Hardware strategy

From the challenge brief, the final Derbot design needs to be able to:

- Follow a white line around the course and stop in the finish zone
- Be small enough to fit through a gate way at the start
- Detect if the object in front of it is lit or unlit
- Move the object to the left if unlit and to the right if lit
- Display the number of lit and unlit object there were around the course on a seven-segment display once inside the finish zone

Figure 1 shows a diagram of the proposed Derbot design. This design should meet all the needed criteria mentioned above.

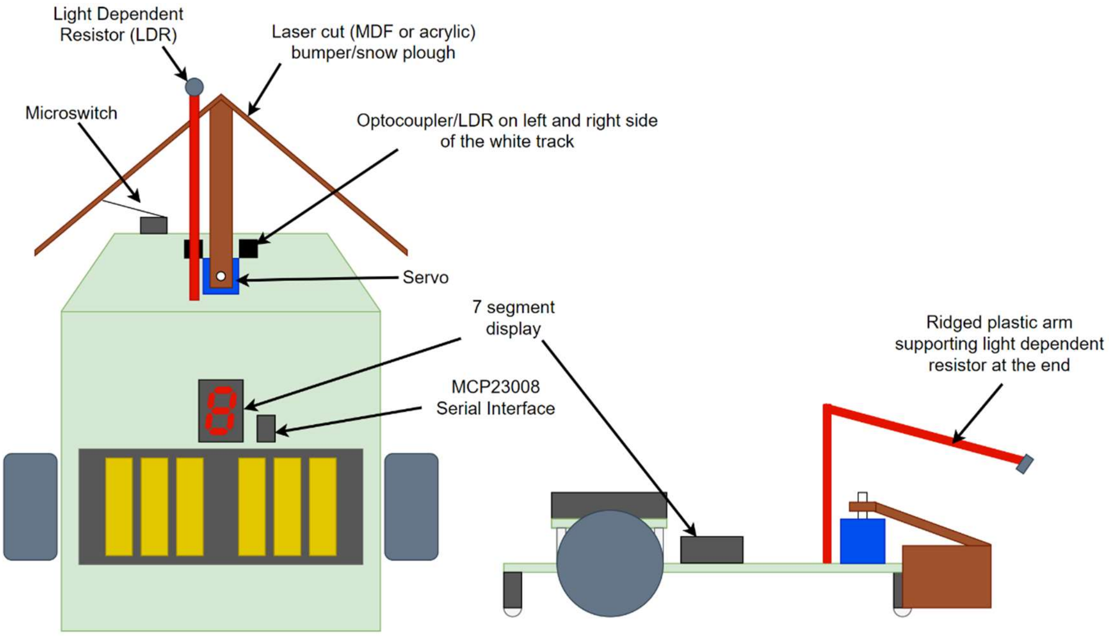

Light Dependent Resistor (LDR)
Laser cut (MDF or acrylic) bumper/snow plough
Microswitch
Optocoupler/LDR on left and right side of the white track
Servo
7 segment display
MCP23008 Serial Interface
Ridged plastic arm supporting light dependent resistor at the end

Figure 1 - Diagram showing the plan view (left) and the side elevation (right) of the Derbot design.

The two optocouplers (or LDRs) will be used to keep the Derbot on the track, allowing the code to adjust the two rear motors depending on their values.

It will have an arrow shaped bumper to push the objects to the left or right as it moves forward; an arm extending from the bumper will be connected to a servo allowing it to be moved left and right.

The default position of the bumper will be in the right position thus pushing everything to the left unless, the Light Dependent Resistor (LDR) at the end of an extended arm detects high level of light from the object, where the servo will move the bumper to the left position pushing the lit object to the right as the Derbot carries on moving forward along the line.

To detect the unlit objects being pushed to the left, the built in microswitch on the left of the Derbot will be connected to the bumper, the bumper will slightly flex when the object is push passed, clicking the microswitch and detecting the object. Both scenarios are shown below in figure 2. By setting the default position of the bumper to the left, the Derbot will not have to slow down when approaching each object, but only change the servo position when it detects high light levels.

There will also be a seven-segment display fitted to the Derbot to show the number of lit and unlit objects detected at the end of the course. This will be via I^{2}C and a MCP23008 serial interface chip.

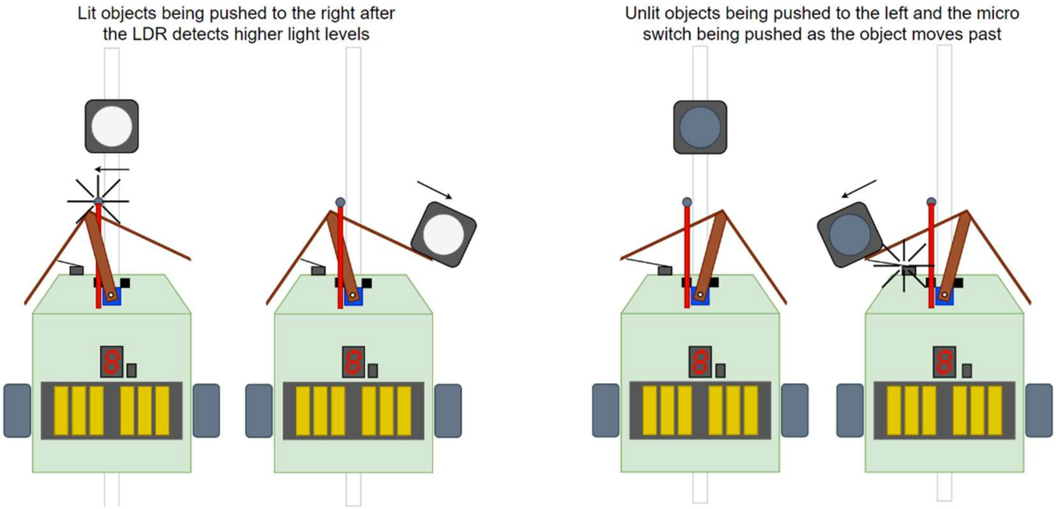

Lit objects being pushed to the right after the LDR detects higher light levels
Unlit objects being pushed to the left and the micro switch being pushed as the object moves past

Figure 2 - How the Derbot will react to a lit object (left) and how it will react to an unlit object (right).

Programming Strategy

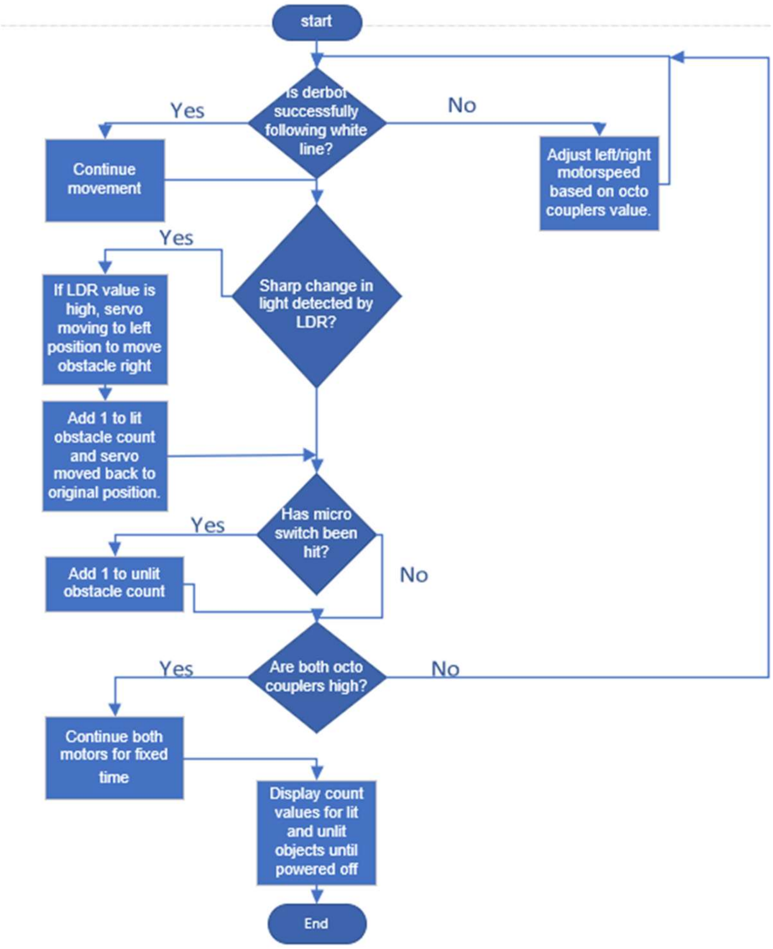
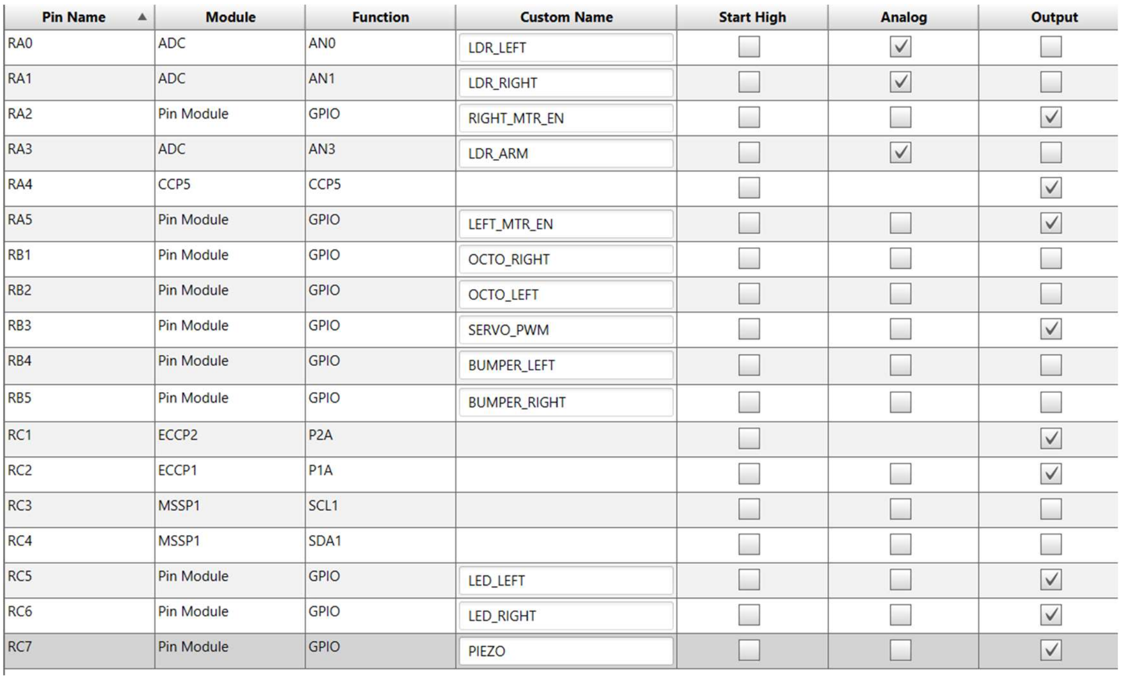

start
Is derbot successfully following white line?
Yes
No
Continue movement
Adjust left/right motorspeed based on octo couplers value.
Yes
Sharp change in light detected by LDR?
If LDR value is high, servo moving to left position to move obstacle right
Add 1 to lit obstacle count and servo moved back to original position.
Yes
Has micro switch been hit?
No
Add 1 to unlit obstacle count
Yes
Are both octo couplers high?
No
Continue both motors for fixed time
Display count values for lit and unlit objects until powered off
End

Figure 3 - Flow chart showing the logical steps the code will make.

Pic resources

Peripheral	Function	Use in Derbot
ACD – Analog to Digital Converter	Convert analogue signals into digital values	Read analogue voltage from pins 2, 3 and 5 (the LDRs)
FVR – Forward Voltage Reference	Set the voltage reference for the ADC (1.024V, 2.048V or 4.096V)	Setting the voltage reference of the ADC to 1.024V. the ADC has a 10bit resolution which will result in a resolution of 1mV
ECCP1 – Enhanced capture compare module 1	Enhanced PWM mode 1	This will generate the PWM signal for the left motor of the DERBOT
ECCP2 – Enhanced capture compare module 2	Enhanced PWM mode 2	This will generate the PWM signal for the right motor of the DERBOT
TMR2 – internal Timer 2 of the PIC	This timer will be used for both PWM pulses for the left and right motor	The PWM values are sent into the IN pins of the L293D
TMR4 – internal Timer 4 of the PIC	This timer will be used to generate a PWM signal in-code (instead of using a CCP module)	The in-code-generated PWM signal will be used as the data for the SERVO
TMR6 – internal Timer 6 of the PIC	This timer will be used at the end of the program to determine the stopping time	When the ending white line is detected, the DERBOT will stop when TMR6 overflows (1s)
MSSP1	I^{2}C – PIC will be the MASTER	The PIC will be the Master
MSSP2	I^{2}C – external I/O will be the SLAVE	The I/O expansion will be the SLAVE

Table 1 - Table showing the peripherals to be used from the PIC microcontroller, their functions, and their purpose on the Derbot.



Pin Name ▲	Module	Function	Custom Name	Start High	Analog	Output
RA0	ADC	AN0	LDR_LEFT	□	☑	□
RA1	ADC	AN1	LDR_RIGHT	□	☑	□
RA2	Pin Module	GPIO	RIGHT_MTR_EN	□	□	☑
RA3	ADC	AN3	LDR_ARM	□	☑	□
RA4	CCP5	CCP5		□		☑
RA5	Pin Module	GPIO	LEFT_MTR_EN	□	□	☑
RB1	Pin Module	GPIO	OCTO_RIGHT	□	□	□
RB2	Pin Module	GPIO	OCTO_LEFT	□	□	□
RB3	Pin Module	GPIO	SERVO_PWM	□	□	☑
RB4	Pin Module	GPIO	BUMPER_LEFT	□	□	□
RB5	Pin Module	GPIO	BUMPER_RIGHT	□	□	□
RC1	ECCP2	P2A		□		☑
RC2	ECCP1	P1A		□	□	☑
RC3	MSSP1	SCL1		□	□	□
RC4	MSSP1	SDA1		□	□	□
RC5	Pin Module	GPIO	LED_LEFT	□	□	☑
RC6	Pin Module	GPIO	LED_RIGHT	□	□	☑
RC7	Pin Module	GPIO	PIEZO	□	□	☑

Figure 4 - Screenshot from MPLABX showing the pin names and custom names which will be used.

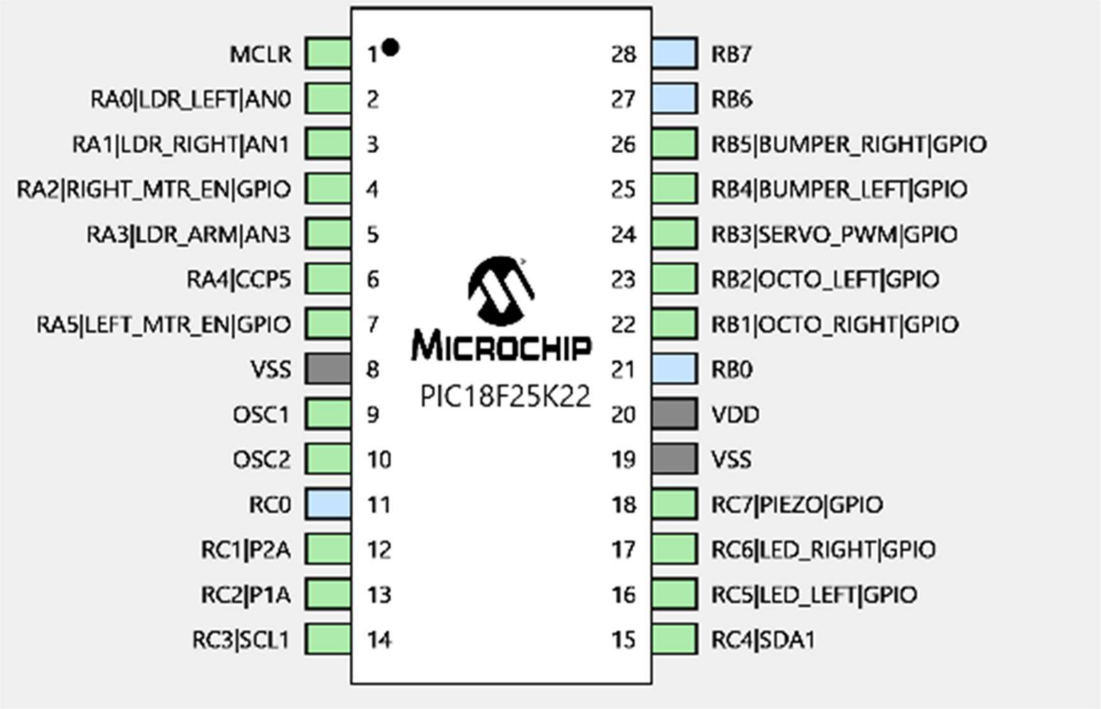


Figure 5 - Screenshot from MPLABX showing a graphical representation of the same data from figure 4.

Allocation of work and time

Allocation of work

Charlie

- Object detection and moving

Oliver

- I^{2}C communication and seven segment display

Mateo

- White line following/starting and stopping

Gannt chart

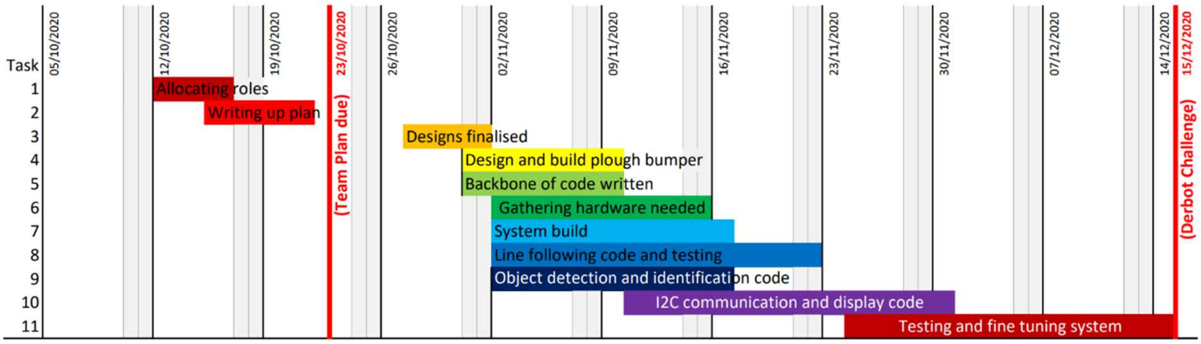


Figure 6 - The Gannt chart for the design and build of the Derbot system.