Design Report
for
Micromouse 2023

1 Introduction

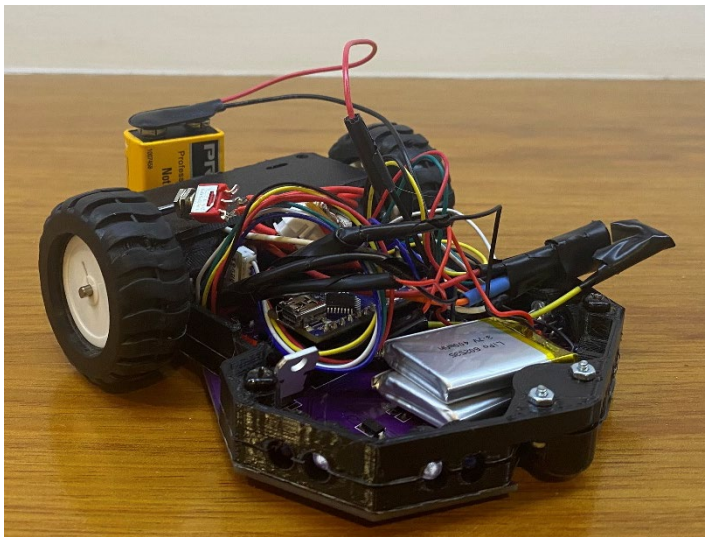
I. Micromouse Specifications

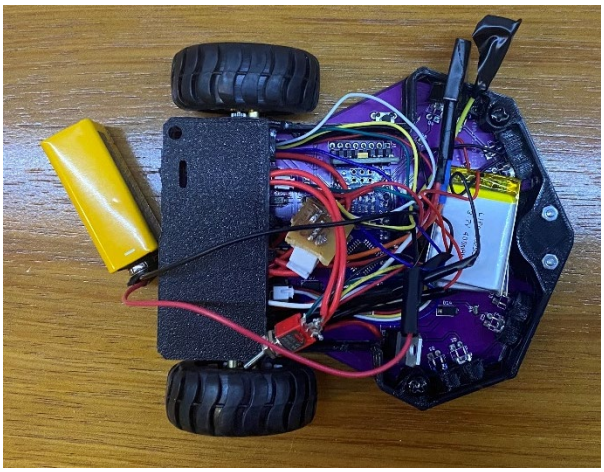
The Micromouse specifications are:

- The total budget for the Micromouse must not exceed $1, 500AUD.
- The length and width of the mouse must both be under 16cm.
- The height of the mouse must not exceed 8cm.
- The mouse can only be powered via battery.
- The mouse must be controlled via on-board system. External connection by any-means during a team's round will result in disqualification.

II. Micromouse Overall Design

The OVERALL COST of the MICROMOUSE was: **$121.91**





2 Control Design

I. Main Script

In the 'main.cpp' script, the setup declares a one-dimensional array of structures which represents the maze and the cells in the maze. The size of the array is the number of cells in the maze. Initially, all the values in the maze are set to zero. The centre and start of the maze are determined and declared as pointers to the maze array. The goal is also declared as a pointer to the centre pointer. The mouse position pointer (mousePos) is set to point to the current cell the mouse is in.

The code then enters a while loop of 150 iterations/movements of the mouse from one cell to the next in the maze. To start, the walls are updated using the update_walls function which calls upon the values received from the IR sensors to determine where (if any) walls are about the mouse and updates the current cell to have detected walls. The update_distance function then updates the distance of each cell in the maze to the goal. The mouse uses these distances to determine the next cell to move to - which is the neighbouring cell with the shortest distance – which occurs when the to_move function is called. It then sets the mouses position to the cell to be moved to. If the mouse has to rotate, the get_direction function is called to get the required orientation of the mouse and sets the mouses orientation to that value.

Once the mouse reaches the centre of the maze (or the goal) it then sets the goal to be the start of the maze and updates distances of each cell based on the goal being the start of the maze. Furthermore, once it reaches the start, the mouse stops.

II. Update Distance Function

The update_distance function updates the distance from each cell in the given maze to the given target cell. To do this the function uses two buffers to store pointers to cells to be updated, and an array that tracks which cells have been added to either buffer. That is the purpose of the listed and buffers array.

Within the while loop, the function updates the distances of each cell in the buffer assigned to the parents pointer. For each cell in the parents buffer, every other cell reachable from it (not blocked by a wall) that hasn't already been listed is added to the buffer assigned to the children pointer. For every loop iteration, the children buffer is overwritten.

Per iteration, after every parent cell in the parents buffer has been updated and their children added to the children buffer the which variable is toggled and the distance variable is incremented. Next iteration the buffer that was previously the children buffer is now the parent buffer. Their distances are updated, and their children are added to the buffer that was previously the parents buffer.

This process continues until every cell in the maze has been listed and updated.

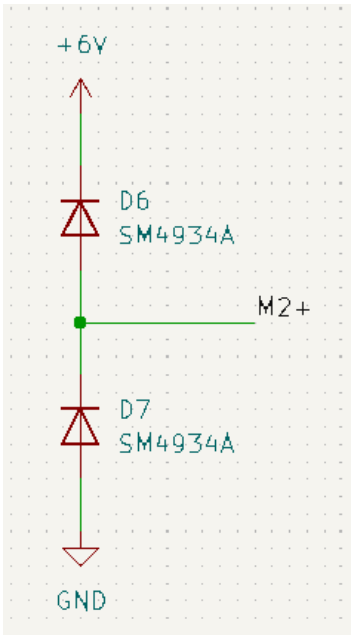
To see the code please follow the link below to the GitHub repository:

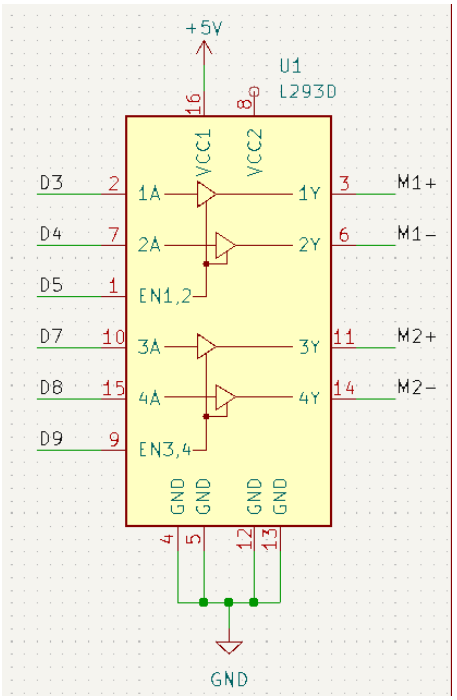
https://github.com/qcuc/MicroMouse2023/tree/84a416fa76fc7899c37efbe69f3e4619b706d999/Navigation

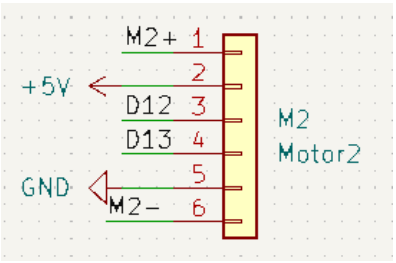
3 Electrical Design

I. Motor & Control Design

For the drive, two brushed geared motors were connected to a L293D motor driver. The motor driver was controlled by the Arduino Nano with PWM signal being supplied to the enable pins to control the speed of the motors and adjusting the digital output to the input pins to control the direction. To block any electrical regeneration from the motors, diodes were used. The motors had encoders so that the number of rotations could be tracked.





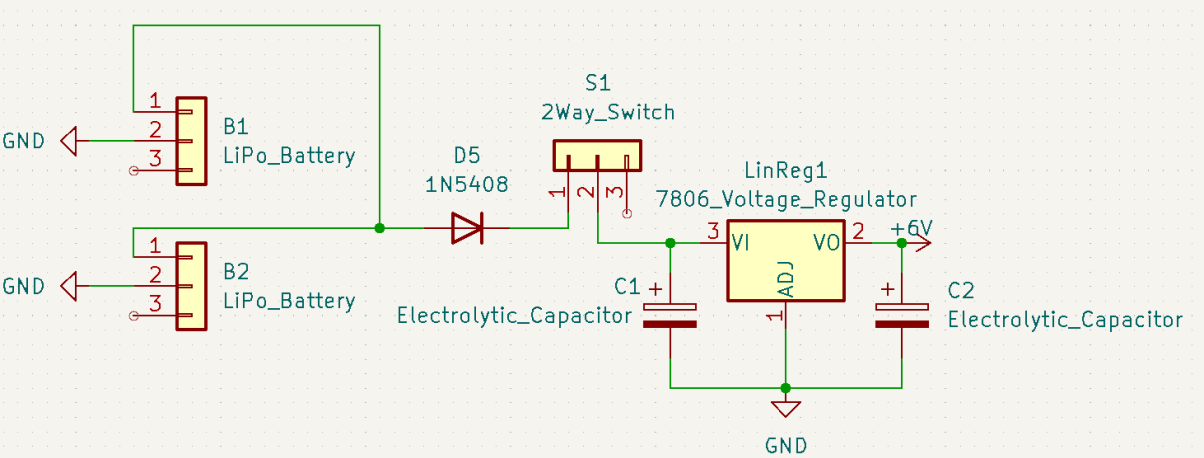


Micro Metal Geared Motor w/Encoder

- Current Rating: 170 mA
- No-Load Current: 60 mA
- Rated Voltage: 6.0 V

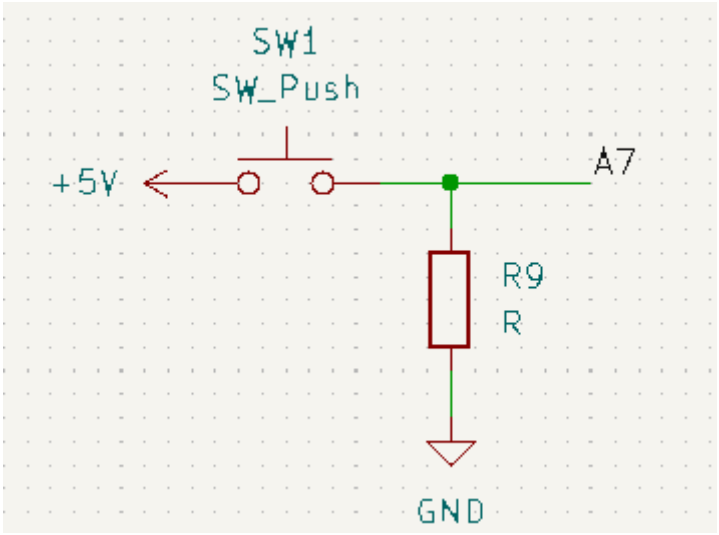
II. Power Supply Design

To supply power for the system, two LiPo batteries (supply voltage – 3.7V, capacity – 400mAh) were connected in series to provide the system with 7.4V and 400mAh. To ensure the one-way flow of power a 1N5408 diode was used as it is appropriate for 3A. The switch was used to connect/disconnect the power. This then flowed through to the linear voltage regulator and electrolytic capacitors to provide a smooth +6V output to the Micromouse.



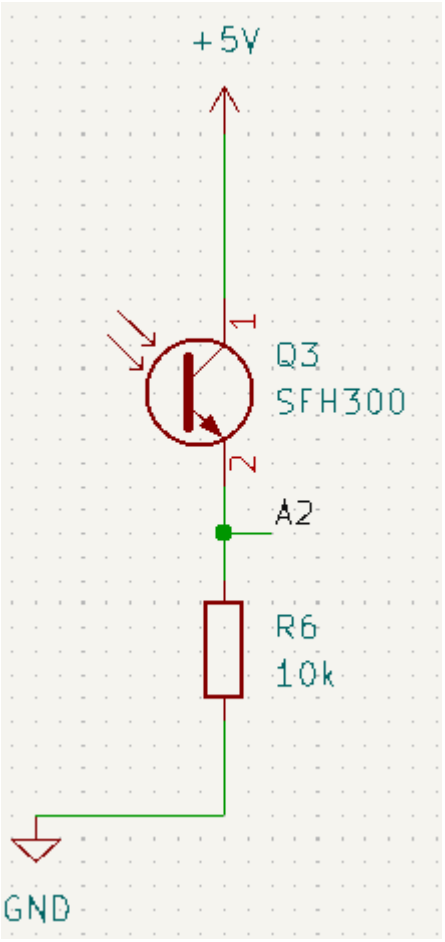
III. Start Button Design

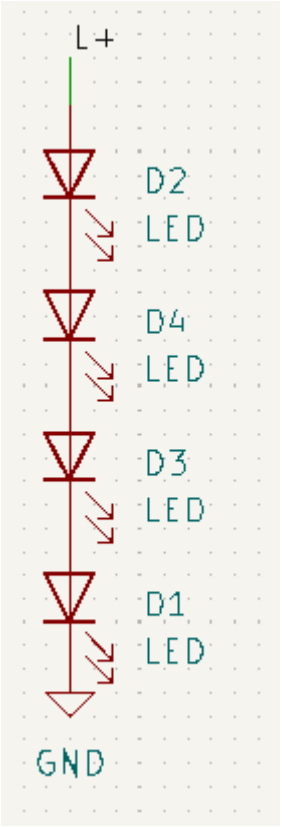
To ensure safety and control on the Micromouse a push button switch was used to start the program for the rover. The schematic for it is shown below:



IV. Sensor Design

For the distance sensors, 5mm Infrared Transmitting LEDs and 5mm Infrared Phototransistors were used in conjunction. To ensure that the power was evenly distributed to the LEDs , they were connected in series from +9V (+L) to GND. The phototransistors were setup such that +5V flows into the collector of the phototransistor, then the emitter is connected to an analogue read pin of the Arduino Nano and a 10kΩ resistor which then runs to GND. This would work by the walls reflecting the light produced by the LEDs to increase the gate voltage and thus the current passing through the phototransistor. This increase in current would then generate a voltage change which can be measured at the analogue read pin of the Arduino nano.





5mm Infrared Transmitting LED

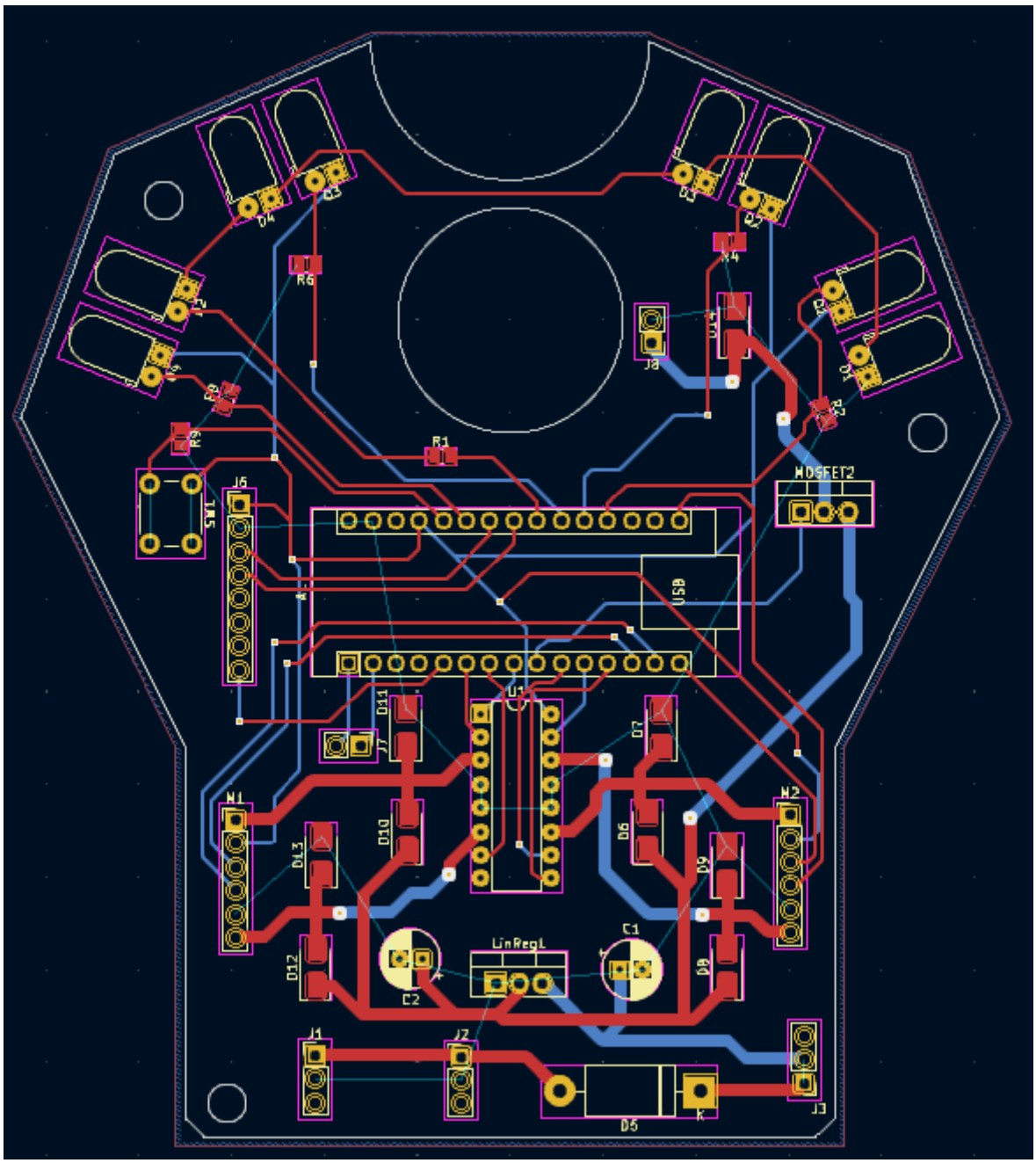
- Forward Voltage: 1.2 V (typical), 1.5 V(max)
- Forward Current: 50 mA
- Peak Forward Current: 1.2 A
- Power Dissipation: 100 mW
- Reverse Voltage: 5 V
- Operating Temperature: -40˚C – 85˚C

5mm Infrared Phototransistor

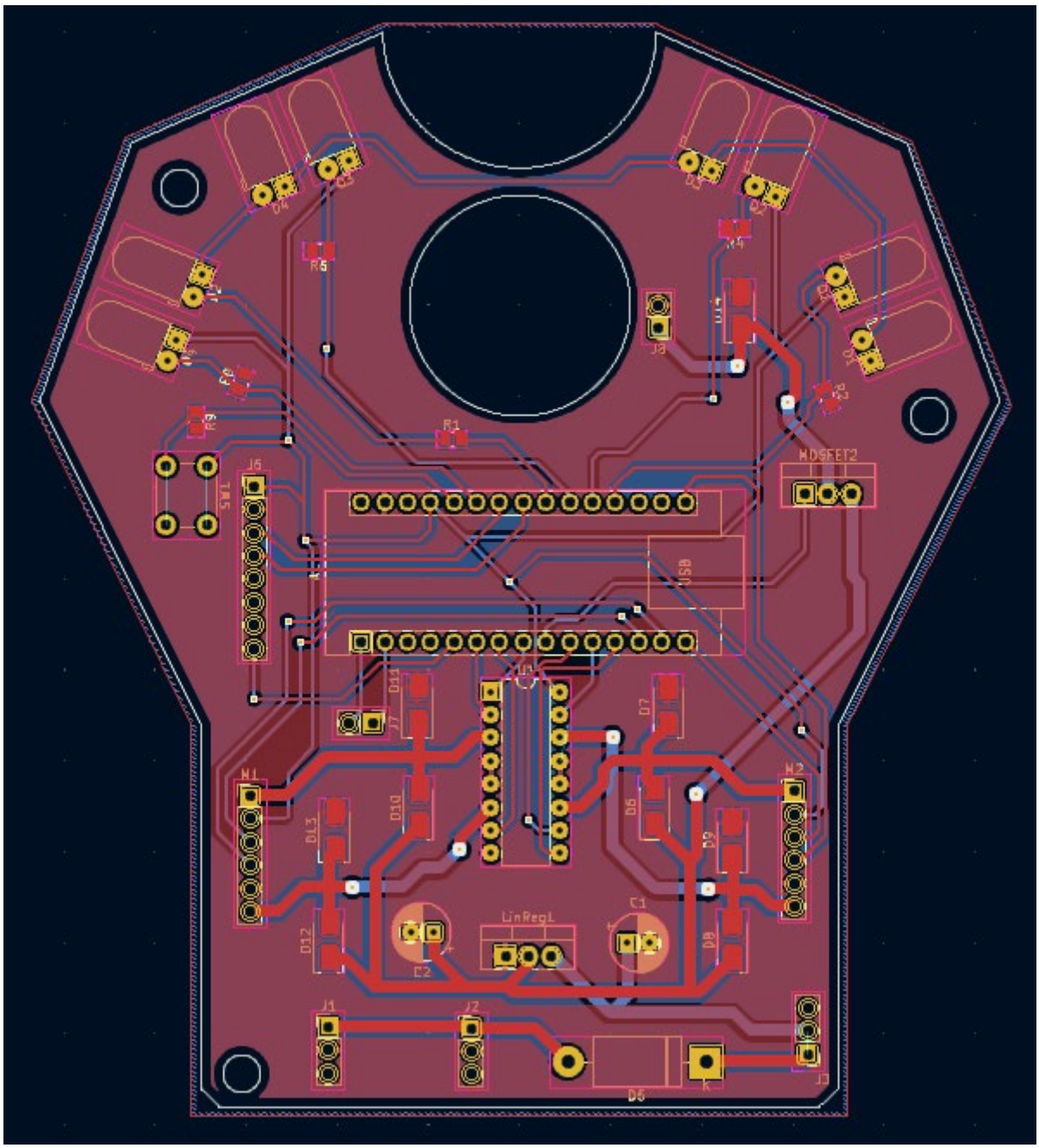
- Collector-to-Emitter Breakdown Voltage: 30 V
- Emitter-to-Collector Breakdown Voltage: 5 V
- Collector-to-Emitter Saturation Voltage 0.8 V
- Collector Dark Current: 100 nA
- On State Collector Current: 0.1 mA (min), 0.5 mA (typical)

V. PCB Design

W/O Filled Zones

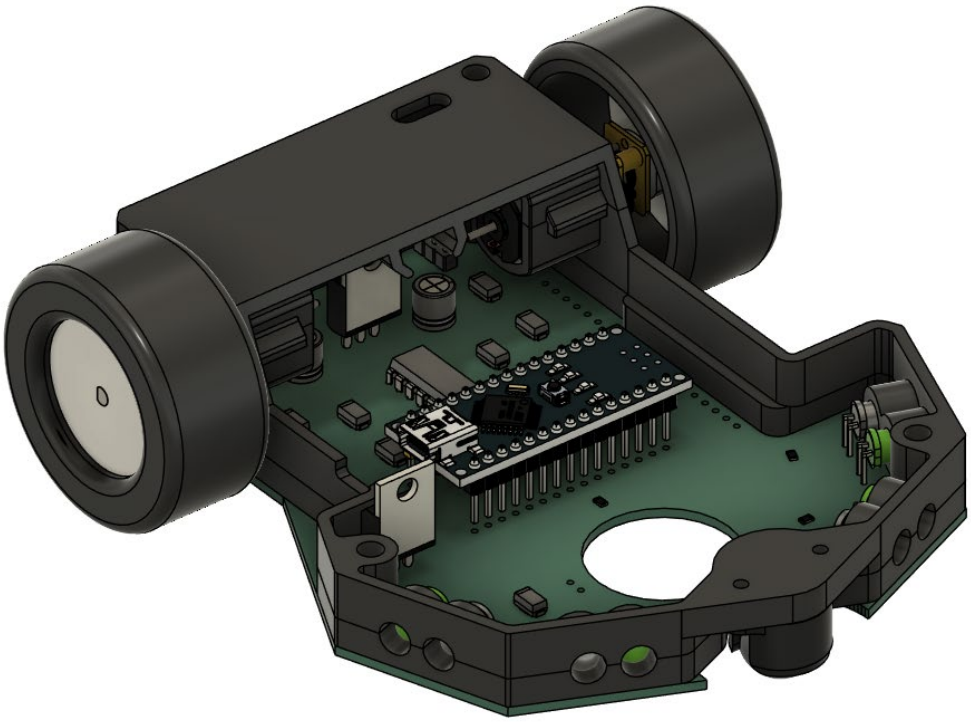


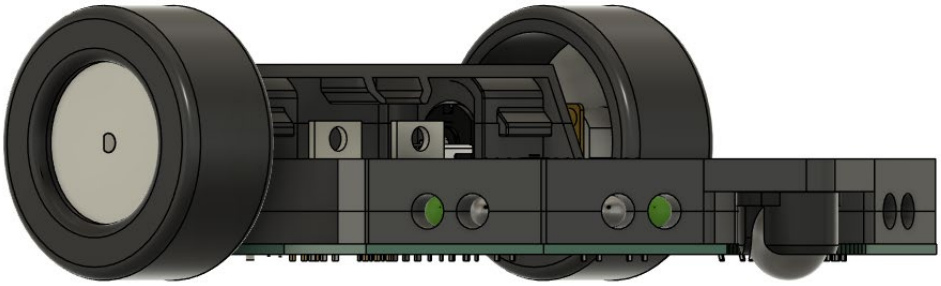
W/ Filled Zones

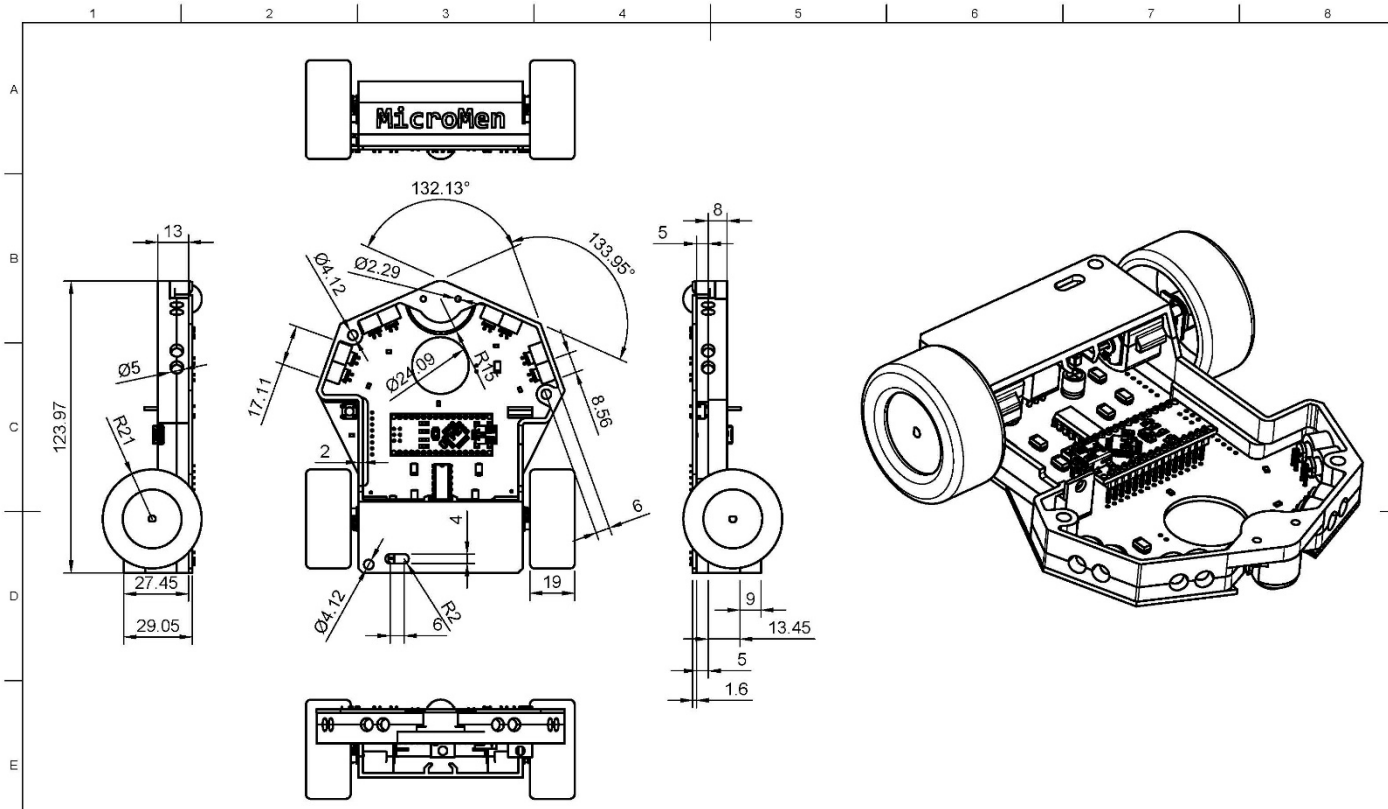


4 Mechanical Design

The chassis used to provide an enclosure over the PCB is made of a Black eSun PLA+. The walls were made to be 2mm in thickness. The 3D print follows DFM guidelines. To secure the 3D print together 2x M4 screws and super glue was used. The 2D drawing and some sample 3D projections are shown below:

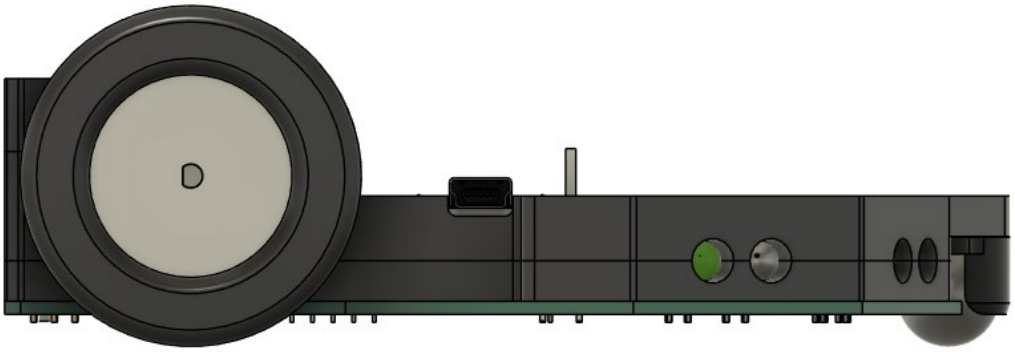


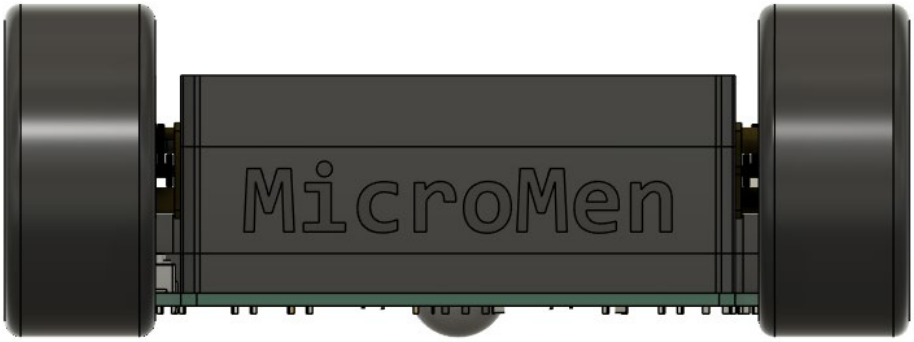


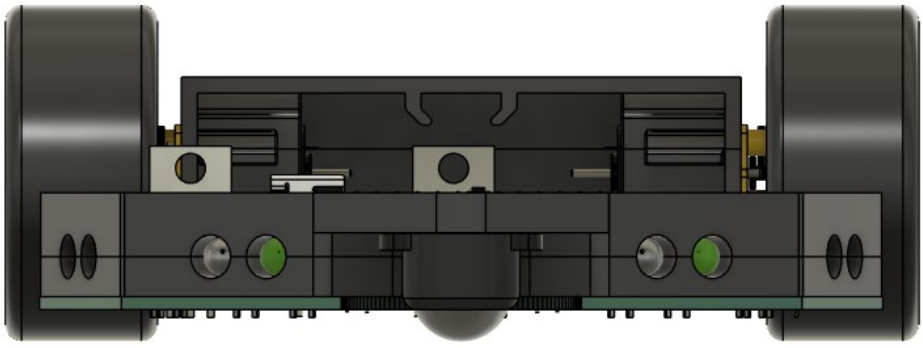


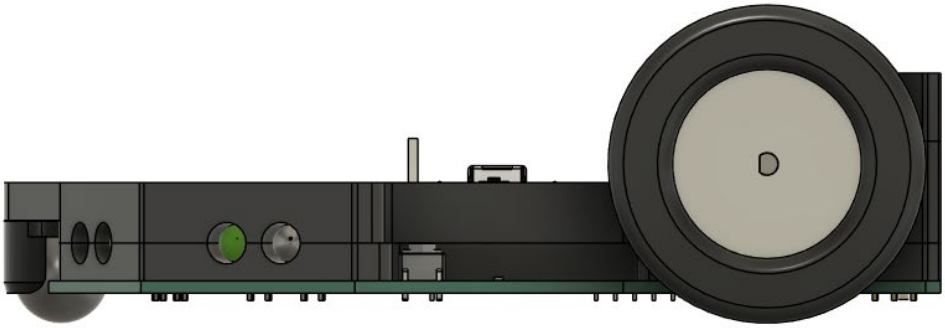
Dept.	Technical reference	Created by: Alex Fox 7/12/2023	Approved by
		Document type	Document status
		Title: Micromouse	DWG No.
			Rev. / Date of issue / Sheet: 1/1

Appendix A: CAD Models









Appendix B: Budget

Store	Item	Quantity	Price	On Robot %	Shipping Boolean	Ordered By	Link
Core Electronics	Makerverse USB-C LiPo Charger	1	$5.15	0.00	0	Alex	https://core-electronics.com.au/makerverse-usb-c-lipo-charger.html
Core Electronics	Polymer Lithium Ion Battery (LiPo) 3.7V 400mAh	2	$12.05	1.00	0	Alex	https://core-electronics.com.au/polymer-lithium-ion-battery-400mah-38456.html
Core Electronics	Shipping	1	$7.36	0.00	1	Alex	
Amazon	3x Arduino Nano V3.0	1	$24.99	0.33	0	Alex	https://www.amazon.com.au/dp/B077272KMZ?psc=1&ref=ppx_yo2ov_dt_b_product_details
DFRobot	Wheel 42x19mm (Pair)	1	$2.90	1.00	0	Alex	https://www.dfrobot.com/product-353.html
DFRobot	Micro Metal Geared motor w/Encoder – 6V 530RPM 30:1	2	$11.50	1.00	0	Alex	https://www.dfrobot.com/product-1431.html
DFRobot	Shipping	1	$18.00	0.00	1	Alex	
JayCar	DIL 2-way Switch	1	$1.85	**1.00**	0	Alex	https://www.jaycar.com.au/dil-2-way-switch/p/SM1012
JayCar	5mm Infrared Transmitting LED	4	$2.25	1.00	0	Alex	https://www.jaycar.com.au/5mm-infrared-transmitting-led/p/ZD1945
JayCar	5mm Infrared Phototransistor	4	$1.75	1.00	0	Alex	https://www.jaycar.com.au/infrared-phototransistor/p/ZD1950
JayCar	7806 +6V 1A Voltage Regulator	1	$1.95	1.00	0	Alex	https://www.jaycar.com.au/7806-6v-1a-voltage-regulator/p/ZV1506
JayCar	1N5408 3A 1000V Diode	1	$0.45	1.00	0	Alex	https://www.jaycar.com.au/1n5408-3a-1000v-diode/p/ZR1018
JayCar	eSUN Black PLA+ Filament 1kg 1.75mm	1	$39.95	**0.03**	0	Alex	https://www.jaycar.com.au/esun-black-pla-filament-1kg-1-75mm/p/TL4454
JayCar	SMD Diode SM4934A 100V 1A D0214AC - Pack 10	1	$4.17	0.90	0	Alex	https://www.jaycar.com.au/smd-diode-sm4934a-100v-1a-d0214ac-pack-10/p/ZR1070
JayCar	MJE2955 PNP Transistor (10A)	1	$3.45	1.00	0	Alex	https://www.jaycar.com.au/mje2955-pnp-transistor/p/ZT2275
JayCar	100uF 25VDC Low ESR Electrolytic Capacitor	2	$0.50	1.00	0	Alex	https://www.jaycar.com.au/100uf-25vdc-low-esr-electrolytic-capacitor/p/RE6322
Altronics	3.5mm SPST Micro Tactile Switch	1	$1.10	1.00	0	Alex	https://www.altronics.com.au/p/s1124-spst-momentary-pcb-mount-8mm-tactile-switch/
Altronics	Motor F130 3-12V 3V Constant	1	$4.00	1.00	0	Alex	https://www.altronics.com.au/p/j0022-F130-1.5V-hobby-motor/
Altronics	1K SMD Resistor 0805 10pk	1	$1.40	0.00	0	Alex	https://www.altronics.com.au/p/r1076-1k-.125w-805-metal-film-smd-resistor-pk-10/
Altronics	9K1 SMD Resistor 0805 10pk	1	$1.40	0.50	0	Alex	https://www.altronics.com.au/p/r1145-9k1-.125w-805-metal-film-smd-resistor-pk-10/
Altronics	100R SMD Resistor 0805 10pk	1	$1.40	0.10	0	Alex	https://www.altronics.com.au/p/r1524-100r-.1w-603-metal-film-smd-resistor-pk-10/
Core Electronics	Red Robot Wheels (Pair)	1	$7.15	0.00	0	Ethan	
Core Electronics	Pololu Ball Caster with 1/2" Metal Ball	1	$4.30	1.00	0	Ethan	https://core-electronics.com.au/pololu-ball-caster-with-1-2-metal-ball.html
Core Electronics	Shipping	1	$7.36	0.00	1	Ethan	
JLC PCB	PCB	1	$3.25	0.00	0	Ethan	https://jlcpcb.com/
JLC PCB	Shipping	1	$26.55	0.00	1	Ethan	
Core Electronics	MPU-6050 Module 3 Axis Gyroscope + Accelerometer	1	$12.05	1.00	0	Alex	https://core-electronics.com.au/mpu-6050-module-3-axis-gyroscope-acce-lerometer.html
JayCar	40 Pin Female Header Strip	1	$2.95	1.00	0	Alex	https://www.jaycar.com.au/40-pin-female-header-strip/p/HM3230
JayCar	L293D Dual Full Bridge Motor Driver IC	1	$6.25	1.00	0	Alex	https://www.jaycar.com.au/l293d-dual-full-bridge-motor-driver-ic/p/ZK8880
JLC PCB	PCB 2	1	$13.21	0.20	0	Alex	https://jlcpcb.com/
JLC PCB	Shipping	1	$29.10	0.00	1	Alex	

Robot Totals			
Total Robot Cost	Total Shipping	Total Project Cost	Cost Per Person
$121.91	$88.37	$210.28	$52.57