UNIVERSITY OF MINNESOTA
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

FALL 2017

CSci 5551: INTRODUCTION TO INTELLIGENT ROBOTIC SYSTEMS

3 Credits

Class Schedule: Mo. and We. 1:00pm-2:15pm, KHKH 3-125
Class URL: On Moodle
Undergraduate Robotics Lab: KHKH 1-202

Instructor: Junaed Sattar
Office: KHKH 4-203
E-Mail: junaed@umn.edu
Office Hours: Mo. and We. 10:00pm-11:00pm, or by appointment

Teaching Assistant: Md Jahidul Islam (& ?)
Office: TBA
E-Mail: islam034@umn.edu (& ?)
TAs' Office Hours: TBA 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, 4th edition, 2017 (ISBN-13: 9780133489798).

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 Homework

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, C/C++ or Python. 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 early to 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, human-robot collaboration, visual tracking and servoing, action recognition, etc). Suggestions are also welcome; please contact the instructor to discuss your topic ideas.
- Theoretical work (problem description & formulation, mathematical derivation of the solution, comparison to related work).

You may decide to work in groups of 3-4 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, and other available equipment (including sensors and computing hardware) in 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 19: Final report – 5-7 page detailed description including results and list of references to related work.

4.4 Final Exam (Option 2)

For students who choose to take the final – this will be **comprehensive** and will take place on **Saturday, December 16, 8am-10am**.

5 Cheating and Plagiarism

It is expected that these policies would not need enforcement, but it is necessary to state cheating and plagiarism policies. Homework 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. University policies for cheating and plagiarism will be followed; specifically for this class:

- Any student caught cheating (even for a first-time offense) in an exam or homework will receive a zero in that assignment or exam.
- A repeat offense will result in an "F" as a class grade.
- The instructor and the TA(s) reserve the right to investigate previously-graded submissions if suspicions of plagiarism arise. In the case that instances of plagiarism is found in past submissions, the same policy will retroactively apply.
- In either case a student will be reported to the OCS (The Office of Community Standards).

Students are encouraged to visit the OCS website (at https://communitystandards.umn.edu/) to familiarize themselves with policies.

6 Class Schedule

Check the class Moodle page regularly for schedule updates and announcements.