MECH 450-010: Robot Motion Planning and Control

Fall 2018

Course Information and Policies:

Instructor:
Subhrajit Bhattacharya (sub216)

Lectures:
Time: Tue & Thurs, 2:35pm-3:50pm;
Location: Linderman Library, Room: 404

Office Hours:
Fridays 11:30am-12:30pm, Packard Lab, Room 562, or, by appointment.

Text Books:
We will use the following reference texts (any edition should be fine) for this class:

1. "Planning Algorithms" by Steve LaValle.
   Available for free download at http://planning.cs.uiuc.edu/
2. "Principles of Robot Motion: Theory, Algorithms, and Implementation" by Choset, et. al.
   Details available at http://biorobotics.ri.cmu.edu/book/
3. "Probabilistic Robotics" by Sebastian Thrun
   Details available at http://www.probabilistic-robotics.org/
4. "A Mathematical Introduction to Robotic Manipulation" by Richard Murray
   Details available at https://www.cds.caltech.edu/~murray/books/MLS/

You need not own a copy of all or any of these books as long as you can get access to these books at the Library.

Catalog Description for MECH 450 (Robot Motion Planning and Control)
This course will start with an introduction to the configuration spaces and kinematics of different robotic systems, including holonomic & non-holonomic mobile robots, spatial robots, and robotic manipulators. Following that basic motion planning algorithms, including potential & navigation function-based motion planning and graph search based motion planning, will be introduced. Sensor-based motion planning and motion planning under uncertainties using probabilistic representations will be introduced. Students will learn about estimation and filtering (Kalman filter, Markov filter, particle filters) and probabilistic robot action models (Markov chains, Markov decision processes, POMDP). Students will get hands-on experience in implementing the algorithms on MATLAB/C++. Application to multi-robot coordination problems, multi-robot coverage problems, pursuit-evasion problems, task allocation problems and exploration problems will be discussed. If time permits, students will be briefly introduced

to topological motion planning, motion planning on manifolds and motion planning on flow fields. The evaluation will be based on two term projects and a final presentation.

Software and Programming Languages:
In this course we'll use MATLAB (alternatively, Octave) and some C++. MATLAB is available for your use through Lehigh University's LTS: https://software.lehigh.edu/install/ . While GNU's C++ compiler is open-source and free, you can download Microsoft's C++ compiler (Visual Studio) from Lehigh University's LTS as well. While I may run a few simple in-class tutorials on these programming lnguages, if you have never used either of these before, it is expected that you'll self-teach yourself the basics of these programming languages as required.

Grading Policy:
- There will be **weekly/bi-weekly assignments** (reading and programming assignments), which you will not need to turn in and on which you'll not be graded. It is however important that you work on the assignments in order to properly learn the class material and be able to do well in the term projects.
- You will need to select **two term projects** to work on, on which you'll be graded. Each project will be worth 30% of the total course credit.
  - You'll need to submit a 4-8 page report for each of two projects (the first project report will be due around end of October, and the second project report will be due by the end of the semester).
  - You will also need to make a single 15-20 min presentation of your work closer to the end of the semester.
  - You will have significant freedom in choosing your own topic(s) for the projects, and you are encouraged to choose a topic that closely aligns with (or is an extension of) your current research area, if any.
  - You are free to consult the internet for working on your projects. But your projects should be your own individual and original work.
- The remaining 40% of the total course credit will be on **class participation**.

Electronic Devices:
- All cell phones, PDAs, tablets, smart watches and the like should be silenced/turned off and stowed off and out of sight during class.
- You are free to consult the internet for working on your projects. But your projects should be your own individual and original work.

Academic Integrity:
Students are expected to be familiar with all the academic integrity principles of Lehigh University. Please visit the Academic Integrity Resources page for details: https://citl.lehigh.edu/academic-integrity-resources

Accommodations for Students with Disabilities
If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the *Office of Academic Support Services, Williams Hall, Suite 301* (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

The Principles of Our Equitable Community
Lehigh University endorses The Principles of Our Equitable Community (http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.