UNIVERSITY OF MINNESOTA
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

FALL 2016

CSci 5551: INTRODUCTION TO INTELLIGENT ROBOTIC SYSTEMS

3 Credits

Class Schedule: Tu. and Th. 2:30-3:45pm, KHKH 3-115
Class URL: http://mars.cs.umn.edu/classes/csci5551
Undergraduate Robotics Lab: KHKH 1-202

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TAs' Office Hours: Mon. and Wed. 1:00-2:00pm, or by appointment

1 Course Objective

The objective of this course is to introduce students to the principles of robotics. The main topics of interest covered in the textbook include: transformations in 3D, kinematics, inverse kinematics, dynamics, and control. Later in the semester we will address issues related to mobile robots, primarily sensing, estimation, and autonomous navigation. Robot programming will be discussed in the context of the final project.

Upon successful completion of the course, students must be able to:

- Apply transformations in 3D
- Describe rotations in space using quaternion algebra
- Derive models for the forward and inverse kinematics of a manipulator.
- Describe the dynamics of a manipulator
- Implement simple robot control laws
- Evaluate the computational complexity of these algorithms
- Describe robot sensing techniques
- Understand the real-time control and programming issues
- Understand the principles of operation for mobile robots

2 Topics Covered

During this course the following topics will be covered:

- Transformations
- Kinematics
- Inverse kinematics
- Jacobians
- Dynamics
- Trajectory generation
- Robot sensing & control
- Robot programming
- Mobile robot navigation

3 Textbook

[1] J. Craig, "Introduction to Robotics: Mechanics and Control," Pearson Prentice Hall, NJ, 3rd edition, 2004 (ISBN: 0201543613).

4 Grading

The grade for this course will consist of the following components (2 options):

• Option 1:

Homeworks	30%
Midterm Exam	30%
Project Presentation	10%
Project Demonstration	10%
Project Report	20%

or

• Option 2:

Homeworks	30%
Midterm Exam	30%
Final Exam	40%

4.1 Homeworks

Homeworks will include primarily theory problems and a few short programming assignments. These will help you understand the material and monitor your progress. Programming assignments should be implemented either in Matlab or C/C++. There will be 4-5 homework assignments during the semester, depending on the material covered.

Homeworks are due at the **beginning** of the lecture, usually 1-2 weeks after the hand out. Homeworks submitted one class session late will be penalized by a 20% grade reduction. No homeworks will be accepted after that point. Solutions to the homework problems will be distributed.

4.2 Midterm Exam

The Midterm Exam will be in mid November on material covered up to that point.

4.3 Project (Option 1)

Projects should take one of the following forms:

- Experimental work. Examples will be given during the course of the class (e.g., robot parallel parking, robot platoons, assisted teleoperation, person following, object manipulation, etc). Suggestions are also welcome; please contact the instructor for discussing your topic idea.

- Theoretical work (problem description & formulation, mathematical derivation of the solution, comparison to related work).

You may decide to work in groups of 4-5 if the content of the proposed work is sufficient for the size of the group (`consult with the instructor`).

Students should write a 5-7 page description (technical report) of their project and give a short presentation towards the last two weeks of the semester. This report and presentation will count for 30% of the total class grade. The project demonstration accounts for 10% of the total grade.

If you choose to do experimental work, you may use the Pioneer mobile robots or the Baxter dual-arm industrial robot located at the Undergraduate Robotics Laboratory (KHKH 1-202).

4.3.1 Project Schedule

- October 20: Initial report – 1 page project proposal (if different from the ones suggested in class).

- November 17: Intermediate report – 2 pages describing your current progress on the project.

- December 22: Final report – 5-7 page detailed description including results and list of references to related work.

4.4 Final Exam (Option 2)

Students who select to take the Final Exam, this will be comprehensive exam and will take place on Thursday, December 22, 10:30am-12:30pm.

5 Cheating and Plagiarism

The homeworks must not be the result of cooperative work. Each student must work individually in order to understand the material in depth. You may discuss the issues but by no means copy the homework or the project of somebody else. All work in the projects must properly cite sources. For example, if you quote a source in your project report, you must include the quote in quotation marks and clearly indicate the source. Any student caught cheating will receive an "F" as a class grade and the University policies for cheating and plagiarism will be followed.

6 Class Schedule

`Check the class webpage regularly for schedule updates and announcements.`