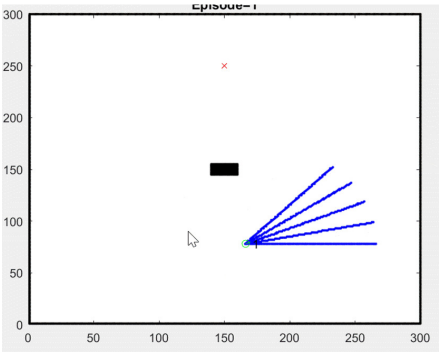
Midterm:
Learn to navigation

1 Simulation:

As Fig. 3, there is a robot with 5 laser scans, an obstacle and a goal. Its goal is to move to the goal {150,250}. The environment is defined as follows:
$state : s \in S = \{0 \sim 300, 0 \sim 300\}$. The state is continuous.
$initial \quad state : s = \{150, 50\}$
$action : a \in A = \{a_1, a_2, a_3, a_4, a_5\}$
The velocity of all actions is $v = 15$
$w_1 = -30°/s$, $w_2 = -15°/s$, $w_3 = 0°/s$, $w_1 = 15°/s$, and $w_1 = 30°/s$.
$reward$ and $terminal : if\ D_{RO} < 10, R = -10, terminal = 1$, where D_{RO} is the distance between the robot and obstacle.
$if\ D_{RG} < 10, R = 10, terminal = 1$, where D_{RG} is the distance between the robot and goal.
$if\ D_{RB} < 5, R = -10, terminal = 1$ where D_{RG} is the distance between the robot and boundary.
$otherwise, R = -0.05, terminal = 0$.
$discount : \gamma = 0.9$
$learningrate : \alpha = 0 \sim 1$(tune it!)
$\Delta t = 0.1$
If the robot hits the walls or obstacles, the robot will reset to the initial state and try the next episode. Please implement Q-learning to solve this problem. Assume the Q function is approximated by a linear function. The four features (see Fig.3) of the approximated Q function are as follows:
(a) $f_1(S)$: constant.
(b) $f_2(S)$: d: the distance between the robot and goal
(c) $f_3(S)$: ϕ: the angle between the robot and goal
(d) $f_4(S, a)$: the laser data (dis) from direction a_1 to a_5. for example, if a=a_1, the robot uses the laser data from $-30°$.
$if\ dis \leq 70, f_4 = f3$
$otherwise, f_4 = -f3$

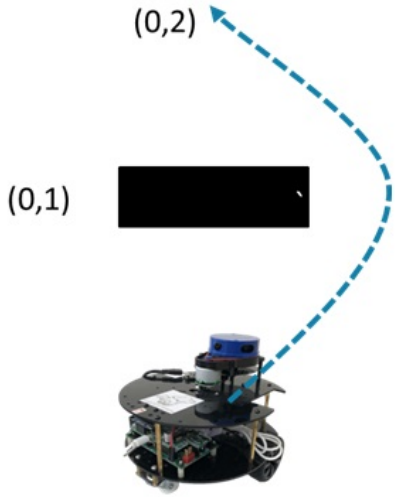


(a) MATLAB HMI

Figure 1: The human machine interface of this problem. The green circle represents the robot location. The blue lines represent the laser scans. The black area represents the obstacles. The red cross maker represents the goal.

2 Turtlebot3:

Implement the Q-learning on the robot. The robot with 2D laser data moves to the destination and avoid obstacles. You can design the features of the Q-function. The goal is to learn to navigation within 10 episodes.



(a) MATLAB HMI

Figure 2: The human machine interface of this problem.