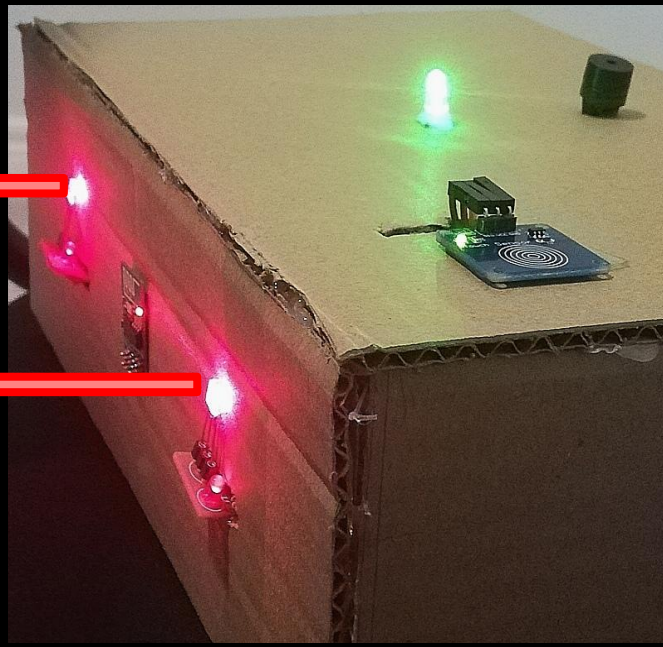
Live Count Tracker



By: Adhiraj Singh
TEJ4MR
30 Jan 2021

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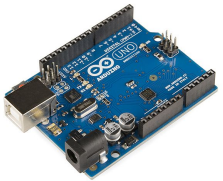
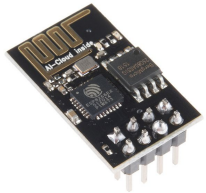
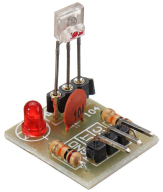
Materials List



Arduino Uno



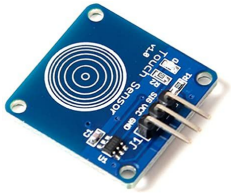
ESP8266



Laser Sensor x2

Laser Diode x2

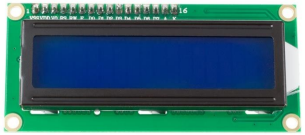
Joystick Module



Touch Sensor

Active Buzzer

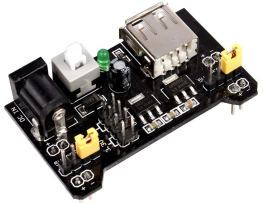
RGB LED



16x2 LCD Display

Materials List

9V DC Adapter

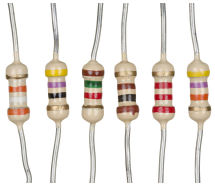


Power Supply Module

Battery Snap with Barrel Plug

Potentiometer

9V Battery



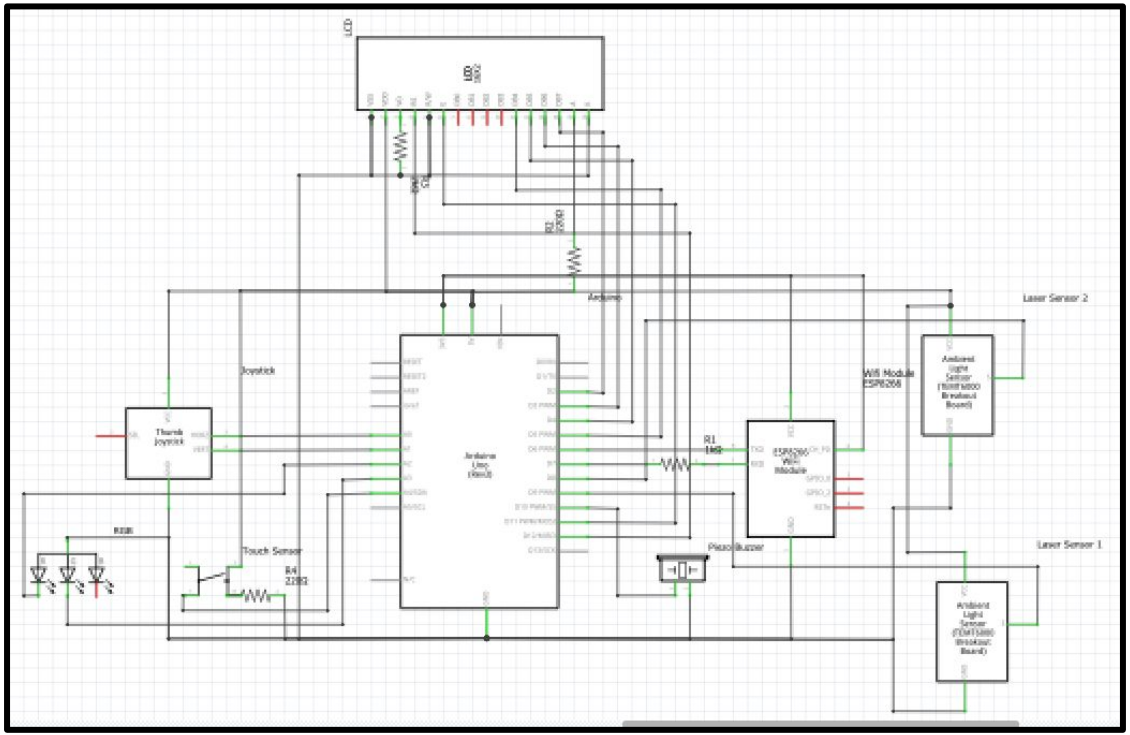
Resistors - 2k Ω, 330 Ω, 1k Ω, 100Ω

Jumper Wires

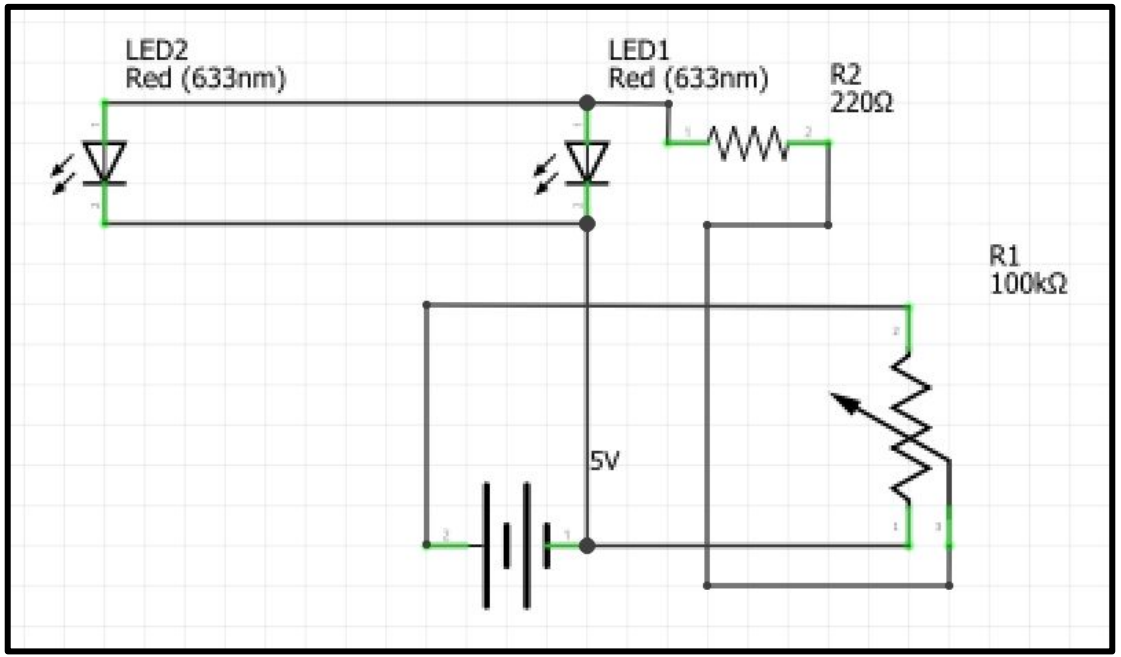
Breadboard

Cardboard

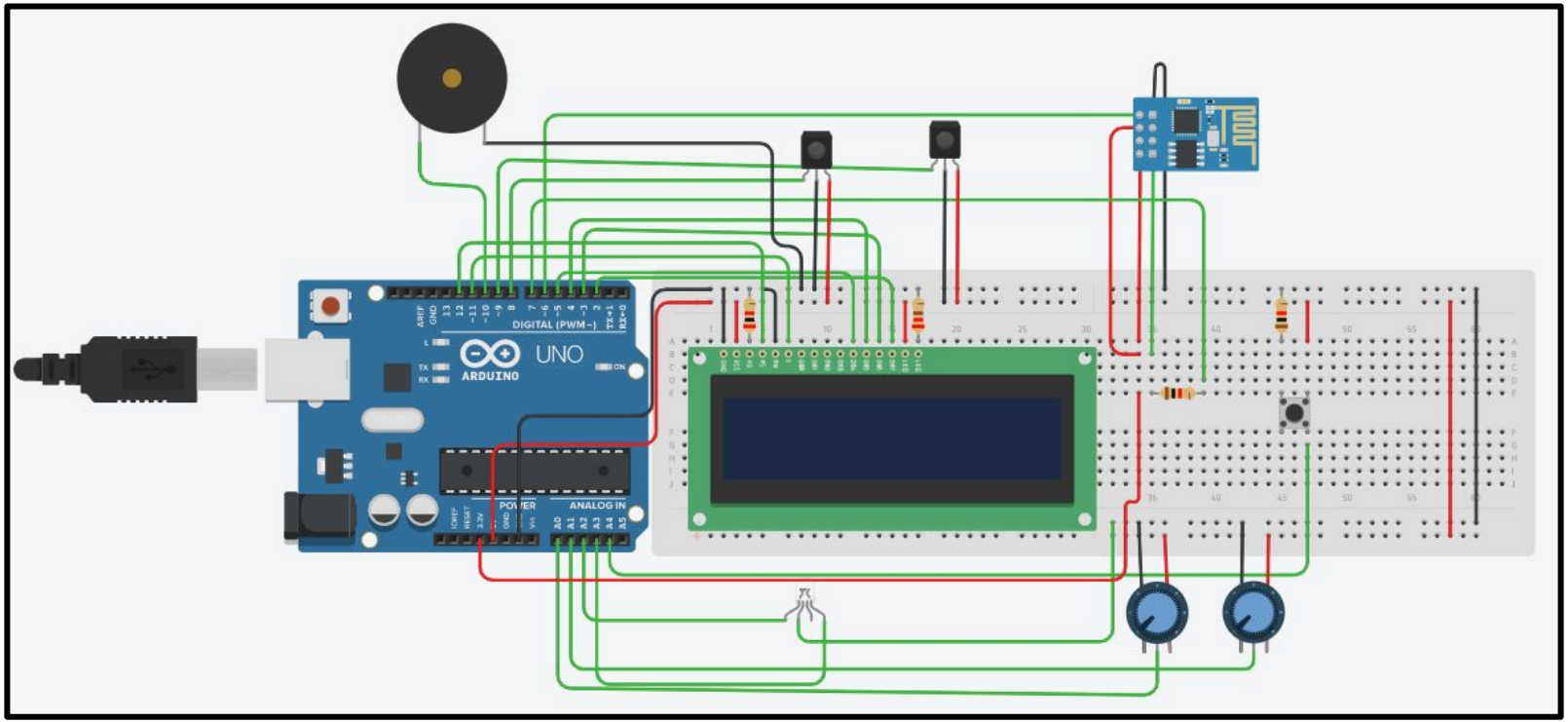
Schematic - Main Device



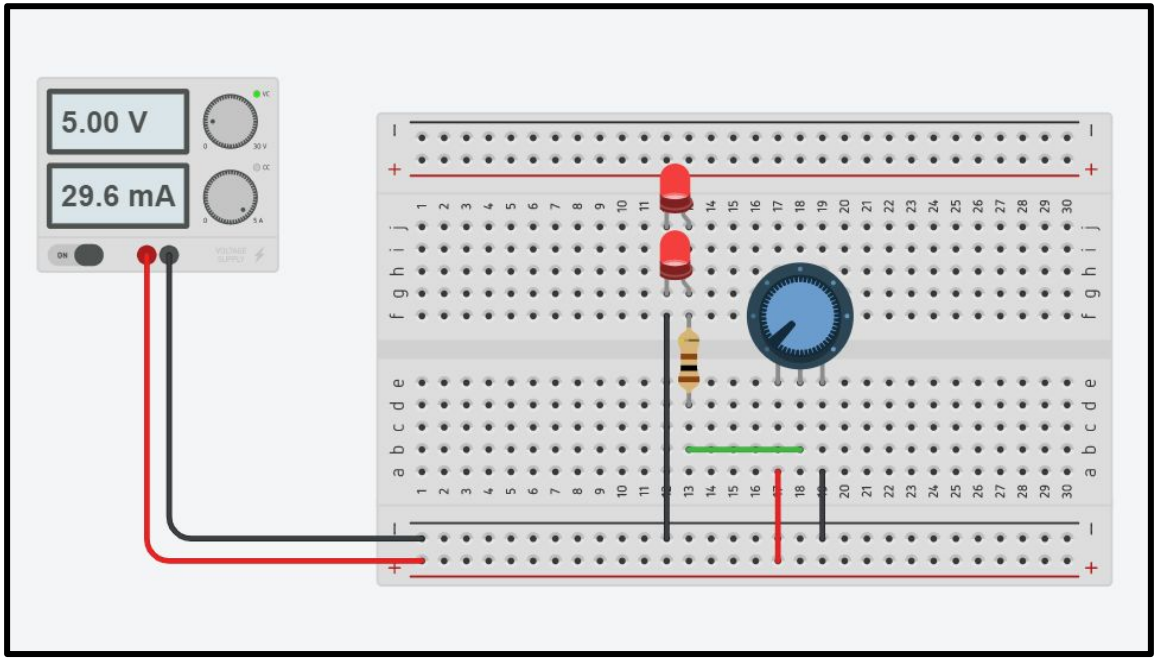
Schematic - Laser Device



Pictorial - Main Device



Pictorial - Laser Device



Final Code

Here is the Final Code Github Repository

This is a link to my github repository for the final code. When you open the code link it will provide a bunch of detailed instructions about which files to view.

Activity Log

Date	Description of Work Done	Hrs
Nov 19	Researched current problems and brainstormed possible solutions to these problems.	2 hrs
Nov 20	Looked into various ideas, and researched how feasible each idea would be.	1.5 hrs
Nov 21	I settled for 2 ideas - a device that would count people in a room or an autonomous system for indoor gardening with multiple sensors to diagnose plant health.	1 hr
Nov 22	Researched the specifics of how to approach each idea and the components that would be required.	2 hrs
Nov 23	• Worked on the proposal for person counter idea. I got the idea of uploading the data on a website for customers to view. • I researched if it would be possible and which component(s) I would need to achieve this.	1 hr
Nov 24 - Nov 25	Finished proposal for person count idea - finished component list, schematic, and pictorial.	2 hrs
Nov 26 - Nov 27	Finished proposal for autonomous indoor gardening system.	2 hrs

Activity Log

Date	Description of Work Done	Hrs
Dec 4 - Dec 5	• After getting the person counter idea approved, I researched more into best possible sensors to detect people. • Picking the correct sensor would have been key to make sure that the device is reliable and accurate. • I mainly explored infrared and ultrasonic sensors at first. However, through research, I found that ultrasonic sensors are more reliable.	1 hr
Dec 6	• Since I had an ultrasonic sensor at home, I decided to test it to see how well it can detect humans. • After thorough testing and iterations, the best configuration that I was able to achieve was ~75% accuracy.	2 hrs
Dec 7	• I looked into ultrasonic sensors more and realized that clothes can absorb ultrasonic waves which can reduce the sensor accuracy. Also, ultrasonic sensors don't work well on non-flat surfaces, like humans. • As a result, I started looking into more alternative sensors to detect humans. ○ I looked at Lidar and time of flight sensors, however, these sensors are very expensive.	2 hrs
Dec 8	• I got the idea to use a laser trip wire. This meant I would have to create a separate device to house the lasers. However, it would also be highly accurate, as lasers have a concentrated beam of monochromatic light. • Hence, I decided to replace ultrasonic sensors, with laser diodes and laser sensors. • Also, the components for the laser wire were a lot cheaper and accessible.	1 hr

Activity Log

Date	Description of Work Done	Hrs
Dec 18	Since this was the last day of school, I made sure I have all the components I need to build my project.	0.5 hrs
Dec 19 - Dec 21	• The first challenge I focused on was getting the ESP8266 module to work as it was a completely new component, and I had to learn how to connect and code this wifi module. • I found out how the ESP8266 can be used in multiple modes and for different purposes. ○ For example, the ESP8266 can be used to get data from a website instead of sending it. • Also, ESP8266 can be used as a standalone microcontroller as it has 2 GPIO pins of its own, so a lot of the solutions I was finding involved disabling the Arduino pins. • I did research to learn about the Internet of Things (IoT) to get a better understanding of how the web world works and how multiple devices can connect with each other. • I learnt about APIs and JSON. • I also learnt how GET and POST requests can be made to communicate between different servers and websites.	12 hrs
Dec 22	• After a lot of iterations and tries, I was finally able to create a local server with ESP8266 using AT commands. • By creating a local server, I was able to verify that the wifi module works properly.	3 hrs

Activity Log

Date	Description of Work Done	Hrs
Dec 23	• I explored ways through which I could get the ESP8266 to send data to a website without deactivating Arduino's pins. After multiple trials, I could not find how to create a web server using the esp8266 without disabling all the pins. • As a result, I was thinking of using 2 arduino's, and using one arduino just as bridge between the ESP8266 and the laptop, and having the second Arduino control the rest of the sensors and components.	2 hrs
Dec 24 - Dec 26	• Since the covid situation kept worsening, I realized that I may not be able to get the second arduino from school and as result, I decided to look for another solution. I found a website called Thingspeak that allowed access to their servers through API keys, so I created an account and tried using it. • I created the code to send a POST request to their servers. After a lot of debugging and wiring, I was finally able to send data to the thingspeak servers.	4 hrs
Dec 27 - Dec 28	• I was testing the code again to see how reliably it can send data to the website and realized that after working one or two times, it stops working completely, so I did more research and found a library. • This library made some configurations to the code and the wifi module and made the data transfer a lot more reliable.	2 hrs

Activity Log

Date	Description of Work Done	Hrs
Dec 30	• I wired the laser sensors and the laser diodes to the arduino, and made a simple program to test if these components are working. • Then, I brainstormed ideas of how to make the algorithm to detect people. • After exploring many options, I was able to decide upon the algorithm that would work best. • I wrote down the basic steps in the algorithm which would help me when I am implementing and coding this.	2 hrs
Dec 31 - Jan 2	• I implemented the counting algorithm and assembled the circuit on a breadboard. However, I realized that the code was very hard to test without an actual device. Since it was difficult to line up the sensors and lasers together properly to test on a breadboard, I decided to make the actual device first. • I sketched some ideas for the lasers device, as I wanted there to be an adjustable mechanism. I decided upon an idea which was simple to make and worked effectively. • I created the lasers device with reusable and recyclable materials like scrap paper and cardboard. • To create the lasers device, I measured and cut all the cardboard pieces, used papers to create the cylinders, soldered all the components, and assembled everything together.	14 hrs
Jan 3	Built the main device.	2 hrs
Jan 4 - Jan 9	Tested and debugged the code, and implemented setup functions.	8 hrs

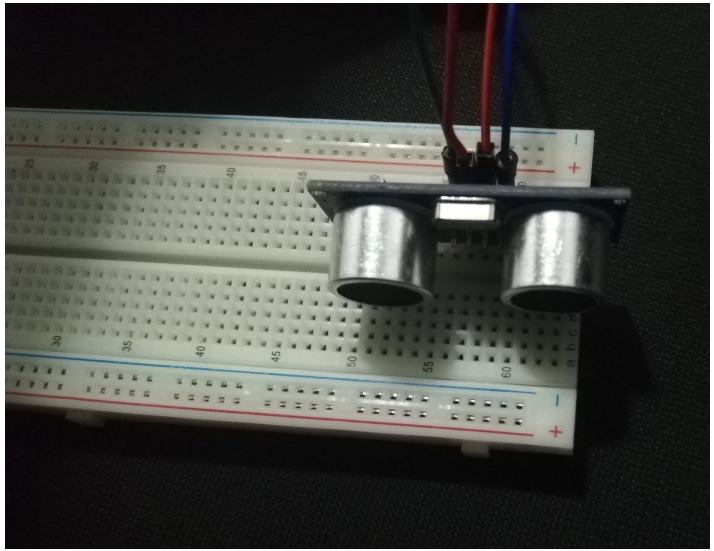
Activity Log

Date	Description of Work Done	Hrs
Jan 10 - Jan 14	• I started creating the website and started looking into how to make a pie chart on the website. • I also learnt how to make an HTTP GET request using the Thingspeak API. • I also embedded the thingspeak graph into my website.	5 hrs
Jan 15 - Jan 16	• I tested and debugged getting the data on my website. • I also started adding comments to the arduino code and the website code so that it is easier to follow.	6 hrs
Jan 17	• I made some refinements to the website styling to make it dark themed. • I also made it responsive so that it can be opened on different screen sizes and aspect ratios. This made my website mobile friendly.	2 hrs
Jan 19 - Jan 21	I wanted to allow the user to input the wifi name and password, but I wanted the arduino to save it so that the user doesn't have to enter their wifi credentials every time the device is rebooted. • I researched and found out about Arduino's EEPROM. • After learning more about how the EEPROM works, I created functions to take user input from the joystick using ASCII, save that input and read from the EEPROM.	7 hrs

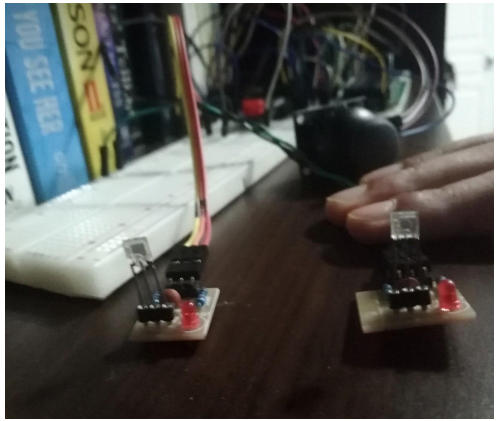
Activity Log

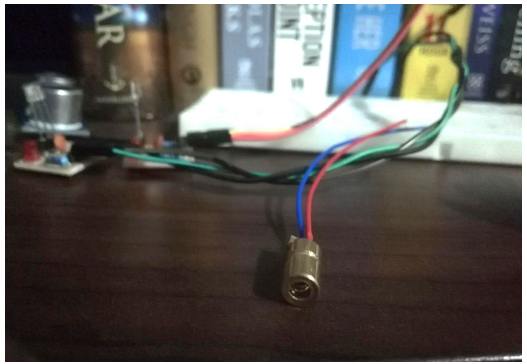
Date	Description of Work Done	Hrs
Jan 22 - Jan 26	• I started working on the content of the report and visuals for the about page of my website. • I recorded the video showing the device working and I recorded the video showing the wifi setup feature. • I edited both the videos and uploaded them on youtube.	4 hrs
Jan 29	I created the schematic and pictorial for both the devices.	2 hrs
Jan 30 - Feb 2	I started working on the final report and added some final finishing styling to my website's about page.	5 hrs
Feb 3	• I embedded the final report slideshow in the about page of my website. • I finished the final report and reflection.	3 hrs
Total Hours		**99 hrs**

Design Process



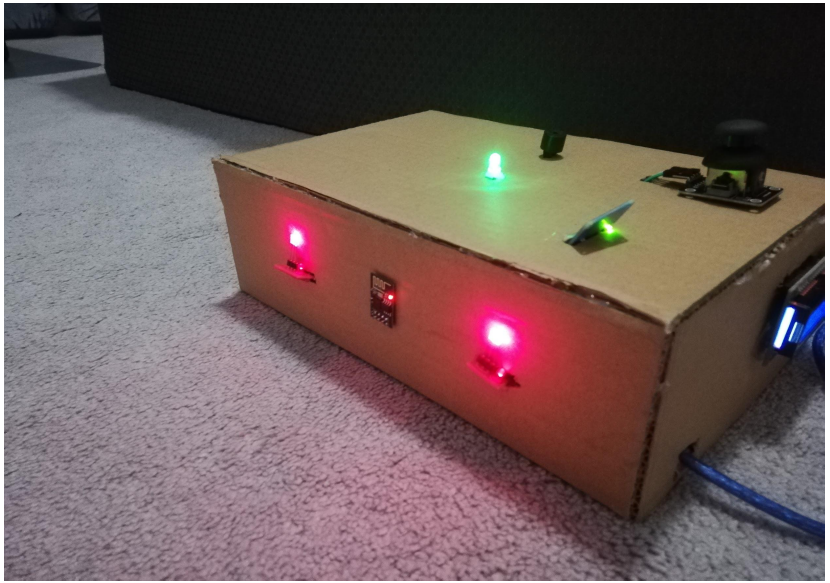
I tested the ultrasonic sensor and tried multiple iterations and configurations. However, due to its inaccuracy, I decided not to use it.





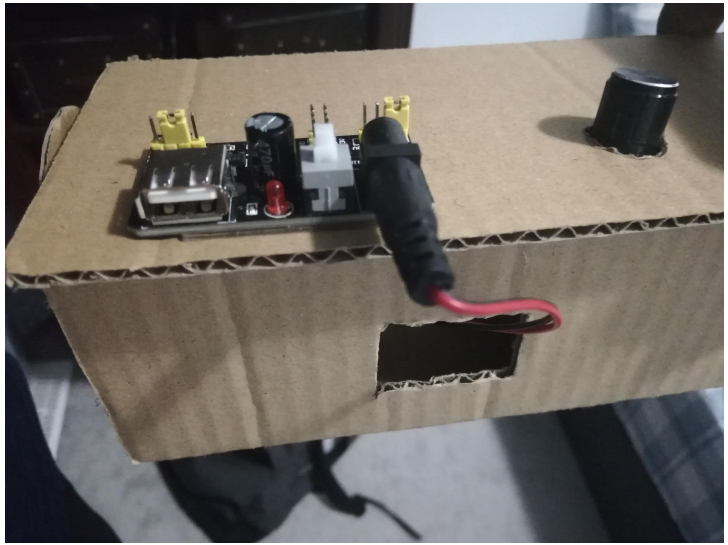
I tested all the components on a breadboard separately to make sure they are working before soldering.

Design Process

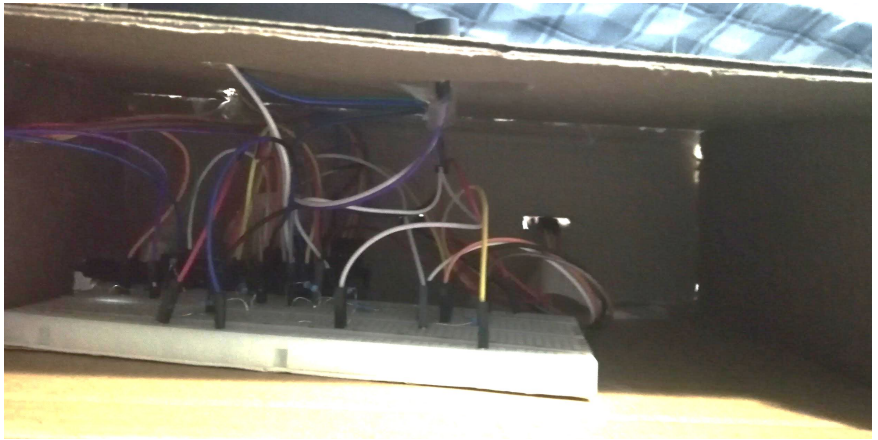


I built both the device so that I could start testing my code, as it was not possible to test the code on breadboard circuit.

Design Process

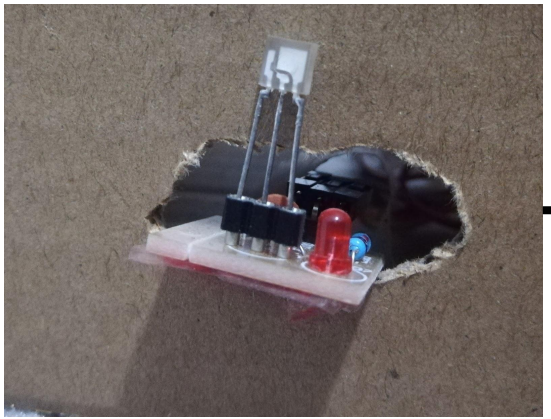


I left an opening for the battery, so that it can be replaced easily if needed.

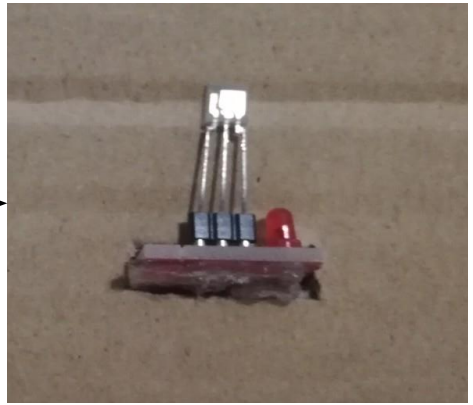


I also decided not to attach the back panel in the device until the end, as having the back of the device open allowed access to electrical components for troubleshooting problems.

Design Process

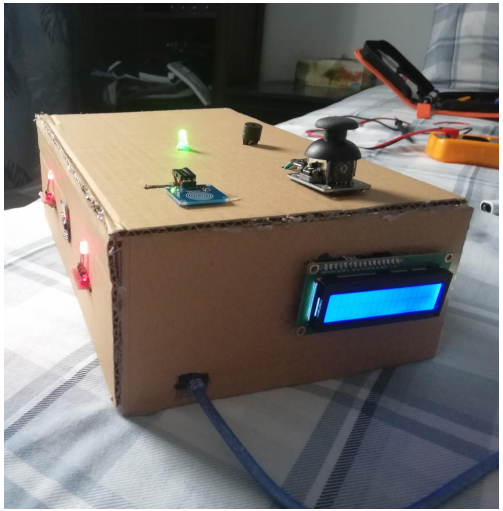


When I first made the measurements for the laser sensors, I did not account for the slight horizontal angle of the lasers.

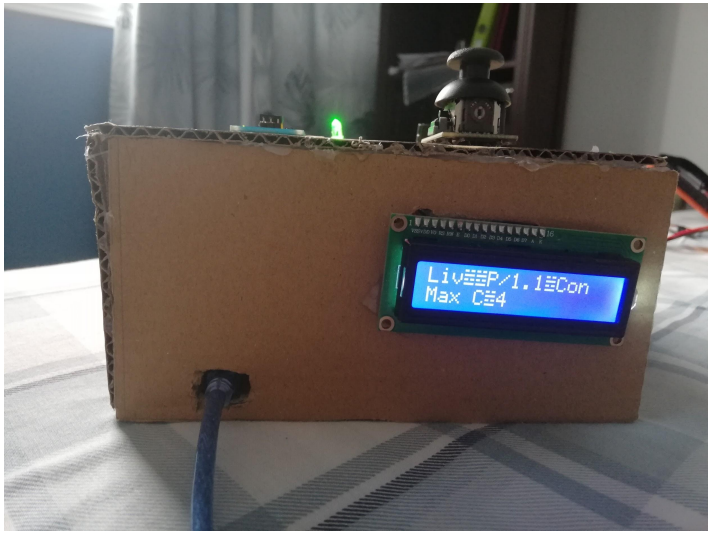


I re-made this piece with corrected dimensions and made the neater a lot neater.

Design Process



After working properly for the first few minutes, the LCD would go blank unexpectedly.



After a few seconds, the LCD would start displaying gibberish, hence, I used a multimeter to check for voltage spikes and double checked all the connections. The final solutions is discussed in the reflection.

Design Process

Finished Product

Reflection

Modifications

The main modification to the project was using laser tripwires instead of ultrasonic sensors. I decided to make this modification because as I was testing ultrasonic sensor for its reliability and accuracy, I kept getting incorrect results. After thorough research, I found that ultrasonics sensors are good at detecting flat surfaces, but they struggle to detect uneven surfaces. Furthermore, I found that clothes can absorb ultrasonics waves which could also affect the sensor.

As a result, I decided to create a laser tripwire system. The laser tripwire required more work in terms of actual device design. It added another layer of complexity I needed to make two devices instead of one. However, this idea offered incredible reliability and accuracy. As a result, to create the laser tripwire system I used 2 laser diodes and 2 laser sensors.

Challenges and Solutions

Challenge: The lasers emitted a small concentrated beam of light and laser sensors had a very small surface area which meant that lining up the lasers with the sensors would be difficult. As a result, I needed to create a mechanism which allow the user to customize the height, and horizontal distance of the laser. This mechanism needs to easily adjustable but also simple enough to make with the resources available.

Solution: After going through multiple ideas, the best idea I got involved creating two cylinders that could rotate and mount the lasers on them. This mechanism was the simplest to create, but was still very effective and allowed the user to easily customize the laser beam height.

Challenges and Solutions

Challenge: After completing the soldering for the laser device, the circuit would sometimes stop working unexpectedly which created problems while testing. Even after checking each soldering junction multiple times, I could not find any weak connections.

Solution: Since the laser device is very compact, the wires had very little space in the device. As a result, the soldering junctions ended up touching each other which would have created unintended paths for the current to flow. This basically caused the circuit to short, so to fix this, I had to tape each soldering junction. The tape acted as an insulator so that the circuit doesn't short.

Challenges and Solutions

Challenge: One of the main challenges I faced was that the LCD kept going blank after 2-5 minutes. Then, random characters showed on the LCD and the entire program would stop working.

Solution: I hypothesized that the reason for the LCD going blank is either a lack of enough voltage, or sudden voltage spikes. After thorough testing I realized that in some cases, the LCD was being updated every 65 ms. As a result, I created a separate variable and functionality in the code to make sure that the LCD only updates every 500 ms or 0.5s. This removed the issue of the LCD going blank.

Strengths and Skills

- **Programming -** Since I am a logical thinker and had prior knowledge with web development and Arduino, I was able to apply these skills to make a much more refined final product.
- **Wiring and Soldering -** Due to the experience from multiple previous projects like the binary counter, traffic lights project and the burglar alarm system, I was able to neatly solder and troubleshoot any issues with the circuit.
- **Troubleshooting and Problem-solving -** Since I have created many projects before, running into problems was nothing new for me as it is a part of every project. By using my previous experience, I was able to come up with resourceful and creative solutions which allowed me to complete my project even during a pandemic and with limited supplies.

Further Improvements

- **Increasing/upgrading the sensor array -** Using 2 tripwires, I was able to track count of people, however, my device would not be able to detect if two people are walking side by side as the tripwires only provide one-dimensional data. To improve, Lidar sensors or radars can be used along with a computer vision camera, as that would provide a lot more data and make the device suitable for even more situations.
- **Creating an App to improve accessibility -** By creating an app, I will be able to make the user experience simpler and would eliminate the need for them to search the website every time.
- **Improve the build quality of the device -** Due to limited resources, the device is made out of reusable and recyclable materials which is good for the environment. However, the device is very light weight and is susceptible to damage. To improve, I would make the device out of metal and plastic casing in the future.