 1. write proposals and 2. the actual development of the hardware and software for the project. Note that each member of the group will be asked to compile a contribution form to evaluate the contribution of the other group members.

Academic Policies: Academic policies and statements can be found at https://tlcommons.wvu.edu/syllabus-policies-and-statements. For the detailed WVU's academic standards policy, please visit: https://provost.wvu.edu/governance/academic-standards-resources.

TENTATIVE COURSE OUTLINE

Date	Topics	Notes
Week 1 Aug 21-23	Introduction to Mobile Robotics No Lab	
Week 2 Aug 26-30	Mobile Robot Systems Design, Communication No Lab	
Week 3 Sep 02-06	Robot Sensors No Lab	
Week 4 Sep 09-13	Basic Probability Lab #1: Serial Communication	Request for Proposals
Week 5 Sep 16-20	Basic Statistics, No Lab	
Week 6 Sep 23-27	Basic Statistics**, Exam 1** Lab #2: Controlling the iRobot Create	
Week 7 Sep 30 - Oct04	Linear Kalman Filter No Lab	Due of Project Pre-Proposal
Week 8 Oct 07-11	Linear Kalman Filter/Extended Kalman Filter Lab #3: Data Collection and Obstacle Avoidance	Mid-semester Oct 10 Fall break
Week 9 Oct 14-18	Extended Kalman Filter Lab #4: One State EKF-1	
Week 10 Oct 21-25	Kinematics and Navigation Lab #5: One State EKF-2	
Week 11 Oct 28 – Nov 01	Robot Perception No Lab	
Week 12 Nov 04-08	Robot Control Lab #6: Tilt Sensing and PID Control	Due of Project Full-Proposal
Week 13 Nov 11-15	Robot Planning and Autonomy No Lab	
Week 14 Nov 18-22	**Exam 2** No Lab	
Week 15 Nov 25-29	No Class No Lab	Fall Recess
Week 16 Dec 02-06	Robot Case Studies Makeup Lab Session	
Week 17 Dec 09-13	Summary Initial Project Demonstration and Team Presentation	
Week 18 Dec 16-20	**Final Project Demonstration**	Due of Project Final Report