Final Project: Aware Travelling

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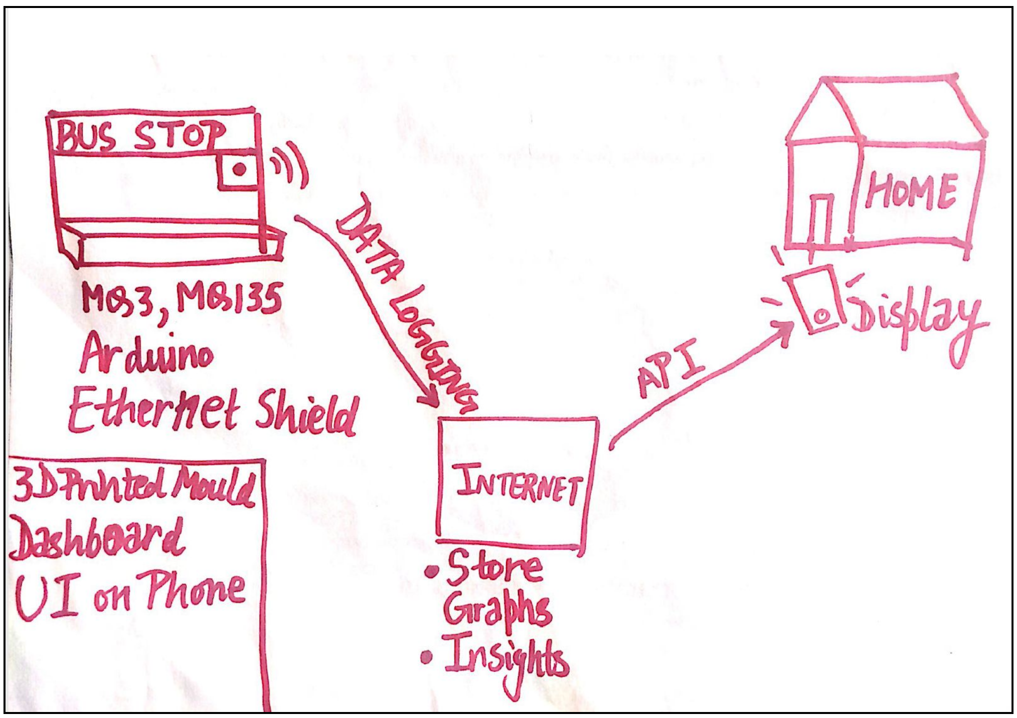
Phase 1: Empathize and Design

Project Idea

We were interested in working on creating a real-time vehicular pollution monitoring system. It is an idea to be applied in polluted cities(such as New Delhi and Beijing) which can help commuters to decide in real-time as to which route to take on road to avoid vehicular pollution.

The system can monitor the pollution statistics and send data over wifi which can then be translated to provide route-advice to End Users on Smartphones. We’ve termed this concept ‘Aware Traveling’.

The overall rationale is to create an ecosystem where Civic Engagement (CE) can be harnessed to account for transparent pollution monitoring and management.



Interviews

We were aware of the dire situation of pollution in the cities of China and India but still wanted to get to know the stories of people actually staying there and therefore we conducted exploratory user interviews to start with.

Sam (23 F, Student, Lives in Beijing)

How do you usually commute from home to workplace/school?
I take the Subway to commute usually.

On a scale of 1-10, how healthy do you think is your living environment?
Environment Rating (1-10): 5

What do you usually do to avoid pollution?
I usually wear mask most of the times and avoid going out when pollution is too serious.

What do you think should be done to curb pollution?
I think people should use less air conditioning and should plant more trees.

What is your living environment like?
My living environment is an Urban city with rising pollution.

Marsha(33 F, Startup CEO, Lives in New Delhi)

How do you usually commute from home to workplace/school?
I drive my Car to the workplace everyday.

On a scale of 1-10, how healthy do you think is your living environment?
Environment Rating (1-10): 3

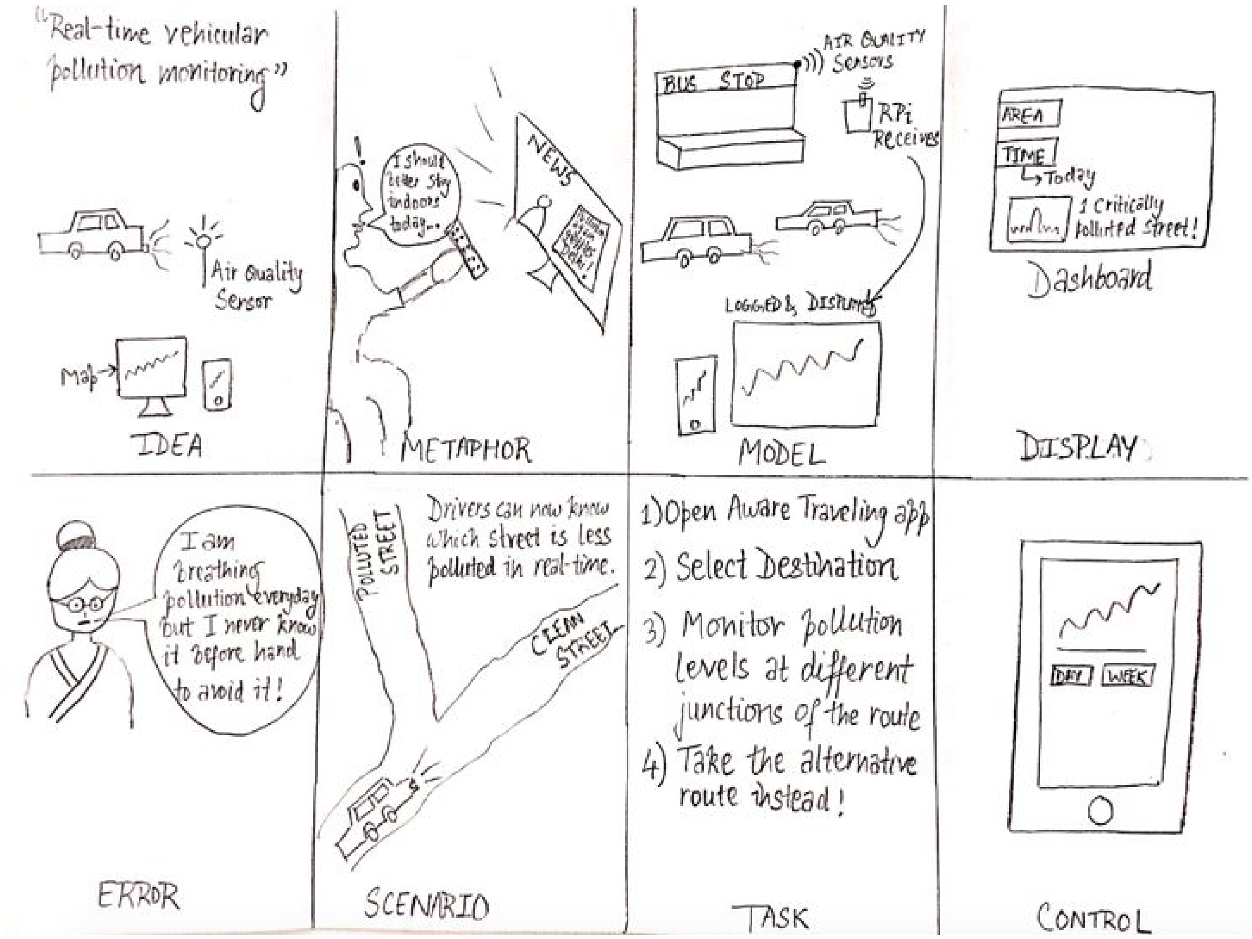
What do you usually do to avoid pollution?
I usually wear mask most of the times

What do you think should be done to curb pollution?
There must be strict laws for those who cause pollution.

What is your living environment like?
My living environment is an Urban city

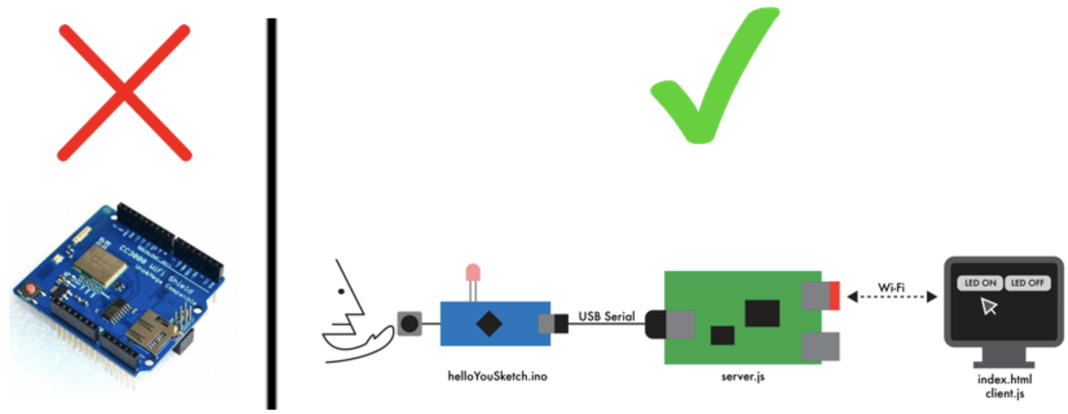
Based upon findings from the interview and our initial rationale about the problem statement, we created the Verplank Diagram to get a better visual understanding of how our system will fit into the environment.

Verplank Diagram

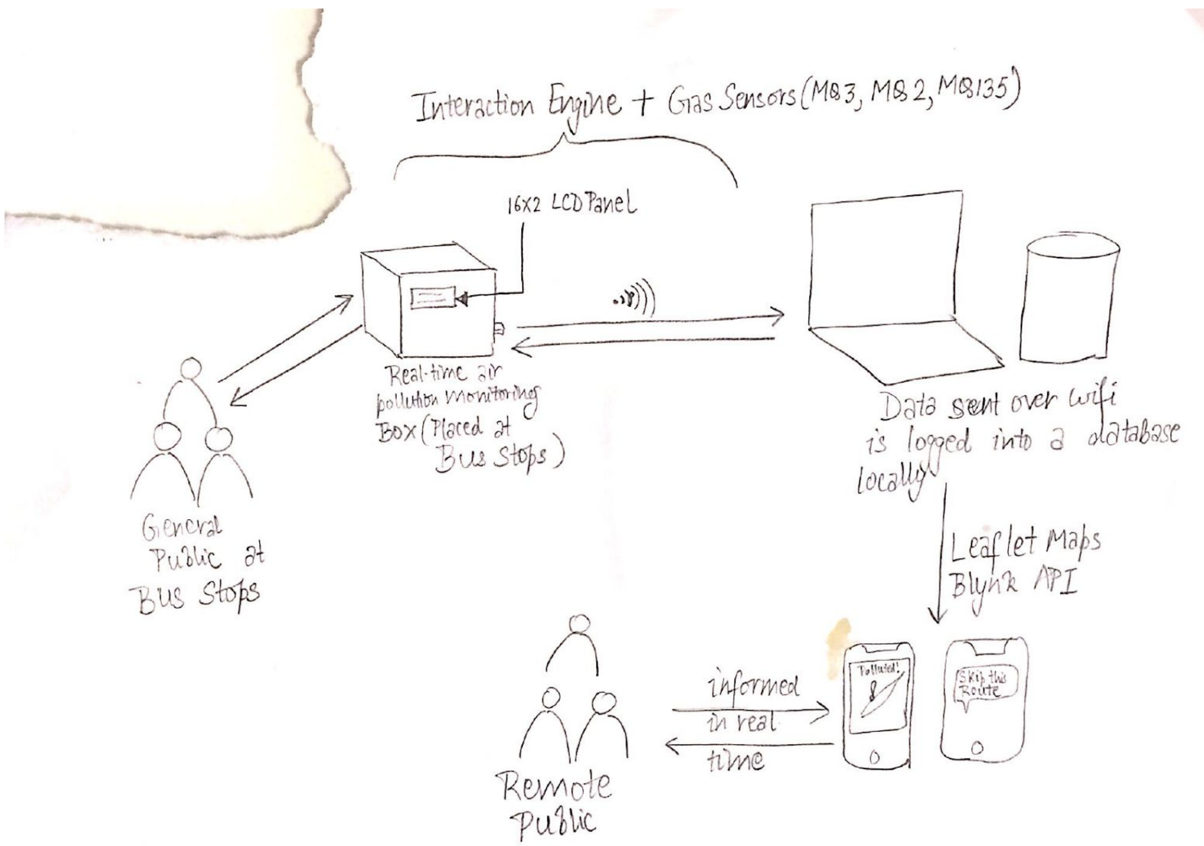


Iterating Idea

We were initially thinking about using Arduino with a WiFi shield to send/receive data to/from our digital platform (laptop/mobile) but after a few stages of failed explorations and buggy nature of Wifi shield in handling large bits of values, we decided to harness Raspberry Pi as for transmitting/receiving serial data to/from arduino and to/from our digital platform over wifi.



State Diagram



Phase 2: Point of View and Execution

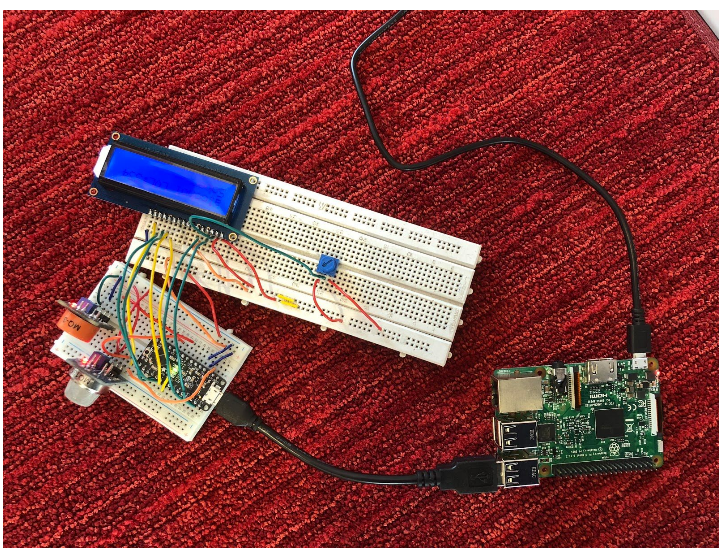
POV

We met people from New Delhi and Beijing who have been staying in polluted environments for quite a while now.
We were amazed to realize that these people wear masks while traveling outside most of the times and the government
Is oblivious to the issue altogether. The pollution statistics for most part are rigged and/or incorrect.
It would be great if we can provide these people with tools to monitor the pollution in their surroundings in real-time
So that they themselves can keep track of which route to follow/not follow.

Prototype 1:

- **Description**

  This is our first prototype with two sensors, one is MQ3 (alcohol gas sensor) and the other is MQ135(smoke sensor), after the sensors detect values of alcohol or CO2 level respectively, the LCD will show the alert messages to users.
- **Photos**



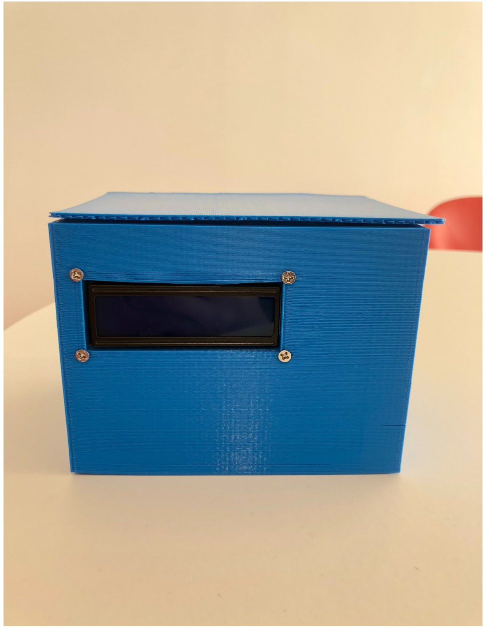
[Demo]

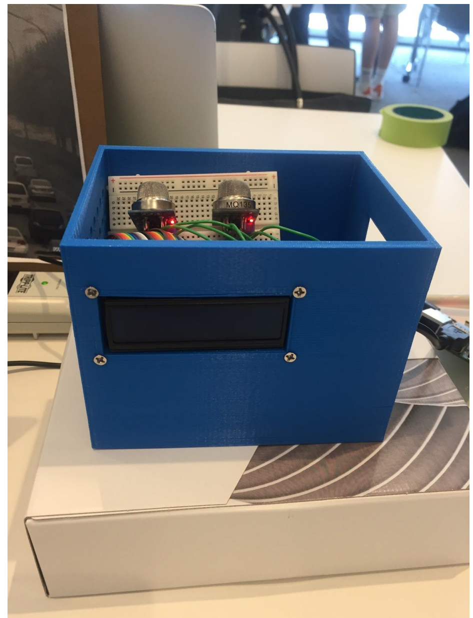
Prototype 2:

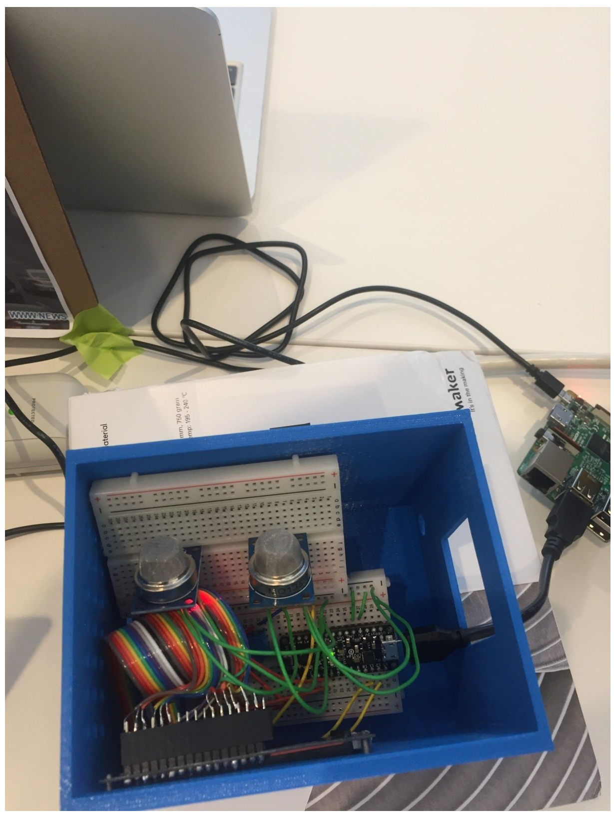
- **Description**

We designed a 3D printed box to serve as a container for prototype 1, we will put this box in different bus stations in polluted cities for alerting people when they are choosing routes to go.

- **Photos**







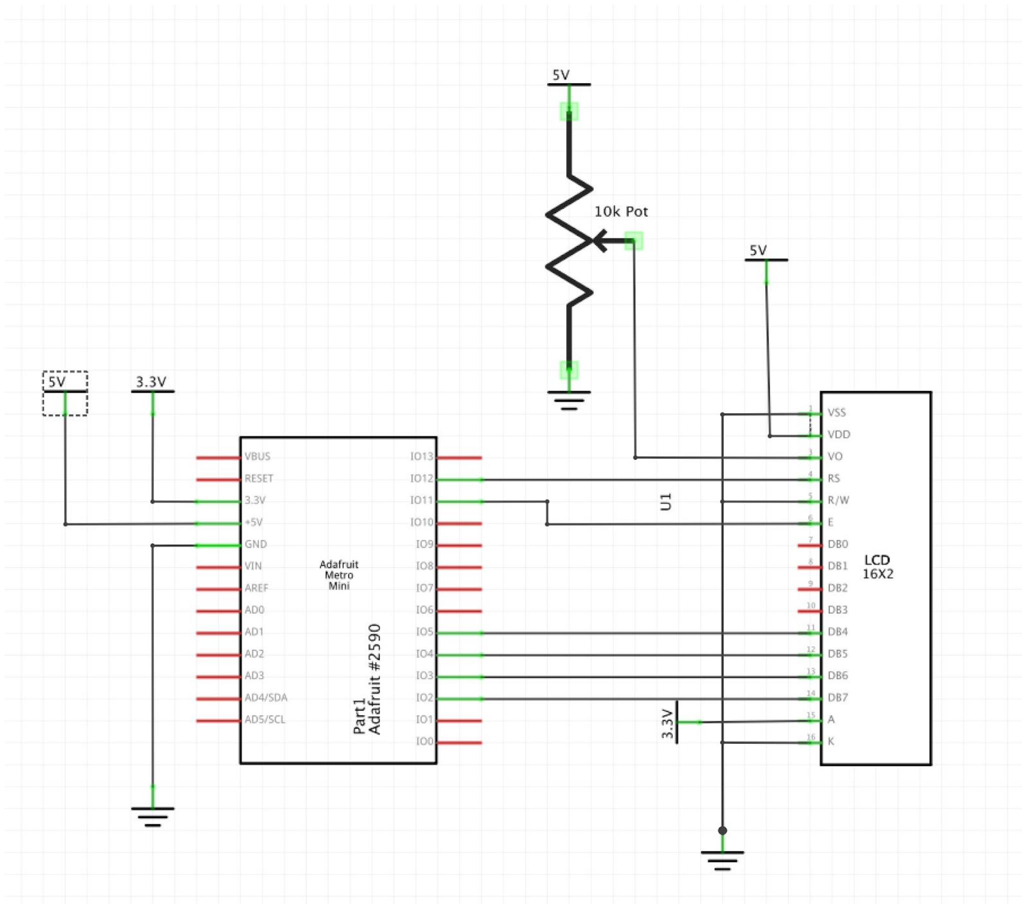
[Demo 2]

Tutorial

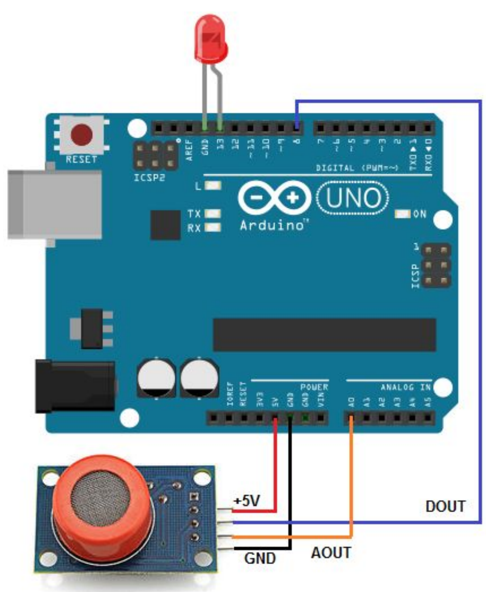
- **Material**
  Hardware
  - Arduino Uno
  - Raspberry Pi
  - Gas Sensors (MQ2, MQ3, MQ1135)
  - LCD Display (16X2)
  - iPhone
  - Laptop
  - 3D Printer with PLA Material
  - 5V Power Supply
  - 4 X Regular Screw Nuts

  Software
  - Node.js environment
  - Blynk Application
  - Leaflet Maps

- **Circuit Diagram**
  Circuit diagram for LCD:

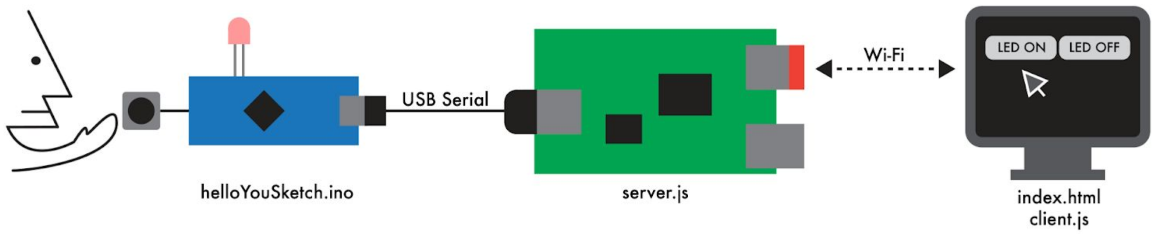


Circuit Diagram for Gas Sensors



The connections for all sensors are made as shown in this picture.

- **Steps**
  Step 1:
  Setup the connections for LCD and gas sensors (as shown above) on a breadboard with an arduino.
  Step 2:
  Set up Node.js environment and create the Interaction Engine setup using Arduino and Raspberry Pi.



  [Interaction Engine by Nick Martelaro]

  Step3:
  Print the 3D Mould for the setup and arrange everything
  STL File: Download Here
  Step 4:
  Create a Blynk account, get the API and setup Blynk environment and Leaflet Map notifications on the client.js end (refer github repo).

- **Code**
  Please see github repo

Appendix

Failures

- **3D printing**

  Although not a big one but we kept getting "Extruder Error" while trying to 3D Print in first place. In the end, we had to take help from the lab expert (Niti Parikh) to take out the filament and clean the extruder manually before we could finally proceed with a successful print.

- **Plotly**

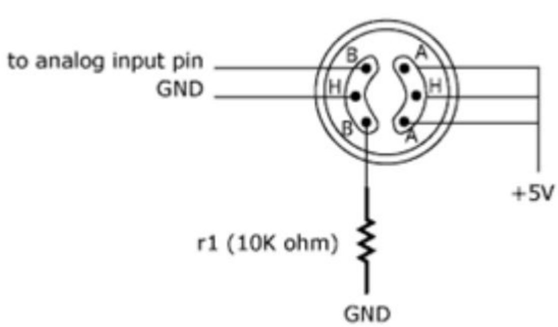
  We try to leverage Plotly API to draw real time graph, however, after finish our coding part, it seems to be some problem regarding Plotly and we couldn't do that. In more details, the code is working properly and the graph is being generated, however, no data streaming is recorded on the graph and give us an empty graph.

Sensors

MQ-3 (and MQ-2) Gas Sensors

It is an SNO2 heating sensor which is highly sensitive to alcohol in particular. Apart from this, it is also slightly sensitive to Benzene components. The stable and long life of these sensors makes them a rigid choice for this project. It is relatively useful and suitable as a Breathalyzer and an alcohol checker.

The values are measured in particles per million (ppm) and indicated as either ppm or mg/L. (0.4 mg/L = 220 ppm in air). The MQ3 consists of 6 pins as shown in the diagram below. In this two of the pins are used for heating and two are used for connecting to Vcc and Gnd. The heating tube is made of aluminum oxide and is covered by SnO_2. When the
current passes through the tube it gets heated up and the tin dioxide, because of heating acts like a semiconductor. This allows the flow of a large number of electrons and hence increases the current flow. When alcohol molecules come near the sensor, the ethanol burns into acetic acid and then more current is produced. Because of the current change, we get the different values of the sensor.



Structural Components

Sno.	Parts of Sensor	Materials used
1.	Gas sensing layer	SnO_2
2.	Heater Coil	Ni-Cr alloy
3.	Electrode	Au
4.	Electrode Line	Pt
5.	Clamp Ring	Ni Copper plating
6.	Tube Pin	Ni Copper plating
7.	Anti-explosion network	Stainless steel
8.	Tubular Ceramic	Al_2O_3
9.	Resin Base	Bakelite

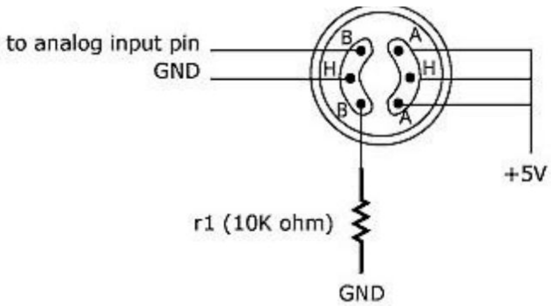
Sensitivity Characteristics

SNo.	Parameter Name	Technical Parameter
1.	Sensing Resistance(Rs)	1MΩ-8MΩ
2.	Preheat Time	Over 24 hours
3.	Standard Detecting Condition	Vcc: 5V±0.1 Temp: 20±2 Humidity: 65%±5%
4.	Concentration Slope rate	≤0.6
5.	Detection concentration slope	0.05mg/L-10mg/L Alcohol

MQ-135 Gas Sensor

The primary purpose of this sensor is to measure air quality for both indoor (offices/buildings) as well as outdoor (parks/dump yards) etc. areas especially in terms of providing particles per million (ppm) value for NH3, NOx, alcohol, Benzene, smoke, CO2 etc.

The features which make them rigid and stable working machines are a simple driver circuit accompanied by a long life of working, a wide detecting scope and fast and high sensitivity response time.The different sensitivity characteristics of MQ-135 are mentioned in table and the various material used in making different parts of the sensor are mentioned below in table. Also, the figure 4 represents the circuit of MQ-135.



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8.	Tubular Ceramic	Al_2O_3
9.	Resin Base	Bakelite

Sensitivity characteristics

SNo.	Parameter Name	Technical Parameter
1.	Sensing Resistance(Rs)	30KΩ-200KΩ
2.	Preheat Time	Over 24 hours
3.	Standard Detecting Condition	Vcc: 5V±0.1 Temp: 20±2 Humidity: 65%±5%
4.	Concentration Slope rate	≤0.65
5.	Detection concentration slope	10ppm-300ppm NH_3 10ppm-1000ppm benzene 10ppm-300ppm Alcohol