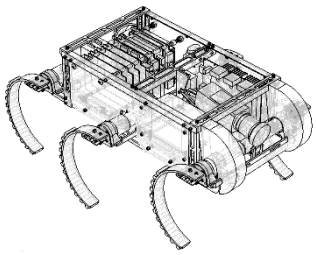

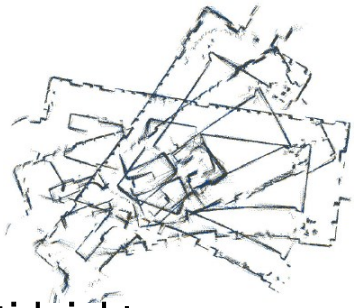

EE 585 Probabilistic Robotics

Homework #1 (Individual Work)

Given: Oct 21,2025 (Tue), *Due:* Nov 05,2025 (Wed) Midnight

General Information About the Homeworks:

Homeworks are to be prepared in Electronic Form composed of an Adobe pdf format homework document "Surname_HW1.pdf" and associated Matlab/Python files (if applicable) having name specified in the homework. All should be packed in a zip file having `Surname_hw1.zip` and uploaded to the appropriate assignment entry in OdtuClass. If required, the document should give all derivations, mathematical solutions, Matlab/Phython figures and comments on your results. All equations must be typeset in a legible and understandable form. The organization and neatness of the homework is an important consideration in grading.

The electronic document should be accompanied by the necessary Matlab m-files (only data files and plotting functions if another language is used) that can be run from a clean Matlab session (no previously defined variables) and provide all the necessary output. The programs should indicate on the command window what they are in the process of doing.

Q1: Review and Use of a Robot Simulator

Our course is all about probabilistic algorithms that process and make sense of noisy models combined with noisy robot sensory data. Implementation and evaluation of such algorithms can be done either (preferably) with real robot hardware/sensors or (in the lack of such hardware) using sufficiently realistic simulations of such hardware. Therefore, any meaningful experience with these algorithms would require you to (as a minimum) have access to a robot simulation environment. Implementation of a robot simulation from scratch is not feasible in the given time.

This introductory homework is about conducting an investigation of a leading open-source 3D robot simulator to acquaint you with the features available relating to the concepts discussed in class. You are asked to document your findings.

The available open-source robot simulation environments is changing every year. The preferred simulator should be available for free for non-commercial use and is available for Windows and/or Linux. (Alternatives such as WeBots or Gazebo or something newer can be investigated.

Your survey should review and document multiple features that pertains to the following criteria:

a. Ability to simulate the kinematics and/or dynamics of a differential drive (wheeled) robot,

b. Ability to command the linear and angular velocities of the robot,

c. Ability to simulate “real” noise into the motion kinematics/dynamics of the robot, either in the command space or at a lower level (e.g. non-modeled dynamics, wheel ground interaction etc.) Alternatively, it should be possible for you to incorporate such noise. (Note that this is different from noise assumed in your estimation algorithms)

d. Provide distance sensor data, especially a “distance scanner” sensor that can provide distance as a function of bearing (e.g., a laser scanning sensor),

e. Ability to define a map environment with pre-defined “landmarks” and/or geometric “obstacles”.

f. Provide wheel odometry data from the robot,

g. Provide camera image data from the robot,

h. Provide Inertial sensor (IMU) data from the robot,

i. Ability to define and incorporate “noise” to sensor outputs by setting appropriate parameters. Alternatively, it should be possible for you to incorporate such noise. (Again different from noise assumed in estimation algorithms)

Prepare a report with your simulator selection, running environment, plus a section on each one of the above considerations. Provide a discussion, examples of generated data with plots, screenshots etc. of your experiments.

Q2: Robot Following Task

As a final task, create two robots. One should be following a pre-defined path or command sequence in a obstacle-free environment. The other robot should be following the first robot while maintaining a specified distance. The “follower” robot can use the sensor of your choice as long as it can identify and track the leading robot. This task would require you to use one or more feedback control algorithm(s).

The aim of this task is to familiarize yourself with the chosen robot simulator and running environment, writing “robot code”, getting ground truth data, generating plots etc.

Clearly define performance criteria for the task and provide experimental data to show how things work.

The structure and quality of your report is a consideration for evaluation.

Good luck.
Afsar.