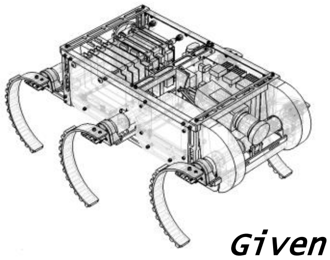

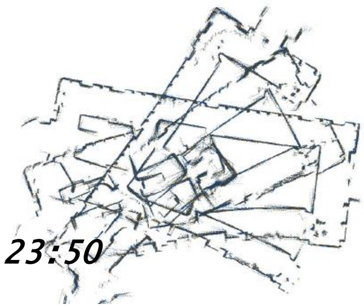

EE 585 Probabilistic Robotics

Homework #2 (Individual Work)

Given: Nov 11,2018 (Sun), Due: Nov 25,2018 (Sun) 23:50

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 files having names specified in the homework. All should be packed in a zip file having `Surname_hw1.zip` and uploaded to the appropriate assignment entry in MetuClass. If required, the document should give all derivations, mathematical solutions, Matlab 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: Consider Chapter 1, Part of Ex. 2 from your textbook:

Suppose we live at a place where days are either sunny, cloudy, or rainy. The weather transition function is a Markov chain with the following transition table:

		tomorrow will be...		
		sunny	cloudy	rainy
today it's...	sunny	.8	.2	0
	cloudy	.4	.4	.2
	rainy	.2	.6	.2

(a) Suppose Day 1 is a sunny day. What is the probability of the following sequence of days: Day2 = *cloudy*, Day3 = *cloudy*, Day4 = *rainy*?

(b) Write a simulator that can randomly generate sequences of “weathers” from this state transition function.

Note: Use Matlab to write this simulator. The m-file should have name `generate_weather.m`

Q2: Generate and Display Samples from Velocity Motion Model

Consider the velocity motion model discussed in Page 34 of your lecture slides (Motion Models).

(a) Implement this "ideal" forward model as a Matlab m-function `motion_model_ideal()` from the current state to the next state within a time duration Δt (also an argument to the function). For an example v and w, illustrate the "simulated motion" by using a small Δt and multiple calls to this function. This will generate a sequence of poses for the robot which you will plot. You may use the `quiver()` plot function of Matlab to plot the position and orientation (x,y,θ). **Hint:** You may attempt to imitate a motion used for the examples of Page 39 of your lecture slides.

(b) Implement the noisy version of the model as a Matlab m-function `motion_model_noisy()` which have Δt and three noise variances as parameters. Select a suitable Δt (maybe larger than in part (a)) and this time starting from the same initial state, "sample" this model N times for different noise variances to imitate the three figures at the bottom of Page 39 of your slides. Note: You may omit robot body circles and only initial pose and final poses. **Note:** Try to use `quiver()` plot to show orientation as well as position. If that is too cluttered, reduce N or plot positions only.

(c) Give the three noise variance values for the three plots that you have generated in approximation of Page 39 of your lecture slides. Discuss the relation between the distribution of the samples and the set of variances that was used to generate them.

Q3: Solve Chapter 5, Question 1 From your Texbook. The question is about including the Dynamics of the robot in the motion model for a 1D robot.

Q4: Develop a continuous sensor model for a camera that exist in the 2D plane.

You will attempt to find a closed form mathematical model for the pdf $p(z/x,m,\lambda)$ where z is the continuous pixel coordinate (for simplicity, we will not consider the discretization of the pixel coordinates), x is the robot pose (x,y,θ), m is the map, including the locations and monochrome intensity values of "obstacles" that the camera would see; finally, λ is all the parameters of your model.

(a) Research the geometric model of a camera known as the "pinhole camera model". Consider the 2D (planar) simplified version. Explicitly list and describe the deterministic model parameters. If necessary, you may have assumptions and simplifications that are clearly indicated.

(b) Consider a noise model for the camera. Assume that we only have Gaussian additive white noise on the continuous pixel coordinates given by $N(v,\mu,\sigma^2)$ where $\mu=0$ and σ^2 is the variance of the noise.

(c) First outline the procedure that you are following to integrate the noise model into the camera model. You should do this both for a closed form model to compute the required posterior pdf $p(z|x,m,\lambda)$ and for a model to *sample the robot pose* from this pdf.

(d) Attempt to derive this model (presenting the derivation in your homework report) to finally describe a computational function named `algorithm_camera_model(z,x,m)`,

(e) Assume a landmark with known location, identity and color is observed on the camera. Attempt to derive and present the function `sample_robotpose_camera_model(…,m)` to sample the robot poses from the camera model, indicating the input and outputs of the function. Would this function be able to sample absolute robot poses? If not, what can you sample?

(f) Discuss any issues and difficulties that you may have encountered as well as any ideas that you might have used but could not use to develop the model.

Good luck.