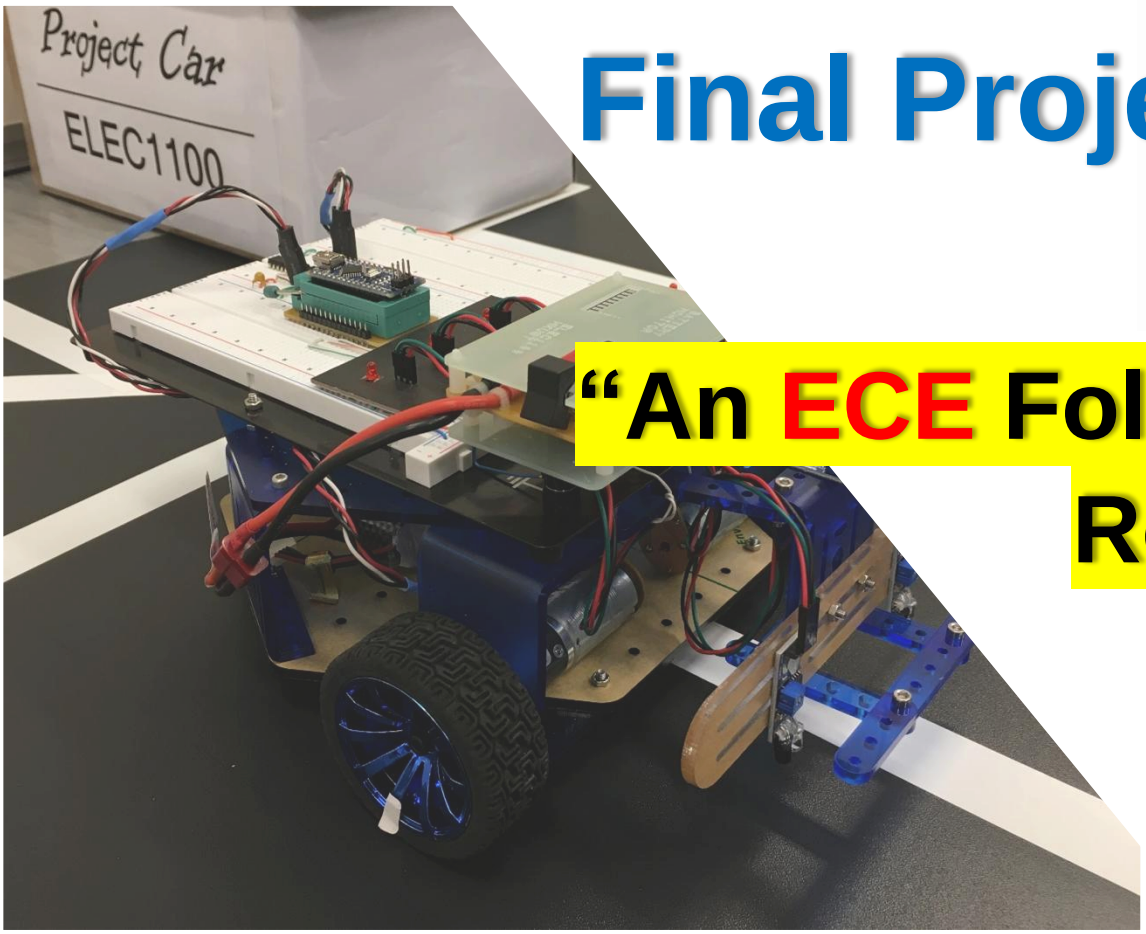
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering

ELEC1100

Final Project



"An ECE Follower Robot"

Contents

This project accounts for 23% of your overall grade: demo (20%) and report (3%).

In this assessment, you are allowed to use any kind of tools, sources, and references to aid you. However, your code and report should be your own work and not copied from elsewhere.

Both your code and report will be used to conduct the plagiarism check.
Copying from others will result in a mark penalty or failing this course.

A) Objectives

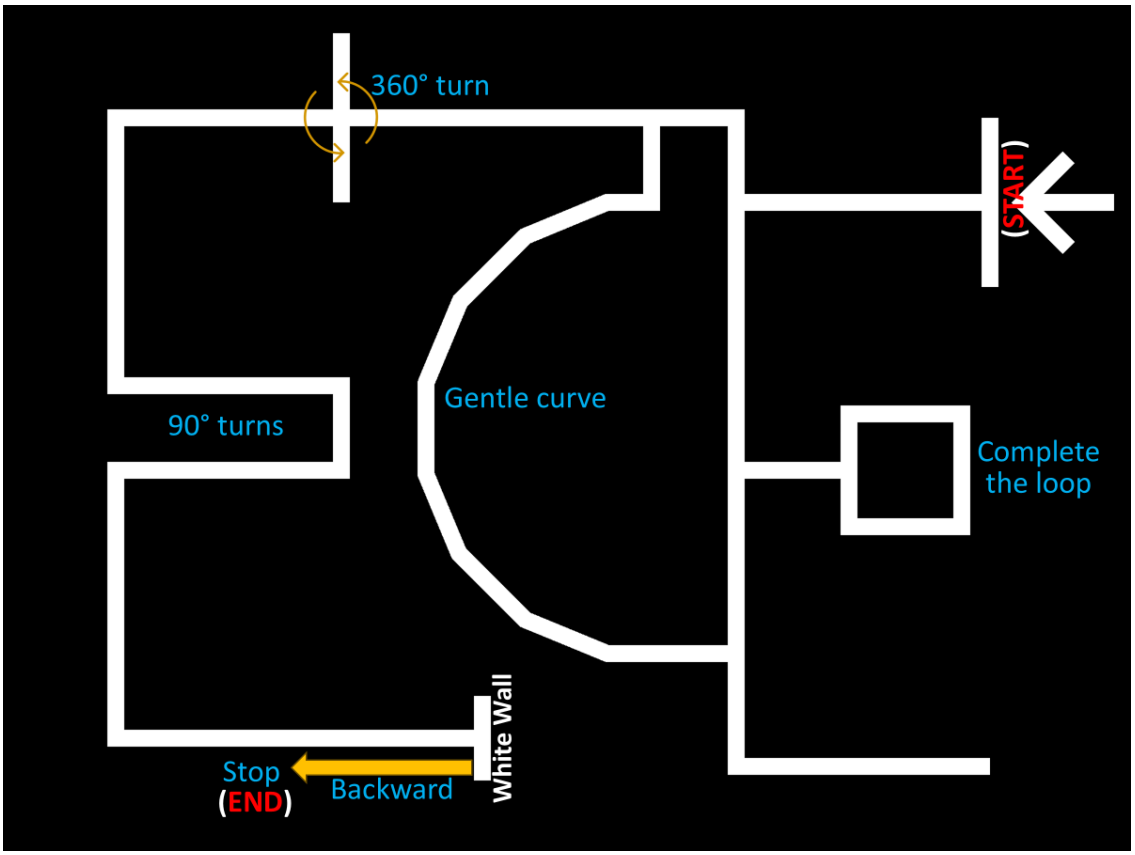
- Put together your work from Lab#04 to Lab#06 to design a vehicle that can navigate through an obstacle course.
- Write a final report to summarize your work in building the vehicle.

B) Introduction

By now, you have learned many important concepts and techniques needed to build an autonomous vehicle. For the final project, you will optimize your design and enrich your Lab#06 code to tackle the final design challenge.

In the final project, a robot car is required to move on an obstacle course from **START** to **END** (See **Part E** the "Grading Policy for the Track Demo").

The course is a white line on a black surface with several challenging stretches and a white wall. Below is a picture of the final course. The proportions and dimensions may not be on a scale, but it should give you an idea of what the real course looks like.



C) Rules for the Final Project

About your vehicle:

- You will be provided with a rechargeable battery (max. ~12V). You are responsible for charging the battery. Read the document about using and charging the battery carefully ("Supplementary", pages 2-5).
- You can only use the given breadboard & Arduino-Nano board for the project.

About the **sensors** (bright sensing):

Each of them would give an output voltage when:

- On white: output 0V
- On black: output 5V

**** You may use at most 6 sensors. ****

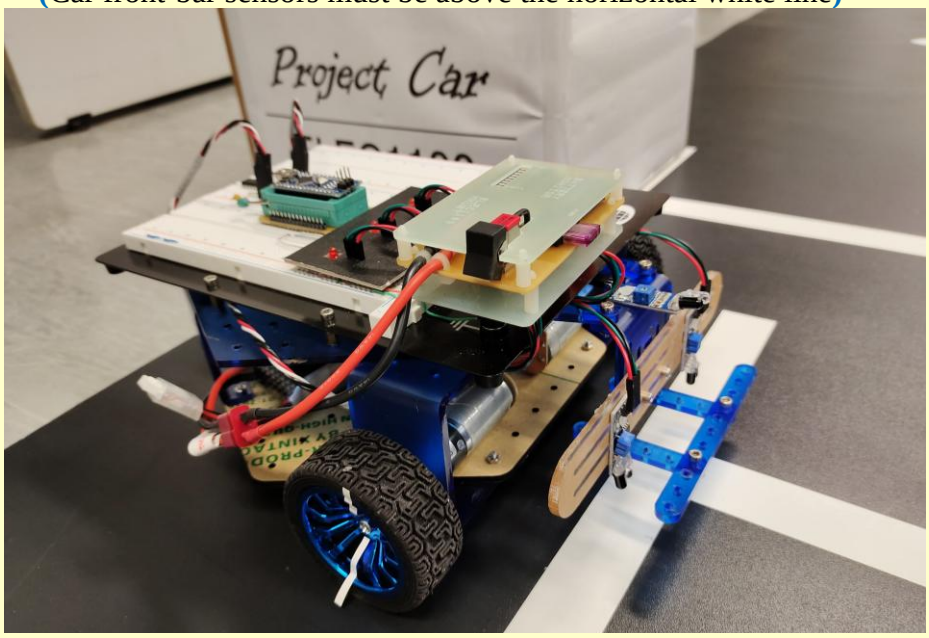
- ✓ Bumper sensor: **ONE** sensor **MUST** be used as bumper sensor for initiating the robot car at the "START" line and to sense the white wall.
- ✓ Front-bar sensors: **TWO** sensors **MUST** be installed on the **car front bar** to track the white lines on the project mat.
- ✓ It's up to you that if to add more sensors and where to place them on the car.

Notice

At demo sessions, you will be required to put the car at the start position with all **front-bar sensors** ON the horizontal "START" white line **(See Photo 1 as below).**

Photo 1: Car at the "START" white line

(Car front-bar sensors must be above the horizontal white line)



About the **motors**:

The two given motors may not have the same rotating speed under the same applied voltage. Under this case, different PWM values shall apply to the two motors for the car to run straightly.

Car Travelling Speed

(Approximated values, for your reference only)

- PWM = 100% (255), ~60cm/s
- PWM = 50% (127), ~40cm/s

- The travelling speed is only an average value and it may not be in linear relationship to duty cycle due to motor's inertia and discharge effect.
- Due to the weight of the car, minimum PWM value shall be 100 to fulfill minimum motor starting power.

About the **Arduino Nano-Board**:

It is highly recommended to use Arduino IDE 1.8.19 for reliable compiling performance. The most recent versions may not align well with your laptop due to various compatibility issues.

- The Arduino nano-board is used to get signals from sensors and output signals to control the car moving direction (**L_DIR**, **R_DIR**) and speed (**L_PWM**, **R_PWM**).
- According to the pin allocation on the nano-board, you are suggested to choose among pins A0-A5 for sensors and D2-D12 for motor controls for a clear layout.
- Note that only D3, D5, D6, D9, D10 and D11 can be programmed to give PWM signal.
- Note that pins A6 & A7 are only for analog applications which **ARE NOT applicable** to the project.
- Refer to the given Lab#06 code for proper pin assignments.

About your **Arduino code**:

You will need to continually work on your Lab#06 system for fulfilling the requirements in **Part E**.

- Your code should be able to read the sensor signals.
- From sensor signals, decide the appropriate values of **L_DIR** and **R_DIR, L_PWM** and **R_PWM** to be sent to the motor control IC such that the car can travel along the track according to project requirement.
- Refer to the given Lab#06 code for properly read from pin and write to pin.

Arduino power up:

Once power is on, the Arduino board needs time to boot-up, just like PC/Mac/Android systems. The Arduino board takes about 2~3 seconds to finish the boot-up and then starts to run the uploaded code. So any behaviors of the motors within the boot-up time are not triggered by the uploaded code. Those behaviors are meaningless and shall not be counted. In other words, you may need to wait for 2~3 seconds after power up, until seeing the car motion as initialized as programmed in your code.

D) Code Preparation and Submission

YOU (each group) will need to submit your complete code to your Canvas lab (LA1/LA2/LA3) page before the deadline for the **Early Demo** or **Final Demo** sessions.

- Fill in your group number (number on the given project box), and the name & student ID of each group member before submitting to Canvas, so your TA will know this is your group work when grading your demo results.

```
/*
  ELEC1100 Your Lab#06 & Project Template

  To program the car tracking the white line on a dark mat

  Group No. (number on your project box):
  Group Member 1 (name & SID):
  Group Member 2 (name & SID):
*/
```

- You should verify your code using Arduino Software (IDE) such that it can be uploaded to the Nano-Board without errors during the demo. The software can be downloaded from https://www.arduino.cc/en/software

- However, there is a constraint for the filename processed by Arduino Software. To avoid errors when opened by the software and for easy identification, you should rename your filename to this format:

  <group_#>

  For example, if your group number is **116**, the submitted filename should be **group_116** (Use the underline. Do NOT add any space in between).

To join the **Early Demo** at Rm2133&34, each group will need to submit your code before the **Canvas Deadline**. This is a group submission (**1 code** allowed), only one of the two members needs to do the canvas submission.

Late submissions will NOT be accepted.

	Early Demo	Submission Deadline	Trials
LA3	Nov 13 (Wed) 10:30-13:20	Nov 13 (Wed) **10:30**	**4**
LA1	Nov 14 (Thu) 15:00-17:50	Nov 14 (Thu) **15:00**	**4**
LA2	Nov 18 (Mon) 09:30-12:20	Nov 18 (Mon) **09:30**	**4**

To join the **Final Demo** at Rm2133&34, each group will need to submit your code before the **Canvas Deadline**. This is a group submission (**1 code** allowed), only one of the two members needs to do the canvas submission.

Late submissions will NOT be accepted.

	Final Demo	Submission Deadline	Trials
LA3	Nov 20 (Wed) 10:30-13:20	Nov 20 (Wed) **10:30**	**4**
LA1	Nov 21 (Thu) 15:00-17:50	Nov 21 (Thu) **15:00**	**4**
LA2	Nov 25 (Mon) 09:30-12:20	Nov 25 (Mon) **09:30**	**4**

[Warning!!!]

All your code submissions will be used to conduct a plagiarism check after the final demo. Copying from others will result in a mark penalty or failing this course.

E) Grading Policy for the Track Demo

At the **Early Demo** or **Final Demo**, each group will be assigned a 5-min slot to bring your robot car to Rm2133&34 for the demo trials.

- **Both of the two members** in a group **MUST** show up at your assigned demo slot. **The one absent will receive a zero mark.**

Your TA will download your code submission from Canvas, upload to your Nano-board, and let you put it back into your robot car to start the demo trials.

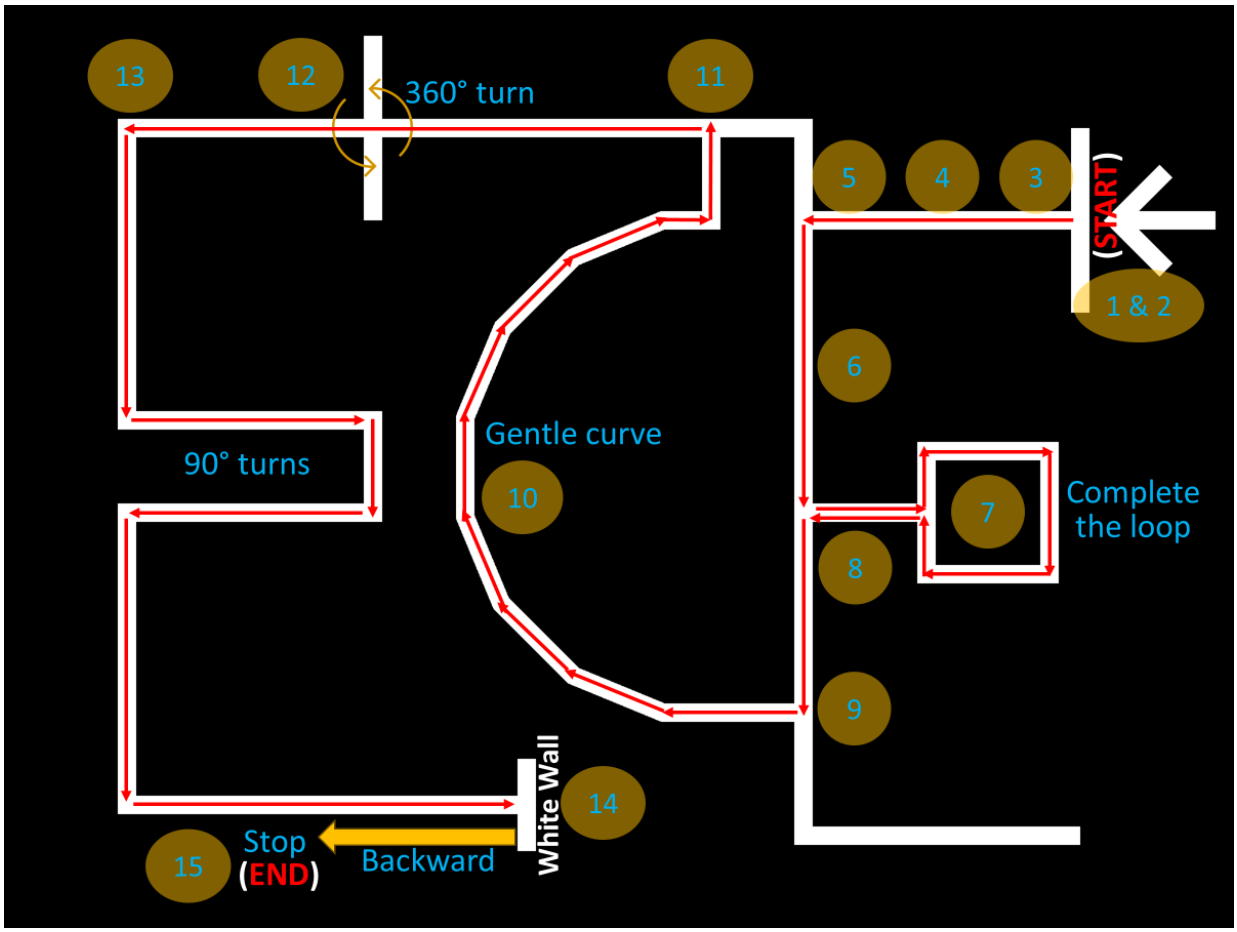
In general, each group can submit at most 2 code versions (1 at **Early Demo** & 1 at **Final Demo**) and can have at most **8 demo trials** (4 trials for each code version).

Your project demo score will be the highest out of all your trials.

Your robot car should complete all following tasks within each trial to achieve a "**perfect run**" **in 25 seconds** (there will be a timer).

Otherwise, your demo score will be given depending on "how far your car can go" within each trial. The goal is to collect as many points as possible.

The points awarding scheme is shown on page 8.



Task No.	Task	Points
1	After powering up, the car wheels start turning but should **STOP** after board initialization.	1
2	Put the car at the start position with all front-bar sensors ON the horizontal START white line (**See Photo 1 on page 3**). The car should still be in a **STOP** state.	1
3	The **bumper sensor** is triggered by a white paper to start running.	1
4	Follow the straight line.	1
5	Navigate the "go left" turning.	1
6	Follow the straight line and navigate the "go left" turning until reaching the entrance of the loop.	1
7	Complete the loop, you can choose to do it clockwise or anticlockwise.	2
8	Out of the loop and navigate the "go left" turning.	1
9	Follow the straight line and navigate the "go right" turning until entering the "C" curve.	1
10	Follow the "C" curve and navigate the "go left" turning until reaching **Task 11** the "T" junction.	1
11	Navigate the "go left" turning at "T" junction and follow the straight line until reaching **Task 12** the "┼" junction.	1
12	Navigate the 360-degree turning at "┼" junction and follow the straight line until reaching **Task 13** the entrance of the 90-degree turnings.	1
13	Navigate all 90-degree turnings until reaching **Task 14** the **White Wall**.	3
14	The **bumper sensor** is triggered by the **White Wall** to let the car move **BACKWARD**.	1
15	The car can **STOP** after moving back for at least 30cm (The car front-bar MUST be behind the 30cm mark).	1
16	The timer stops counting when the car stops. Complete all tasks above in **25 seconds**.	2
	Total	**20**

- **Turning in the wrong direction at any splits/turnings or going out of the track will be regarded as a failure, and the trial ends.**

To test and improve your code versions before submitting to the **Early Demo** & **Final Demo**, you may come to **ELEC1100 Coding Test Sessions** as listed below (timeslots & venues).

F) Appendix: Coding Test Sessions

- The project "ECE" demo mat will be provided at each test session.
- However, the results at any test session will NOT be used for grading your demo.

ELEC1100 Coding Test Sessions

Venue	Date	Time	IA/TO support
LTB	06 Nov 2024 (Wed)	12:00-17:20	**16:30-17:20
CYTLTL	07 Nov 2024 (Thu)	10:30-12:20	**11:30-12:20
LTA	08 Nov 2024 (Fri)	15:00-17:50	**17:00-17:50
CYTLTL	11 Nov 2024 (Mon)	16:30-18:20	**17:30-18:20
LTJ	12 Nov 2024 (Tue)	10:30-14:50	**14:00-14:50
LTB	13 Nov 2024 (Wed)	13:30-17:20	**16:30-17:20
CYTLTL	14 Nov 2024 (Thu)	10:30-12:20	**11:30-12:20
LTA	15 Nov 2024 (Fri)	09:00-11:50	**11:00-11:50
CYTLTL	18 Nov 2024 (Mon)	16:30-18:20	**17:30-18:20
LTJ	19 Nov 2024 (Tue)	10:30-14:50	**14:00-14:50

** IA/TO support: These slots in above sessions will be supervised by your Instructional Assistant (IA): Yimeng, and Technical Officers (TOs): Allen and Joseph. Extra components (wires, ICs, sensors, Arduino boards & cables, etc.) will also be provided there.

For those unsupervised slots, only the project "ECE" demo mat will be provided at the venue.