Assignment 3 Report

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1 Task 1

1.1 Motivation

In order to solve this task, I have used fixed algorithm that is followed by the car to reach the road without crossing the boundaries of 700×700 grass field. I have made the assumption that the road has fixed width (of 150) and the dimensions of car are going to be same as the on given earlier (50×25). For solving this problem, I have thought of two approaches.

1.2 Experiments

1.2.1 Approach 1

- The first approach that I used was based on moving straight along the axial directions.
- First rotate the vehicle so that it points perpendicular to X-axis (here I have given zero acceleration i.e. only steer in the beginning)
- Then move the vehicle along the Y-axis till it cross the range of (-40, +40) on the Y-axis. Also while we are moving the steering angle should be kept 0, so that the vehicle moves along the straight line. As it reaches this zone, stop giving acceleration to the vehicle. (Friction will act on the vehicle and will stop the vehicle immediately)
- Then steer the vehicle in such a way that it points along the zero degree (or along the positive X-axis towards the road). Here while steering we are not providing acceleration to the vehicle (i.e. action_acc = 2, or vehicle is at rest). Since we also have some gaussian noise in the angle through which we are going to rotate, I am keeping a margin of δ_{angle} around our target angle (i.e. (target - δ_{angle}, target + δ_{angle})).
- After the previous step, we just have to move straight along the X-axis.
- In order to avoid it getting steered in slightly different direction due to some error we keep checking the angle and the position of the vehicle and choose our next action based entirely on the state.

1.2.2 Approach 2

- The second approach was based on to improve the number of steps it took to reach the road.
- Since when the steering angle is zero, gaussian noise doesn't act on it (since the noise gets multiplied with zero), therefore, I decided to first steer the car by angle $\theta = \tan^{-1}((350 - x)/(y + 1e - 8)$ (1e-8 is added in the denominator in order to avoid division by zero in some of the cases)
- Then positioning the theta along that direction with a maximum error of 2 degrees, I started moving along that direction with full acceleration and no steering.
- essentially the angle was calculated to point the car from its initial coordinates to (350,0) or the centre of the road.
- The number of moves taken in this approach is significantly smaller than the first approach because we are saving the number of moves by only steering once and moving along the shortest distance.

1.3 Algorithm

- First store the values x,y,velocity and theta at the beginning of each state.
- Then find the angle to which we will be heading by finding $\theta =$ `np.arctan((350-x)/y)` and then convert it in degrees and make the angle in the range [0, 360) by adding 360 and taking modulus with 360 ($\theta = (360 + \theta) \mod 360$)
- Then we keep on rotating until the difference between theta and the current angle of the car is not less than $\theta_{angle} = 2°$
- Once we are in the required configuration, then just move along the straight line with zero steering and full acceleration. When we are steering then we do it without any acceleration

2 Task 2

2.1 Motivation

The approach used in the Task is the extension of first approach in Task 1, that is, moving along the axial directions until you reach the destination. Observe that there are four pits, one in each quadrants. Each pit has absolute value of x,y coordinate in the range [120, 230] . And also I have assumed that the width and the length of the pit is going to be 100. Therefore, based on this facts there will be a horizontal strip of 140 around 0 (i.e. -70 to 70) where there will be no part of the pit and it is safe for our car to move.

But still to be on the safer side, I have assumed the width of this zone to be 80, (-40, 40) because there were several cases while I was experimenting where car went a bit outside this zone, and then it had to steer back inside the zone. But while steering a part of the car touched the pit. Therefore, taking width 40 ensures that even if the car somehow makes a turn of say 90 degrees, it would never touch any pit (as car's centre might be somewhere abs(y) = 40 + ϵ and after that turn 40+length_of_car/2 = 65 < 70)

2.2 Approach

- First check if the current position of the car is inside the safe zone or not. If it is, then steer the car with zero acceleration along the positive X-axis within the margin of angle $\delta = 2°$. Then move along the X-axis with 0 steering angle and full acceleration.
- Otherwise check if for the current position, if there is pit above (for quadrants 1 and 2) or below (for quadrants 3 and 4) or not. If there is no pit, then first steer the car with zero acceleration perpendicular to X-axis. Then move along the Y-axis, with zero steering, until you reach the safe zone.
- If there is pit above or below (depending on the quadrants) then move horizontally along X-axis to a vertical strip such that there is no pit to hinder your vertical movement. Because of the configuration of the pits there will always be a vertical strip in all the quadrants such that we can move along it without encountering any pit. After this move along this strip to horizontal safe strip and repeat the step 1.
- I have kept a margin of $\delta_x = 35$ (along x-axis) and $\delta_y = 25$ (along y-axis) around the pits in order to avoid collision to due to any error. That is while checking the condition for step 2 and 3.
- Also while steering to a target angle, I am maintaining of margin of $\delta_{angle} = 2°$ in order to accommodate the effect of gaussian noise.