SC635 : Homework 1

Total points : 5

Note: Provide the list of assumptions, if any.

1. (3 points) Consider a robot having driving mechanism as a bicycle. The diameter of each wheel is d. Both wheels are mounted to the frame of length l. The front wheel can swivel around a vertical axis, and its steering angle will be denoted by α. The rear wheel is always parallel to the bicycle frame and cannot swivel. A range sensor is mounted on the handle of the bicycle robot. A sensor reading z_t at a time t comprises of range readings of 360° scan with the resolution of 1°. Driving mechanism for the handle allows it to take angular positions $2\pi k/12$ for $k = -2, -1, 0, 1, 2$.
   (a) Define the state variables X_t for a time t.
   (b) Define action state variables u_t for a time t.
   (c) Derive the posterior probability of state X_t given the action command u_t, $p(X_t \mid u_t, X_{t-1})$.
   (d) Derive the probability of sensor reading z_t for a state X_t.
   (e) Given a known map m describing occupancy of a state X_t, redo Parts (c) and (d).

2. (2 points) Consider landmark based map that describes the location of distinct features in the environment. A sensor mounted on the robot is able to provide the range and bearing information of visible features.
   (a) How many features must be visible to uniquely identify the state of the robot with ideal sensor (accurate sensing)? Explain your answer.
   (b) Define sensor reading z_t at a time t.
   (c) Derive the probability of sensor reading z_t for a state X_t.