CSE 4360 / CSE 5364
Autonomous Robots

Spring 2014 - TTh 5:00 - 6:20

Instructor: Manfred Huber (huber@cse.uta.edu)

1 Course Description

Contents and Objectives:

This course is an introduction to Robotics from a computer science perspective and aimed at establishing the basis for the design and programming of autonomous robot systems. It covers basic kinematics, dynamics, and control as well as motion planning, sensors, and artificial intelligence techniques for robot applications. Emphasis is given to the application of these techniques to simulated and real robots. Throughout the course students will work individually and in groups to analyze robot control problems and to design hardware and software solutions. Students successfully completing this course will be able to write basic control programs for different robot platforms and to apply state-of-the-art artificial intelligence techniques to the control of robotic mechanisms.

Prerequisites:

Prerequisites include CSE 2320 and CSE 3442. Of particular importance is knowledge of the programming language C since all programming assignments will be using this language.

Course Materials:

This course draws from a number of different books. Selected parts of other textbooks will be used as part of the course readings. Copies of these materials will be put on reserve in the Physical Science Library. Additional course materials such as assignments and example solutions will be available electronically on the course web page. Changes and corrections, if any, will also be announced by e-mail.

Computer Access:

This course will use UNIX as the operating system for all programming assignments. For this purpose all students will have access to computers in the Robotics Teaching Laboratory and to OIT supported unix computers (e.g. Omega) Additional details will be announced in class.

Tentative Office Hours:

Office hours for the course will be held by the instructor in ERB 522 or in ERB 128,
TTh 3:30 - 4:30 and TTh 6:30 - 7:00, or by appointment. Times are subject to change and will be posted. If for some reason you can not make it to any of these office hours, please inform the instructor.
e-mail: huber@cse.uta.edu

E-mail and WWW page:

There is a course web page at http://ranger.uta.edu/∼huber/cse4360 . All changes and supplementary course materials will be available from this site. In addition, necessary changes or important announcements will be distributed by e-mail. By default e-mail will be sent to your UTA account.

2 Assignments and Grading

Homework Assignments:

There will be 3 homework assignments in this course. The assignments consist of written parts as well as programming exercises on simulated robot mechanism and are due in or before class on the date indicated on the assignment. Solutions will be posted shortly after on the web page. Late assignments will not be accepted and extensions will only be granted in extreme situations. If you find yourself in such a situation and can not deliver a homework on time, immediately inform the instructor. Homework solutions must be your work only. Violations of this will not be tolerated and result in severe penalties for all parties involved.

Projects:

For the 3 projects groups of 2-3 students will be formed. Each project will involve designing and programming of a real robot system to solve a given task. At the end of each project, the programmed robot system has to be presented and a project report describing the design decisions made has to be delivered. Again, no extensions are generally granted for projects. If for any reason you can not finish the project or deliver the report in time, inform the instructor as early as possible.

Exam:

The exam is closed book, closed notes and will cover the materials until "Adaptation and Learning" with an emphasis on the more theoretical aspects. As in the case of homework extensions, a make-up exam will only be given in extreme situations. If for any such reason you can not attend the exam, inform the instructor.

CSE 5364:

For students enrolled in the graduate section CSE 5364 the homework assignments, as well as the exam will contain additional problems which are not required for students of CSE 4360.

Grading Policy:

The final grade will be calculated using the following policy:

Homework Assignments	35 %
Group Project 1	20 %
Group Project 2	10 %
Final Project	25 %
Exam	10 %

3 Class Schedule

CSE 4360 / CSE 5364 - Autonomous Robots
Tentative Lecture and Assignment Schedule
Spring 2014 - TTh 5:00 - 6:20

Class	Date	Readings	Lecture Topics	Assignments
1	01/14		Course Details and Overview	
2	01/16	Craig Ch. 2	Introduction to Robot Systems	
3	01/21	Craig Ch. 3	Forward Kinematics	
4	01/23		Forward Kinematics continued	
5	01/28	Craig 5.1 -5.8	Jacobian	
6	01/30	Craig 4.1 - 4.4	Inverse Kinematics	
7	02/04	Craig 9.1 - 9.5	Robot Dynamics and Control	
8	02/06		Control and System Identification	
9	02/11	Latombe pp 153 - 161, 169 - 175	Robot Motion Planning - Roadmaps	
10	02/13	Latombe pp 200 - 207, 248 - 268	Robot Motion Planning - Cell Decomposition	
11	02/18	Latombe pp 295 - 334	Robot Motion Planning - Potential Field Approaches	Homework 1 due
12	02/20		Nonholonomic Motion Planning	
13	02/25	Everett Ch. 2	Robot Sensors	
14	02/27	Everett pp 91-97	Robot Sensors	
15	03/04	Ballard 3.1 - 3.3.4	Basic Vision	
16	03/06		**Group Project 1 Presentations**	
	03/11	*Spring Break - No Class*		
	03/13	*Spring Break - No Class*		
17	03/18	Ballard 5.1 - 5.3	Basic Vision	
18	03/20	Dorst pp. 9 - 51 (by J.Crowley)	Sensing and Control	
19	03/25	Elfes & Burgard	Sensors, Map Construction, and Motion Planning	
20	03/27	Braitenberg Ch. 1 - 5	Intelligent Robot Behavior	Homework 2 due
21	04/01	Arkin 1.3 - 1.4, 4.1 - 4.3	Robot Control Architectures	
22	04/03	Arkin 4.4 - 4.7	Robot Control Architectures	
23	04/08		Robot Control Architectures	
24	04/10	Haykin 8.3 - 8.5, 6 - 6.4	Adaptation and Learning	
25	04/15		**Group Project 2 Presentations**	
26	04/17		Adaptation and Learning	
27	04/22	Arkin 8 - 8.4	Adaptation and Learning	
28	04/24		**Exam**	
29	04/29		Integrated Systems	
30	05/01		Summary	Homework 3 due
31	05/06		**Final Project Presentations**	

Recommended Readings from:

- John J. Craig, *Introduction To Robotics*, Addison Wesley
- Jean-Claude Latombe, *Robot Motion Planning*, Kluwer Academic Publishers
- H. R. Everett, *Sensors for Mobile Robots*, A K Peters
- Dana H. Ballard and Christopher M. Brown, *Computer Vision*, Prentice-Hall
- L. Dorst, M. Lambalgen, F. Voorbraak (Eds.), *Reasoning with Uncertainty in Robotics*, Springer
- Alberto Elfes, *Using Occupance Grids for Mobile Robot Perception and Navigation*, in IEEE Computer 22(6)
- W. Burgard, D. Fox, D. Henning, T. Schmidt, *Estimating the Absolute Position of a Mobile Robot Using Position Probability Grids*, in Proc. of AAAI 1996
- Valentino Braitenberg, *Vehicles*, MIT Press
- Ronald C. Arkin, *Behavior-Based Robotics*, MIT Press
- S. Haykin, *Neural Networks*, Macmillan Publishing

This schedule is tentative and subject to change. If changes are necessary they will be announced in class and posted in the schedule on the course page.

4 University Policies and Services

Grade Grievances:

Any appeal of a grade in this course must follow the procedures and deadlines for grade-related grievances as published in the current undergraduate catalog.

Drop Policy:

The standard UTA drop policy applies to this course. Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. Students will not be automatically dropped for non-attendance. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/ses/fao).

Americans With Disabilities Act:

The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

Academic Integrity:

All students enrolled in this course are expected to adhere to the UT Arlington Honor Code: I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence. I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

Instructors may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System Regents' Rule 50101, paragraph 2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Student Support Services:

UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at www.uta.edu/resources.

Electronic Communication:

UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

Student Feedback Survey:

At the end of each term, students enrolled in classes categorized as lecture, seminar, or laboratory shall be directed to complete a Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit http://www.uta.edu/sfs.

Final Review Week:

A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures:

Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit, which is located to the right when exiting the room. When exiting the building during an emergency, one should never take an elevator but should use the

stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist handicapped individuals.