CG2271: Real-Time Operating Systems

Project

Canvas Team Number: _____ HP Number: _____

The aim of the project is to add some excitement to this module and allow you to develop an RTOS-based system beyond the structured labs. The project is expected to be completed at your own time, beyond the lab slots. You are free to make use of the Makers Lab to develop your project.

The aim of the project is to design a RTOS-based robotic car that will be controlled through an Android App. The robotic car must be able to fulfil the following features:

1. Establish a WiFi/BT connection with the Android App OR Alternative Controller
2. Receive commands from the Control Device and execute the correct response
3. Move the car in multiple directions.
4. Control the various LED's according to the car's status
5. Play different sounds/tunes according to the cars status.

Grouping: The project can be completed in groups of **4 to 5**. You need to be in the same group as your structured lab slot.

Budget: No additional budget is provided. Work with the material given to you.

Assembly Instructions:

1. The assembly of the chassis is quite intuitive so should be manageable by everyone.
2. The H-bridge motor drivers are different from the one issued to you in EPP2, but it is simple to use. Each motor's speed is controlled by two PWM signals, one for forward and one for backwards. Each motor driver can drive two motors, hence you need a total of four PWMs for each motor driver. The interface details can be found here: https://www.pololu.com/product/2130
3. The interface of the ESP32 module and the Android App Interface will be elaborated through a video tutorial.

Requirements Checklist:

A. Motor Control

Requirement	Level of Achievement
1. The robot must be able to move in all FOUR directions, Forward, Left, Right and Back.	
2. The robot must be able to perform curved turns while moving.	
3. The robot must stop all movement if no command is being sent.	

B. LED Control

Requirement	Level of Achievement
1. The front 8-10 Green LED's must be in a Running Mode (1 LED at a time) whenever the robot is moving (in any direction).	
2. The front 8-10 Green LED's must all be lighted up continuously whenever the robot is stationery.	
3. The rear 8-10 Red LED's must be flashing continuously at a rate of 500ms ON, 500ms OFF, while the robot is moving (in any direction).	
4. The rear 8-10 Red LED's must be flashing continuously at a rate of 250ms ON, 250ms OFF, while the robot is stationery.	

C. Audio Control

Requirement	Level of Achievement
1. The robot must continuously play a Song tune from the start of the challenge run till the end.* There should not be any break in the song even if the robot is not moving.	
2. When the robot completes the challenge run, the robot must play a unique tone to end the timing.	

*You are free to select any Song Tune. For this test, you must play the actual audio clip of the song and demonstrate that you are able to replicate a similar tune using the buzzer.

RTOS Architecture Minimum Requirements:

The architecture should have a minimum of **4 tasks and 1 Interrupt**. The names of the Tasks and ISR are for reference only. You can choose your own names.

tBrain: Decode the data from the Serial Port and perform the necessary action

tMotorControl: Control the Action of the Motors

tLED: Control the LED's

tAudio: Provide Audio Output

Serial_ISR: The Serial Data received by the ESP32 device. The serial data **MUST** be captured through the use of Interrupts.

This is a general guideline. You can have more tasks if you wish but not less.

You are free to decide the way in which the tasks will communicate and synchronize with each other. You must ensure that shared data is protected using appropriate RTOS constructs.

TikTok/YouTube Video Submission:

Each team is to submit a video to share their journey in this project. You have TWO options.

Option One: 2-3 min YouTube video to be submitted at the end of the semester.

Option Two: 3 TikTok videos (>= 1min each) to be spread across the semester.

Total = 12 marks

You will get the full 12 marks as long as you have uploaded content that is related to the project/module.

Grading Criteria:

Item	Marks
Fulfilment of Requirements (9 x 2)	18
Challenge Run Leaderboard Rank	70
Video Submission	12

Total Marks for the Project = 100

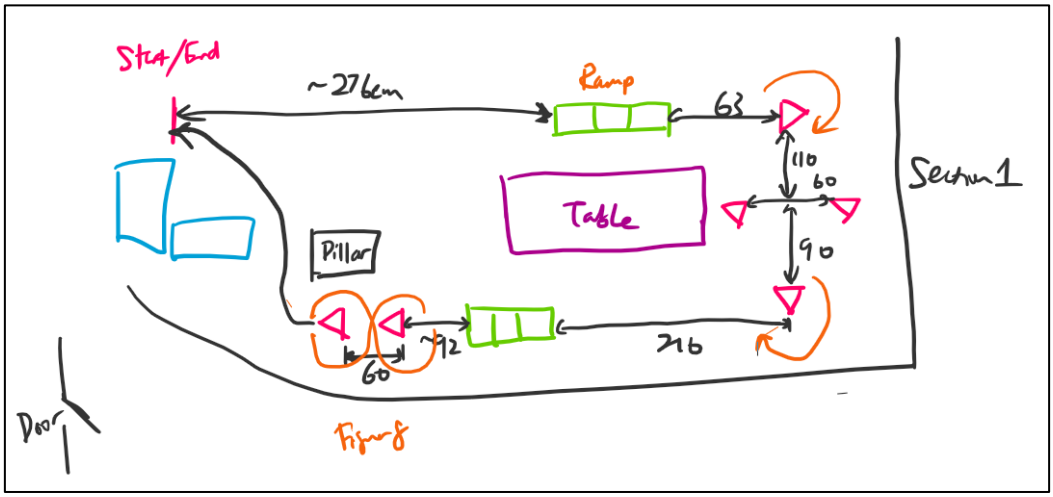
Contribution to the Final Grade = 40%

CHALLENGE RUN

The challenge run will require you to control your robot and navigate it through a simple maze while fulfilling all the requirements in the checklist above. The actual challenge run maze is still being finalized, so stay tuned for an announcement on that.

*** This is the old maze setup in the DSA Lab. We will have a similar setup outside the Makers Lab ***

Challenge Run: Remote-Control Mode



Challenge Run Test Run:

The challenge run will be conducted in the open area just outside the Makers Lab. The ramp setup will be made available in the second half of the semester once your robot is fully assembled.

Please ensure that you have performed sufficient tests on the maze before the final assessment.

IMPORTANT POINTS TO NOTE:

- The Leaderboard Ranking will be based on how **fast** your robot is able to traverse both the challenges.

- There will be Penalty timings imposed if certain events happen, e.g. hitting the wall/block, not stopping within the box. If your car falls off the ramp while going up, you need to place it back before the ramp and try again.

  Penalty Timings
  - Each Cone Hit: +2s
  - Unable to go up ramp in first attempt: +3s
  - Unable to go up ramp in second attempt: +5s
    You can place the robot on-top of the ramp and continue after this.
    - No penalty for falling off while going down ramp.

- Each group is given **FOUR ATTEMPTS** for each challenge run. The second attempt must be taken **immediately** after the first attempt. You will not be given any additional time in-between attempts.

- For attempts 3 and 4, the team is allowed to make modifications to the HW/SW and return for the assessment. There are additional penalties for these attempts:

  - Attempt 3: Add 15s to the final timing.
  - Attempt 4: Add 30s to the final timing.

- The **BEST** timing out of the 4 attempts will be taken.

  Challenge Run 1:

Attempt	Timing	Cone Hits		Ramp-Up Penalty		Final Timing
		Count	Time	Ramp 1	Ramp 2	
1						
2						
3						**+15**
4						**+30**

***** Final Project Evaluation (Tentative): Saturday, April 12th, 2025**
***** SUBMISSION DEADLINE FOR ALL PROJECT RELATED MATERIAL: Friday, April 25th, 2025 (11:59PM) *****

THE END