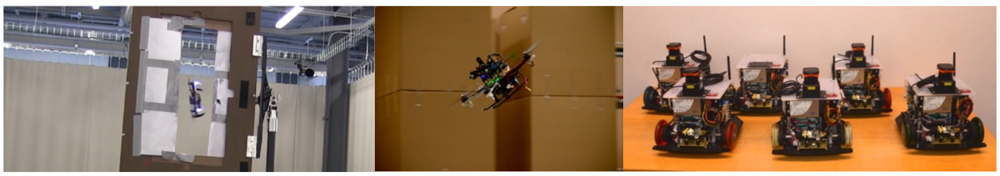
NYU TANDON SCHOOL OF ENGINEERING

ECE-9253 Robot Localization and Navigation
ME-7933 Fundamentals of Robot Mobility
Spring 2019 Monday 3:20-5:50 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
- Yaakov Bar-Shalom, Estimation with Applications to Tracking and Navigation, Wiley

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. 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 and 2: Introduction to perception: the perception problem, review of probability notions, orientation parametrization, and basic kinematics, differential kinematics

Week 3: Bayes Filter and Kalman filter

Week 4 and 5: Extended Kalman filter vs. Error state Kalman filter. Example: ground robot or cart

Week 6: Unscented Kalman filter. Example: ground robot or cart nonlinear model

Week 7: Particle filter or Introduction to Vision and Laser sensors

Project 1: Fuse inertial and Vicon data

Week 8: Midterm

Week 9 and 10: Introduction to SLAM, Sfm, and mapping approaches

Week 11: EKF SLAM

Week 12: Pose Graph SLAM

Week 13 and 14: Laser-based vs. Vision-based SLAM, and the future in this area
ROS packages, 3D navigation example

Week 15: Project presentation

Project 2: Fuse Robot sensor data

Grading Policy

Homeworks 30%
Project 20%
Midterm 30%
Final Report and Presentation 20%