

# CSE 4360 / CSE 5364

## Autonomous Robots

Spring 2013 - TTh 5:00 - 6:20

Instructor: Manfred Huber ( [huber@cse.uta.edu](mailto: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 6:30 - 7:30, 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](mailto: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 2013 - TTh 5:00 - 6:20				
Class	Date	Readings	Lecture Topics	Assignments
1	01/15		Course Details and Overview	
2	01/17	Craig Ch. 2	Introduction to Robot Systems	
3	01/22	Craig Ch. 3	Forward Kinematics	
4	01/24		Forward Kinematics continued	
5	01/29	Craig 5.1 -5.8	Jacobian	
6	01/31	Craig 4.1 - 4.4	Inverse Kinematics	
7	02/05	Craig 9.1 - 9.5	Robot Dynamics and Control	
8	02/07		Control and System Identification	
9	02/12	Latombe pp 153 - 161, 169 - 175	Robot Motion Planning - Roadmaps	
10	02/14	Latombe pp 200 - 207, 248 - 268	Robot Motion Planning - Cell Decomposition	
11	02/19	Latombe pp 295 - 334	Robot Motion Planning - Potential Field Approaches	Homework 1 due
12	02/21		Nonholonomic Motion Planning	
13	02/26	Everett Ch. 2	Robot Sensors	
14	02/28	Everett pp 91-97	Robot Sensors	
15	03/05	Ballard 3.1 - 3.3.4	Basic Vision	
16	03/07		<b>Group Project 1 Presentations</b>	
	03/12		<i>Spring Break - No Class</i>	
	03/14		<i>Spring Break - No Class</i>	
17	03/19	Ballard 5.1 - 5.3	Basic Vision	
18	03/21	Dorst pp. 9 - 51 (by J.Crowley)	Sensing and Control	
19	03/26	Elfes & Burgard	Sensors, Map Construction, and Motion Planning	
20	03/28	Braitenberg Ch. 1 - 5	Intelligent Robot Behavior	Homework 2 due
21	04/02	Arkin 1.3 - 1.4, 4.1 - 4.3	Robot Control Architectures	
22	04/04	Arkin 4.4 - 4.7	Robot Control Architectures	
23	04/09		Robot Control Architectures	
24	04/11	Haykin 8.3 - 8.5, 6 - 6.4	Adaptation and Learning	
25	04/16		<b>Group Project 2 Presentations</b>	
26	04/18		Adaptation and Learning	
27	04/23	Arkin 8 - 8.4	Adaptation and Learning	
28	04/25		<b>Exam</b>	
29	04/30		Integrated Systems	
30	05/02		Summary	Homework 3 due
31	05/08		<b>Final Project Presentations</b>	

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.