MAE4040 Mechatronics

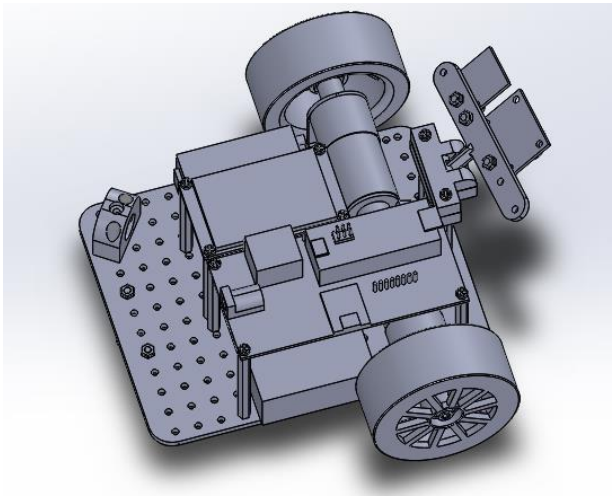
Department of Mechanical & Automation Engineering
The Chinese University of Hong Kong

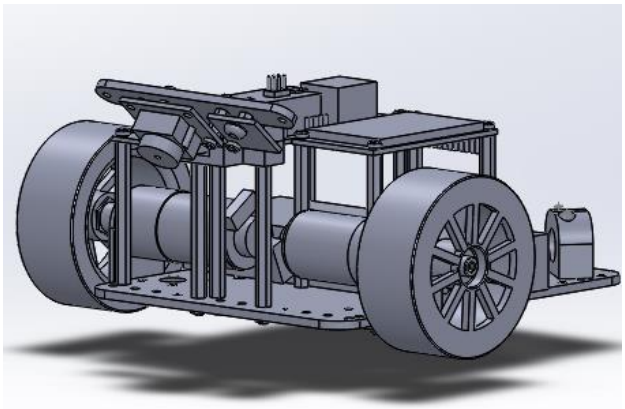
Laboratory: Project outline

Project objective is enhancing the knowledge gained from lectures and MCU workshops. With the knowledge, students got the skill to control a smart car to follow a black line (~18mm in width) on a racecourse as shown in figure 1.

*Before the project starts, students are advice to go through the MCU workshop.
Project requirement:

1. ***NO more than 3 students*** *to form a team.*
2. A Two-wheels drive robot car with battery will be provided to each team as the picture below.
3. NO further modification is allowed for the robot car, however, you can adjust the pan-tilt of camera.
4. To work with the algorithm for tracking a black line by a sensor (line scan camera TSL1401-DB).
5. Programming technique employed (sample code will be provided for a start).
6. Trouble shooting technique.





Goal

Refer to Fig. 1 Map of racecourse; the robot car must follow the black line from the robot start point (START, follow the routine as the arrows and finally **stopped** at the End T as fast as it can. Time will be taken as the reference of score. Each team will have **TWO** trials to achieve the goal. Only the best score of the trials will be encountered. Time limit for each trial is **TWO** minutes. (One minute before each trial for set up preparation)*

The Game rules and score:

1. During the game, there should NOT be any physical disturbance to the car!
2. During the game, ONE restart request is allowed. It can be started on the restart line as shown in Fig2 for coming incomplete zone.
   (Completed Zone: it is defined as the car follows at least 80 % of the track in the zone)
3. In case of restart request, FIVE seconds as penalty will be added to the final score.
4. Referring to figure 2, the racecourse is divided into 5 zones. In case the robot car cannot complete ALL zones, the score will be counted in different categories as the table shown:

Rank 1	Rank 2	Rank 3	Rank 4
Complete 1,2,3 &4 zones	Complete 1,2 & 3 zones	Complete 1 &2 zones	Complete zone 1
Time taken	Time taken	Time taken	Time taken

In case the robot car has completed 1, 2, 3 & 4 zones, but it cannot stop on the "End T" (zone 5). THREE seconds as penalty will be added to the final score of the trial.

5. The game algorithm should be based on line tracking (~18mm in width), however, special strategies of skipping zone are allowed but limited to ONE zone by-pass.
6. Within two weeks of the project start, if you submit a flowchart or a mind map with description of (a) how to use the camera data to control the robot movement in detail (within 200 words); and (b) how to read the line scan camera data (within 100 words). Then the Time taken in your score will be deducted 10 seconds.

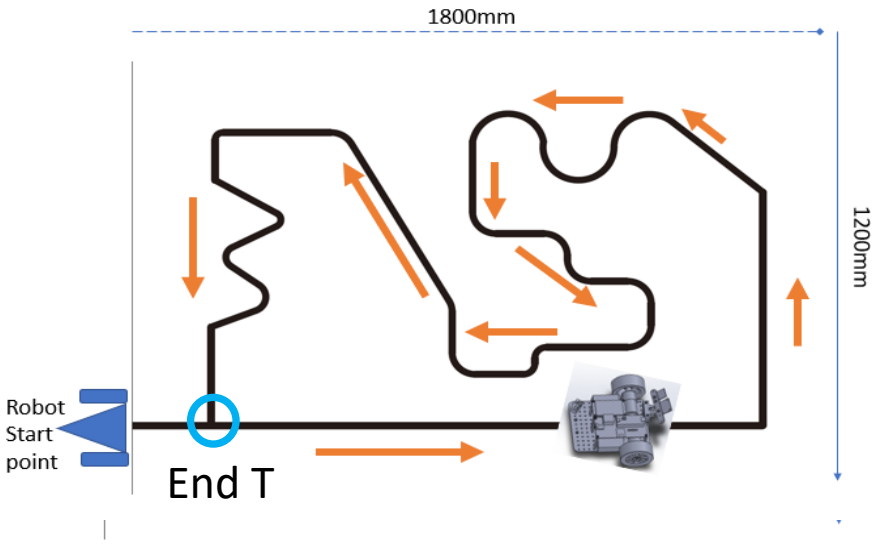


Fig. 1 Map of racecourse

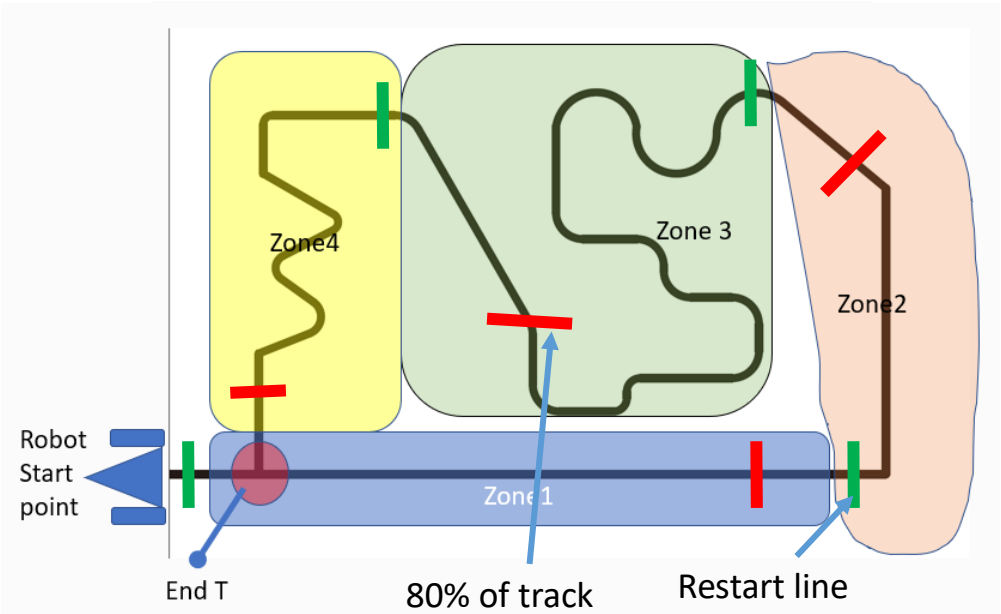
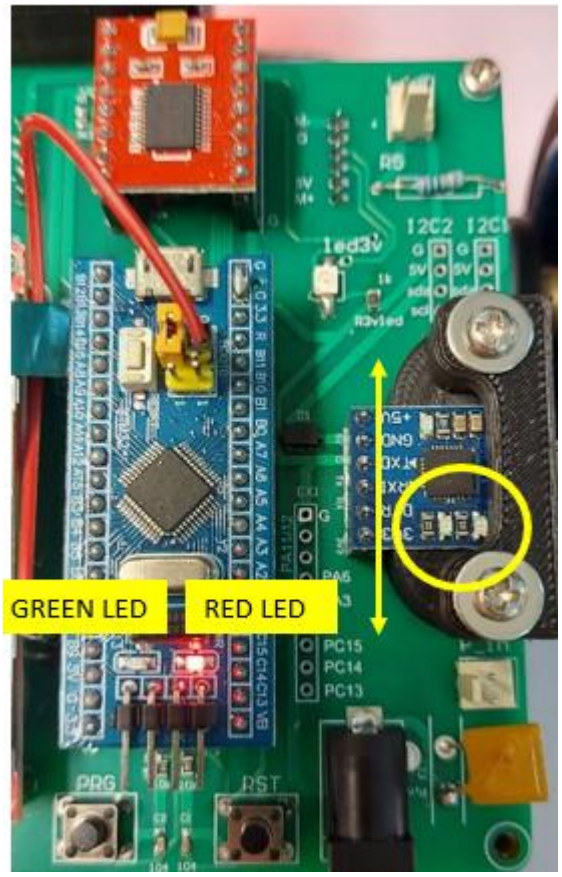


Fig. 2 Zones of racecourse

Program download note



When you press both the RST and PRG button and then release the RST first and then PRG. The PCB green LED will be off and the red is still on. The two LEDs (yellow circled) should be off. Otherwise, you cannot download program into the STM32. If the circled LED is ON, a) try to power off the robot and remove the USB cable and wait few seconds, then power on and insert the USB cable again. Or b) try to shake the small pcb in yellow arrows.

MAE4040 Project programs note

1. In the given program 4040_car-yr2023_motor_demo.ino, we control the motor speed by function “void motorMOVE(MOT_dir actX, uint8_t spdL , uint8_t spdR)”. Please try to understand how to use it to control the robot. By the way, you can write your own code.

2. In the given program 4040_car-yr2023_cam.ino, we demonstrate how to tackle the camera data and display it to the TFT display. We use the serial monitor of Arduino, input ‘1’, ‘2’ or ‘3’ in sequential, to show how we tackle the camera data. Results will be shown in the serial monitor.


```
display_sel =1
194
189 197 192 194 192 196 197 205 194 198 195 199 197 201 197 201
202 205 198 203 201 205 200 205 203 205 204 203 203 205 205 207
207 212 205 207 204 205 201 205 203 206 202 206 204 206 203 209
206 209 205 206 204 205 197 189 174 171 166 166 164 163 162 166
163 164 162 164 164 167 167 178 163 164 164 166 163 164 160 164
162 165 163 165 159 165 164 165 162 164 162 165 162 165 174 188
197 204 204 200 199 198 198 197 195 200 197 207 198 198 196 198
194 195 193 195 193 194 192 193 193 196 192 193 193 200 193
```

Input ‘1’


```
display_sel =2
163
155 160 157 164 161 163 161 164 161 164 159 166 164 169 168 170
169 172 171 176 172 173 168 172 172 174 174 177 174 175 173 172
168 173 169 174 170 173 171 178 176 179 174 176 172 176 170 172
171 176 172 174 173 174 163 151 133 128 124 125 125 125 122 124
122 123 122 127 123 123 122 124 122 124 122 126 121 124 126 130
132 137 128 129 125 127 123 128 124 126 124 127 122 125 132 153
159 168 165 168 164 167 163 164 163 164 163 166 162 167 159 164
157 163 161 166 161 164 159 161 159 164 159 161 161 170 157
display_sel =2
```

Input ‘2’


```
display_sel =3
207
207 207 207 207 207 207 207 207 207 207 207 207 207 207 207 207
207 207 207 207 207 207 207 207 207 207 207 207 207 207 207 207
207 207 207 207 207 207 207 207 207 207 207 207 207 207 207 207
207 207 207 207 207 207 119 119 119 119 119 119 119 119 119 119
119 119 119 119 119 119 119 119 119 119 119 119 119 119 119 119
119 119 119 119 119 119 119 119 119 119 119 119 119 119 207 207
207 207 207 207 207 207 207 207 207 207 207 207 207 207 207 207
207 207 207 207 207 207 207 207 207 207 207 207 207 207 207 207
display_sel =3
```

Input ‘3’

MAE4040 Project programs note

In the program,

1. we need clear the past display in the TFT by the function XCam_plot(&camARR[0], 0) before rewrite the new one XCam_plot(&camARR[0], 1).
2. We can read and then mapped the raw data to the TFT display window in the function camera_data().
3. We displayed the mapped data into to TFT display window in the function XCam_plot(&camARR[0], 1).
4. We use XCam_2serial(&camARR[0]) to display camera data to serial port in the period of 3 seconds.

Don’t forget to submit a flowchart or a mind map with description that mentioned in the Game rules and score.