West Virginia University

MAE 493G, CpE 493M Mobile Robotics

Fall 2013

Lecture: ESB 449 Time: TR 09:30 - 10:45 am

OBJECTIVE: The objective of this course is to introduce students to the field of mobile robotics, which involves mechanical design, electrical design, programing, artificial intelligence, sensing, navigation, planning, decision making, and control.

INSTRUCTOR: Dr. Yu Gu
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PREREQUISITE: There is no prerequisite for the Mobile Robotics course. However, you need to know how to program in MATLAB before taking this class. It is also recommended for MAE students to first take the MAE 211 Mechatronics course and LCSEE students to first take the CPE 310/311 Microprocessor course.

OFFICE HOURS: I will keep regular office hours on Tuesday and Thursday from 1:00 -2:00 pm. I am also happy to see you for individual help. You can make an appointment to see me by email or by talking to me before or after the class.

TEXT: "Robotics, Vision and Control: Fundamental Algorithms in MATLAB," Peter Corke, Springer, 2011. 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.

COURSE Introduction: What do Mars rover Curiosity, Google's Driverless Cars, DARPA's Big Dog, Northrop Grumman's Global Hawks, and iRobot's Roomba have in common? They all share a same name: *mobile robot*. A mobile robot has the ability to move around in its environment, which distinguishes it from traditional industry robots that work on assembly lines. This freedom of movement also brings in many unique challenges. Autonomous navigation in an everyday environment without bumping into other objects, a trivial skill for animals and humans from a very early age, is not quite as simple for a robot. However, a lot of progress has been made recently! Mobile robotics is starting to penetrate into many aspects of our life: service, health care, logistics, education, and entertainment, just to name a few. In fact, the mobile robotics industry is predicted to be the next driving force for creating US design and manufacturing jobs. To prepare you for this new wave of innovation, we have created this course, which gives you the opportunity to learn and program robots. You will also learn how to perform robot navigation, control, path planning, and collision avoidance. If you like robots, and are willing to put in a lot of hard work and dedication, this will be a fun course!

LEARNING OUTCOMES: By the end of this course you should be able to:

- Explain the advantages and disadvantages of different mobile robot designs.
- Select and interface sensors, actuators, and microprocessors for controlling a mobile robot.
- Program a robot in MATLAB for navigation, control, path planning, and collision avoidance tasks.
- Write sophisticated technical proposals and reports.
- Work effectively within an inter-disciplinary design team.
- Acquire hands on experiences in robot design, system integration, programing, and debugging.

GRADING POLICY:

Homework	15%
Lab Reports	20%
Quizzes	15%
Midterm Exams	20%
Final Project	30%

Letter grades are typically 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: You will sometimes take a short quiz during the class. The quizzes will cover lecture material, lab material, as well as required reading material. **Quizzes will 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 20% 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 20% per day. Lab reports submitted for labs not attended will not be accepted.

LAB ATTENDANCE: Attendance for all labs is mandatory. If you miss a lab you must make it up. This can be done either during one of the other lab sections or during "off hours" by making arrangements with the instructor.

PROJECTS: You will be divided into teams and will undertake a final project, as specified in a request for proposal, 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: development of a design proposal and the actual construction 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. The evaluation will be used to determine your grade of the project.

STUDENT OBLIGATIONS: Unexcused absences from tests and failure to attend required lectures may result in failing grades. It is your responsibility to keep abreast of class procedural announcements, obtain handouts, etc.

ACADEMIC HONESTY: The highest level of academic honesty is expected of all WVU students. While cooperation is encouraged on lab reports, unique and individual efforts must be demonstrated for evaluation. Individual efforts on quizzes, exams, and the final are demanded. **Cheating on exams and quizzes will result in a grade of 'F'.** Please don't assume that I can't catch cheating: solving procedures that are too similar to other students' with the same mistakes may constitute cheating. If you engage in academic dishonesty, I will notify you that you will receive an 'F' in the course. Please see the Student Conduct Code for details at http://studentlife.wvu.edu/office_of_student_conduct/student_conduct_code.

Statement on Social Justice: WVU is committed to social justice. The instructor of this course concurs with WVU's commitment and expects to maintain a positive learning environment, based upon open communication, mutual respect and nondiscrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color, or national origin. Any suggestions are encouraged as to how to further such a positive and open environment and to anticipate needing any type of accommodation in order to participate in this class. Please advise us and make appropriate arrangements with Disability Services (293-6700).

TENTATIVE COURSE OUTLINE

Date	Topics	Notes
Week 1 Aug 19 ~ 23	Introduction to Mobile Robotics No Lab	
Week 2 Aug 26 ~ 30	Mobile Robot System Design, Communication No Lab	
Week 3 Sep 02 ~ 06	Microprocessor, MATLAB, Simulink, and Robot Programing Lab #1: Serial Communication	
Week 4 Sep 09 ~ 13	Robot Sensors and Sensor Calibration Lab #2: SMART Robot Introduction and Data Acquisition	Request for Proposal
Week 5 Sep 16 ~ 20	Statistics and Data Analysis Lab #3: Robot Sensor Calibration	
Week 6 Sep 23 ~ 27	Navigation (Encoder, Inertial, Magnetic, GPS) Lab #4: Basic Robot Navigation and Control	
Week 7 Sep 30 ~ Oct 04	Exam 1, Linear Kalman Filter No Lab	Due of Project Pre-Proposal
Week 8 Oct 07 ~ Oct 11	Extended Kalman Filter and Navigation Lab #5: Simple Kalman Filters	
Week 9 Oct 14 ~ 18	Mobile Robot Kinematics Lab #6: Kalman Filter Based Robot Navigation	
Week 10 Oct 21 ~ 25	Robot Control Lab #7: PID Control	
Week 11 Oct 28 ~ Nov 01	Reactive Navigation No Lab	
Week 12 Nov 04 ~ 08	Map Based Planning Lab #8: Reactive Navigation	Due of Project Full-Proposal
Week 13 Nov 11 ~ 15	Localization and Mapping Lab #9: Path Planning #1	
Week 14 Nov 18 ~ 22	Exam 2 Lab #10: Path Planning #2	
Week 15 Nov 25 ~ 29	Thanksgiving Break No Lab	
Week 16 Dec 02 ~ 06	Initial Project Demonstration and Team Presentation	
Week 17 Dec 09 ~ 13	Final Project Demonstration	Due of Project Final Report