Fall 2023

ME 625-101: Introduction to Robotics

Petras Swissler

Introduction to Robotics

Instructor

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Lecture: Thursday 6PM – 8:50 PM, FMH 321
Office Hours: Thursday 10:00 – 12:00, ME326
(notice will be given for any deviations from these office hours)

Website

Canvas, Slack

Course Text

Lecture slides will generally be uploaded to Canvas before the lecture

Recommended Reading

No textbooks are required for this course, however there are several books that you may find useful to have access to:

- Modern Robotics by Lynch and Park, 1st Edition. ISBN: 1107156300
- Probabilistic Robotics by Thrun, Burgard, and Fox, 1st Edition. ISBN: 0262201623
- Artificial Intelligence by Russel and Norvig, 4th Edition. ISBN: 9356063575

Electronics Kit

For project 3, students will be required to purchase several electronic components. The estimated cost is approximately $100.

Prerequisites

Matrix analysis, Dynamics, Matlab programming

Learning Objectives

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

1) Demonstrate the principles and concepts in robotics, encompassing robot manipulation, swarm behaviors, robot navigation, and robot control through applied projects
2) Communicate effectively about the principles, challenges, and applications of robotics.
3) Analyze and evaluate the performance of robotic systems using appropriate metrics and assessment methods.
4) Assess and select appropriate robotic platforms, sensors, and actuators for specific robotic applications or tasks.
5) Evaluate ethical, societal, and legal implications associated with the development and deployment of robotics technologies.

Grading

Weekly in-class quizzes:	5%
Weekly Canvas quizzes:	5%
Individual projects:	60% (4 × 15%)
Final collaborative project:	30%

Final grades will be based on a weighted average of the above.
See https://www5.njit.edu/registrar/policies/grading.php

- [90, 100] A
- [85, 90) B+
- [80, 85) B
- [75, 80) C+
- [70, 75) C
- [60, 70) D
- [0, 60) F

Late Assignment Policy

Late assignments will be graded as normal, but a penalty will be assessed to the maximum possible grade. Penalties will be applied per day and will increment by one per day. For example, if an assignment is turned in two days late, a 1 + 2 = 3 point penalty will be assessed. If an assignment is 7 days late, a 1+2+3+4+5+6+7 = 28 point penalty will be assessed. Any assignment turned in more than a week late will receive a grade of 0.
No late assignments will be accepted for the final project or for quizzes.

Projects

The projects in this course are meant to provide students an opportunity to apply classroom learnings in scenarios like those that might be encountered in their research or future work. These projects will be fairly open-ended in how students can approach them, and students will generally be given several weeks to complete these projects. Project assignments will outline the requisite deliverables.

Final Project

The final project will be a group-based project where students will propose some extension of the material covered in class or other robot-related subject, and deliver a presentation and final report detailing their work.

Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.
Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Active Learning

This course has been revised to incorporate significant active learning activities throughout the semester. These activities have been designed to promote holistic thinking about the material. At the end of the semester you will receive a survey.
Below, items marked *AL:* ----- correspond to planned active learning activities. Further activities will be incorporated into lessons as practical.
TPS = Think-Pair-Share, PBL = Problem-based learning, SIM = In-class simulation activities.

Tentative Course Outline:

WEEK	DATE	DUE	TOPICS
1	Sep 7		Introduction, Degrees of freedom, Rotation Matrices *AL: TPS: Degrees of freedom, how to represent rotations*
2	Sep 14	Project 1.a	Transformation matrices, Forward kinematics pt 1 *AL: TPS: Using matrices to represent robots* *PBL: Kinematics*
3	Sep 21	Project 1.b	Forward kinematics pt 2, Joint torques *AL: TPS: Forward Kinematics formulation*
4	Sep 28		Inverse kinematics *AL: TPS: Inverse Kinematics formulation* *SIM: Kinematics simulator*
5	Oct 5	Project 1.c	Swarm robotics overview, Swarm localization *AL: TPS: How to localize?*
6	Oct 12		Swarm robot algorithms and hardware *AL: TPS: Conceptualizing a swarm algorithm* *SIM: Demonstrating Swarm Behaviors*
7	Oct 19	Project 2	Path planning algorithms *AL: TPS: How to find the shortest path?* *PBL: GPS routing*
8	Oct 26		Sensor measurement and information filtering *AL: TPS: How to account for noisy data?* *SIM: Processing sensor data*
9	Nov 2	Project 3	Introduction to hardware and distribution of material *AL: Hands-on with Arduino*
10	Nov 9		Motor control and robot sensors *AL: Hands-on with Arduino*
11	Nov 16		PID control on robot hardware *AL: Hands-on with Arduino*
12	Nov 21	Project 4, Final proposal	Special topics 1: Machine learning algorithms *AL: Guest Speakers and Q&A* *TPS: Based on scheduled speakers*
13	Nov 30		Special topics 2: ROS *AL: Guest Speakers and Q&A* *TPS: Based on scheduled speakers*
14	Dec 7		Final project presentations *AL: Q&A*
15	Dec 14	Final report	Reading day: no class

In addition to the above active learning activities, there will also be video supplements to these lectures posted online. Paired with these videos will be Canvas quizzes meant to make you think critically and apply the subject material in ways not possible in a traditional lecture setting.