Development Guide

By
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System Overview

This project involves developing a sumo robot capable of sensing its opponent and driving forward to push them out of the ring, all while maintaining to stay within the ring itself. It makes use of an HC-SR04 Ultrasonic Sensor module, and an IR sensor module to survey its surroundings, and the code written and uploaded into the Arduino will take the data and perform actions based on them.

Electrical Specifications

Electronic Specifications:	
Peak Output Current	2000 Ah to 2500 mAh
Peak Output Voltage	4.8V to 6V
Max Current Drawn	465 mA to 500 mA

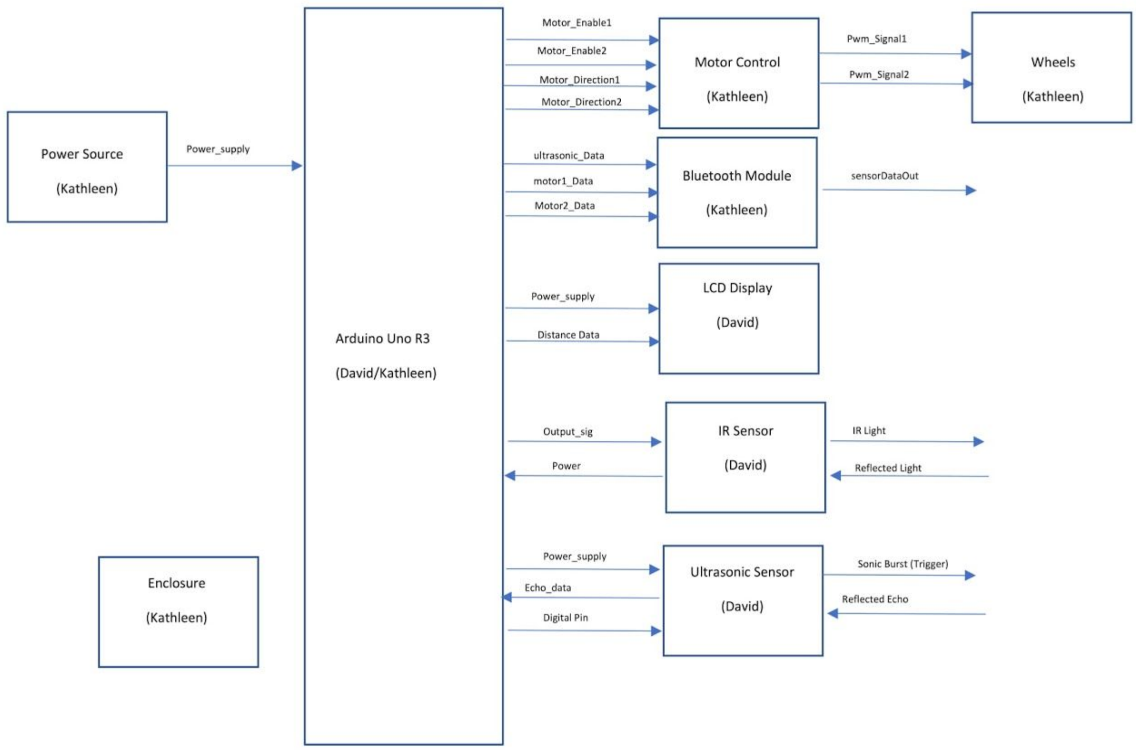
User Guide

Setting up and operating the system itself is very simple. The code is written so that once it is turned on, the behavior dictated by the Arduino code starts up immediately. From there, the robot will gather information from the sensors and perform its different actions.

Design Artifact Figures (block diagram, schematic, 3D model)

Block Diagram

Sumo Project Block Diagram



This is the block diagram for the entire system. It has a total of 8 blocks, not including the Arduino block. The Arduino block contains the code that will be written to dictate the robot's behavior when it takes in the data. It takes in the data through two sensors: the Ultrasonic Sensor, and the IR Sensor, which will detect the distance from the opponent and detect whether the robot is in the ring or not, respectively. The code takes the data, deciphers it, and send instructions to the motors to behave accordingly. The bluetooth isn't being used due to our team downgrading to only two members.

Schematics

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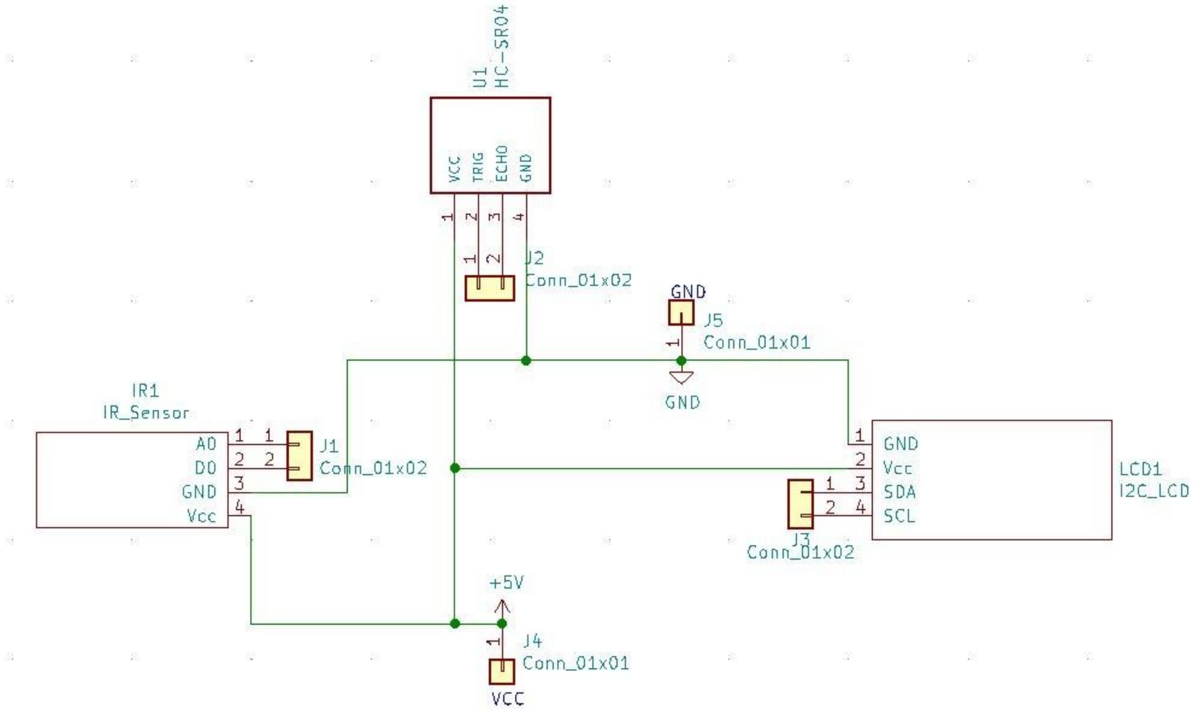
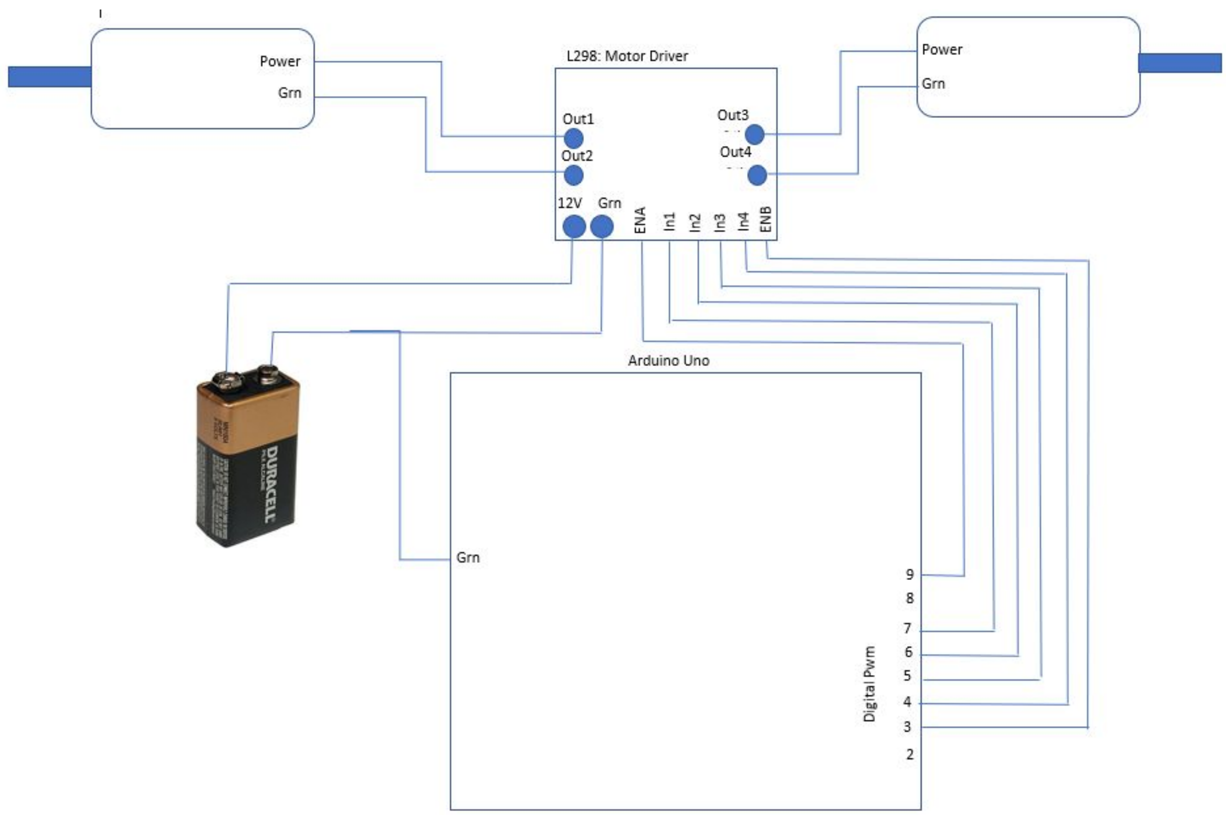
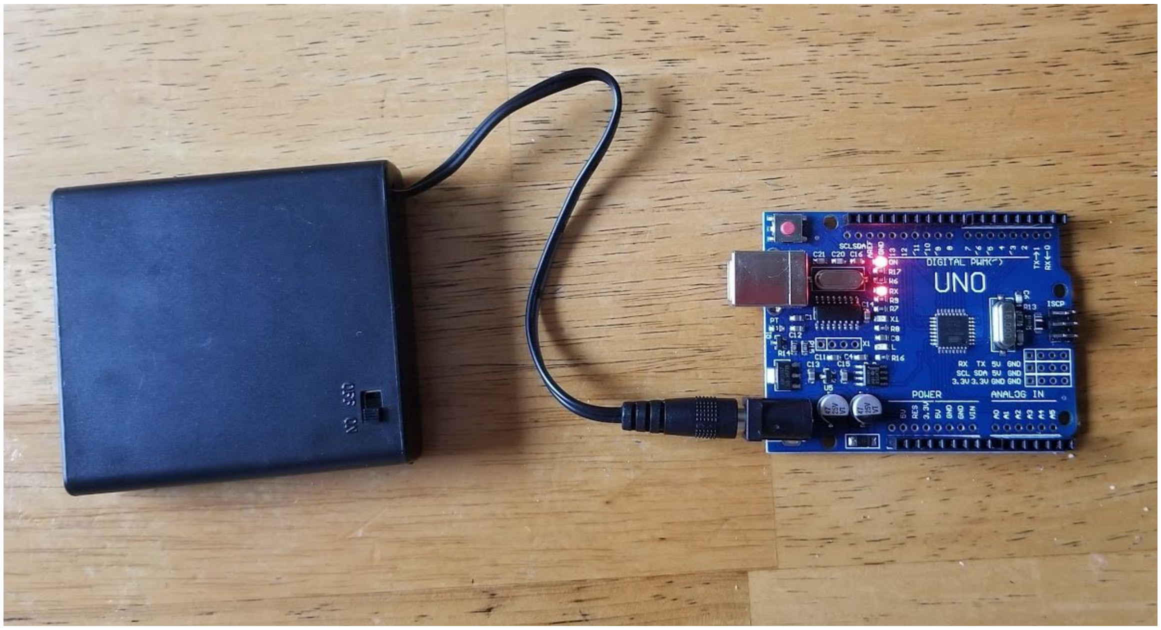


This is the schematic for the sensors and the LCD display that shows the data from the sensors. The only thing connecting these modules together are the VCC pin header and the GND pin header. The other module pins are connected to the Arduino. The IR Sensor will relay two different types of data to the Arduino: analog, and digital (for the robot, the digital data was used). The Ultrasonic sensor (HC-SR04) has one bidirectional pin, and one output pin. To get the distance, we must send a signal through the TRIG pin to tell it to turn on for 10 microseconds, which will cause the module to fire an eight cycle ultrasound at 40Hz. It will catch the echo and send the data through the ECHO pin to the Arduino. The code from the Arduino takes that data, and projects it to the LCD display through the SDA and the SCL pins.



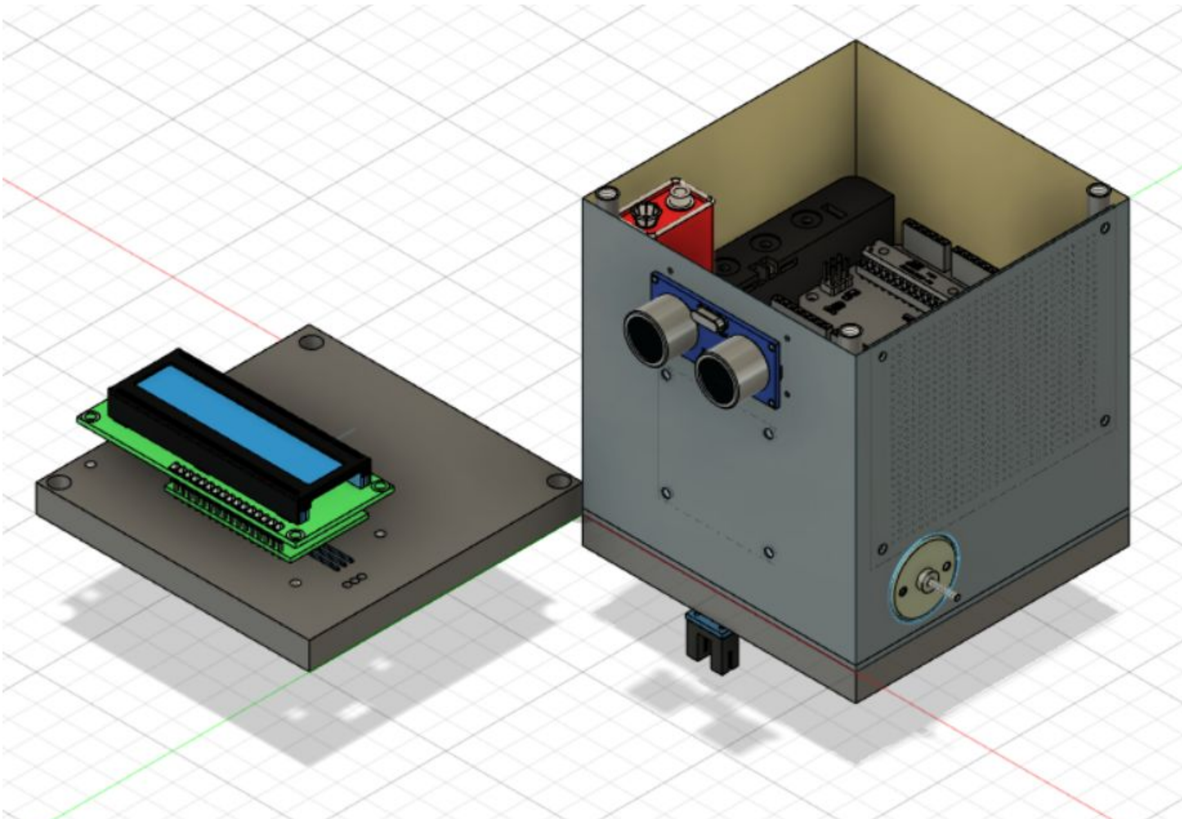
In the schematic above, this image represents the motor controls for our sumo robot. As we can see here, the L298 motor driver is connected to the digital inputs of the Arduino Uno Clone. Then the motors are connected to the motor driver because the motor driver will tell the motors what direction and at what speed. The pins ENA and ENB are pins that control the speeds of the motors. ENA and ENB controls the speed of the motors using Pulse Width Modulation (PWM), and using the datasheet for the arduino, we know that the arduino only has certain output pins that will run using PWM. Therefore, ENA and ENB are connected to pins 9 and 3. ENA controls the speed of motor A and ENB controls the speed of motor B. Then the next pins connected to the arduino and the motor driver are IN1, IN2, IN3, and IN4. IN1 and IN2 controls the direction motor A will spin. Then IN3 and IN4 controls the direction of motor B. The arduino will tell the motors to spin clockwise, counter clockwise, or to make a complete stop using binary codes. Then after the arduino tells the motor driver what to do, the motor driver will then pass this information to the motors. It does so by connecting OUT1, OUT2, OUT3, and OUT4 to the motors. OUT1 and OUT2 are connected to motor A, and OUT3 and OUT 4 are connected to motor B. Finally, since the motors are 12volt motors, they need more than the 5volts that the arduino can supply. Therefore, the L298 motor driver will be connected to a 9 volt battery that will power the motors.



In the image above, it represents the schematic of the power source. Because our robot will be moving and be running for at least 15 mins, we will need a power source that is mobile. The figure above shows how we will be connecting a battery holder to the arduino using its power plugging port. Inside the battery holder are 4 AA batteries, and these batteries will be powering our whole sumo robot.

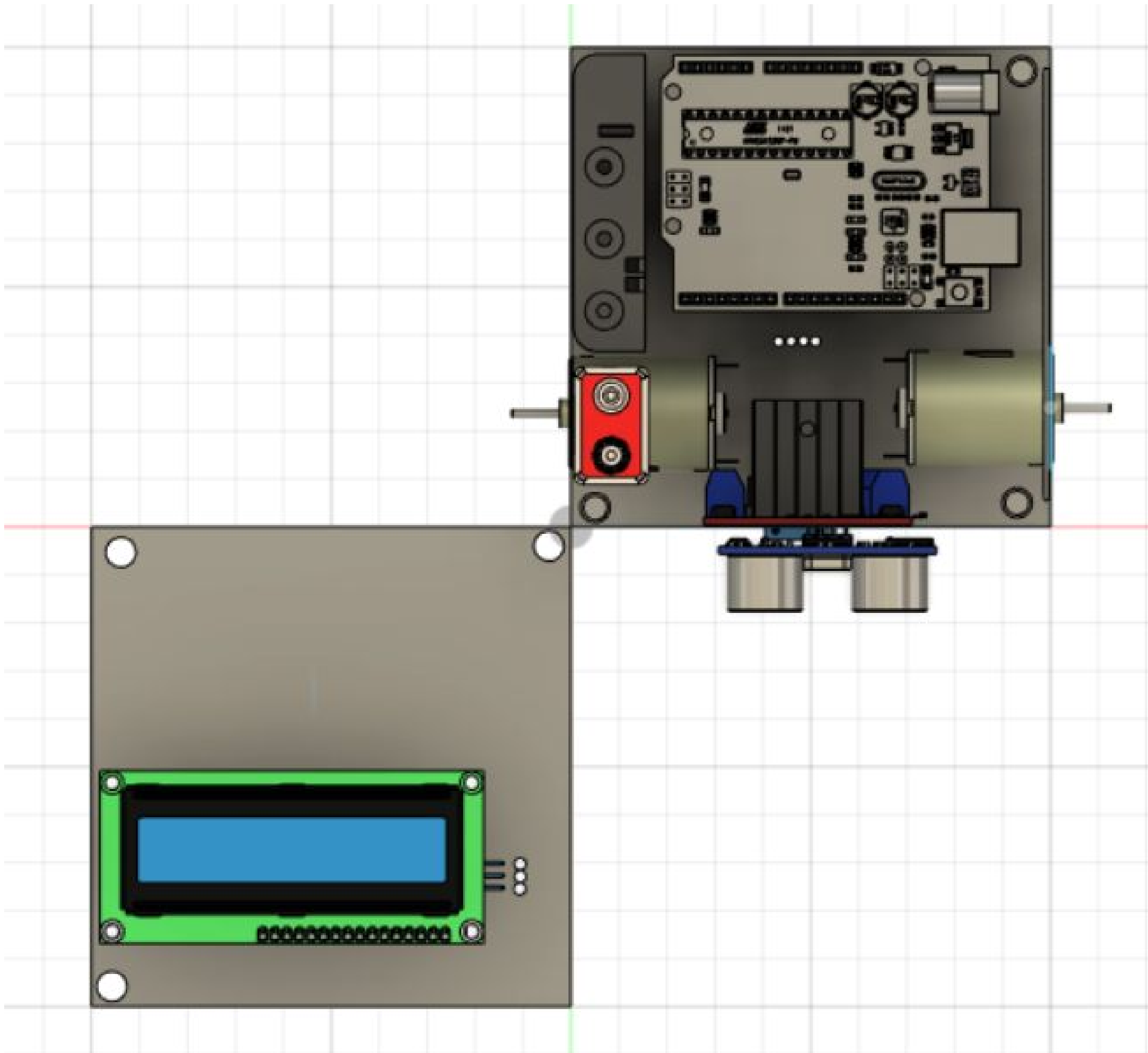
3D Model

Next up will be a demonstration of our sumo robot in a 3D model. In the next few images below, it will represent where each component will go inside the enclosure. The enclosure will be 2D printed, and the elements attached to the enclosure are merely for demonstration purposes.



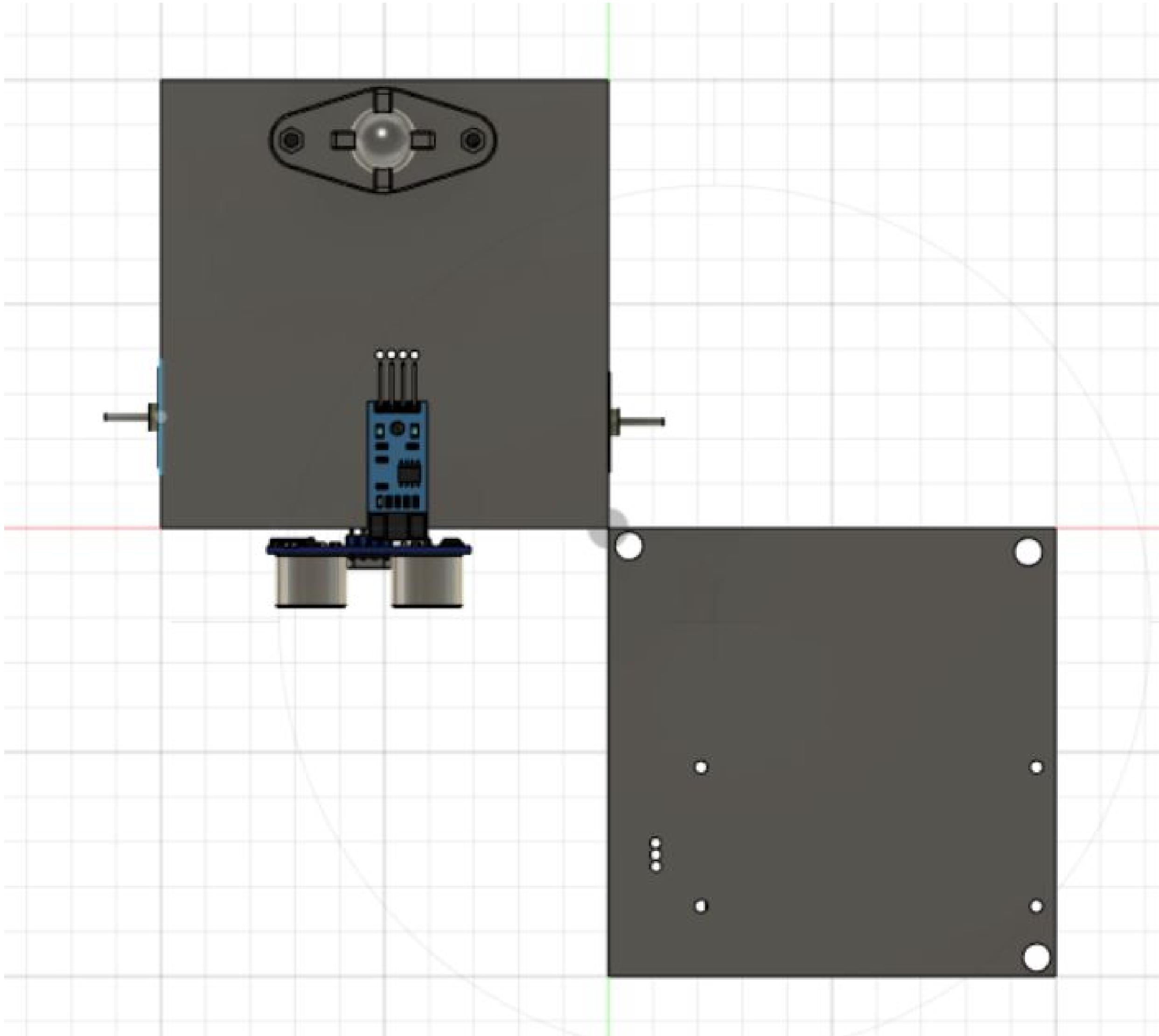
In the figure above, it represents the basic idea behind the enclosure of the sumo robot.The sumo robot will be a 10cm by 10cm box, and within that box will be all of the elements used to make the robot run. The sumo robot will have the lid on top which is designed to mount on top of the box. The front of the sumo robot is the surface with the Ultrasonic sensor on it; therefore, the forward direction would be where that surface is facing.

From this image we can point out that for our design, we will have the sensors at the front so that the robot can detect if there is anything in front of it. The ultrasonic sensor is mounted to the front, while the infrared sensor will be mounted to the bottom of the robot. Then on the side, you can see a motor that would have our wheels on it. Also from this image, we can see that the LCD display will be mounted to the top of the robot so that it is easy to read while the robot is in action. All of these modules, except for the motor, will be mounted by adding screws to the already cut holes. The motors however will be tight enough that it doesn't need to be mounted.

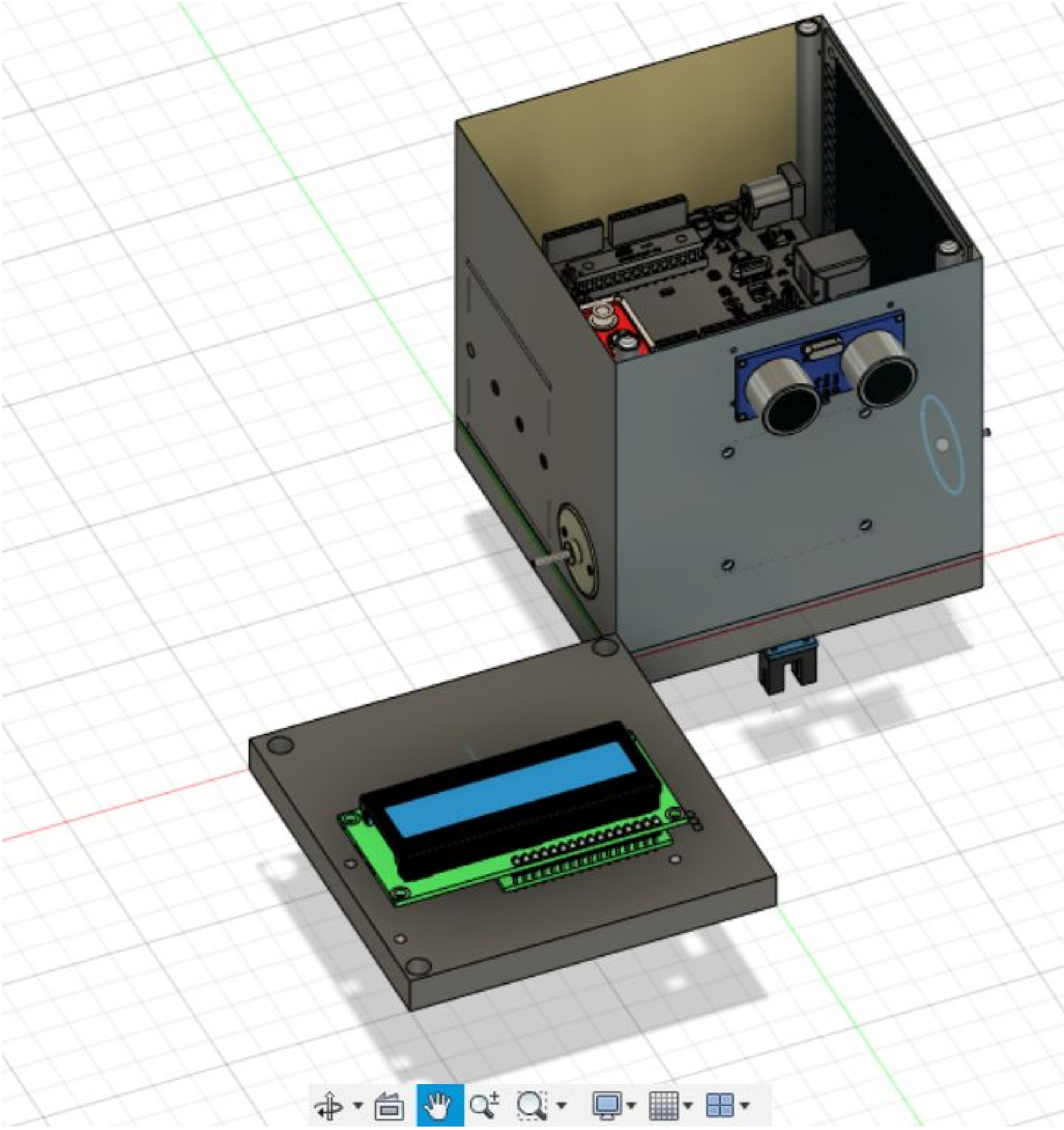


This image above is the 3D model at a view from the top. As we can see the mounting of the lid will be done by adding screws to the holes and directly into the columns that are in the same positions as the holes. We can also see that the LCD display has three holes next to it. Those holes will be used to let the wires through the enclosure and connected to the rest of the circuit. The sensors also have similar holes for the same reason.

From this top view, it is easier to point out where the rest of the modules will go. We can see that both motors are pushed through and each side. Then we can also see that the L298 Motor driver will be attached on the inside of the enclosure, and on the same side as the ultrasonic sensor. The motor driver will be directly below the sensor. Then we have a 9 volt battery that is attached to the side and is directly above the left motor. Right beside that motor and the battery, is the battery holder. The battery holder is a little different than the one that we are using, but for demonstration purposes, this is approximately the same size and the same position the battery pack would be at. Finally, there is the arduino. Although it is not shown in this image, the arduino is lifted up on columns and then mounted into those columns. The reason for this, is so that we can still mount our caster wheel at the bottom without having to worry about space for the arduino to fit and be mounted.



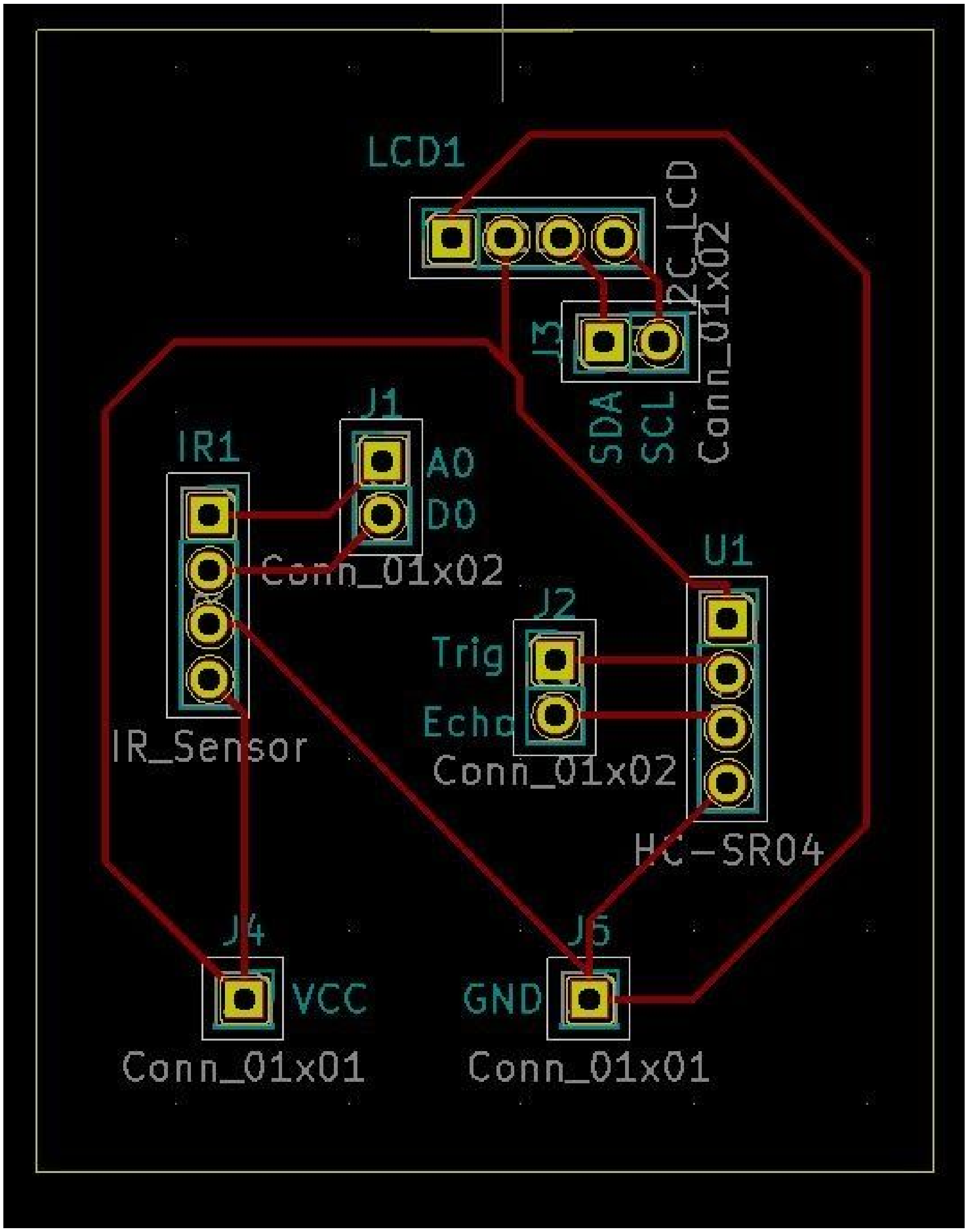
This image above shows the bottom view of our sumo robot. It shows that all the holes are cut through so that we can mount on the lid. It also shows the Infrared sensor that will be mounted at the bottom. The infrared sensor is mounted using holds to indicate where the screws will go. It also shows the four holes where the wires will come through and into the rest of the circuit. Then finally, this view shows the caster wheel that will be mounted onto the bottom on the robot. This wheel is mounted on the sides using holes, however it is hard to see because the arduino is blocking it. But we know that the arduino is lifted up on columns which makes room for the mounting of this caster wheel.

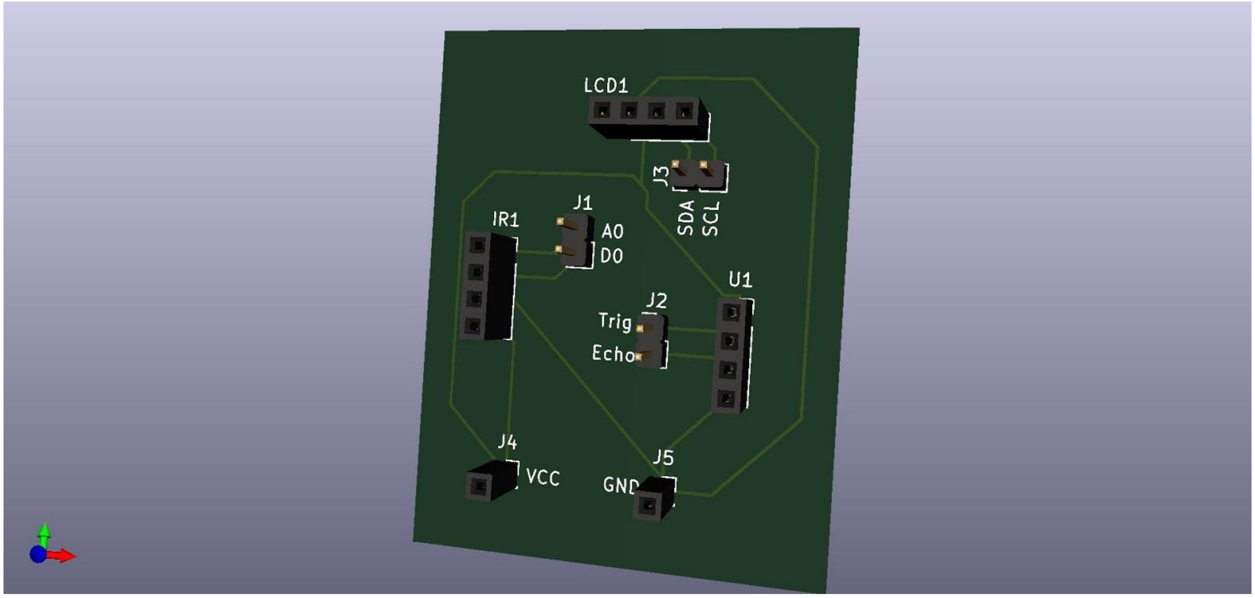


Finally, this last image shows a view where the PCB is present. On the far side of the sumo robot, the PCB that we created will be mounted onto the enclosure.
Overall, that is the 3D model of the sumo robot. This 3D model can also be found here at this link: https://a360.co/3gAYXDk

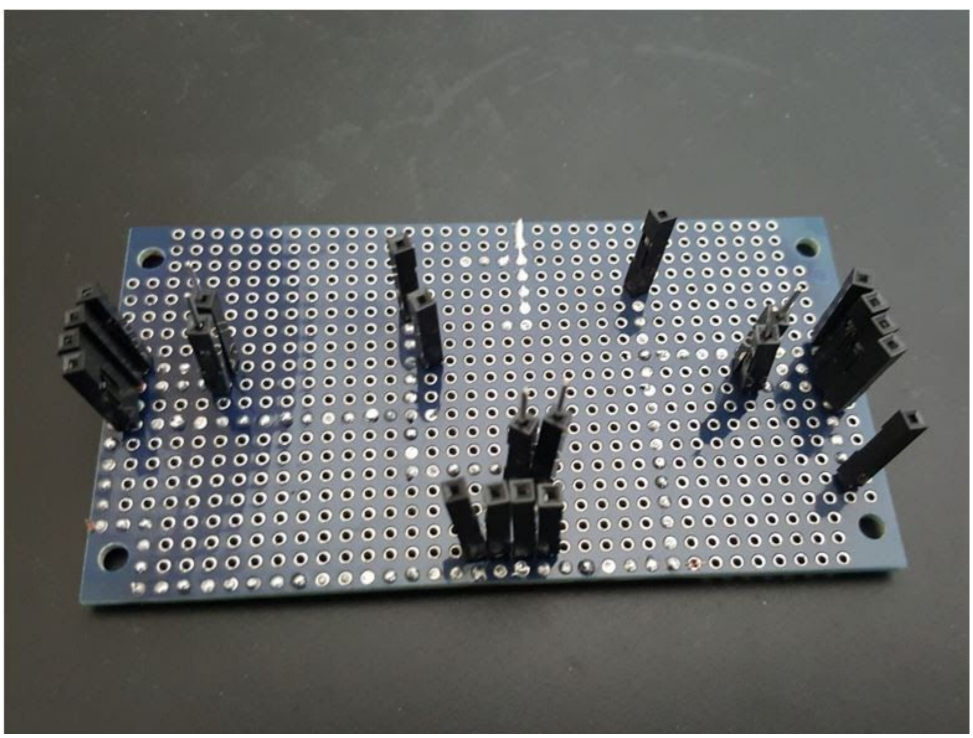
PCB information: Size, Layout, Picture

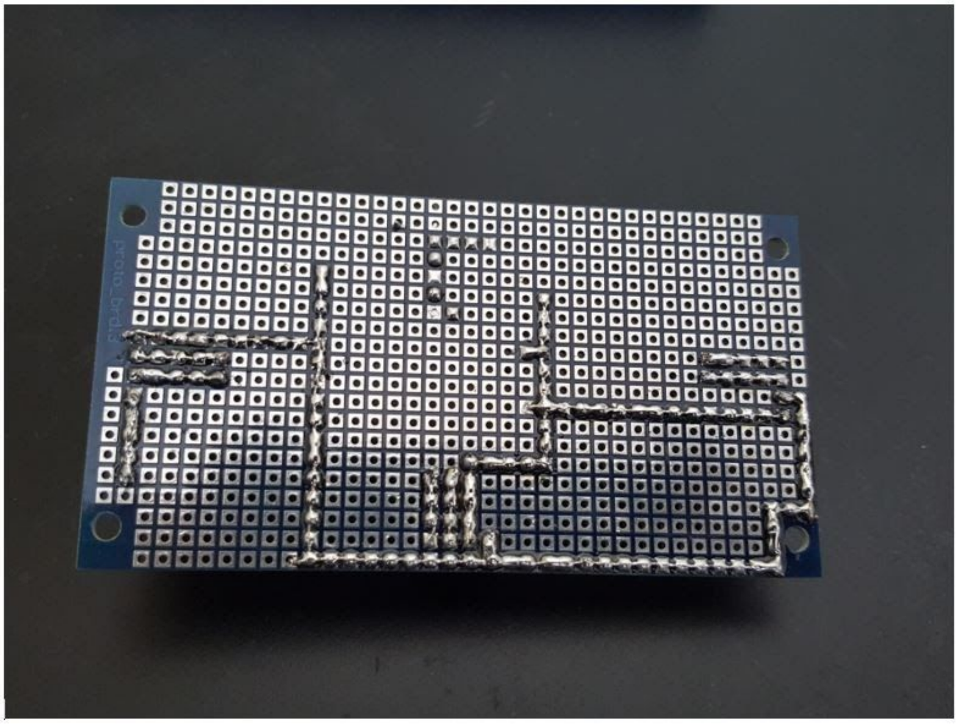
David’s PCB


LCD1
I2C_LCD
Conn_01x02
J3
SDA
SCL
J1
A0
D0
IR1
Conn_01x02
IR_Sensor
U1
J2
Trig
Echo
Conn_01x02
HC-SR04
J4
VCC
Conn_01x01
J5
GND
Conn_01x01



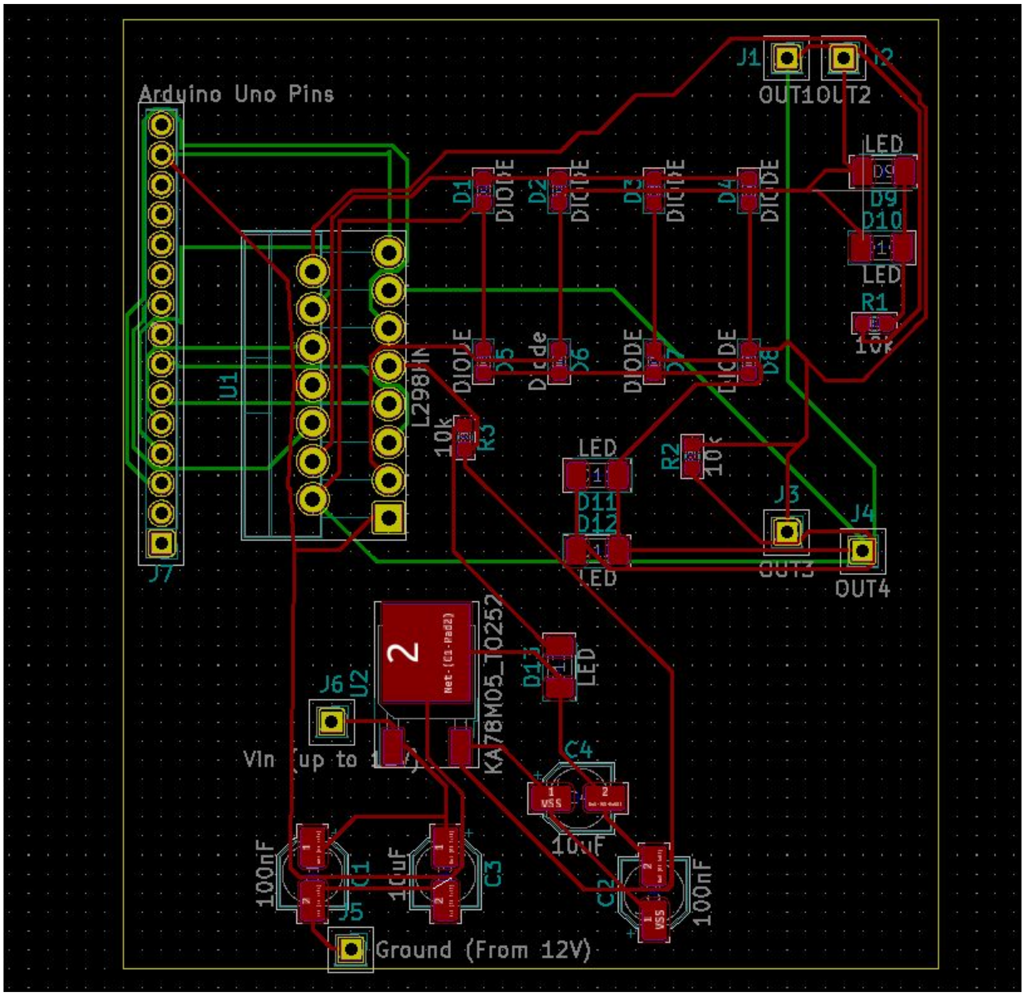
The PCB schematic and layout for the sensors and LCD display was created on KiCAD. The first image is of the layout, which shows the copper traces, pins, and board edges. The board itself measures 33.02 x 41.91 mm, or 1.3 x 1.65 inches. This is one of the simpler boards to make, since the sensors and the LCD display are already modules. The only thing that needed to be connected was the power and ground. The second image is a 3D rendering is what the PCB should've looked like.



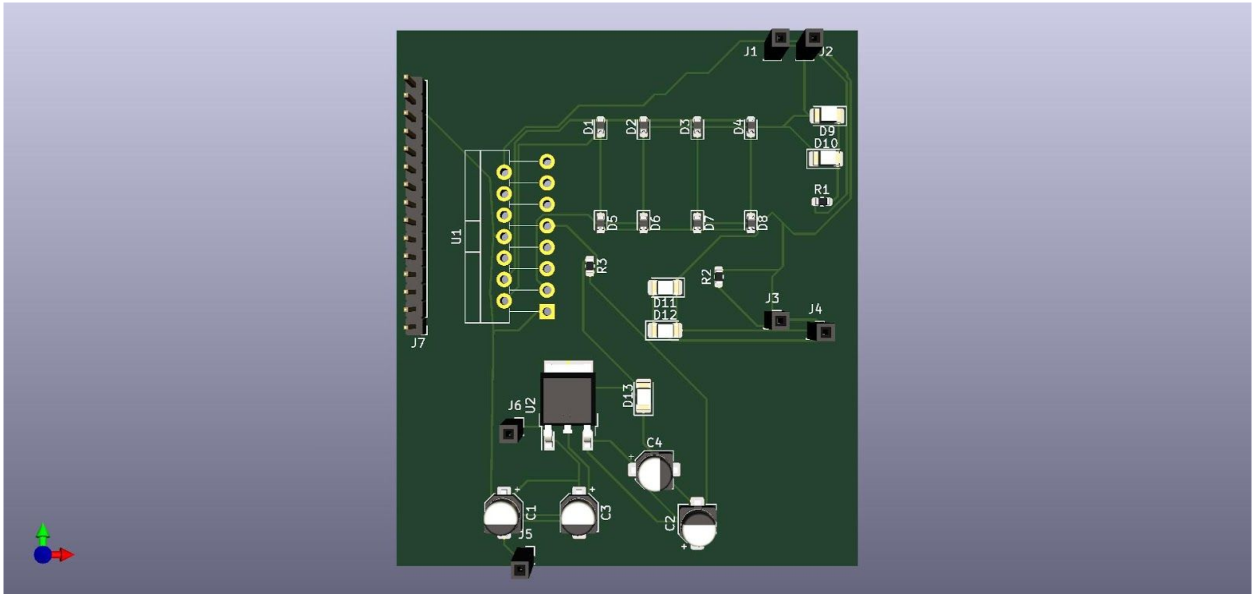


Unfortunately, we couldn’t get a board for this PCB printed in time. The two images above is the circuit built onto a protoboard with solder bridges, while continuing to fulfill the requirements.

<u>Kathleen's PCB</u>



From the figure above, this PCB is an optional PCB. From our artifacts above, the sumo robot needs a module called an L298N motor driver. However, the PCB will act as that module and instead it will be placed like a shield on the arduino. Since the PCB is made as an arduino shield, the dimensions of this PCB is the same as the arduinos. The PCB's size is 68.6 mm × 53.3 mm. As we can see in the figure above, the PCB's layout is based on the L298N motor driver module, and this module is a Dual H-Bridge layout.



In the image above, the PCB is represented as a 3D model. On the left side of the board, the 15 pins will be aligned to fit into the arduino inputs. Then the rest of the circuit represents the dual H-Bridge layout. Then the circuit will connect to the motors and a power supply that will supply the motors.

Part information

Component	Quantity	Manufacturer
Arduino Uno Clone	1	HK Shang Hai Group Limited
Ultrasonic ranging Module HC-SR04	1	Shenzhen Zhinengpai Technology, Ltd
Dot matrix Liquid Crystal Display Controller/Driver	1	Hitatchi
I2c backpack	1	Mantech Electronics
TCRT5000 IR Sensor Module	1	Vishay
Caster Wheel	1	Adafruit
L298 Motor Driver	1	STmicroelectronics
Rubber Wheel	2	DFRobot
12 Volt DC motor	2	OSEPP
AA Battery	4	Energizer

Battery Holder	1	OSEPP
9 Volt Battery	1	Duracell
Enclosure (Outside Casing)	1	3D Printed