



ECE 497: Special Topics: Introduction to Mobile Robotics*
Spring 2008 - 2009
3R-3L-4C

Description:

This course will introduce the basic principles of mobile robotics hardware and control. Topics will include robot components, effectors and actuators, locomotion, manipulation, sensors, feedback control, control architectures, representation, navigation and learning. This is a project-oriented course and the student will have hands-on experience with a real mobile robot. The student will be required to complete several laboratory assignments and a multidisciplinary team design project.

Prerequisites: ECE 320 or ME 406 (Control Systems) required
Programming Proficiency (JAVA, C# preferred) or
Instructor permission

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office hours: MTR – 5th hour, W – 7th hour

Required Textbook:

Matarić, M.J., “The Robotics Primer”, The MIT Press, Cambridge, Massachusetts, 2007, 300 pp,
ISBN 0-262-63354-X

<http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=11229>

http://roboticsprimer.sourceforge.net/workbook/Main_Page

References:

1. Arkin, Ronald C., “Behavior-Based Robotics”, The MIT Press, 1998
2. Bekey, George A., “Autonomous Robots: From Biological Inspiration to Implementation and Control”, The MIT Press, 2005
3. Jones, Joseph L., Flynn, Anita, M., and Seiger, B.A., “Mobile Robots: Inspiration to Implementation”, AK Peters, 1999
4. Martin, Fred G., “Robotic Explorations: An Introduction to Engineering through Design”, Prentice Hall, 2001
5. Murphy, Robin R., “Introduction to AI Robotics”, MIT Press, 2001
6. Siegwart, R. and Illah R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2004. (<http://autonomousmobilerobots.epfl.ch/>)

Hardware:

Traxster II Robot Kit programmed with Microsoft Robotics Studio (C#)

<http://www.roboticsconnection.com/p-15-traxster-robot-kit.aspx>

You and your lab partner will check out the robot for the quarter and it must be returned by the first day of finals week at the end of the quarter. You and your lab partner are solely responsible for the robot’s care and security. If the robot is **not** returned with all peripherals in its original condition, you will receive an incomplete in this course. If it is lost, you must purchase the robot and peripherals at a cost of **\$1800** in order to receive a grade in this course. The robot must be returned to the instrument room in the same condition it was received or the student will be charged the complete cost of repair or



replacement. You will receive a base robot on the first day of class and go to the parts room to check out additional peripherals such as the camera, sonar, and compass as needed.

Grading:

Grades will be assigned at the end of the quarter based on the grade weights and grading scale shown below:

Participation	10%	A	90 – 100
Quizzes	30%	B+	87 - 89
Laboratory Assignments	30%	B	80 – 86
Final Project	30%	C+	77 – 79
		C	70 – 76
		D+	67 – 69
		D	60 – 66
		F	Below 60

Participation:

Classroom participation actually counts toward your grade in this class. Not participating in classroom activities or excessive absences will have a measurable detrimental effect on your grade. You are expected to be attentive and engaged in the lecture (i.e. not sleeping, reading the newspaper, surfing the web, doing homework for other courses, disturbing others with electronics). As a rule of thumb, you should expect to put in **eight hours** per week outside of class reading the text, preparing for quizzes, completing the laboratory assignments and final project.

Quizzes:

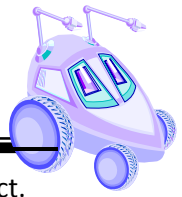
There are no exams in this course; however there will be daily quizzes over the required reading and lectures. These quizzes will represent 30% of your grade, equivalent to two exam grades. Robotics is a very theoretical and application-based field; there is minimal benefit to working with the robot in lab and not being informed about robot theory and history. Therefore it is *very important* to read the text and be conscientious about preparing for these quizzes.

Laboratory Assignments:

The purpose of the laboratory assignments is to prepare you to complete the final project. These assignments will be used to develop some of the robot’s basic behaviors and interface. The laboratory assignment will include a demonstration, submission of the code and implementation report in the Angel drop box. If there is a pre-lab associated with a laboratory assignment, it will be due at the beginning of the class prior to the laboratory demonstration. The pre-labs, demonstration and reports will receive a 20% late penalty if not submitted at the beginning of the class when they are due. A missed laboratory assignment **must** be made up but the students may not receive full or any credit for the lab report. **Always** bring your laptop computer and the robot fully charged to class. Laboratory reports must follow the format provided by the instructor. One laboratory report should be submitted per team and should be a product of the joint effort between the members. The team member roles should alternate on a weekly basis between programmer and technician.

Final Project:

The final project report and demonstration will be due on the last day of class. The final project demonstration may involve a team exhibition as well as a class competition. The final report must follow the same format as the laboratory reports. Each student will be required to submit confidential self and peer evaluations several times throughout the quarter. These evaluations will be your only opportunity to share information about your team dynamic and should be honest and fair. It should be



noted that it is possible for members of the same team to receive different grades on the final project.
No incomplete will be given on the final project.

Course Policies:

- Students are encouraged to check their RHIT email account daily for information regarding the class, the homework, exams and the labs. You are responsible for all information sent to your account from the professor, whether read or not.
- All students are expected to join in class discussion and all activities with a positive attitude. All students are expected to exhibit an attitude that is appropriate to a successful and fulfilling experience. Please leave the classroom and laboratory neater than you found it.
- Operating your computer in class for anything other than an approved course activity is not permitted. Students must not hinder the learning environment of their fellow classmates with any other distracting behavior such as talking, sleeping or reading the newspaper. Continued disruptive conduct will lead to the student being asked to leave class and marked absent for that class period. The student will remain responsible for all class assignments.

Attendance:

- Regardless of whether formal attendance is recorded, attendance at each class is expected. Experience has shown that regular attendance and engagement improves learning and consequently improves quiz and assignment performance. According to the Academic Rules and Procedures, “A student whose total absences in a course, excused or unexcused, exceed two per credit is liable to fail the course.” For the purposes of this class, that limit will be set at **no more than 8 absences per quarter.**
- Students are responsible for all information presented in class whether present or not.

Honor Policy:

- Rose-Hulman Institute of Technology does not tolerate plagiarism or cheating in any form. The penalties for these and other forms of academic misconduct range from a lowered course grade, through failure in the course, up to and including suspension from the Institute.

†Excused Absence (RHIT Academic Policies):

- Instructors will normally permit make-up work to be done when a student has legitimate conflicting obligations, such as illness or emergency, Institute-sponsored activities, plant trips or interviews. These conflicts do not excuse the student from course responsibilities. The student is responsible for informing the instructor of any legitimate excuses and making arrangements for make-up work, if permitted, as soon as possible. Whenever possible, the student must discuss unavoidable absences with instructors in advance.

***Disclaimer:**

This is the second time this course is being offered and it is still under development. Therefore, the instructor requests flexibility and patience as the course materials, format, hardware and homework, laboratory assignments are evaluated and modified as deemed necessary.



Course Schedule * :

Class	Day	Date	Topic	Reading	Assignment Due
1-1	M	3/9	Defining Robotics, History of Robotics	Ch. 1, 2	
1-2	T	3/10	<i>What's in a Robot?:</i> Robot Components	Ch. 3	Quiz 1 Pre-Lab 1
1-L	R	3/12	Lab 1 – Locomotion and Odometry		Lab 1 Report
2-1	M	3/16	<i>Wheels, Tracks and What Really Drives Them:</i> Effectors and Actuators	Ch. 4	Quiz 2
2-2	T	3/17	<i>Move It!</i> Locomotion Lab Recitation	Ch. 5	Quiz 3 Pre-Lab 2
2-L	R	3/19	Lab 2 – Sensor Calibration, Obstacle Avoidance		Lab 2 Report
3-1	M	3/23	<i>What's Going On?:</i> Sensors	Ch. 7	Quiz 4
3-2	T	3/24	<i>Switch on the Light:</i> Simple Sensors Lab Recitation	Ch. 8	Quiz 5 Pre-Lab 3
3-L	R	3/26	Lab 3 – Path (line) following, Wall following		Lab 3 Report
4-1	M	3/30	<i>Sonars, Lasers, and Cameras:</i> Complex Sensors	Ch. 9	Quiz 6
4-2	T	3/31	<i>Stay in Control</i> Feedback Control Lab Recitation	Ch. 10	Quiz 7 Pre-Lab 4
4-L	R	4/2	Lab 4 – Feedback Control		Peer Evaluation Lab 4 Report
5-1	M	4/6	<i>The Building Blocks of Control:</i> Control Architectures	Ch. 11	Quiz 8
5-2	T	4/7	<i>What's in your Head?</i> Representation Lab Recitation	Ch. 12	Quiz 9 Pre-Lab 5
5-L	R	4/9	Lab 5 – Color Blob, Person following		Lab 5 Report
6-1	M	4/20	Deliberative and Reactive Control	Ch. 13, 14	Quiz 10
6-2	T	4/21	Hybrid Control Lab Recitation	Ch. 15	Quiz 11 Pre-Lab 6
6-L	R	4/23	Lab 6 – Reactive Control		Peer Evaluation Lab 6 Report
7-1	M	4/27	<i>Think the Way You Act:</i> Behavior-Based Control	Ch. 16	Quiz 12
7-2	T	4/28	<i>Making Your Robot Behave:</i> Behavior Coordination Lab Recitation	Ch. 17	Quiz 13 Pre-Lab 7
7-L	R	4/30	Lab 7 – Hybrid Control		Lab 7 Report
8-1	M	5/4	<i>When the Unexpected Happens:</i> Emergent Behavior	Ch. 18	Quiz 14
8-2	T	5/5	<i>Going Places:</i> Navigation Lab Recitation	Ch. 19	Quiz 15 Pre-Lab 8
8-L	R	5/7	Lab8 – Behavior-based control		Peer Evaluation Lab 8 Report
9-1	M	5/11	Final Project – Emergent Behavior/Navigation		
9-2	T	5/12	Final Project – Emergent Behavior/Navigation		
9-L	R	5/14	Final Project – Emergent Behavior/Navigation		
10-1	M	5/18	Final Project – Emergent Behavior/Navigation		
10-2	T	5/19	Final Project demonstration		Peer Evaluation
10-L	R	5/21	Final Project competition		Final Project Report

*This course is under development and the schedule, topics and assignments may be modified at the discretion of the instructor