

CECS 347 Embedded Systems II

Project 2: An Autonomous Wall Follower Robot Car

Project Description:

In this project, you will build an autonomous Wall Follower Robot Car. Our goals in this project are: be able to use embedded systems basic hardware components, including GPIO, hardware timer, interrupt, analog to digital conversion (ADC), and hardware PWM; be able to use GPIO to interface basic input/output devices, including switches, LEDs, motors and sensors, and implement I/O drivers.

Project Requirements:

You will build an autonomous robot car that can navigate through a prebuilt track with walls on both sides. The robot car will use a minimum of two IR sensors to detect left and right distances to the walls and control power to each wheel to keep the left and right distances to the walls equal. An optional third IR sensor looks directly forward can be used to avoid a head-on collision.

Hardware Requirements:

1. Use hardware PWM to drive two DC motors at variable duty cycles.
2. SysTick timer is required to control sampling rate for IR sensors.
3. Minimum of two GP2Y0A21YK0F analog IR distance sensors are required to allow the robot to follow the walls. The two IR sensors are mounted looking forward at an angle to the left and forward to the right. A 45° angle is recommended, not required. You can choose your own mounting angle. You can use more than two sensors to provide more vision aid for your robot car.
4. Onboard LEDs are used to indicate car status. Here is the color information: yellow light: two seconds yellow light before robot start to move; purple light: when reaching end of the track, turn on purple light; red light: the car is too close to a wall and stopped before restart; green light: the car is closer to the left wall; blue light: the car is closer to the right wall; white light: the car is in speed setting mode. No light indicates the car is moving in the middle of the track.
5. Potentiometer: one potentiometer is used to setup robot starting speed. You can only set the speed when the car is in speed setting mode. Speed setting mode is set by switch 2(right switch).
6. Onboard push buttons: sw1 will toggle on/off the car, sw2 will toggle speed setting mode on/off.

Feature Description:

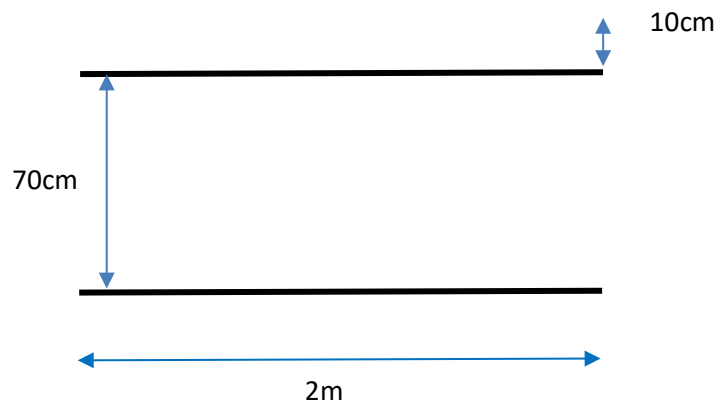
1. After reset the car, the car will show yellow LED for 2 seconds, then turn of yellow LED and start moving from one end of the track and navigate by itself toward the other end of the track.
2. The robot car should drive as much as possible in the middle of the track.
3. The robot car will stop at the end of the track. Assume there is no object within the range of 50cm at both ends of the track.
4. The robot car should be able to drive through the track in both directions.
5. Three different starting points will be tested: 20cm to the left wall, in the middle of the two walls, 20 cm to the right wall.
6. If a wall is detected within 15cm to the robot car, both wheels should stop immediately. After stopping for 1 second, the robot car should be able to bring itself back to the middle of the track and continue moving toward its destination.

This project can be developed in the following two phases:

Phase I: A Straight-Line Wall-Follower (5 points)

Track setup: Straight wall with height =10cm, length = 2m, width = 70cm.

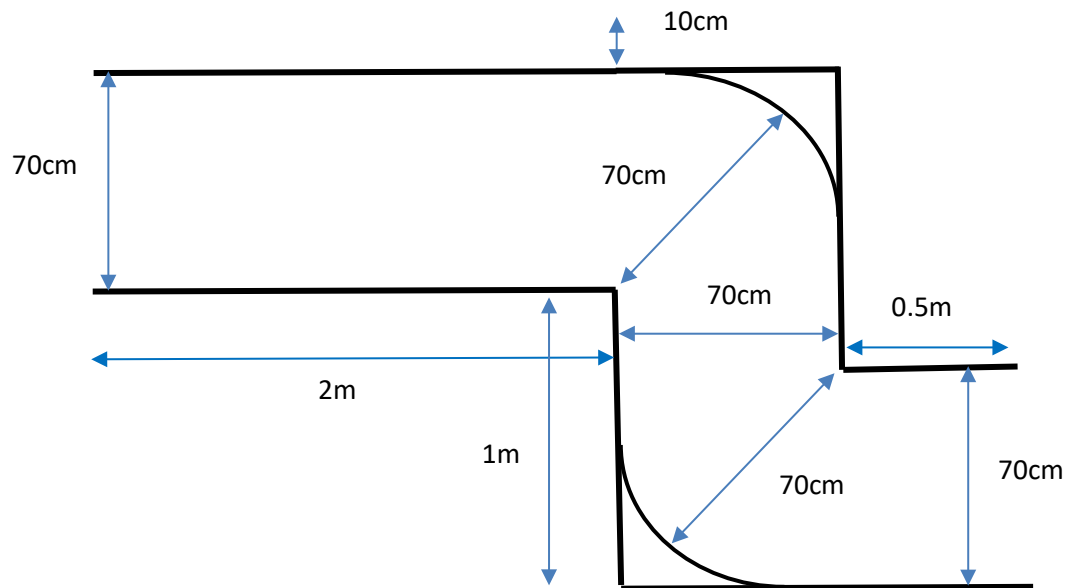
You are to implement an autonomous Robot car that will navigate through a straight route between two walls. The distance between the two walls is 70cm and both walls are 2 meters long. The Robot car will be tested for three starting locations: 15cm to the left wall, in the middle of the two walls, 15 cm to the right wall. The robot car will start to navigate to the other side of the route, as soon as it reaches either end of the route, it should stop.



Phase II: A Power Wall-Follower (5 points)

Track setup: Straight wall with height =10cm, length = 2m width = 70cm, followed by a 90° right turn wall with height =10cm, length = 1m, width = 70cm, end by a 90° left turn wall with height =10cm, length = 0.5m, width = 70cm.

In this phase, we will improve our Wall Follower Robot car by empowering it to be able to navigate through a track that has both a right turn and a left turn. The Robot car will be tested for three starting locations from each end of the wall: 20cm to the left wall, in the middle of the two walls, and 20 cm to the right wall. The robot car will start to navigate to the other side of the route and stop as soon as it reaches end of the track.



Extra points:

There will be an optional car race for students who finished this project with all features required. Top three winners will gain extra points based on the following rule. The extra points will be added the final weighted total.

1st place: 3 extra points

2nd place: 2 extra points

3rd place: 1 extra points

Deliverables:

1. Demonstrate one successful pass both way on one spot specified by your instructor. The three test spots are: 20cm to the left wall, in the middle of the two walls, 20cm to the right wall.
2. Submit a final project report and source code.
3. Upload six videos or a link for the six videos. If link(s) are provided, put the link(s) in the operation section of your project report. The six videos are: 1 for each direction on each of the three starting points: 20cm to the left wall, in the middle of the two walls, 20 cm to the right wall.