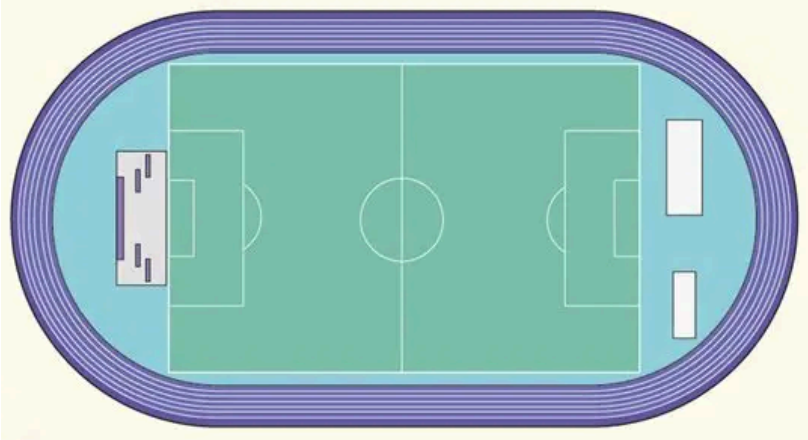
Robotic System Group Project Plan

week2

Topic: Project 2: Leader-Follower

Final goal: Two cars can run like the map below, as the leader and the follower

- extension: they can switch the roles(the leader becomes the follower)



Plan and steps:

1. ***Basic Movement*s**: Utilize the basic movement codes implemented in the first assessment to make sure the car can follow the map and move smoothly
2. ***Sensors implementation***: preferably implement a combination of sensors to make sure it can detect and gain multiple data
3. ***Movement Controller***: Use the data collected to control the follower's movement. Also, embed some basic move limitations.
4. ***Tests and Measurements***: Test and improve codes to let two cars work effectively. Then try different measurements to compare the behaviours between the follower and the leader, such as the comparison of kinematics & odometry
5. ***Reports and Final Results***

Week3

Finished for now:

1. Basic Sensors development for the follower robot, including bump sensors and line sensors: Digital Approach. It can use the data to control the robot to follow the IR to move (haven't tuned it with the leader robot)
2. Movement development for the leader robot: the leader robot can move along the path as we expected
3. The system, hypothesis, and experiment design

Contribution: 2 for the sensors and 2 for the leader robot movement

System Design:

Leader robot:

Move as the expected path, including a straight path and curved paths with different curvatures.

Led light

IR light

Follower robot:

Two sensors: bump sensor and line sensor, including Calibration

Controller: Use the sensor data as the movement controller

Led light

Data record

Hypothesis:

1. The performance of the follower with different sensors will be different
2. The performance of the follower will be influenced by the curvature of the leader's path

Experiment designs:

Environment:

same light conditions; same room & daytime; Fixed camera; 2 robots

Scenario for one sensor:

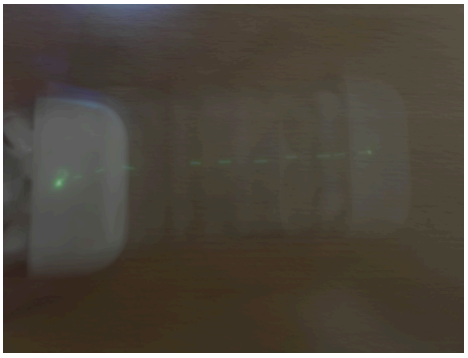
Number	Path Type	Curvature κ	Purpose
A	Straight line	0	Baseline reference
B1	Circular arc	1/2	Gentle turn
B2	Circular arc	1/1	Medium turn
B3	Circular arc	1/0.5	Sharp turn

Plan:

1. Let the follower robot do the Calibration
2. Check the camera and start to record

3. Start experiment

The measurement & methods:

1. The path error
   Use a long exposure photo to get the path of both robots
   Compute the cumulative arclength of each path: MAE (mean absolute error), RMSE (root mean square error), and max deviation
   
2. The recorded data comparisons - plotting on Google Colab
   (data of the follower)
   vL_ref — left wheel target speed
   vR_ref — right wheel target speed
   vL_meas — left wheel measured speed
   vR_meas — right wheel measured speed
   v — body linear speed [m/s] = (vL_meas+vR_meas)/2
   x — odometry x [m]
   y — odometry y [m]
   theta — odometry heading [rad]
   bumpL — left bump sensor, normalized [0..1]
   bumpR — right bump sensor, normalized [0..1]
   lineL — left outer line sensor (DN1), normalized [0..1]
   lineR — right outer line sensor (DN5), normalized [0..1]
   sensor_sum — distance proxy (for BUMP use bumpL+bumpR, for LINE use lineL+lineR)
   e_dir — directional error (for BUMP: bumpL−bumpR, for LINE: lineL−lineR)

3. Final Position: A picture of the final position at the end of each experiment, and calculate the
   Position Error (the distance between two robots in the final stop photo)
   Heading Error

Plan for next week:

1. For the follower’s controller, it needs more updates to make it follow stably.
2. Develop the system and experiment design
3. Develop a function to record the data for measurements
4. Start the first experiment to debug the programme set and see how it goes

Question: There are 2 variables: curvature of the leader's path and sensors. Will it be too abundant to finish?

Week4
What we have done:
the codes for experiments, including basic experiment design, recording data, and printing the map

We will finish the experiment shortly

Next Week Plan:
gain experiment data
make plots use collab
start writing the paper