ROB-GY6003 Foundations of Robotics
Fall 2020 Tuesday 2:00-4:30 pm
Instructor Giuseppe Loianno
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https://wp.nyu.edu/arpl/

Introduction
This course aims to provide an introduction to robotics introducing kinematics, dynamics, control, for robot manipulators and simulation tools used in the field.

Prerequisites
None.

Course Description
This course presents the concepts, techniques, algorithms, and state-of-the-art approaches for mobile robots and robot manipulators covering modeling, control and simulation. The class will focus on direct and inverse kinematics problem, Denavit-Hartenberg representation, Euler and RPY angles, homogeneous transformations, Manipulator Jacobian, differential relationships, force and moment analysis, inverse Jacobian, trajectory generation and path planning. The final part will involve robot arm dynamics and PD and PID controllers for robotic manipulators, practical robotic system implementation aspects, limitations and constraints, and sensors and actuators. The students will practice these concepts using matlab or an equivalent simulation environment.

Class Material
Slides distributed during the class and the textbook

- B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics: Modeling, Planning, and Control, Springer Verlag, 2010, instructor notes and slides.

The textbook is free accessible to NYU students on Springer website.

Project
There is a plan to give 2 projects to the students. The final grade will depend also on the results of these projects. Projects will be discussed at the end of the semester, in the form of a short

presentation and a report. The evaluation is based on the reports and presentations as well. These projects are intended to take the material taught in the course in a new and insightful direction of your choosing, for instance by incorporating the course into your research. Specific details on the project will be available mid-semester.

Schedule

Week 1: Introduction to robotics and industrial applications

Week 2 and 3: Rotation parametrizations and Homogeneous Transformations

Week 4 and 5: Matlab review and direct kinematics problem Denavit-Hartenberg representation

Week 6: Inverse kinematics and examples

Project 1: Direct and Inverse Kinematics for SCARA manipulator

Week 7 and 8: Manipulator Jacobian, differential relationships, force and moment analysis, inverse Jacobian, trajectory and path planning

Week 9: Midterm

Project 2: Second order inverse Kinematics for SCARA manipulator

Week 10 and 11: Robot Arm Dynamics: Euler-Lagrange formulation and Newton-Euler formulation.

Week 12: Trajectory generation

Week 13: Linear controllers for robot manipulators, i.e., PD and PID. Feedback linearization for robotic manipulators

Week 14: Practical robotic system implementation and simulation aspects, limitations and constraints, and sensors and actuators

Week 15: Final

Project 2: Dynamics and control of SCARA manipulator

Grading Policy

3 Homeworks 30%
Project 1, report and presentation 10%
Project 2, report and presentation 10%
Project 3, report and presentation 20%
Midterm 15%
Final 15%