Computer Science 6912
Graduate Course:
Autonomous Robotics

Memorial University of Newfoundland
Spring, 2017

Instructor: Dr. Andrew Vardy

Office: EN-2018
E-mail: av followed by the ‘at’ symbol, then mun.ca

Web page: www.cs.mun.ca/~av/courses/4766-current

Lectures: Mon, Wed, Fri from 12:00 - 12:50 in EN-1052

Labs: Wednesdays from 9:00 - 11:50 in EN-1049. The lab slot will be used for technology demonstrations and for students completing group assignments to demonstrate their work. The lab slot will not be used every week.

Instructor Office Hours: 1:00 - 3:00 on Tuesdays. You can also email to arrange an appointment outside of office hours.

Calendar Description:

Introduction to Autonomous Robotics examines the fundamental constraints, technologies, and algorithms of autonomous robotics. The focus of this course will be on computational aspects of autonomous wheeled mobile robots. The following topics will be covered: major paradigms in robotics, methods of locomotion, kinematics, simple control systems, sensor technologies, stereo vision, feature extraction, modelling uncertainty of sensors and positional information, localization, SLAM, obstacle avoidance, and 2-D path planning.
Course Outline:

- Introduction: Major paradigms in robotics
- Mobility: Methods of locomotion; kinematics; motion control; coordinate transforms
- Perception: Sensor technologies; stereo vision; feature extraction
- Localization and Navigation: Belief representation; Bayes filter; Markov localization; particle filter; Kalman filter; simultaneous localization and mapping (SLAM)
- Motion Planning: Obstacle avoidance; path planning
- Biologically-Inspired Robotics

Textbook: There is no required textbook, but the following texts may prove useful to supplement the material presented in class. Note that the Siegwart et al. book is available electronically from the university library:


References:


Prerequisites:

Students should have a solid background in computer programming, algorithms, calculus, linear algebra, and statistics. Such a background may have been obtained through completion of the following courses at Memorial: COMP 2711, MATH 2000, MATH 2050, and STAT 2510. Assignments will require the use of ROS (Robot Operating System) and the Python programming language. ROS will be introduced through completion of the assignments. It is expected that students will be able to develop sufficient knowledge of Python on their own.

Revised: May 8, 2017
Evaluation scheme:

<table>
<thead>
<tr>
<th>Assignment (5 @ 6%)</th>
<th>30%</th>
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<tbody>
<tr>
<td>Presentation</td>
<td>7.5%</td>
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<tr>
<td>Project</td>
<td>12.5%</td>
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<tr>
<td>Mid-term Exam</td>
<td>15%</td>
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<td>Final Exam</td>
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Presentation:

Each student will prepare a presentation on a modern research paper in robotics. The paper should be chosen from the proceedings of one of the main conferences in robotics:

- IEEE/RSJ International Conference on Intelligent Robots and Systems
- IEEE International Conference on Robotics and Automation

The proceedings for both of these conferences are available through IEEE Xplore, which is accessible through the university library’s web site. Papers published in other respectable conference proceedings and journals may also be acceptable. The paper chosen should be reasonably self-contained so that it can be explained without having to go through all of its references. It should also present additional material beyond what is discussed in class.

Students should select two different topics of interest and for each topic submit a recent paper (2010+), plus an older paper which the recent paper builds upon. Thus, a total of four papers should be provided as PDF files to the instructor by the paper selection deadline. The instructor will consult with the student to discuss which paper is most suitable for presentation.

Project:

The project will involve implementation of one or more of the concepts developed in the presented paper. The student should discuss the scope of the implementation with the instructor. It is crucial that some experimental results be demonstrated either in simulation or using physical robots.

The project can be completed either individually or in groups of two. Projects completed by groups will be held to a significantly higher standard of accomplishment.
Tentative schedule:

Assignment 1 (Individual) 17 May
Assignment 2 (Individual) 31 May
Assignment 3 (Group) 14 June
Mid-term Exam 16 June
Paper selection 23 June
Assignment 4 (Group) 5 July
Assignment 5 (Individual/Group) 19 July
Presentations July (Dates TBD)
Project interim demo 26 July
Project final demo 2 August

Labs:

ROS Tutorial Lab 10 May
Assignment Demonstrations (See table above)
Assignment 3 Prep 7 June
Assignment 4 Prep 28 June
Project Demonstrations (See table above)

Note: The schedule for significant events (assignments, labs, mid-term exams, ...) will be posted online. This schedule is subject to change. Any such change will be announced in class.

Assignments:

The first two assignments will be completed individually. Remaining assignments can be completed individually or in groups of two. However, assignments with a hardware component must be done in pairs. In both cases, the assignments will consist of small analysis/programming projects. Depending upon the nature of each assignment, some written work may be required in addition to a programming component. The programs written will usually serve as controllers for simulated robots. We will make extensive use of ROS (Robot Operating System) and Python for the assignments.

Evaluation of both individual and group assignments will take place during the lab slot and will involve a demonstration component.

Other Info.

- Note that there will be an assignment due during the last two weeks of term.

- Late assignments and missed tests will only be accepted in case of illness, childbirth, or bereavement, or by prior arrangement with the Instructor. In case of illness, you should obtain a doctor’s certificate prior to the test time or due time.

Revised: May 8, 2017
• If you feel any mark was unfair or incorrectly recorded, ensure that I am aware of the problem before the final exam. *No reconsideration of term marks will be made after the final exam.*

• Cases of academic offences will be dealt with in accordance with the University Regulations. Academic offences includes: copying, allowing work to be copied, failing to cite sources, and presenting work done in collaboration as one’s own. Please read Section 11.4 of the University Regulations or consult the Instructor, if you need clarification as to what constitutes an academic offence.