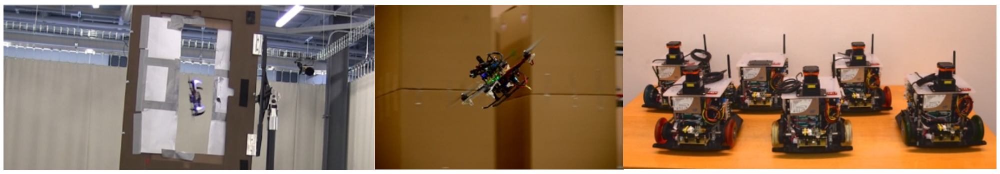
ROB-GY6213 Robot Localization and Navigation
Spring 2021 Tuesday 11:00-1:30 pm
Instructor Giuseppe Loianno
Agile Robotics and Perception Lab
https://wp.nyu.edu/arpl/



Introduction

This course aims to provide new theory, tools, and concepts to allow flying and ground robots to autonomously navigate, reason, and take actions in unstructured environments.

Prerequisites

Linear Systems ECE-GY 6253 or ME-GY6923 or ME-GY6703 or prior instructor approval.

Course Description

This course presents the concepts, techniques, algorithms, and state-of-the-art approaches for robot perception, mapping and localization. The course will show the theoretical foundations and will also have a considerable experimental component based on Matlab/ROS.
The course will start from basic concepts in probability and then introduce probabilistic approaches for data fusion such as Bayes Filters, Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter, and Particle Filter. Then, the course will introduce the SLAM problem showing how this has recently been solved using batch optimization and graph methods. Finally, mapping algorithms will also be briefly discussed.

Class Material

Slides distributed during the class. These will have most of the details needed by the students to successfully pass the class.
Optional

- Thrun, Burgard, Fox, Probabilistic robotics, MIT Press
- R. Siegwart, I.R. Nourbakhsh, and D. Scaramuzza, Introduction to autonomous mobile robots, MIT press
- Simo Särkkä, Bayesian Filtering and Smoothing, Cambridge University Press
- T. Barfoot, State Estimation for Robotics

Project

There is a plan to give 3 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. 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 perception: the perception problem, transformations

Week 2: Kinematics

Week 3: Differential Kinematics with singularity free representations

Week 4: Review of probability notions and Bayes Filter

Week 5: Bayes Filter and Kalman filter

Week 6: Midterm

Week 7: Information Filter and Extended Kalman filter

Week 8: Introduction to Vision and Projective Geometry

Week 9: Optical Flow and Motion Field

Week 10: Unscented Kalman filter

Week 11: Pose estimation

Week 12: Introduction to Sensor-models, SLAM, Sfm, and mapping approaches

Week 13: EKF SLAM and Pose Graph SLAM

Week 14: Guest Lecture

Week 15: Final Exam

Grading Policy

Homeworks 30%
Project 40%
Midterm 15%
Final 15%

Inclusion Statement

The NYU Tandon School values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is my intent that all students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. If this standard is not being upheld, please feel free to speak with me.

If you are experiencing an illness or any other situation that might affect your academic performance in a class, please email Deanna Rayment, Coordinator of Student Advocacy, Compliance and Student Affairs. Deanna can reach out to your instructors on your behalf when warranted.
deanna.rayment@nyu.edu
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