THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering
ELEC 1100 Final Project

This project accounts for 25% of your overall grade: demo (20%) and report (5%).

A) Objectives

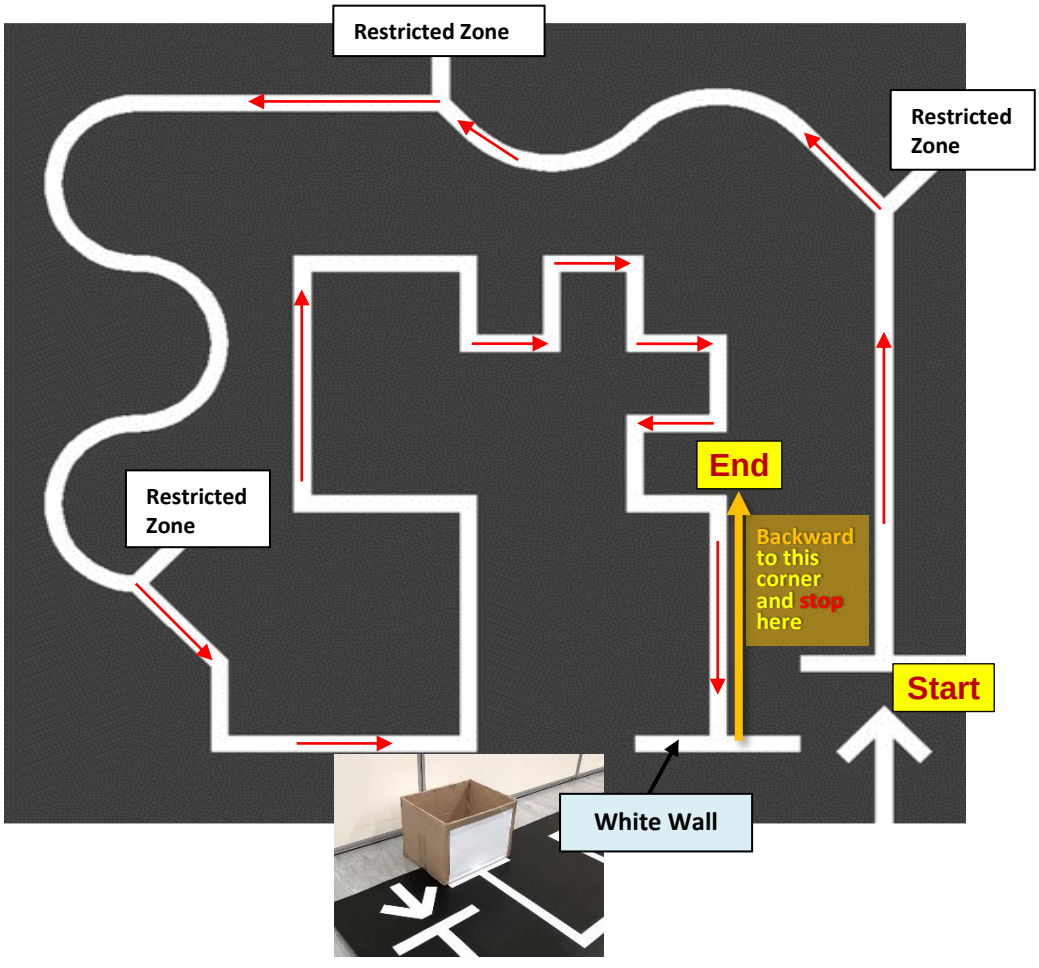
- Put together your work from Lab#02 to Lab#06 to design a vehicle that can navigate through an obstacle course.
- **Write a final report** to summarize your work in logic design.

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 Arduino code by adding conditional execution to tackle the final design challenge.

To allow the project to be completed in an online mode using Tinkercad, but provide a real hardware experience, we will download and run your Tinkercad code on a real robot car and track to determine how well your system can operate. At test & demo lab sessions (through ZOOM meeting), your TA will download your Arduino code from Canvas, upload to the robot car and start the trials on the demo mat at physical lab for grading. Please read the following instructions thoroughly to understand the details of how to do this.

In the final project, a robot car is required to move on an obstacle course from **Start** to **End** (See **Part D** the "Grading Policy for the Track Demo"). The course is a white line on a black surface with several challenging stretches. Below is a picture of the final course. The proportions and dimensions may not be on scale but it should give you an idea of what the real course looks like.



C) Rules for the Final Project

- About **the robot car**:
  The robot car will be provided by the teaching team at test & demo sessions, configured with completed control circuits on the breadboard including an Arduino-Nano board (see Photo 1) and three light sensors at working position (see Photo 2).

Photo 1: breaboard layout of your project

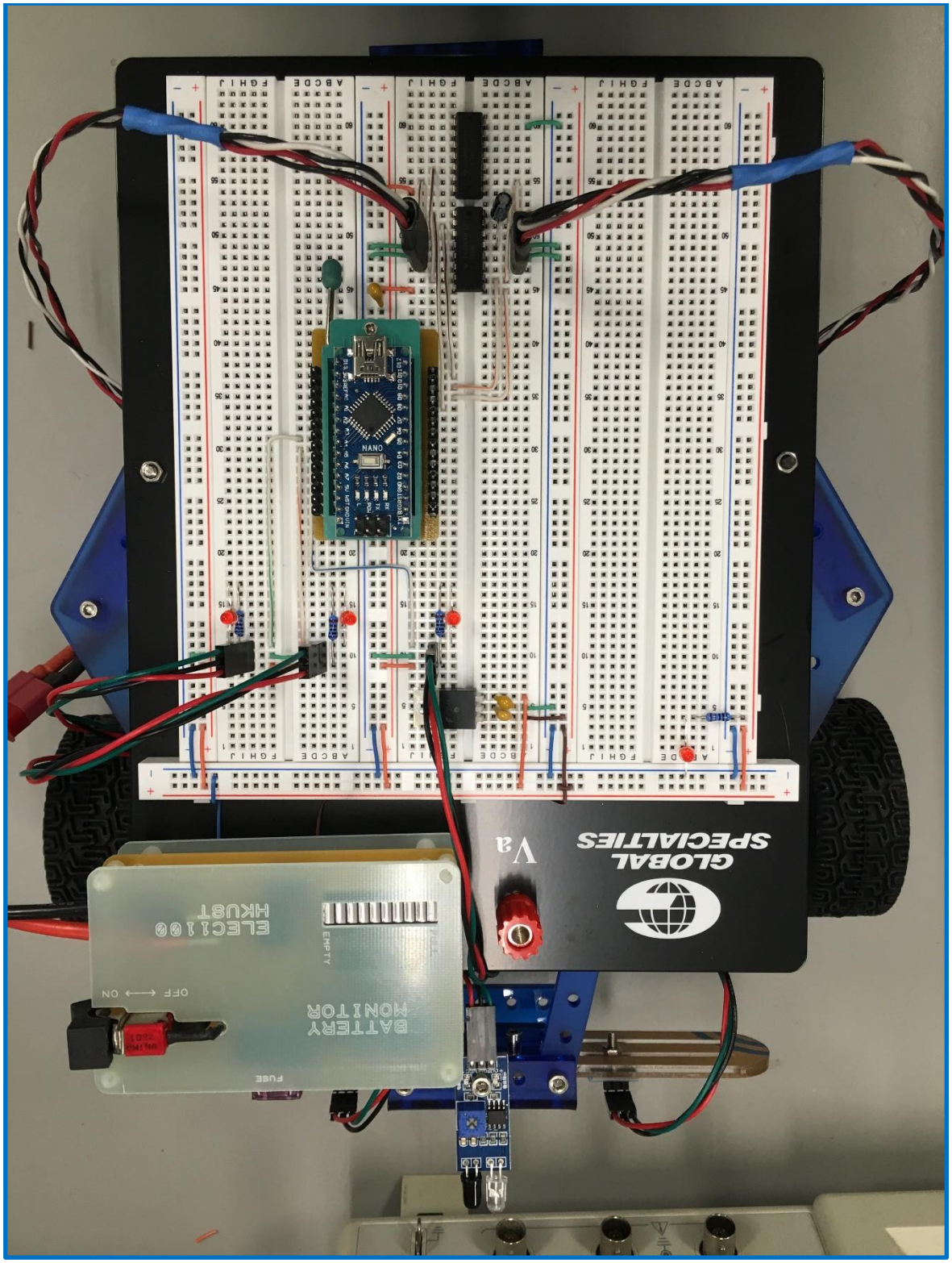
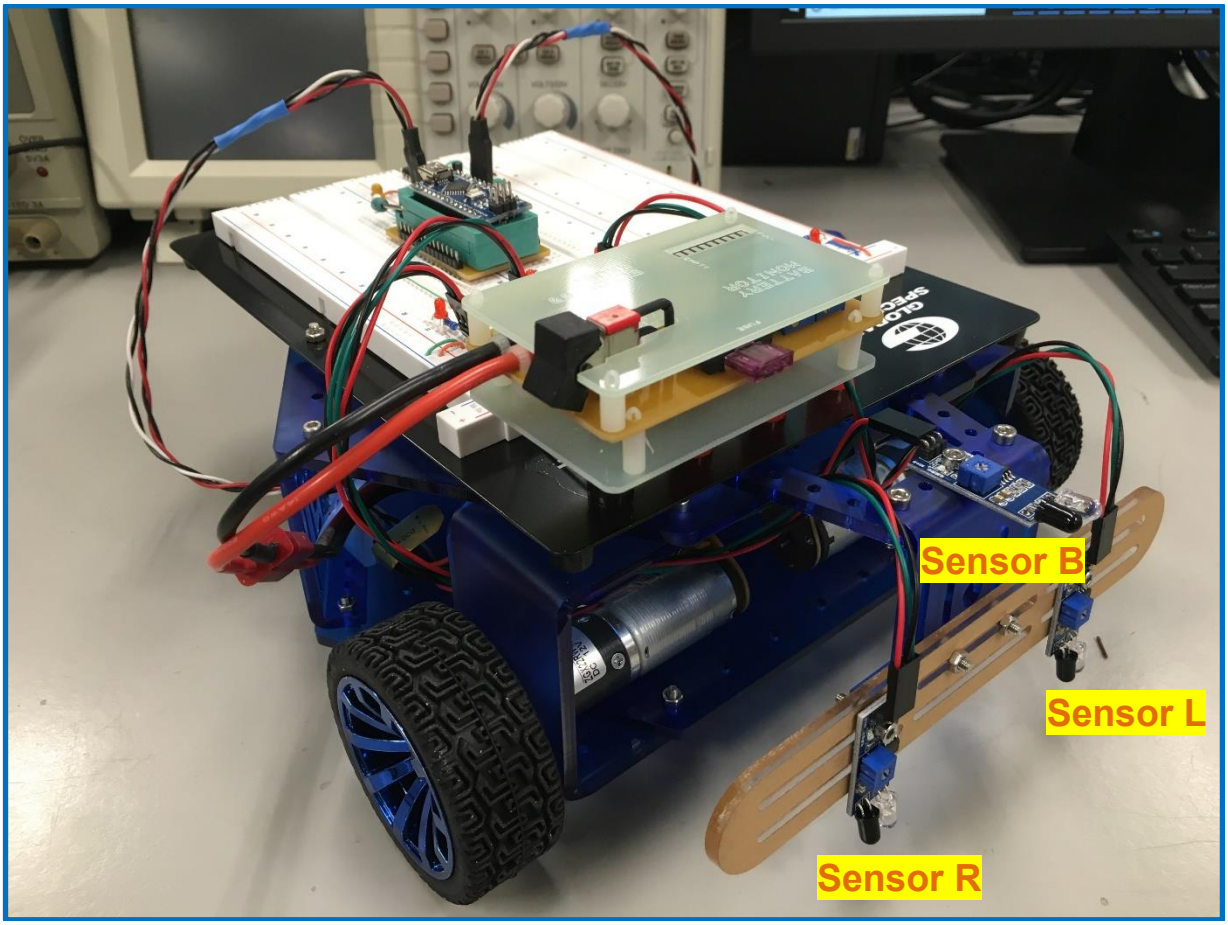


Photo 2: car sensors placement

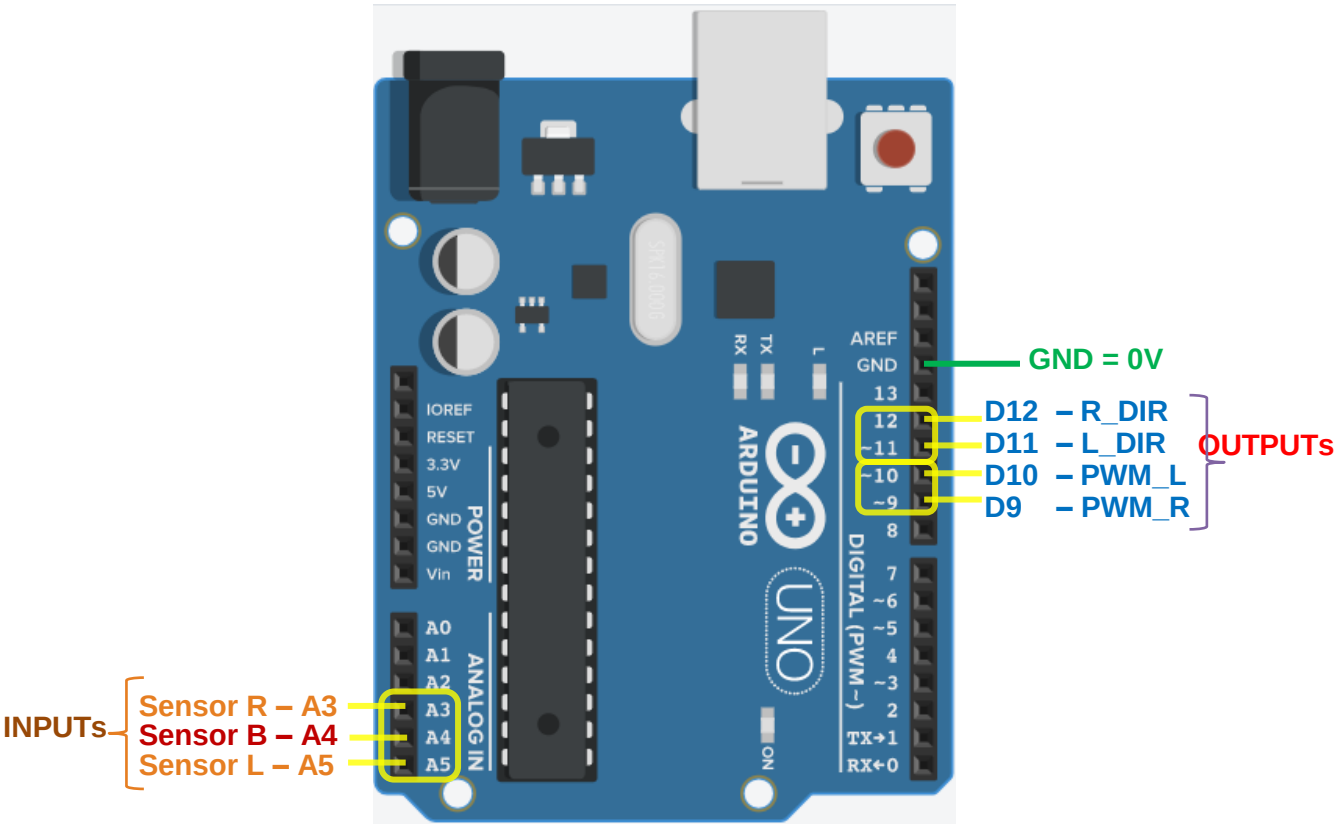


- About the **light sensors** (3 in total) on the car:
  - Line tracking sensors: for detecting the white lines on the demo mat.
    Sensors R & L are connected to the Arduino input terminals A3 & A5 as what you used in your lab#06 circuit.
  - Bumper sensor: for initiating the robot car at the "Start" line and for triggering the car at the "white wall" to run backward.
    You will need to define terminal A4 in your Arduino code to be used as **bumper sensor pin** (you may refer to the given lab#06 code, see how A3 & A5 has been defined as right & left sensor pins).

- About the **Arduino board** on the car:
  - The Arduino board will be accepting signals from the line sensors R, B, L.
  - The Arduino board will be controlling the motor's rotating directions R_DIR and L_DIR.
  - The Arduino board will be controlling the motor's speeds PWM_L and PWM_R.

Notes:

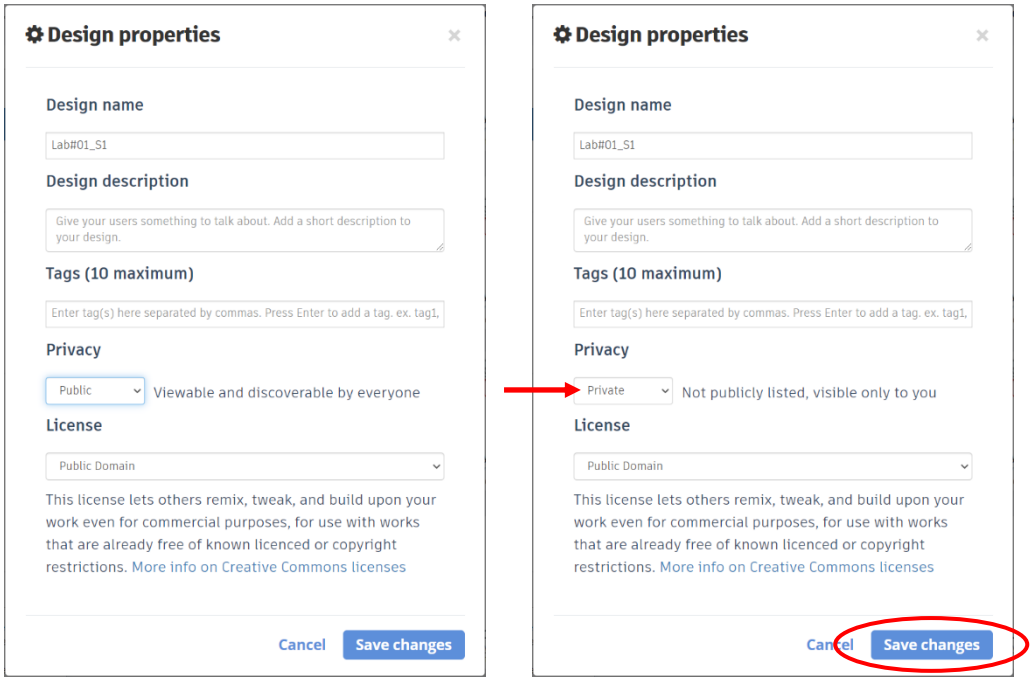
1. Arduino Uno-board in your Tinkercad simulation circuit is fairly similar to Arduino Nano-board. Nano-board is preferred at physical lab because of the small size.
2. Arduino Pins assignment is given below and you must follow the given connection.



- About your **Tinkercad simulation** model:

  YOU will need to continually work on your Lab#06 Tinkercad simulation model to include the bumper sensor (**Sensor B to A4**) into your circuit and to write in the coding text template given at Lab#06 for fulfilling the requirement in **part D**.

  Note: In "Design properties" dialog box, change the "Privacy" value to "Private" to protect your own work.



- Your code should read sensor's signals R, B, L as the logic inputs.
- Your code should send logic outputs through L_DIR and R_DIR to control the rotating directions of motors.
- Your code should send logic outputs through PWM_L and PWM_R to control the speeds of motors.

D) Grading Policy for the Track Demo

You will need to download your completed Arduino code from Tinkercad and submit to your Canvas lab page (LA1/LA2/LA3) before the deadline of your test/demo lab session.

Fill in your name & student ID before uploading to Canvas. This part of the code will be posted on the screen at test & demo sessions, so you would know it's your demo trials on the camera.

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

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

  Your Name:
  Student ID:

*/
```

Download your completed Arduino code from Tinkercad

During test & demo lab sessions (through ZOOM meeting), your TA will download your Arduino code from Canvas, upload it to the robot car, and start the trials on the demo mat at physical lab for grading your coding work. This will be recorded in ZOOM meeting.

With a correct Arduino code (the logic control unit), the robot car should complete the following tasks within each trial to achieve "**perfect run**":

- ✓ After power up, **the car wheels should not be started yet**. The robot car is put at the START position such that the line tracking sensors are **on** the horizontal "Start" white line.
- ✓ By using a white paper to trigger the **bumper sensor**, the car should start to run.
- ✓ Once the car starts running, it tracks the white course, and navigates through all of the splits and turnings.
- ✓ When the car arrives at the front of the white wall, the bumper sensor shall be triggered and the car go backward until it reaches the "End" corner and stop there (ensure the bar of line tracking sensors pass the horizontal line of the corner).

Touching the Restricted Zones or going out of the track will be regarded as **failure**, and you may start from the very beginning as **the next trial**. Your demo score will be the highest one out of all your trials.

E) Coding Test

	Coding Test Session	*Submission Deadline*	*Trials*
LA1	May 06 (Wed) 12:00-14:50	May 06 (Wed) 12:00	**2**
LA2	May 07 (Thu) 09:00-11:50	May 07 (Thu) 09:00	**2**
LA3	May 11 (Mon) 13:30-16:20	May 11 (Mon) 13:30	**2**

At your Coding Test lab session:

- If your code could already let the car achieve a "**perfect run**" on the demo mat out of 2 trials, you will receive a full mark of 20 points as your demo score and will not need to attend the demo session.
- If not, your test results will not be graded and you may come back one week later at the final demo session with an improved coding work.

F) Final Demo

	Final Demo Session	*Submission Deadline*	*Trials*
LA1	May 13 (Wed) 12:00-14:50	May 13 (Wed) 12:00	**2**
LA2	May 14 (Thu) 09:00-11:50	May 14 (Thu) 09:00	**2**
LA3	May 18 (Mon) 13:30-16:20	May 18 (Mon) 13:30	**2**

At your final demo lab session:

- If your car can achieve perfect run, then you will obtain full marks.
- Otherwise, your score will be given depending on "How far your car can go" within each trial.
- To obtain more marks, you have to collect as many points as possible from the "Start" white line.
- Points awarding scheme is as below.

Task No.	Task	Points
i	Car wheels should be **STOP** at the beginning and **START** running after the bumper sensor is triggered	**2**
ii	Follow the straight Line	**1**
iii	Navigate the 1st Left Split	**2**
iv	Gentle Curves I	**1**
v	Navigate the 2nd Left Split	**2**
vi	Gentle Curves II	**1**
vii	Navigate Right Split	**4**
viii	Right angle Curves I (finish all 6 right angles)	**1**
ix	Right angle Curves II (finish all 10 right angles)	**1**
x	Backward after the bumper sensor sense the wall	**3**
xi	Stop at the **End** corner	**2**
	Total	**20**

- About Tasks Demo:
  After 2 demo trials, if you are not satisfied with the results at physical lab, you may select to do an online Tasks demo by showing your TA that your Tinkercad Arduino code can achieve the motor motions listed below.

►	Tasks	Points
	Start your Tinkercad simulation, let **Sensor B = 0V** for the 1st time, both motors are with **+ve rpm**	**2**
	Let **Sensor L & R = 0 0** for the 1st time, your left motor is with **-ve rpm** and right motor is with **+ve rpm**	**2**
	Let **Sensor L & R = 0 0** for the 2nd time, your left motor is with **-ve rpm** and right motor is with **+ve rpm**	**2**
	Let **Sensor L & R = 0 0** for the 3rd time, your left motor is with **+ve rpm** and right motor is with **-ve rpm**	**4**
	let **Sensor B = 0V** for the 2nd time, both motors are with **-ve rpm**	**4**

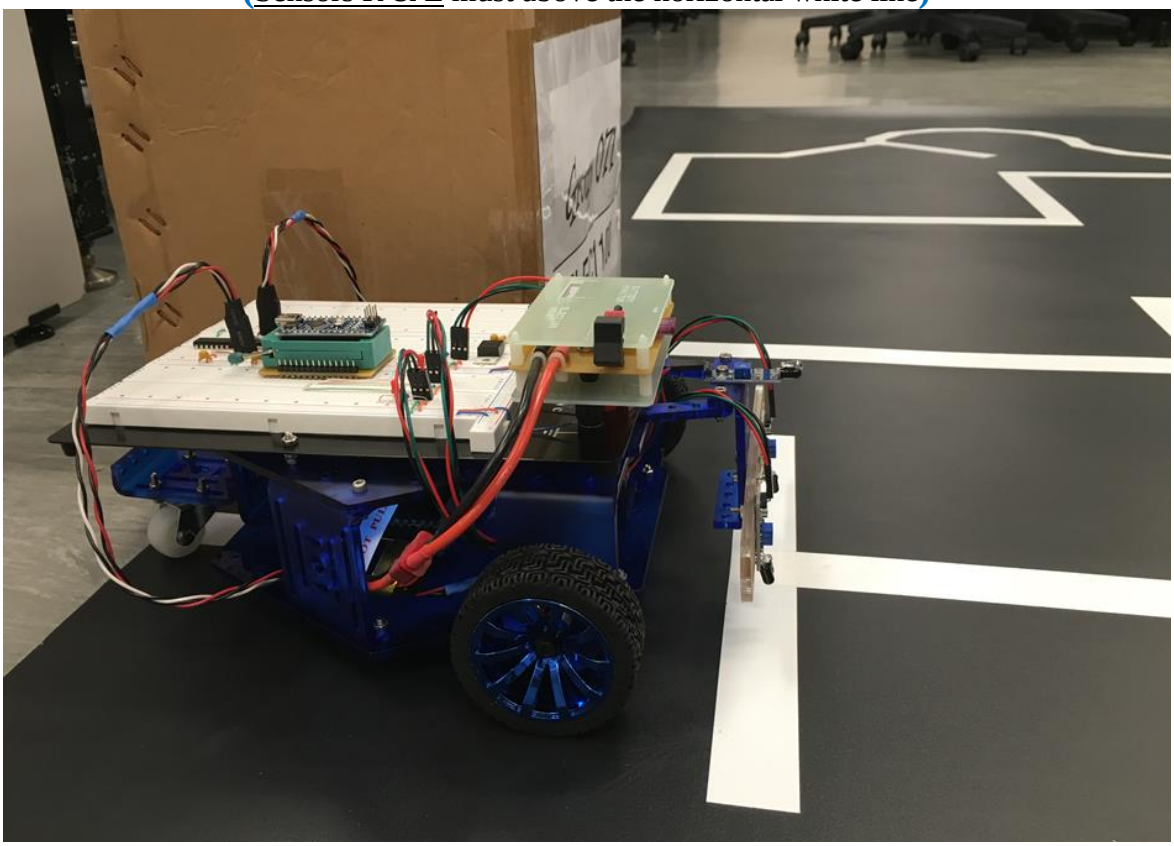
**However, by choosing to demo in Tinkercad, you may obtain at most 14 points as your demo score.

G) Appendix: Car Specification

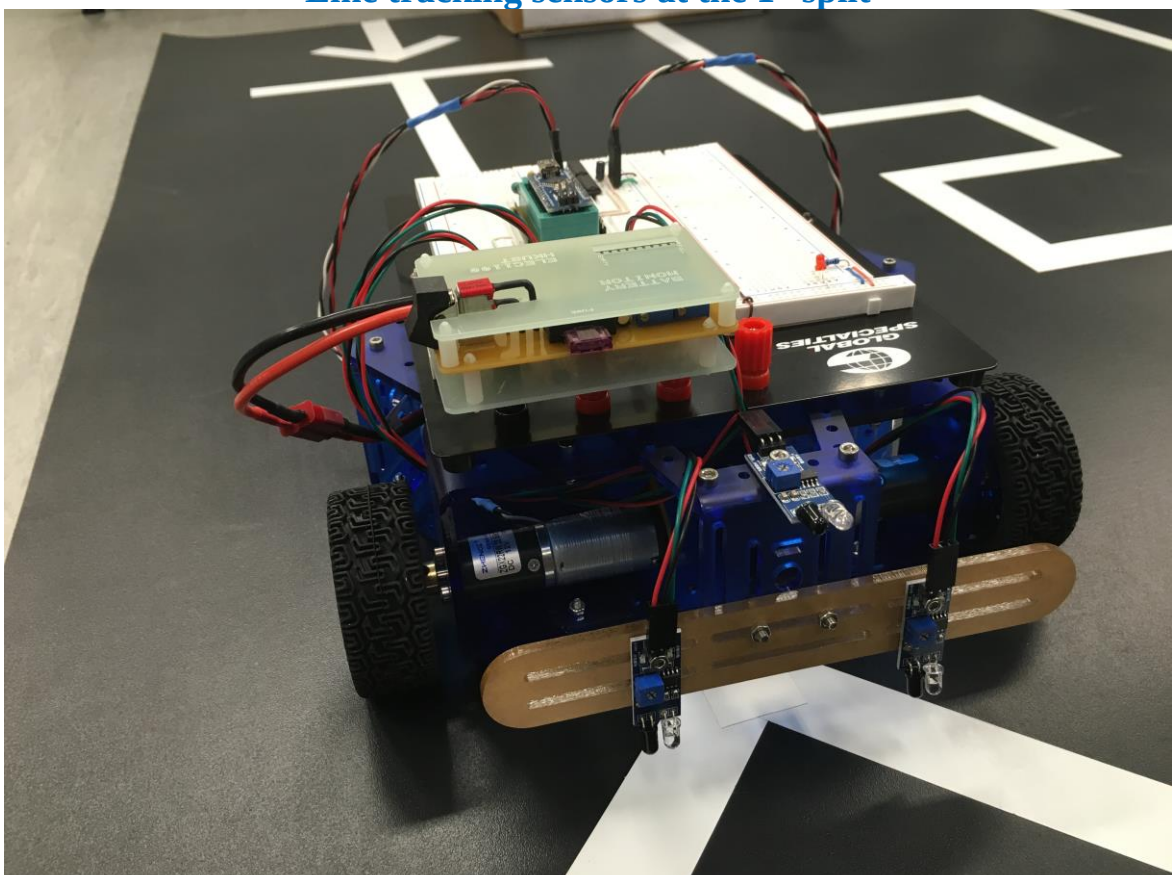
Below is for your reference to do the coding work.

Car at the "Start" white line

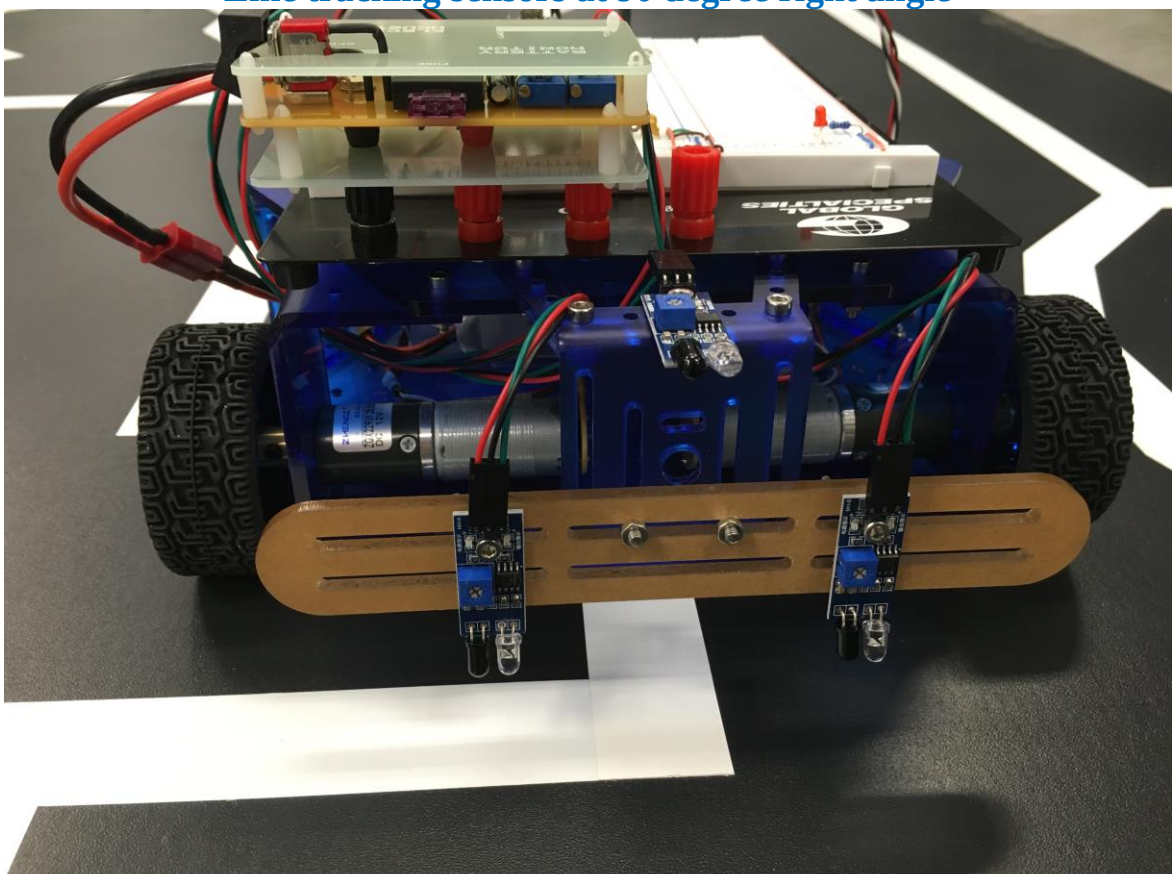
(Sensors R & L must above the horizontal white line)



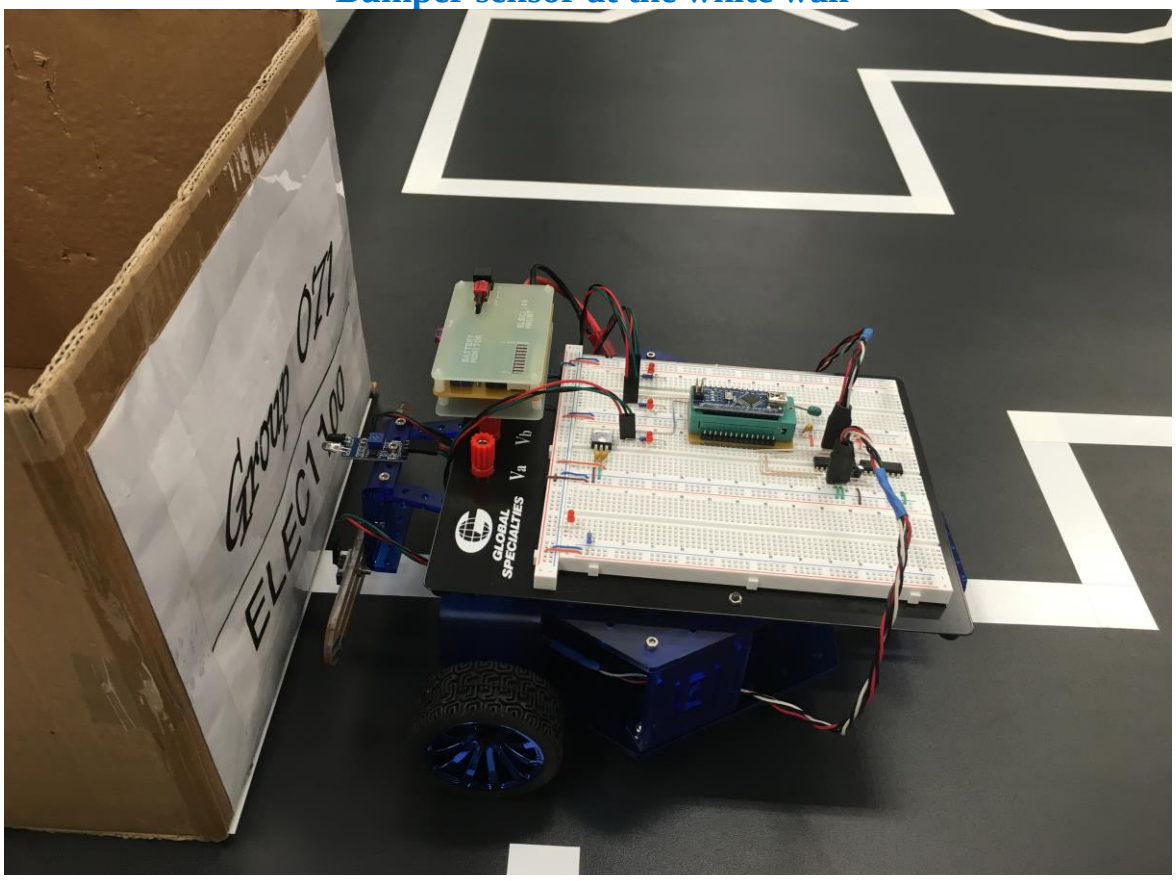
Line tracking sensors at the 1st split



Line tracking sensors at 90 degree right angle



Bumper sensor at the white wall



Car stop at the “End” corner