CS 3630 Spring 2007
Final Exam, May 2007

Instructions Put your name and GTID on every page (starts with 901). If you make a mess, clearly mark your final answer. Answer the short questions concisely but do show derivations, if any.

Recursive Estimation Assume x indicates the robot location, with $x \in [1..5]$ the room number. Rooms 1 and 5 are not connected, i.e. this is just 5 rooms in a row. The robot has one (noisy) sensor which indicates whether the room number is odd or even, i.e., $z \in \{odd, even\}$

1. Give a non-informative prior $P(x_1)$

2. Invent a measurement model $P(z_t|x_t)$. List as a table.

3. Calculate $P(x_1|z_1 = odd)$. Explain the formula you use.

4. Invent a motion model $P(x_t|x_{t-1})$. List as a table.

5. Apply the motion model to calculate $P(x_2|z_1)$. Explain the formula you use.

Particle Filters Using the same example as above, assume that the prior $P(x_1)$is instead given as a set of 7 unweighted particles $\{1, 1, 2, 1, 2, 3\}$. Calculate the *weighted* particle set representing $P(x_1|z_1 = odd)$. Explain your reasoning.

Features Two questions:

1. What are rotationally invariant features and why are they desirable ? Give an object recognition example for which rotationally invariant features are the only thing you need, i.e., no scale or affine invariance is needed.

2. How do SIFT feature descriptors achieve rotational invariance? Do the gradient directions not depend on rotation ?

Structure From Motion Also two questions:

1. Give and explain the non-linear least-squares objective function from the slides. Identify the following parts of the expression: (a) measurement (b) predicted measurement (c) 3D point (d) 6DOF camera parameters.

2. If we use structure from motion to provide visual odometry for a robotic platform, can we then even know how far the vehicle moved ? Why or why not ? What is the real-life practical solution ?