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(GTU)

AHEMADABAD- 382424



Vishwakarma Government Engineering College, Chandkheda-382424
(Affiliated with Gujarat Technological University, Ahmedabad)

A
Project report
On

IOT BASED AIR POLLUTION MONITORING SYSTEM

Prepared as a part of the requirement for the subject of
B.E- Semester- **VI**
(Electronics and Communication Branch)

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Academic Year 2022-23



Vishwakarma Government Engineering College – Chandkheda

Department of Electronics and Communication Engineering

CERTIFICATE

This is to certify that the Design Engineering 2B (3160001) Report entitled “**IOT BASED AIR POLLUTION MONITORING SYSTEM**” submitted by

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Towards the partial fulfilment in Design Engineering **2B** (Electronics and communication Engineering) of Gujarat Technological University is the record of work carried out by him under our supervision and guidance. The work submitted has in our opinion reached a level required for being accepted for examination. The results embodied in this Project Work to the best of our knowledge have not been submitted to any other University or diploma.

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Finally, I would like to thank our friends and family for their support and patience throughout the year, especially to our parents who without their encouragement and financial support, this would not have been possible.

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1. Introduction

In this era of modernization, technologies are advancing rapidly. Every day we realize some new technology coming in market to simplify our lives more than ever. Back in time checking the pollution in a particular area was a very tedious task which was not very efficient also.

With the increasing pollution and advancing technology various new methods were introduced to keep an eye on the rapid increase in pollution. More efficiency. Internet of things is one of the latest works that has been done in this path. The increment in use of internet and the interaction of human with machine gave rise to IOT.

It allows exchange of information among various devices like fridge, washing machine, automobile, watches etc. This exchange of information takes place with the help of numerous sensors. The account for the success of IOT is its efficiency and makes it a feasible technology at low cost. Air pollution are two main constituents that have the most adverse effect on humans as well as the entire earth. Therefore it is very important to check and control it. traditional methods involve manual work in which data loggers used to visit the site to collect the data, analyze it and perform comparisons to provide the output which was very lengthy and time consuming besides being inefficient.

The pollution monitoring system involves use of sensors (MQ135) which measures the Air pollution concentration and level of harmful gases like benzene, alcohol, smoke, steam, stream which mainly pollutes the air. Comparisons are done automatically using previously stored data in database and output is stored on cloud to make it accessible from remote area. This paper involves description of the system that presents its output to the server thingspeak.com which the user can access it whenever it wherever they want. It can be used for notifying the authorities.

2 CANVASES:

2.1 AEIOU SUMMARY:

1. ACTIVITY: This section will include the applications of the product such as the sending data, monitoring, maintenance, research, assemble of equipment, measuring data, etc.

2. ENVIRONMENT: This will include the effect of the objects placed in its surroundings such as: Vast Area, industry area, production, profit, user friendly

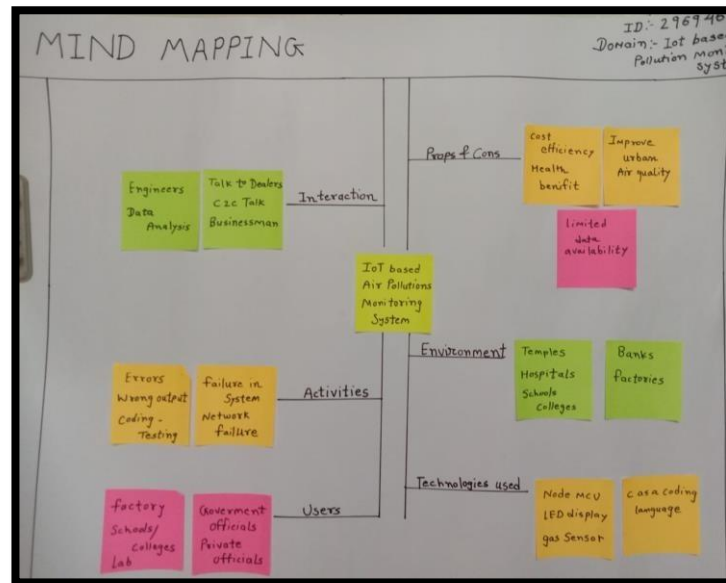
3. INTERACTION: This will include the Stakeholders such as Industries, Power Plants, Schools, Colleges, Farms, etc.

4. OBJECTS: This section of the canvas includes the equipment used for the production such as Arduino, gas sensor, node mcu, lcd, batteries, etc

5. USERS: As usual it will include the people who are associated with the product like Engineers, Students, Farmers, Domestic Users, and Public Sectors.

AEIOU Summary:		Group ID: 296946	Date: 27/	Version:
		Domain Name: IoT based air pollution Monitoring System		
Environment: <ul style="list-style-type: none">- General impressions / observations (Style, material & atmosphere)- Floor plan- Elements, features and special notes	Interactions: <ul style="list-style-type: none">- General impressions / observations (Who is interacting with whom, what?)- Scene of interaction (How it is being done)- Elements, features and special notes	Objects: <ul style="list-style-type: none">- General impressions / observations (What components are involved? How?)- Inventory of key objects- Elements, features and special notes		
<ul style="list-style-type: none">- user friendly- Reduce Pollution- Production- Profit	<ul style="list-style-type: none">- Machine - Machine- Online Monitoring- System- Internet cloud - System	<ul style="list-style-type: none">- Smart Screen- wires- Development Board- Sensing device		
Activities: <ul style="list-style-type: none">- General impressions / observations- Sketch/photo Summary of activity- Elements, features and special notes		Users: <ul style="list-style-type: none">- General impressions / observations (Who is present? Role and responsibilities)- Scene of user in context- Elements, features and special notes		
<ul style="list-style-type: none">- Sending data- coding- monitoring- Maintenance- Research		<ul style="list-style-type: none">- factory- work shop- Public place- Hospital- Laboratories- school/ college		

2.2 MIND MAPPING:



2.3 EMPATHY CANVAS:

This is the first step of the project or a problem. In this canvas, we will find out what is user? Who is a User? What is Stakeholder? Who are they? And what are the broad stories of their activities?

1. User:

- In this stage, we find various users who are directly or indirectly related to our product
- For Example: Engineers, Students, Professionals, Common People, etc.

2. Stakeholders:

- Stakeholders are people or an organization with an interest.
- In this stage, we find those users which are directly or indirectly related to the users.
- For Example: Industries, Power Plants, Colleges, Residences, etc.

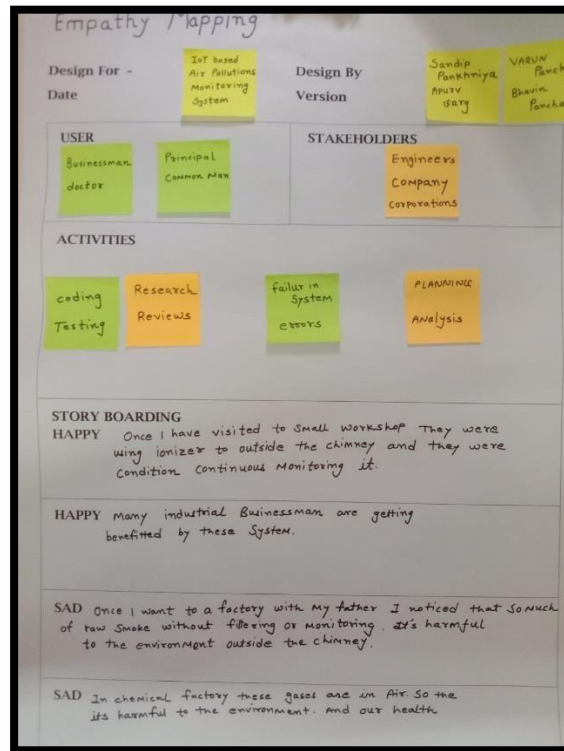
3. Activities:

- Activities are directly or indirectly related to the stakeholders.
- For Example coding, testing, research, error correction and detection , analysis etc.

4. Story Boarding:

- **Happy:** once I have visited to small workshop they were using ionizer to outside the chimney and were condition continuous monitoring it.

- **Sad:** once I went to a factory with my father I noticed that so much of raw smoke without filtering or monitoring .its harmful to the environment outside the chimney.



2.4 Ideation canvas

This canvas consists of the ideology behind the user, so in this canvas some brief ideas are expressed. People section consists of persons related to user technically and similar persons may relate to user. Then we divided activities in social & technical and try to find out the importance of each activity and situations & location regarding are find out related to each.

PEOPLE:

- Engineers
- Students
- Society
- Transportation user
- Domestic Users

ACTIVITIES:

- Measuring gases in air
- Display interfacing
- Output on server

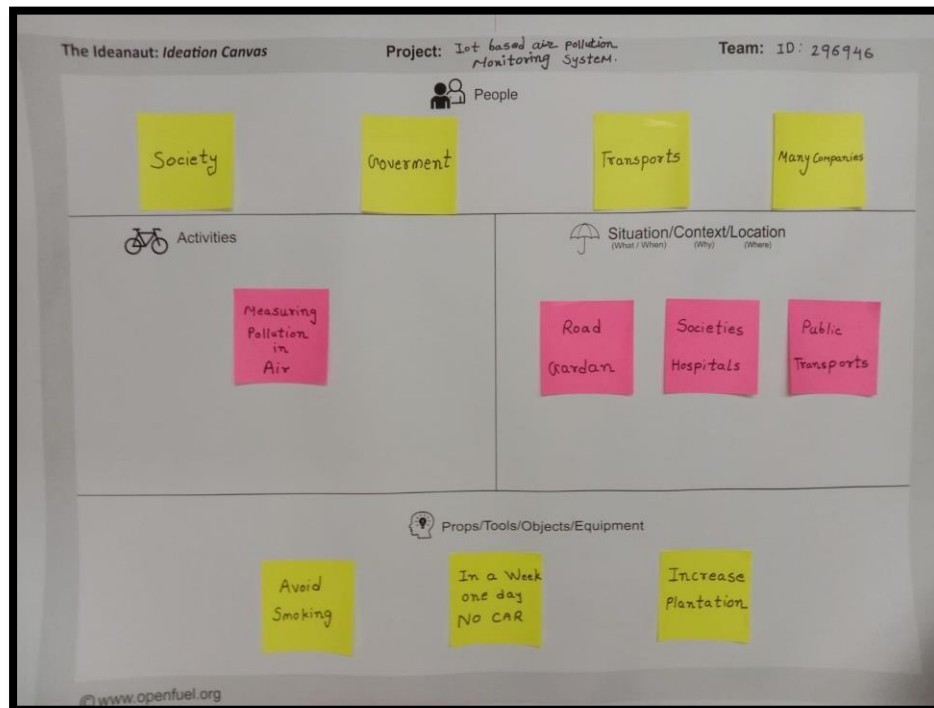
LOCATION:

- Industries

- Power Plants
- Colleges
- Public Sector
- Residential Areas
- Hospitals

PROPS:

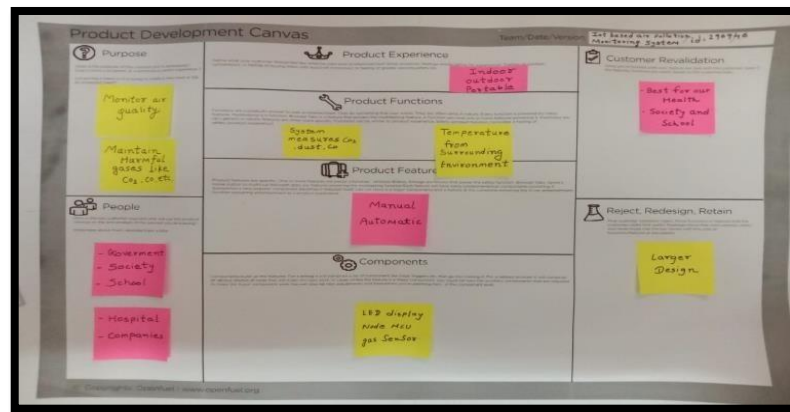
- Avoid smoking
- In a week one day no car
- Increase plantation



2.5 product development canvas:

PURPOSE:

The most important and the most needed purpose of such products using air pollution monitoring system is **TO MAINTAIN HARMFUL GASES**



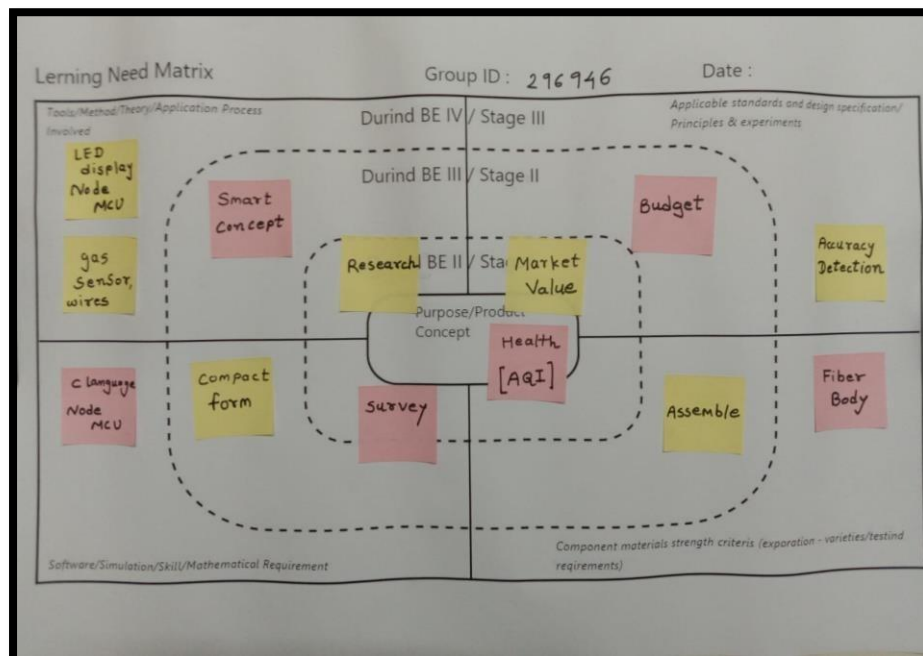
PEOPLE:

The most basic users of such kind of products are Engineers, bussiman, doctors.

PRODUCT FUNCTIONS:

- The three most important and basic functions of these products are:
 1. Measuring gases
 2. Detect harmful gases

2.6 LEARNING NEED MATRIX



3. Literature Survey

The motive of thinking a smart city can be fulfilled by using technology, thus making the life better and also enhancing the quality of services, therefore meeting every individual's needs.

With modern technology in fields of information and communication, it has become easy to interact with the authorized people of city to tell them where about of area or city, how well city is developing and how to make it possible to achieve a better life quality.

In this system, an application was created to make one more step in the fulfilment of the goal. An area is analyzed for evaluating how much pollution is affecting the area. The components of gases and their amounts are calculated and checked.

If the amount is higher than the officials are reported about it. After that the people are made to clear the area and taken to a safe place. The combined network architecture and the interconnecting mechanisms for the accurate estimation of parameters by sensors are being explained and delivery of data through internet is presented.

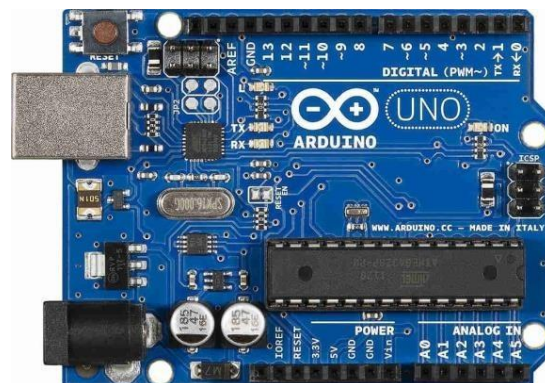
Some of the research work made for monitoring the pollution parameters in a particular location in order to make the environment safe and that area smart. Different methods were used in the past and are described in this section.

First is smart environment monitoring using wireless sensor networks in which the main focus was on th developing an environment free of pollution by making it smart. Wireless sensors are fitted all over the city and in public transports.

By monitoring all the sensor networks, all the environment happenings can be gathered as a streaming database to analyze the environment position.

3.1 Explanation of blocks:

1) Arduino UNO as microcontroller: Arduino Uno is a microcontroller board based on the ATmega328P. it has 14 digital input/output pins 6 analog inputs, a 16 MHZ quartz crystal, a USB connection ,power jack, an ICSP header and a reset button as shown in figure :



Arduino UNO:

Microcontroller	Atmega 328p-8bit AVR family
Operating voltage	5V
Recommended input vol.	7-12V
Input voltage limits	6-20V
Analog input pins	6(A0-A5)
Digital i/o pins	14
Dc current on i/o pins	40mA
Dc current on 3.3v pin	50mA
Flash memory	32KB
SRAM	2KB
EEPROM	1KB
Frequency (clock speed)	16 MHZ

2)Node mcu: NodeMCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module.



3 Node mcu

- Microcontroller: Ten silica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz

3) MQ135 sensor as gas sensor: The MQ135 sensor can sense NH₃, NO_x , Alcohol, Benzene, smoke ,CO₂ and some other gases. It gives the output in form of voltage levels. Figure shows the sensor MQ135.



MQ135 Gas sensor:

- Wide detecting scope
- Fast response and high sensitivity
- Stable and long life
- operating voltage is +5V
- detect NH₃, NO_x, alcohol, Benzene, smoke, CO₂
- Analog output voltage:0V to 5V
- digital output voltage :0V to 5V
- preheat duration 20 seconds
- can be used as a digital sensor
- the sensitivity of digital pin can be varied using the potentiometer

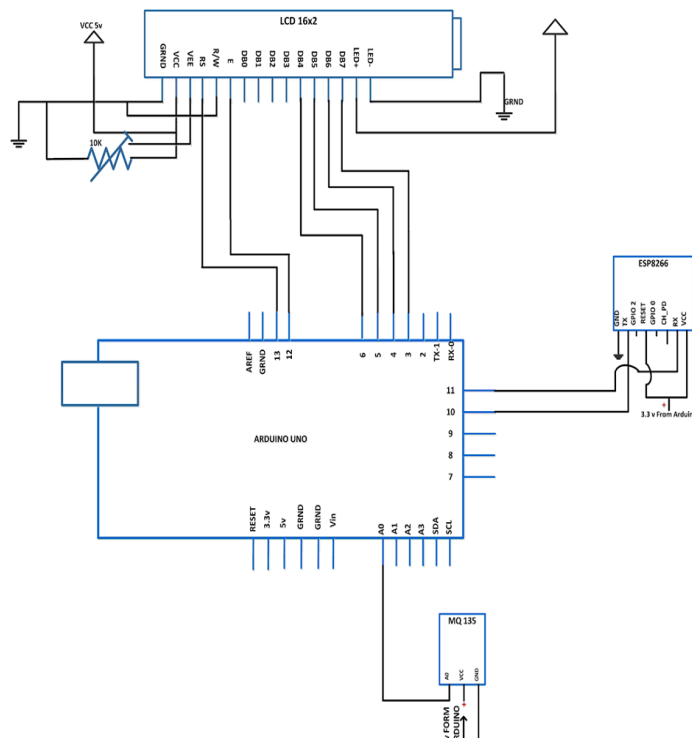
4) 16x2 LCD: as display this is basic (16x2) 16 character by 2 line display. Black text on green background. It is used to indicate the Air and humidity in PPM. Figure:



16x2 LCD

- operating voltage is 7.4V to 5.3V
- Current consumption is 1mA
- consists of two rows and each row can print 16 characters.
- each character is built by a 5x8 pixel box
- available in green and blue light
- it can also display any custom generated characters

3.2 Circuit diagram



Working Of Circuit:

First applying 5V to the Arduino board will start executing program uploaded on chip. As per program first it will try to connect to the router through Wi-Fi module; it will search for SSID and password match entered in a program. If SSID and password match, it will connect; else, it will show Wi-Fi connect error.

The microcontroller LCD display will show the welcome note and all that is written in code. The controller will read values coming from the gas sensor and display on LCD. Values coming from the analog pin will be displayed as fresh air or poor air. The range of fresh air is between 0 to 300 PPM; above this value, air will be considered as poor air.

Microcontroller will send the values on 16 seconds delay of each value to the Wi-Fi module which is connected to the internet through the router.

Now , Wi-Fi module will send data to the thingspeak server through a special key called API key which specifies our channel and field for plotting graph of our sensors values.

For that first Wi-Fi module will request to server for providing services. This will establish TCP connection on “api.thingspeak.com” at port no.80 through at commands.

After establishing TCP connection this start sending data through a data frame this frame contains start bit, stop bit, guard bit and tail bit .through at commands data will be sending to the server on desired API key. After every delay values will be updated through microcontroller.

Thingspeak is free server for storing data it provides collect data analyze data and act on data. Thingspeak will collect data on 16 seconds delay of each value which is default for this server for analyze the data and plotting graph.

This will collect our sensor data and analyze it for visualization on graph, after analyze data it will show the graph on your monitor.

Connection description:

LCD to Arduino:

GND	GND
VCC	GND COMMON
VEE	05 V
RS	12
R/W	5 V
ENABLE	12
DB4	5
DB5	4
DB6	3
DB7	2
LED+	GND
LED-	5 V

mq135 to Arduino:

VCC	Vin
GND	GND
AO	A0 common

Pot connection:

Output pin of pot must connect to 3rd pin (VEE) of LCD.

Other two remaining pins connect to 5v and ground.

Cost:

750/-_ Uno

200/- node mcu

150/- mq135 gas sensor

135/- display 16x2

65/- breadboard

100/- cable uno and jumper

Total cost is around 1400/-

4 Software development

Output of sensor mq 135 will be form of different voltage levels. This is sensation of alcohol, smoke, and benzene gases. Different voltage levels will convert further in digital from 0 to 1024 in microcontroller.

Controller will calculate the average value of gases. And it will represent it in form of PPM. This data is PPM is only the average value of alcohol, smoke and benzene. Now that data in PPM will go to the server through one desired special API key to that exact channel of us and from values of sensor graph will automatically plotted by thingspeak.

SERVER:

Here, for sending data of sensor on internet, we are using thingspeak server which can collect analyses data and can also act as per given conditions of different data values.

Thingspeak shows graph on their server of our channel, for that we have to sign up on thingspeak .com and have to create our channel .process in this figure

Step: 1 sign up things speak

https://thingspeak.com/users/sign_up

Step: 2

Fill out all fields

The image shows the Thingspeak sign-up process and a diagram of the IoT architecture. On the left, the 'Create MathWorks Account' form is displayed with the following fields: Email (amar.amarjith123@gmail.com), Username (amarjith12345), Password (masked), Country (India), First Name (Amarjith), and State (TN). All fields have green checkmarks indicating they are valid. Below the form is a 'Continue' button. On the right, a diagram illustrates the IoT architecture. It shows 'SMART CONNECTED DEVICES' (represented by icons of various sensors and a router) connected to a cloud labeled 'DATA AGGREGATION AND ANALYTICS' with the Thingspeak logo. The cloud is also connected to a 'MATLAB' computer icon labeled 'ALGORITHM DEVELOPMENT SENSOR ANALYTICS'.

Step: 3

Verify email account



Step:4

After verification, click on continue

To start using ThingSpeak you must create a new MathWorks account, or click cancel and log in using an existing MathWorks account.

Verify Your MathWorks Account

To finish creating your account, complete the following steps:

1. Go to your inbox for **amar.amarjith123@gmail.com**
2. Click the link in the email we sent you.

Once you've done this, click Continue.

Didn't get the email?

1. Check your spam folder.
2. Send me the email again.
3. Contact Customer Support if you still do not have the email.

Cancel
Continue

Step:5

OK

ThingSpeak™

Channels • Apps • Community Support •

How to Buy Account • Sign Out

Sign-up successful






Congratulations, you have successfully linked your MathWorks account to ThingSpeak. Use the following email ID and its associated MathWorks account password on all subsequent logins to ThingSpeak.

Email ID: `amar.amarjith123@gmail.com`

Welcome to ThingSpeak!

OK

Community | Documentation | Tutorials | Terms | Privacy Policy



© 2018 The MathWorks, Inc.

Step:6

Agree to terms

ThingSpeak Terms of Use

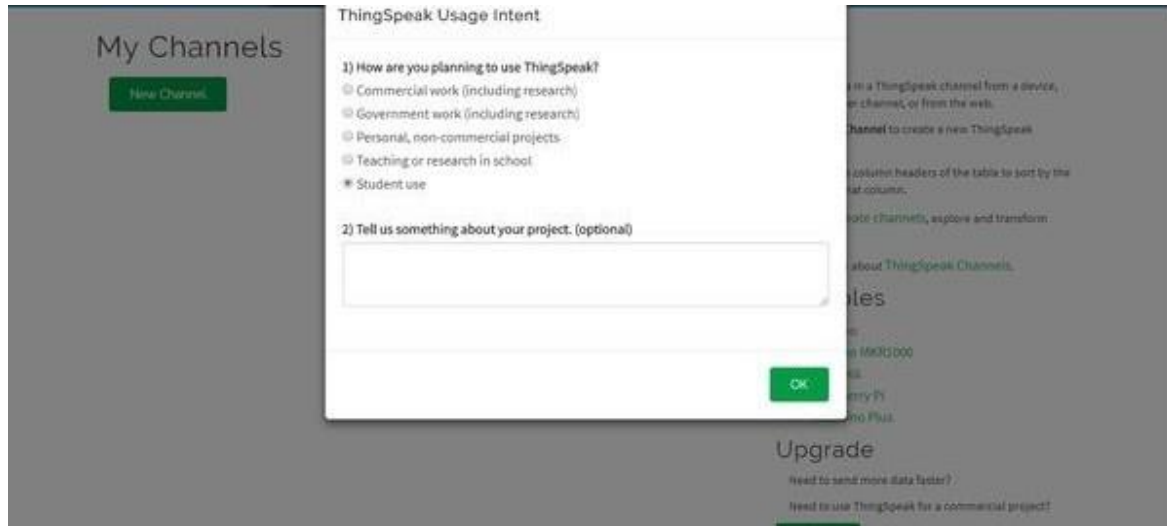
ThingSpeak Terms of Use have changed. We require that you agree to the [Terms of Use](#) and [Privacy Policy](#) before continuing.

Agree to Terms

Decline and Sign Out

Step: 7

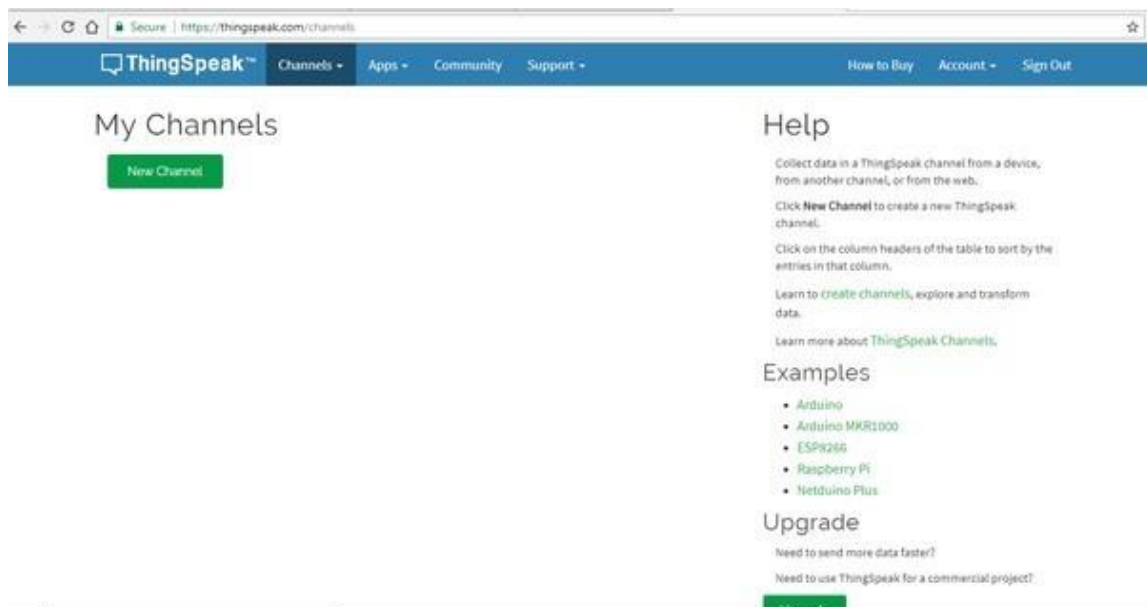
Select Student Use



The screenshot shows the 'My Channels' page on the ThingSpeak website. A modal window titled 'ThingSpeak Usage Intent' is open in the center. The modal contains two sections: '1) How are you planning to use ThingSpeak?' with radio button options for 'Commercial work (including research)', 'Government work (including research)', 'Personal, non-commercial projects', 'Teaching or research in school', and 'Student use' (which is selected); and '2) Tell us something about your project. (optional)' with a text input field. A green 'OK' button is at the bottom right of the modal. The background page shows a 'New Channel' button and some introductory text about channels.

Step : 8

Wait for this window



Step:9

Create new channel

The screenshot shows the 'New Channel' form on the ThingSpeak website. The form includes fields for Name, Description, and eight numbered fields (Field 1 to Field 8). Field 1 is currently set to 'Temperature' and has a checkbox checked. The 'Help' section on the right provides instructions for each field. The 'Channel Settings' section on the right lists various settings that can be configured for the channel.

ThingSpeak Channels Apps Community Support How to Buy Account Sign Out

New Channel

Name:

Description:

Field 1: ☒

Field 2: ☐

Field 3: ☐

Field 4: ☐

Field 5: ☐

Field 6: ☐

Field 7: ☐

Field 8: ☐

Metadata:

Help

Channels store all the data that a ThingSpeak application collects. Each channel includes eight fields that can hold any type of data, plus three fields for location data and one for status data. Once you collect data in a channel, you can use ThingSpeak apps to analyze and visualize it.

Channel Settings

- Channel Name:** Enter a unique name for the ThingSpeak channel.
- Description:** Enter a description of the ThingSpeak channel.
- Fields:** Check the box to enable the field, and enter a field name. Each ThingSpeak channel can have up to 8 fields.
- Metadata:** Enter information about channel data, including JSON, XML, or CSV data.
- Tags:** Enter keywords that identify the channel. Separate tags with commas.
- Latitude:** Specify the position of the sensor or thing that collects data in decimal degrees. For example, the latitude of the city of London is 51.5072.
- Longitude:** Specify the position of the sensor or thing that collects data in decimal degrees. For example, the longitude of the city of London is -0.1275.
- Elevation:** Specify the position of the sensor or thing that collects data in meters. For example, the elevation of the city of London is 33.052.
- Link to External Site:** If you have a website that contains information about your ThingSpeak channel, specify the URL.
- Video URL:** If you have a YouTube™ or Vimeo® video that displays your channel

Step:10

Save channel

The screenshot shows the 'Save Channel' form on the ThingSpeak website. The form includes fields for Tags, Link to External Site, Elevation, Show Location, Latitude, Longitude, Show Video, Video URL, and Show Status. A green 'Save Channel' button is at the bottom. The 'Help' section on the right provides instructions for each field.

ThingSpeak Channels Apps Community Support How to Buy Account Sign Out

Save Channel

Tags:

(Tags are comma separated)

Link to External Site:

Elevation:

Show Location: ☐

Latitude:

Longitude:

Show Video: ☐

* YouTube
@ Vimeo

Video URL:

Show Status: ☐

[Save Channel](#)

Help

You can get data into a channel from a device, website, or another ThingSpeak channel. You can then visualize data and transform it using [ThingSpeak Apps](#).

See [Tutorial: ThingSpeak and MATLAB](#) for an example of measuring dew point from a weather station that acquires data from an Arduino® device.

[Learn More](#)

Step:11

Make channel public

The screenshot shows the 'Channel Settings' tab for a channel named 'Amarjith' with ID 431583. The channel is currently set to 'Private View'. Under 'Channel Sharing Settings', the option 'Share channel view with everyone' is selected. There is a text input field for 'Email Address' and an 'Add User' button. A 'Help' section on the right explains the sharing options. The channel description is 'Temperature logger using Arduino and LM35'.

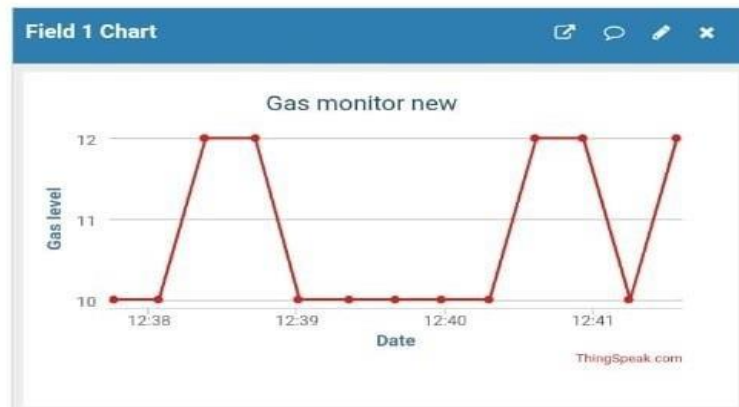
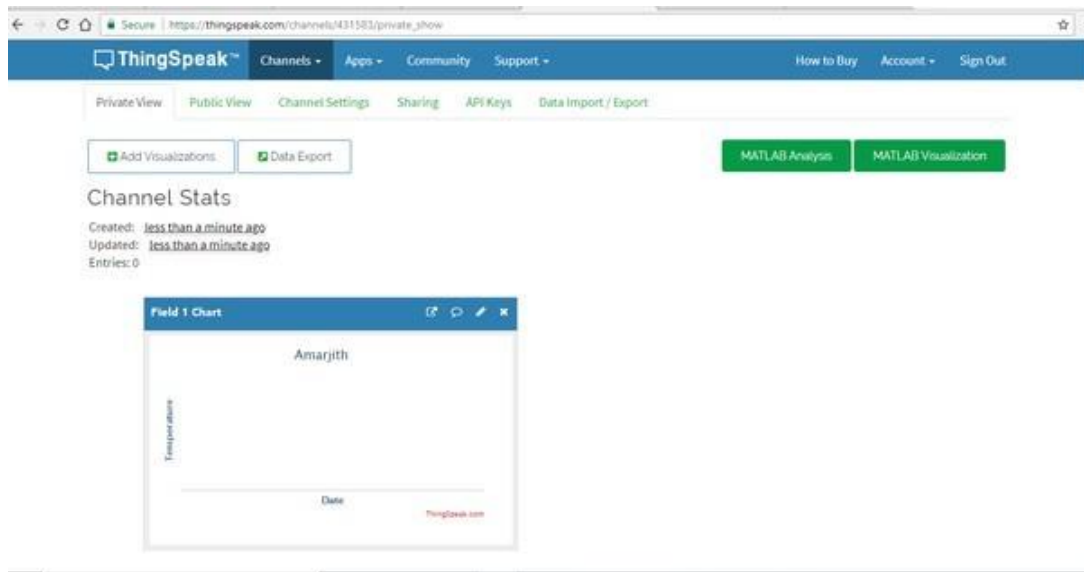
Step:12

Copy “write apikey” and then paste it in your program (later)

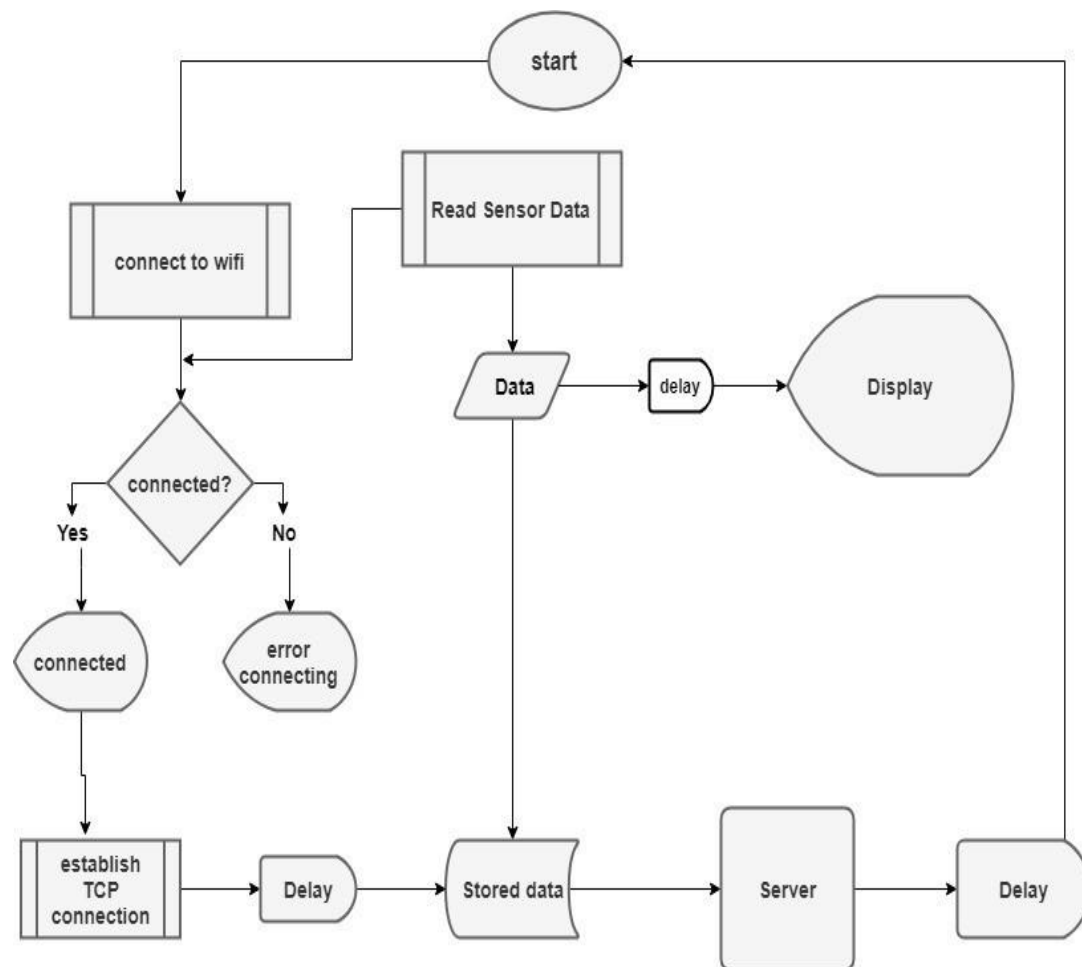
The screenshot shows the 'API Keys' tab for the same channel. It displays a 'Write API Key' section with a key 'HF5OCR8DE47HRTT0' and a 'Generate New Write API Key' button. Below it is a 'Read API Keys' section with a key 'I7WZ6JLVMYLG6FI'. A 'Help' section on the right explains the purpose of write and read API keys. The channel name 'Amarjith' and ID '431583' are visible at the top.

Step:13

Open private view

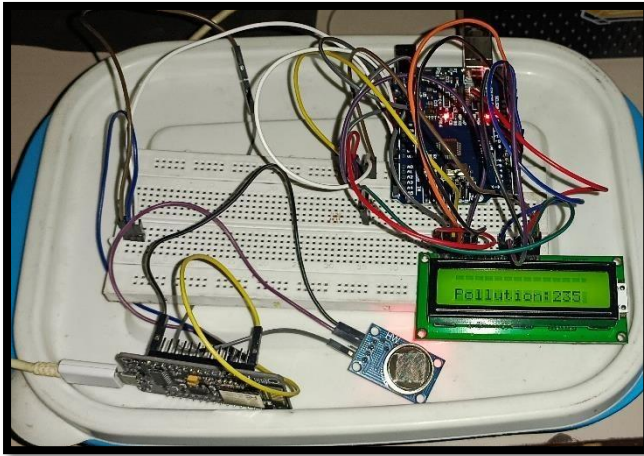


Flow chart:

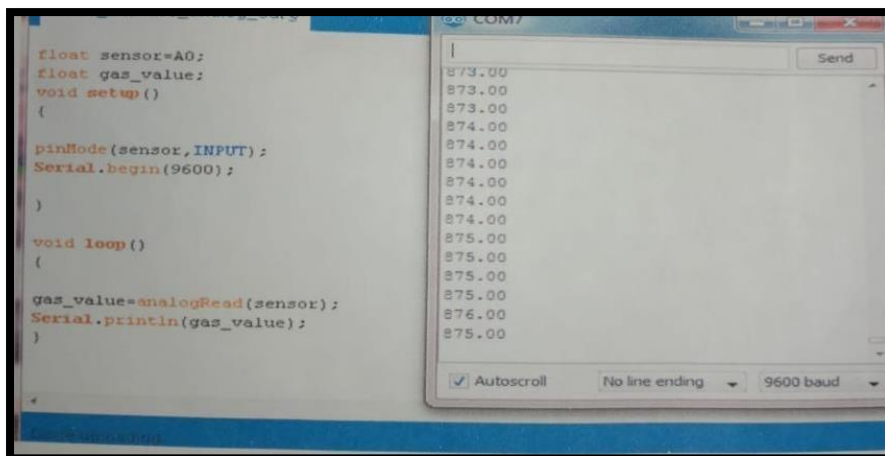


5. Project outcomes and Applications:

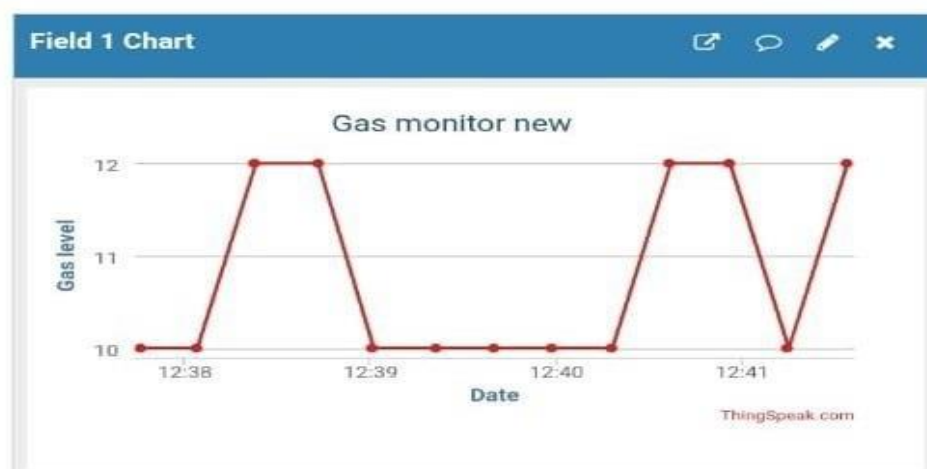
Outcomes:



Outout of Arduino to gas sensor interfacing



Graph:



Applications:

In hospitals and pollution affected areas
Air pollution control for coating industry
Measurement of methane and non-methane hydrocarbons for environmental air quality
Ambient air quality monitoring for government.
Continues emissions monitoring for CO2 capture.
For tunnel monitoring.

6. Future Expansions

This System is IOT based means this system can access the internet. You can monitor your home, office, and factory pollution continuously. In the future, making the system more advanced, we can add an air purifier or air ionizer relay through the system.

This means we can switch on or off our purifier on some conditions like, if pollution increases from some PPM then on the relay that enables purifier and in else off the relay.

In the next step we can use node MCU instead of Arduino. It decreases cost, size and power also because node MCU takes only 3.3V dc for running it.

In addition, we can put Raspberry pi and we can control the system through voice commands from anywhere on the earth. We can interface more sensors in that system to cause different pollution levels measurement in different departments of my office or factory.

This system can be used after making it powerful and reliable in corporate offices and manufacturing.

7. References

1. www.engineersgarage.com/contribution/arduino-based-air-quality-monitoring-iot-project
2. www.instructables.com/id_Air-Qualiy-Monitoring/
3. <http://www.components101.com/sensors/mq135-gas-sensor-for-air-quality>
4. [create.arduino.cc/projecthub/ruchir1674/air-quality-monitoring-7c5bae?ref=search&ref_id=air%20 quality&offset=3](http://create.arduino.cc/projecthub/ruchir1674/air-quality-monitoring-7c5bae?ref=search&ref_id=air%20quality&offset=3)



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