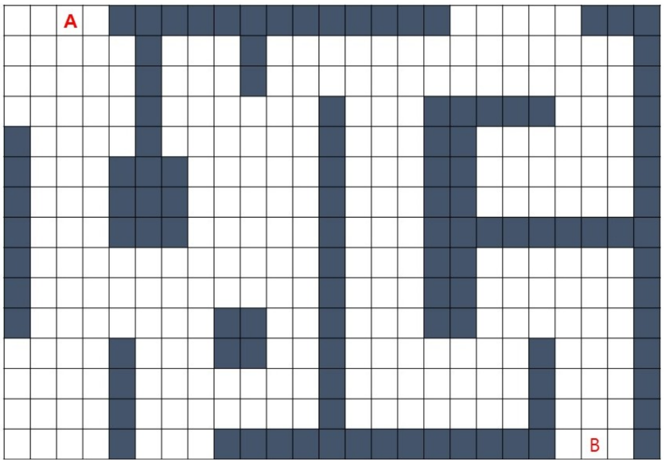
Aerospace Engineering
Seoul National University

Motion Planning
Spring '24

HW 1 (due April 12 at etl.snu.ac.kr)

1. Consider the 2-D environment below. Assume that the robot can move to neighboring 8 cells, and the cost is 1 for each horizontal or vertical movement, and 1.4 for diagonal movement. Find the shortest path A $(x, y) = (3, 15)$ to B $(x, y) = (23, 1)$. You may neglect the dimension of the robot.



2. Now, neglect the grid lines in the above problem. Find the trajectory from A $(x, y, \theta) = (3, 15, 0)$ to B $(x, y, \theta) = (23, 1, 0)$ for the following system

$$\begin{aligned} \dot{x} &= v \cos\theta \\ \dot{y} &= v \sin\theta \\ \dot{\theta} &= u_1 \\ \dot{v} &= u_2 \end{aligned}$$

where θ is the angle with respect to the x axis, $u_1, u_2 \in [-1, 1]$. You may neglect the dimension of the car.

   (a) Use RRT and shortest path search.

   (b) Use the potential function method. (You may show only partial result for this.)

3. Try to track the shortest path computed in Prob. 1 with the car in Prob. 2. Show the actual resulting trajectory of the car.

4. Suppose that one car is moving from A $(x, y, \theta) = (3, 15, 0)$ to B $(x, y, \theta) = (23, 1, 0)$ and the other car is moving from B to A in the same environment, starting at the same time. Their equations of motion are identical to Prob. 2. They do not communicate with each other, but can sense moving objects within the radius of 3 from their own position, except those occluded by static obstacles. The safety regulation is to keep the minimum distance of 1 between the cars (in addition to obstacle avoidance as before).

   Use any methods to compute their efficient trajectories. For example, you can combine the result from Prob. 3 and the potential function.