CS 547: Sensing and Planning in Robotics
Fall 2003
Quiz 2: October 29, 2002

Notes:

1. The quiz is open notes, not open book.
2. You may use a calculator.
3. You may not borrow notes or papers from others.
4. The quiz duration is 1 hour and 30 minutes.
5. There are 7 pages in this enclosure.
6. Attempt all questions.
7. *Good Luck*

Name:_____

SS#/USC ID#:_____

Problem	*Score*	*Out Of*
1		10
2		20
3		20
4		10
Total		60

Question 1 [10 points]

The table below compares the three Markov localization techniques we studied in class. Circle one (and only one) entry in each cell of the table that best describes the corresponding technique.

	Kalman Filter	**Grid-based**	**Particle Filter**
Observations	Gaussian Non-Gaussian	Gaussian Non-Gaussian	Gaussian Non-Gaussian
Actions	Gaussian Non-Gaussian	Gaussian Non-Gaussian	Gaussian Non-Gaussian
Computational Complexity	High Medium Low	High Medium Low	High Medium Low
Provable Convergence	Yes No	Yes No	Yes No
Unimodal Posterior	Yes No	Yes No	Yes No

Question 2 [20 points]

Consider a robot which moves in one dimension along the positive x axis. At each instant in time the robot is commanded to move one step to the right. The robot's actuators are not accurate, and the following action model has been developed to predict the robot's motion.

With probability 0.8, the robot actually moves to the right by one step when commanded to do so (*i.e.* executes the correct command). With probability 0.2, the robot moves 1.5 steps to the right when it is commanded to move to the right by one step (*i.e.* . it overshoots the desired movement distance by 0.5).

Given this action model for the robot, answer the following:

What is the expected distance the robot moves after one command ? Why ?

What is the expected distance the robot moves after two commands ? Why ?

What is the expected distance the robot moves after n commands ? Why ?

Question 3 [20 points]

A robot is in a hallway facing a dead end. It has one range sensor with which it can measure the distance between itself and the end of the hallway. The sensor model for the range sensor is shown below in the figure. The x axis on the sensor model is the difference between the measured range and the actual range. The y axis is the corresponding probability. The robot is given a 'map' of the environment i.e. it is told that the wall is at $x = 9$.

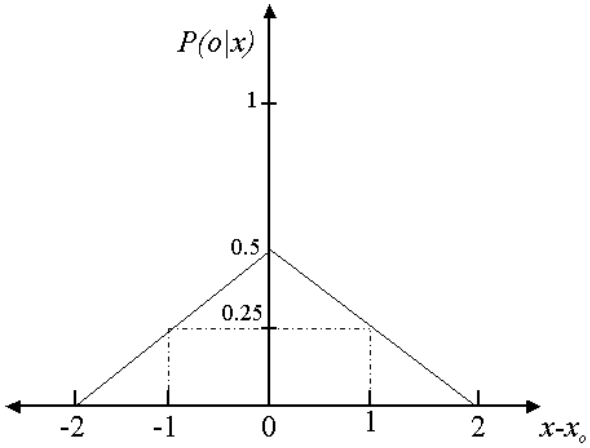

Figure 1: The sensor model.

At a given instant in time, the robot's belief B_1 about its location is shown below in the figure. At this point in time, the robot makes a range measurement which returns the value 5.

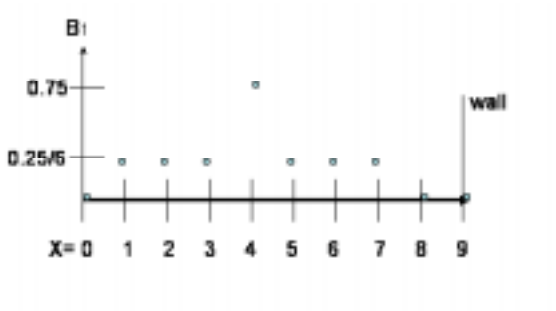

Figure 2: The initial belief.

Use the Bayes filter to update the robot's belief and draw the new belief B_2.

Compute the entropy of B_1 and B_2. Is there an entropy increase or decrease as a result of incorporating the sensor measurement ? If an entropy filter were to be used, would this sensor measurement be used or discarded ? Does this agree with the intuition behind the entropy filter ?

Question 4 [10 points]

Briefly answer the following questions:
What is the difference between a (conventional) determinstic action model and the probabilistic action model we studied in class ?

What is the Markov asumption in the Bayes filter ?