SMART POLLUTION LEVEL INDICATION WITH PRECAUTION ALGORITHM USING IOT

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Abstract: Air quality monitoring is a hot topic during the current scenario. No wonder, with so many recent studies showing a strong correlation between certain types of air pollution and negative health effects. There are several sensors are system which monitors the Air Quality but they are not distributed. These sensors are only installed in major cities and industries and they provide data only about a very small radius. In order to overcome this threatening issue a distributed system that gathers data and performs data logging and makes it a more efficient system that makes the preventive measure more easy and comfortable. The data which is collected is then logged into maps that give a better perception and cognizance about the locality. Rather than normal numeric data these maps provide information about the particular spot and also the Air Quality Index about the particular place. This can also provide images of agents that cause potential increase in the Air Quality Index. The data is not only used for viewing but it is then manipulated to provide various precaution measures through and algorithm which takes the collected data as input. The data can also be used to forecast the future scenario of each particular area based on the conditions, plantation and vehicular count in each area of a required span. Thus, this system will prove out to be a reliable and definitive solution to this alarming problem.

Index Terms **– Air quality, Maps, Plantation, Raspberry PI, Arduino, Precaution, AQI, Data-logging, Scripts**

I. INTRODUCTION

The emergence of automobile industries and their rapid progress in manufacturing and assembling has opened up a path to place more and more vehicles on road every day and finally be able to meet the market demand. The large majority of today's cars and trucks travel by using internal combustion engines that burn gasoline or other fossil fuels. The process of burning gasoline to power cars and trucks contributes to air pollution by releasing a variety of emissions into the atmosphere. The demand for transport through vehicles that use either diesel or petrol as fuel is said to be estimated at 1.1 billion units by 2020. Emissions that are released directly into the atmosphere from the tailpipes of cars and trucks are the primary causes of vehicular pollution.

The major pollutant present in the atmosphere is CO (Carbon Monoxide) which reduces the oxygen carrying capacity of blood resulting in headache, respiratory problems and even death. Some of the other pollutants responsible for vehicular pollution include NOx (Nitrogen Oxide Compounds), SO2 (Sulphur Dioxide), Hydro Carbons (HC) and Particulate Matter(PM). Transportation in India emits an estimated amount of 260 tonnes of CO2, of which 94.5% is from road transport. There are various negative health hazards such as asthma, lung cancer, heart disease, hearing loss, irritation, restlessness and also increasing the risks of death for heart patients due to this kind of problem.

Several studies have shown that the risks associated with cardiovascular and respiratory morbidity increase with chronic exposure to air pollution. Also, acute inhalation of pollutants even for a short period of time can lead to a dysfunction in the cardiovascular system and lung function. As in most cities, the basic pollution problem arises because the residential areas are far from workplaces, resulting in daily large population movements. Thus, transport, especially road traffic, is a major source of air pollution in most of the cases. In urban environment, there is a range of pollutants in the atmosphere with the capacity to cause harm to both humans and the ecosystem, including Carbon monoxide, Nitrogen oxides, Sulphur dioxide, Particular matter, Volatile organic compounds, Ozone, and Hydrocarbons.

II. EXISTING SYSTEM

In the past few years, many researches were centered around the use of static air quality monitoring stations along with crowdsourcing and participatory sensing. Such solutions lend themselves not only to monitoring the state of the physical world but can also help raising peoples' awareness of issues related to air quality and pollution. One of the main projects which proposed such a solution is the MESSAGE (Mobile Environmental Sensing System Across Grid Environments) project. It aims to develop fixed and portable devices for high-density measurement of concentrations of carbon monoxide and nitrogen oxides in urban areas. They have very recently reported their development and deployment experience in the Cambridge area, and demonstrated that the use of low-cost fixed and portable devices deployed in high densities can give a much more accurate picture of the spatial and temporal structure of air quality in the urban environment. Authors introduced a low-cost mobile sensor based participatory air quality monitoring system. this work presents the design and implementation of GasMobile a small and portable measurement tool suited to be used by a large number of people.

III. IMPLEMENTATION

This system can be used in both home and industrial purposes. In our system we can monitor the device and handle the devices very easily. We have prepared a new Internet Protocol address which can be used anywhere. For the security purposes we introduced new login identification and a password. By knowing the user ID and password can only enter the web page and monitor the devices which are connected to the smart

plug and control. There will be two tabs, the first tab shows the power usage and second tab shows the device and the switch to turn on and turn off the device. So we can control and monitor the devices from anywhere. Ref Fig 3.1 for the block diagram of the model.

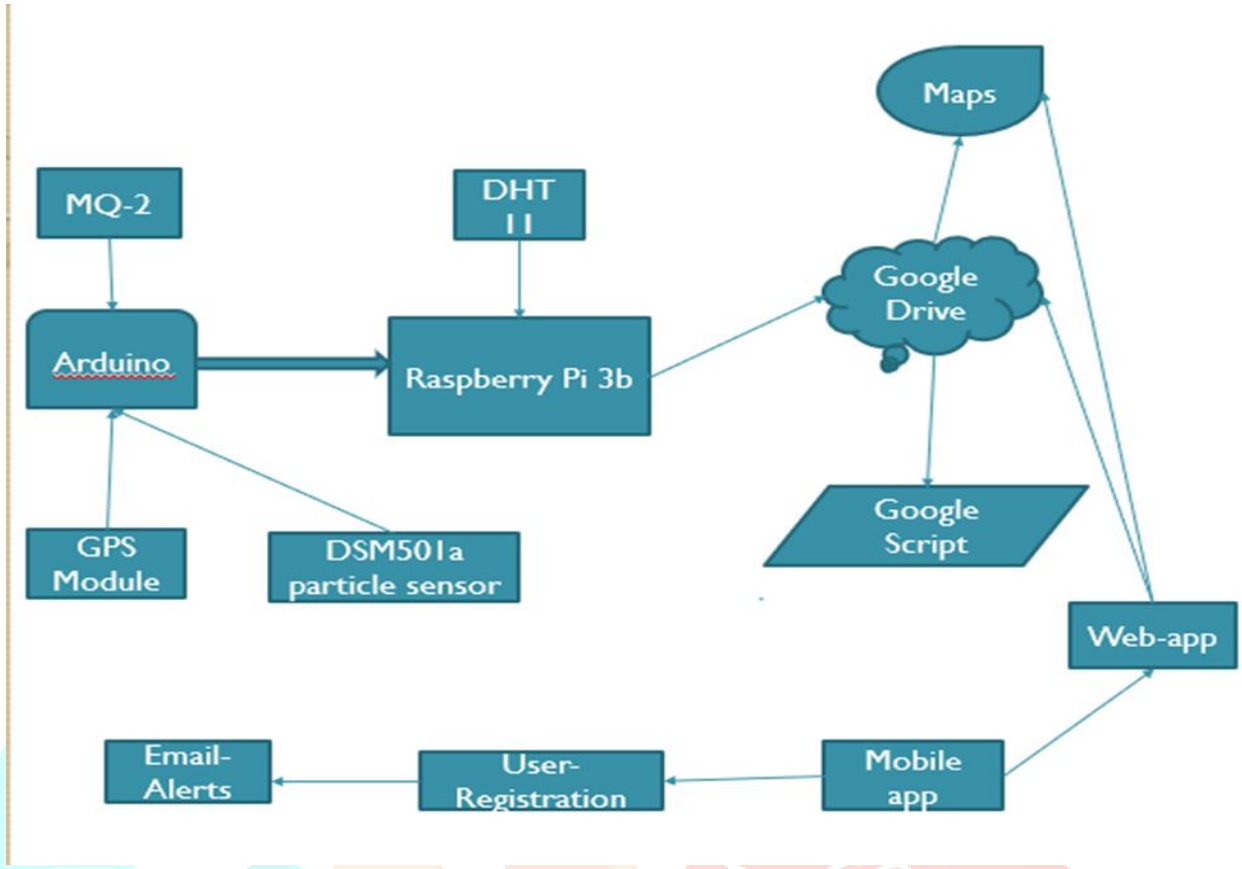
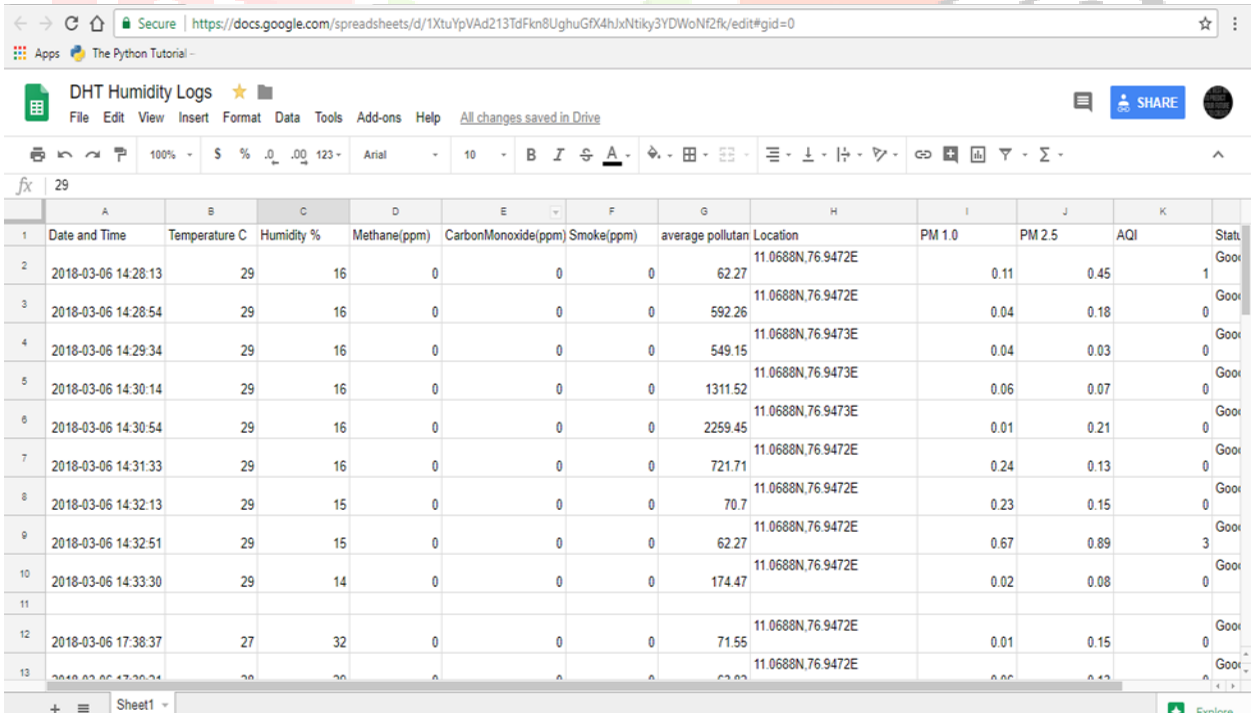


Fig-3.1 The Block

The picture of the sheet in which data is logged Refer Fig-3.2.



DHT Humidity Logs

	Date and Time	Temperature C	Humidity %	Methane(ppm)	CarbonMonoxide(ppm)	Smoke(ppm)	average pollutan	Location	PM 1.0	PM 2.5	AQI	Statu
2	2018-03-06 14:28:13	29	16	0	0	0	62.27	11.0688N,76.9472E	0.11	0.45	1	Goo
3	2018-03-06 14:28:54	29	16	0	0	0	592.26	11.0688N,76.9472E	0.04	0.18	0	Goo
4	2018-03-06 14:29:34	29	16	0	0	0	549.15	11.0688N,76.9473E	0.04	0.03	0	Goo
5	2018-03-06 14:30:14	29	16	0	0	0	1311.52	11.0688N,76.9473E	0.06	0.07	0	Goo
6	2018-03-06 14:30:54	29	16	0	0	0	2259.45	11.0688N,76.9473E	0.01	0.21	0	Goo
7	2018-03-06 14:31:33	29	16	0	0	0	721.71	11.0688N,76.9472E	0.24	0.13	0	Goo
8	2018-03-06 14:32:13	29	15	0	0	0	70.7	11.0688N,76.9472E	0.23	0.15	0	Goo
9	2018-03-06 14:32:51	29	15	0	0	0	62.27	11.0688N,76.9472E	0.67	0.89	3	Goo
10	2018-03-06 14:33:30	29	14	0	0	0	174.47	11.0688N,76.9472E	0.02	0.08	0	Goo
11												
12	2018-03-06 17:38:37	27	32	0	0	0	71.55	11.0688N,76.9472E	0.01	0.15	0	Goo
13								11.0688N,76.9472E				Goo

Fig-3.2 Logged sheet

Picture of fusion tables. Refer Fig-3.3.

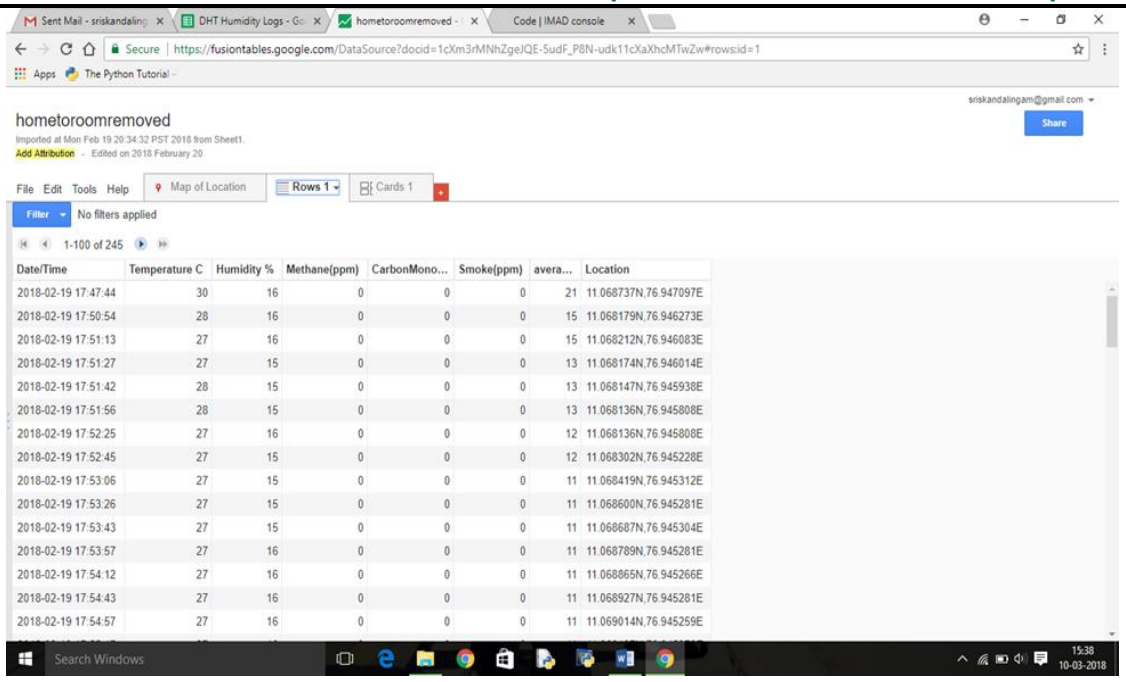


Fig-3.3 Fusion tables

Picture of the heat map from fusion tables Refer.Fig-3.4

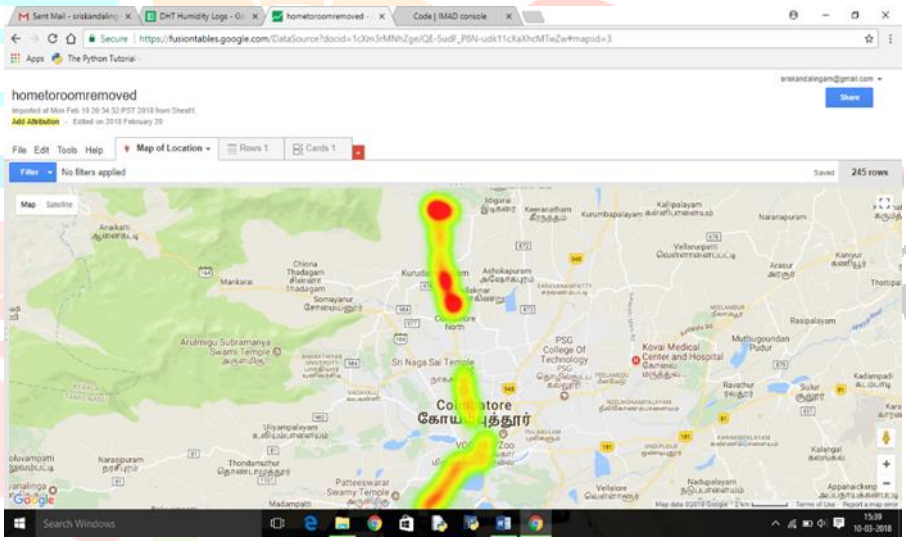


Fig-3.4 Heat map

Picture of the complete setup Fig-3.5.

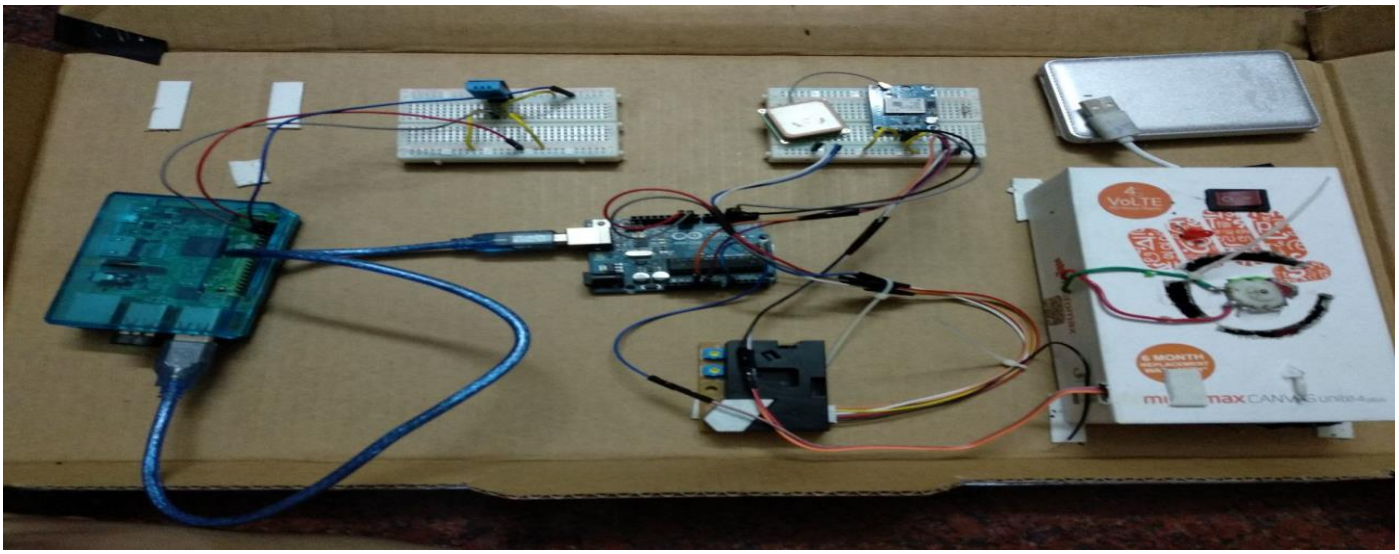


Fig-3.5 The project setup

IV. HARDWARE

4.1 Raspberry PI

Raspberry PI is a credit card sized minicomputer. Raspberry PI is a series of small single board computers. There are several generations in Raspberry PI. Raspberry PI3 model B has an on-board Wi-Fi/Bluetooth support. We use Raspberry PI3 model B in our smart plug device.

The Raspberry PI has several advantages and speed of the processor than many other micro controllers. This Raspberry PI3 model B has some advantages. Raspberry PI runs Debian based GNU/Linux operating system. Raspberry PI3 model-B has a Broadcom BCM2837 Processor which we can also use for 64-bit processors. Raspberry PI3 model B have a Central Processing Unit (CPU) core is Quad core ARM Cortex-A53. The speed of the processor is 1.2 GHz, which is purely 50% faster than its previous model Raspberry PI2. The Random Access Memory is 1GB. For network connection reliability, there is an Ethernet port where RJ-45 cable can be inserted.

One of a specialty in Raspberry PI3 model B is, it has a Wireless LAN (Wi-Fi) which has an Internet Protocol address 802.11 which is majorly used for Local Area Network. Also it has a Bluetooth connectivity version 4.1. Raspberry PI3 models B have a ceramic antenna which is used by Wi-Fi and Bluetooth 4.1. It also has four USB ports mounted and a 15-pin MIPI port for camera usages. Refer Fig-4.1.

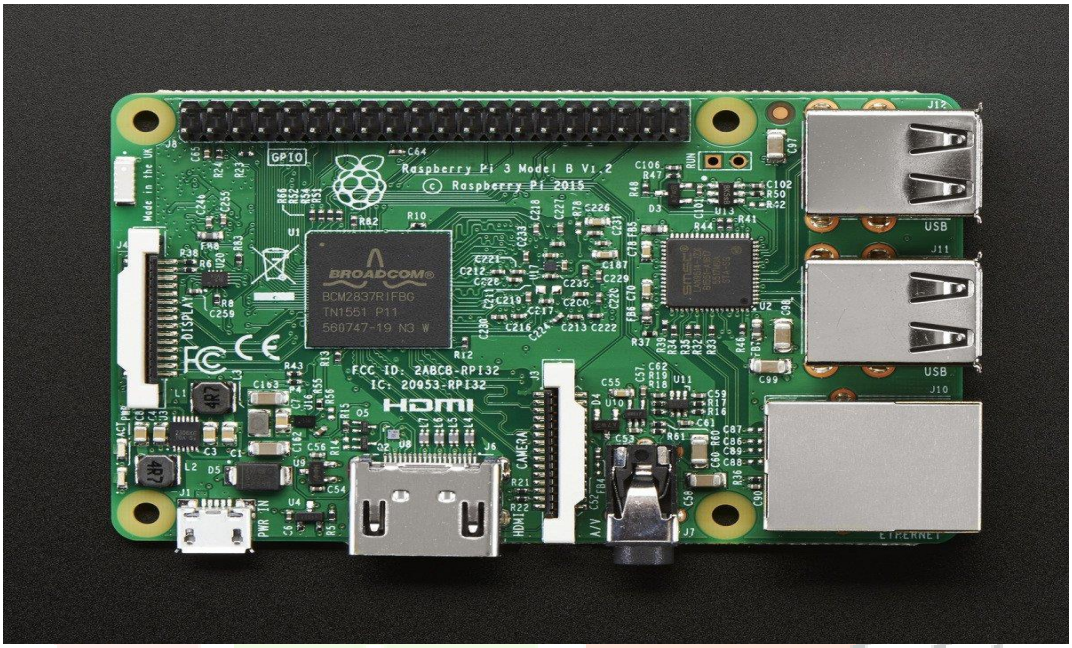


Fig-4.1 Raspberry Pi-3b

4.2 DSM501A Particle sensor:

The DSM501A is low cost, compact size for a particle density sensor.it is used to quantitative particle (> 1 micron) measurement with the principle of particle counter, can sense the tobacco smoke and pollen, house dust. This sensor consists of light emitting diode lamp, detector, signal amplifier circuit and heater, it can be used in applications such as the air cleaner or air purifier, users can use this sensor easily with sensor PWM output. Refer Fig-4.2.

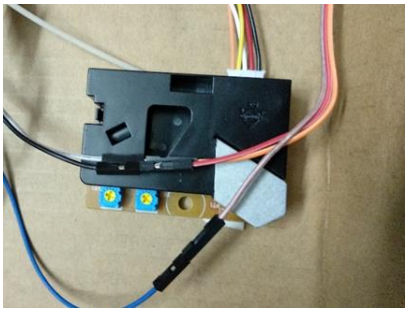


Fig-4.2 DSM501a

4.3 Arduino UNO

As the Raspberry PI3 model does not have any analog to digital data converters, here we use a Arduino Uno which performs as an analog to digital converter. .

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Refer Fig-4.3.

Fig-4.3 Arduino UNO

4.4 MQ-2

The Grove - Gas Sensor (MQ2) module is useful for gas leakage detection (home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer. Refer Fig-4.4.

Fig-4.4 MQ-2

4.5 GPS Module (Ublox Neo 6m):

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high-performance u-blox 6 positioning engine. These flexible and cost-effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints. The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments. Refer Fig-4.5

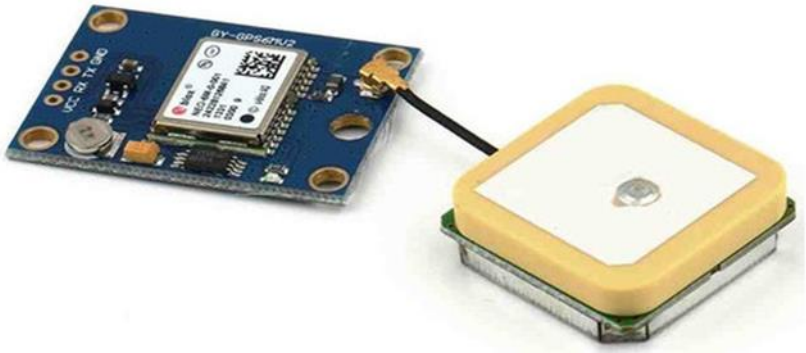


Fig-4.5 GPS Module

4.6 DHT Temperature and Humidity sensor

DHT11 digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. Refer Fig-4.6.

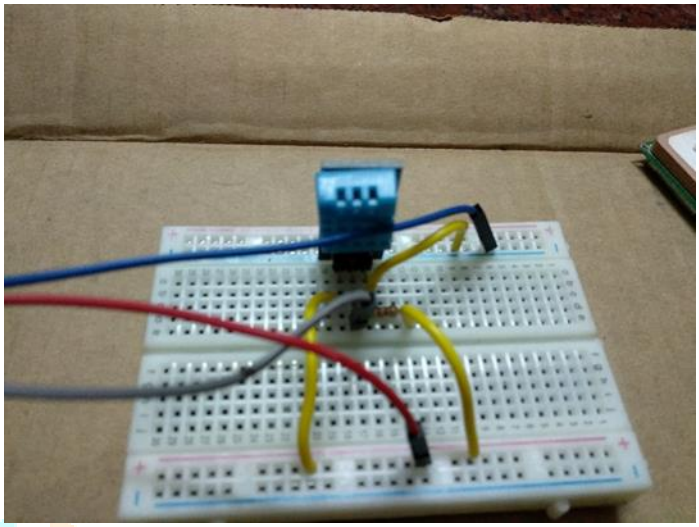


Fig-4.6 DHT Temperature and Humidity sensor

V. SOFTWARE

5.1 Python

The Python is a programming language also used for software programming in Raspberry PI. Python is basically a general-purpose, high-level programming language. It is very easy to read the program. The Raspberry PI3 model-B has twenty four pins GPIO (General Purpose Input/output). We can give input at any GPIO pins and tend output at any pin.

5.2 Data logging using RaspberryPi:

The collected data is directly uploaded to google drive. For this the RaspberryPi must be connected to the internet via Wi-Fi or Ethernet dongle.
To initiate connect between the pi and google drive we need to enable google OAuth2 access to the spreadsheet
We also need to install some packages in the RaspberryPi using the following commands

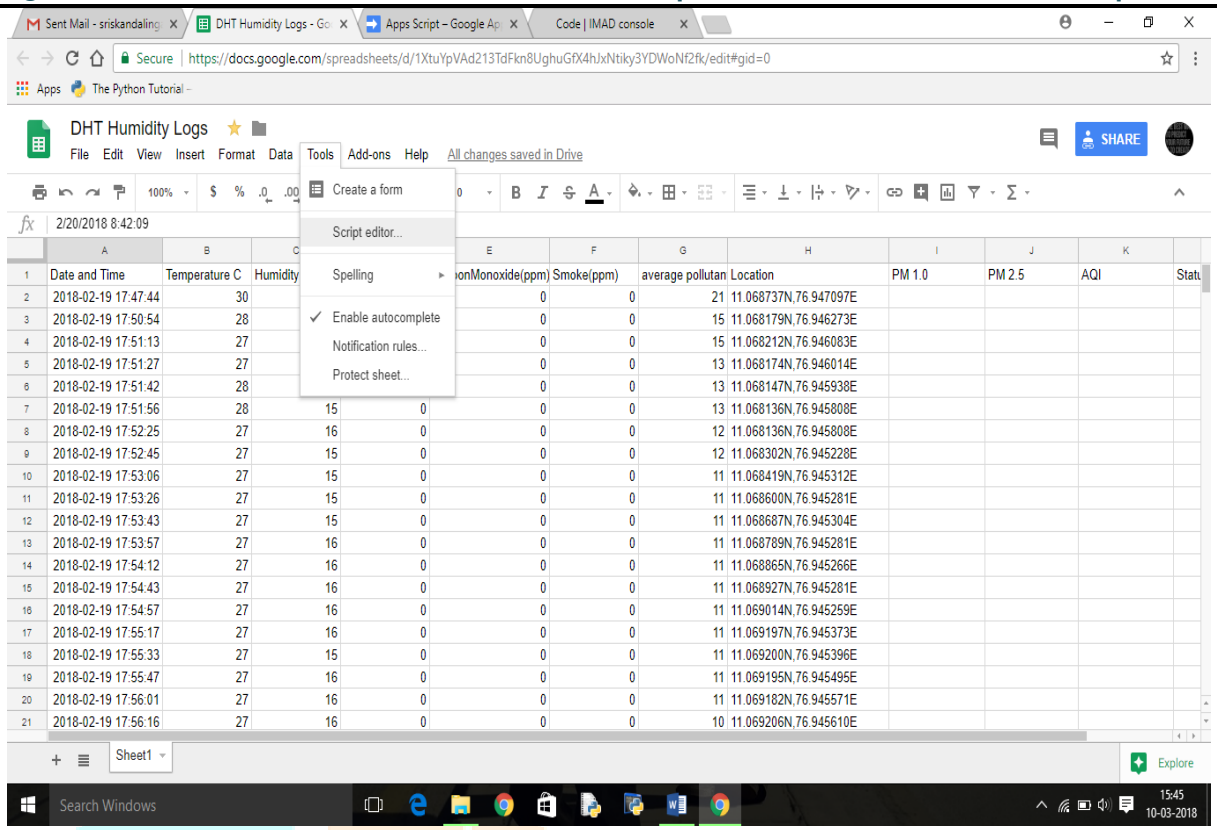
sudo apt-get update
sudo apt-get install python.pip
sudo apt-get install gspread oauth2client
A google sheet is created with the name of the sheet is noted which will be need further in the python script
OAuth credentials can be generated in several different ways using the oauth2client library provided by Google. If you are editing spreadsheets for yourself then the easiest way to generate credentials is to use Signed Credentials stored in your application. Then we visit google developers console and then enable “Drive API” under “API and auth”. Then after heading to credentials tab. We choose “New credentials > Service Account Key”.
A json file will be automatically downloaded
The json file will look like this

```
{
    "private_key_id": "2cd … ba4",
    "private_key": "-----BEGIN PRIVATE KEY-----\nNrDyLw … jINQh/9\n-----END PRIVATE KEY-----\n",
    "client_email": "473 … hd@developer.gserviceaccount.com",
    "client_id": "473 … hd.apps.googleusercontent.com",
    "type": "service_account"
}
```

JSON stands for JavaScript Object Notation. When exchanging data between a browser and a server, the data can only be text. JSON is text, and we can convert any JavaScript object into JSON, and send JSON to the server. We can also convert any JSON received from the server into JavaScript objects.
This way we can work with the data as JavaScript objects, with no complicated parsing and translations.
The python code and the JSON file must be kept in the same directory.

5.3 Running Google script on Google sheets:

Google Apps Script is a JavaScript cloud scripting language that provides easy ways to automate tasks across Google products and third-party services and build web applications. Refer Fig-5.1.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Date and Time	Temperature C	Humidity		onMonoxide(ppm)	Smoke(ppm)	average pollutan	Location	PM 1.0	PM 2.5	AQI	Statu
2	2018-02-19 17:47:44	30			0	0	21	11.068737N,76.947097E				
3	2018-02-19 17:50:54	28			0	0	15	11.068179N,76.946273E				
4	2018-02-19 17:51:13	27			0	0	15	11.068212N,76.946083E				
5	2018-02-19 17:51:27	27			0	0	13	11.068174N,76.946014E				
6	2018-02-19 17:51:42	28			0	0	13	11.068147N,76.945938E				
7	2018-02-19 17:51:56	28	15	0	0	0	13	11.068136N,76.945808E				
8	2018-02-19 17:52:25	27	16	0	0	0	12	11.068136N,76.945808E				
9	2018-02-19 17:52:45	27	15	0	0	0	12	11.068302N,76.945228E				
10	2018-02-19 17:53:06	27	15	0	0	0	11	11.068419N,76.945312E				
11	2018-02-19 17:53:26	27	15	0	0	0	11	11.068600N,76.945281E				
12	2018-02-19 17:53:43	27	15	0	0	0	11	11.068687N,76.945304E				
13	2018-02-19 17:53:57	27	16	0	0	0	11	11.068789N,76.945281E				
14	2018-02-19 17:54:12	27	16	0	0	0	11	11.068865N,76.945266E				
15	2018-02-19 17:54:43	27	16	0	0	0	11	11.068927N,76.945281E				
16	2018-02-19 17:54:57	27	16	0	0	0	11	11.069014N,76.945259E				
17	2018-02-19 17:55:17	27	16	0	0	0	11	11.069197N,76.945373E				
18	2018-02-19 17:55:33	27	15	0	0	0	11	11.069200N,76.945396E				
19	2018-02-19 17:55:47	27	16	0	0	0	11	11.069195N,76.945495E				
20	2018-02-19 17:56:01	27	16	0	0	0	11	11.069182N,76.945571E				
21	2018-02-19 17:56:16	27	16	0	0	0	10	11.069206N,76.945610E				

Fig-5.1 Creating scripts

A typical script looks like the one below

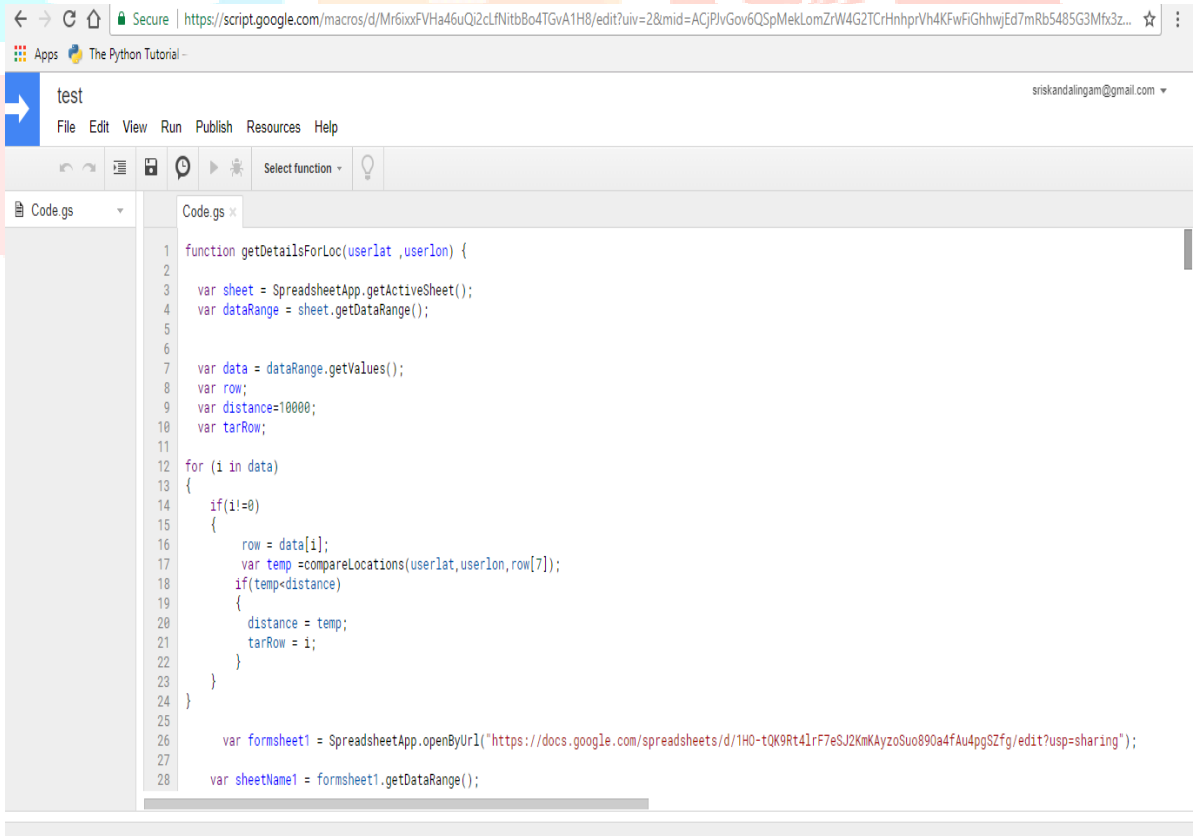


Fig-5.2 Google scripts

Using these script, we can automatically send notifications to user. We can also set timed triggers in order to send notifications at regular interval of time.

5.4 Mobile app:

In order for the users to register, an android app has been developed.

Fig-5.3 App's home page

This app lets the user to

- View the raw data which is collected
- View the heat map and fusion table
- Register to get email notifications
- Access the Web-App which lets us do a lot more functionality

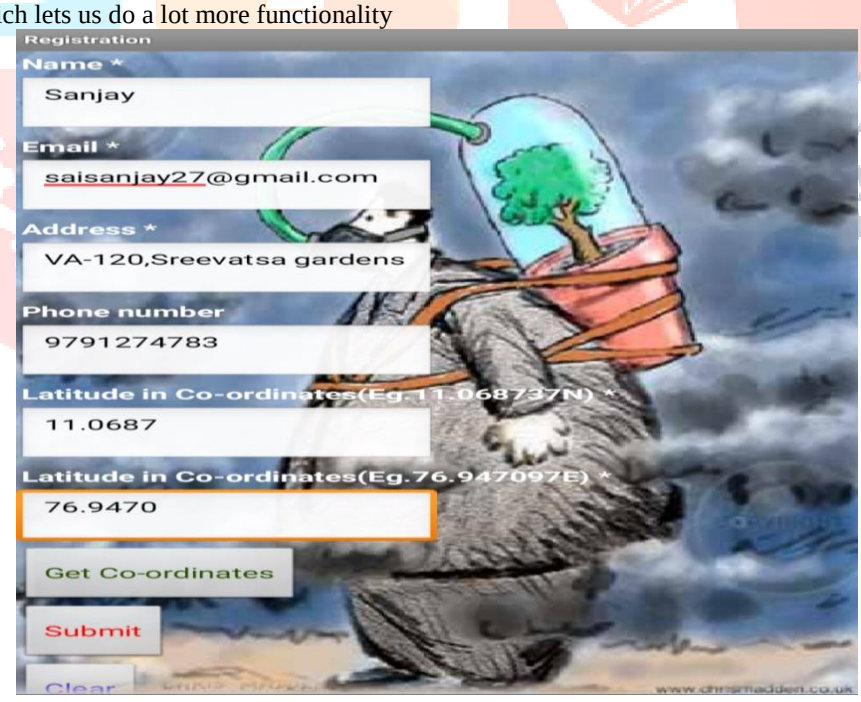


Fig-5.4 Getting data from users

The email address is collected through a Google for whose prefilled link is embedded to the mobile app. The mobile app also automatically collects the GPS data of the user. This data is then sent to the form which is in turn updated to a sheet.

5.5 Web App:

The collected data, fusion tables and heat Map can be viewed at the web-app which has been created. The web app also has many plantation information and precaution measures which can be taken in order to reduce pollution.

The web app is hosted at hasura. The contents of the web app can be viewed remotely anywhere by anyone. The administrator can also easily update/modify the contents of the web-app.

5.6 Algorithm on google script:

The algorithm that runs on google script uses all the data collected so far such as data, time, humidity, temperature, concentration of all the gases, particulate matter and location from the pi which is in a sheet and also the user registration data which the user has enter from the mobile app.

The algorithm then gives several alerts and precaution measures based on the pollutants present and also the location of the user.

The algorithm first checks whether if there is any data which collected near the user's GPS coordinates if not then it sends a mail saying that the data is not yet collected in his/her locality

If there are ample number of data points that are collected then it searches for the nearest data point.

A set of predefined checkpoints are present in another sheet the user's location is compared with this location to determine whether the user lives in an urban or rural location in order to give location specific precaution measures.

If the uses are found to live in an urban area then the pollutants are checked and a mail is triggered based on the highest pollutant.

If the user is found live in a rural area, another set of measure for a rural area according to the pollutants levels are sent.

VI CONCLUSION

Thus, data was collected using some of the sensors such as MQ-2, DSMA501a and was mapped along with the GPS co-ordinates. The data is logged, and it is shared with the users who register with the pollution app with respect to their GPS co-ordinates.

This is the cheapest alternative, and a dynamic method to analyze and determine the pollution driven places with along with the specific pollutants. The main advantage this project has over other conventional methods is that it's mobile and compact setup, which contributes to the dynamicity.

As Todd Park says "Data by itself is useless, Data is only useful if you apply it", therefore the future phase of work is to build a system that uses data wisely that suggests user the measure that can be taken to bring the hazardous condition under control. A system that reduces accumulation of traffic with the help of the map, which is shared to the users. This enables the users to get aware and choose and alternate route, which reduces the traffic as well as the accumulation of pollution in a particular place. This is also an excellent system which suggests house plants and maps according to the particular area (GPS co-ordinates), based on whether it is rural or urban

VII FUTURE WORKS

The device is now placed on any automobile, future plans would be to build an autonomous robot which be able to collect data on its own which can operate on both terrestrial and extra-terrestrial landmass which is capable of capturing images this requires cameras with high resolution Electronic image stabilization since capture is done in motion. This would give a better insight. Additional sensors can also be added to the system in order to provide more data

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