Syllabus: CS 5970-002: Mobile Manipulation
(Spring 2012)

Mobile Manipulators are robotic systems that are capable of navigating through and interacting with unstructured environments in order to perform a wide range of tasks. Designing control systems for this domain is a non-trivial process, due in part to the complexities of constructing and manipulating flexible and extensible representations of the environment, motor action and task. In this seminar course, we will study the representation, learning, planning and control techniques that are currently driving this field forward.

General Information

- Meeting time: Tu/Th 1:30-2:45
- Location: CEC 123
- Prerequisites: permission of the instructor. Students need to have a solid background in a language such as C or C++ (or an ability to learn quickly) and mathematics (linear algebra, calculus, probability and statistics). Useful background includes: artificial intelligence, machine learning, robotics, control systems, and/or embedded systems.
- Reading Materials: we are drawing from online sources for our reading.
- We will be doing all of our robot simulation and control work within the Robot Operating System (ROS). This package is available for free, but works primarily under the Ubuntu distribution of linux. You are responsible for making sure that you have adequate access to ROS (note that it is installed on the linux machines in the DEH cluster).
- Other key materials:
  - Doxygen: [http://www.stack.nl/~dimitri/doxygen/](http://www.stack.nl/~dimitri/doxygen/)
- We will also be making heavy use of Desire to Learn
- Instructor: Dr. Andrew H. Fagg
  - Office: DEH 243
  - Phone: 325-8606
  - Homepage: [http://www.cs.ou.edu/~fagg](http://www.cs.ou.edu/~fagg)
  - Email: fagg@cs.ou.edu
  - Office hours: see the office hours web page [http://www.cs.ou.edu/~fagg/office.html](http://www.cs.ou.edu/~fagg/office.html)
Course Goals and Topics

By the end of this course, you should be able to:

- read and present technical materials in the areas of machine learning and robotics;
- employ techniques for planning (and replanning) courses of action to achieve a goal;
- design, implement and debug control systems for integrated sensory processing and control; and
- work in collaborative teams.

This is a very hands-on class: every student will be involved in the design, implementation, and programming for the project work. Note that this component of the class will involve a non-trivial amount of time; students should plan their schedules accordingly.

Topics will include:

- Grounding conceptual knowledge in sensorimotor interaction.
- Constructing generalizable, task-oriented representations of the robot, environment and task.
- Planning under uncertainty and with incomplete information.
- Human-robot interaction for learning and cooperative task execution.
- Integrated planning and execution of whole body movements.
- Grasp/manipulation planning and execution.

Course Policies

- **Attendance:** This is a very discussion-oriented course. While keeping up with the readings is an important step to take, it is not a substitute for attending class.

- **Class Web Page:** Most of the material that you will need can be found on the class web page located at: [http://www.cs.ou.edu/~fagg/classes/mobile_manipulation_2012](http://www.cs.ou.edu/~fagg/classes/mobile_manipulation_2012)

- **Desire to Learn:** This class will also use D2L, located at: [http://learn.ou.edu](http://learn.ou.edu)

Login with your 4+4 (typically the first four letters of your last name followed by the last four digits of your student number), using your standard OU password. If you have difficulty logging in, call 325-HELP. This software provides a number of useful features, including a list of assignments and announcements, an electronic mailing list, newsgroups, and a grade book.

I will update the main web site and the D2L page several times a week. When I update the site in any significant way, I will post an announcement on D2L telling you what has been added and where it is located. You are responsible for things posted on the site within 48 hours of the post.
Class Email Alias: Urgent announcements will be sent through email. It is your responsibility to:

- Have your university supplied email account properly forwarded to the location where you read email.
- Make sure that your email address in D2L is correct, and forwards email to the place where you read it. I'll send out a test message during the first week of class. If you do not receive this message, it is your responsibility to get the problem resolved immediately.
- Have your email program set up properly so that replying to your email will work correctly the first time. You can send email to yourself and reply to yourself to test this. I will not make any attempt to get bounced email messages delivered.

If you need assistance in accomplishing any of these tasks, contact 325-HELP.

Final Examination: The final exam period is Friday, May 11th from 1:30 to 3:30. We will use this time for final demonstrations and presentations.

Newsgroups and Email: The newsgroup on D2L should be the primary method of communication (outside of class). This allows everyone in the class to benefit from the answer to your question, and provides students with more timely answers since I and the rest of the students will read your message and can respond. Matters of personal interest should be directed to email instead of to the newsgroup, e.g. informing me of an extended personal illness. Posting guidelines for the newsgroup are available on D2L.

Proper Academic Conduct: For each of the paper readings, everyone will be turning in a half page summary of each research paper. This writing is to be your own.

For the project work, everyone is expected to make a nontrivial personal contribution. This contribution can include the design and development of different components of the robot control system, a detailed presentation or document that explains the proper use of complicated external components, the development of a useful "world" that the robots can manipulate, or the nontrivial assembly of existing components to solve a larger problem. Project work will be done in groups of 2-3. However, we will be sharing components across groups and we will be drawing components from the net. When you adopt a component from outside of your group, you must properly document its source.

Handing in written summaries that are not your own or claiming code to be yours when it is not is considered cheating and will result in the submission of a academic misconduct complaint. The complaint will be submitted to the OU Academic Integrity Office. Details of the procedures are available at the OU Integrity Website.

Note that the programs and the written summaries will be checked by software designed to improper copying. This software is extremely effective and has withstood repeated reviews by the campus judicial processes.

Incompletes: The grade of "I" is intended for the rare circumstance when a student who has been successful in a class has an unexpected event occur shortly before the end of the class. I will not consider giving a student a grade of "I" unless the following three conditions have been met:

- It is within two weeks of the end of the semester.
- The student has a grade of C or better in the class.
- The reason that the student cannot complete the class is properly documented and compelling.
Accommodation of Disabilities: The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in Goddard Health Center, Suite 166, phone 405/325-3852 or TDD only 405/325-4173.

Classroom Conduct: Because cell phones and laptops can distract substantially from the classroom experience, students are asked not to use either during class (except in cases in which the laptop is required as part of a classroom exercise).

Disruptions of class will also not be permitted. Examples of disruptive behavior include:
- Allowing a cell phone or pager to repeatedly beep audibly.
- Playing music or computer games during class in such a way that they are visible or audible to other class members.
- Exhibiting erratic or irrational behavior.
- Behavior that distracts the class from the subject matter or discussion.
- Making physical or verbal threats to a faculty member, teaching assistant, or class member.
- Refusal to comply with faculty direction.

In the case of disruptive behavior, I may ask that you leave the classroom and may charge you with a violation of the Student Code of Responsibilities and Conduct.

Grades

Grades will be computed according to the following distribution:

- In-class participation: 16%
- Paper presentation: 5%
- Twelve written summaries: 24%
- Project work: 55%

In-Class Participation

All students are expected to actively participate in class discussions. Come to class with questions, ideas and demonstrations.

Paper Presentations

Each student will be responsible for presenting and leading the subsequent discussion for one week's worth of research papers (this will be either one or two papers). We will settle on the list of papers and the assignments in the first week of class. Guidelines for these presentations will be available before the first presentation.

Written Summaries

A one half page summary of each research paper is due at the beginning of class on the day that we are discussing the paper. These summaries must be handed in using D2L. Late or missing summaries will be logged as a zero grade. Guidelines for these summaries will be distributed before the first one is due.
Project Grades

The primary unit of project work is a group of 2-3 people. However, individuals may work on components on their own. Furthermore, components may be borrowed from other groups in the class or from existing repositories. Project components are turned in using our mobile manipulation subversion tree. They may be turned in any time prior to the final class presentation (but don't wait).

The rules for assessing project grades are as follows:

- A total of 100 individual project points is equivalent to full project credit for the class (55% of your grade). You will accumulate project points over the course of the semester.
- A project component is worth a maximum of 30 points. A component of this size is approximately equal to one person working for 3 solid weeks (about 18 hours).
- Smaller components will be common and will be worth less than the 30 points.
- 50% of the component points are earned through the implementation; 50% are earned through high-level and function-level documentation (the latter must make use of doxygen).
- Component values are negotiated. Before the component is complete, you may get an assessment of approximate value. However, final value is assessed at the time of grading.
- Significant modifications to an already graded component may be considered as a separate component for grading purposes. In particular, this will be considered if the modifications are in response to requests from other groups.
- Project component points are split between the class members who work on it. Generally, the split will be equal, but the instructor is open to other splits.
- You may officially release your component to the entire class. If another group uses your component for one of their graded components, then you may receive up to 10% of their grade (this 10% is not subtracted from the other group). This "trickle-down" is limited: if one group repeatedly uses your component for several of their components, then the return will be discounted.
- Individuals can offer a bounty for the implementation or modification of a shared component. The agreement must be sent in email to the instructor and include the number of project points that you are putting up, the requested functionality and the expected timeline. Upon completion of the request, the agreed upon project points will be transferred. The instructor reserves the right to mediate in any disagreements.
- In order to initiate the grading process, a component must be presented/demoed in class.

General Grade Issues

- **Grade questions:** If you have a question about grading (including assessment of points), you may address these during office hours or email. Note that if you are asking me to reconsider a grade, then I will likely re-examine the entire project. You have one week from the point that you receive feedback to address grading questions.
- **Desire to Learn Grade Summary:** D2L has a grade book that is used to store the raw data that is used to calculate your course grade. It is the responsibility of each student in this class to check their grades on D2L after each project. If an error is found, please bring it to my attention.

Copyright notice: Many of the materials created for this course are the intellectual property of Andrew H. Fagg. This includes, but is not limited to, the syllabus, lectures and course notes. Except to the extent not protected by copyright law, any
sale of such materials requires the permission of the instructor.