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IoT based Air Pollution Monitoring device using Raspberry Pi and Cloud Computing

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***Abstract*— Nowadays, pollution is remaining as a major issue of concern. Air pollution is basically a mixture of various dangerous particles and toxic gases in the environment. The release of suspended particles, hazardous gases, dust pollutants cause depletion of ozone layer. In this paper, various sensors are used to identify carbon dioxide gas present in the air, humidity, environment temperature, and atmospheric pressure. Raspberry pi 3 and Arduino UNO are boards used in interfacing above mentioned sensors. MQ-135 is air pollution gas sensor interfaced with Arduino uno and DHT11 temperature and humidity sensor is interfaced with Raspberry pi 3 along with HW-611 e/p 280 atmospheric pressure detection sensor. As soon as atmospheric pressure sensor detects air pressure with humidity and temperature the result obtained will automatically get fed in ThingSpeak IOT app. After wards, derived value on IOT can be read. To run Arduino uno board Arduino IDE software have been used. Arduino IDE software is an open source software that makes easy code writing, compiling and then it uploads the code on the basis of circuitry designed in UNO board. Raspberry pi installation requires a long running process and to run the circuitry a software named Putty is required. Coding is done in Python as Putty work with python. Installation of Raspbian OS in the fresh flashed SD card is the basic step to give power to raspberry pi. The models have been implemented on ThingSpeak using cloud computing. Sensors used in the presented work have been interfaced to their respective board in order to perform detection of various parameters in real time and obtain detection results simultaneously**

Keywords—**Temperature sensor, DHT11, Humidity sensor, Atmospheric sensor, HW-611 e/p 280, Arduino Uno, Raspberry pi 3, Raspbian OS, Putty software, python, ThingSpeak , IOT , Arduino IDE, CO2 Gas**

I. INTRODUCTION

ThingSpeak referred as an IOT based analytics platform that provides service that actually allows us to aggregate, visualize and analyze the live data that streams in the cloud platform. Data can also be delivered to ThingSpeak from any operating system and instant visualizing live data can be created and delivered alert through Matlab. Pollution now a days is a major issue of concern. In this work, two boards are being taken (Raspberry pi 3, Arduino UNO) to perform the detection of some environmental parameters. Parameters under consideration are Carbon dioxide present in air, atmospheric temperature, humidity in environment and atmospheric pressure. These parameters will lead to know about current environmental conditions and safety measures to be taken if the scale goes higher in terms of danger. To perform this task, few essential sensors are taken namely DHT11 temperature sensor, MQ135 gas sensor, HW-611 e/p 280 humidity and air pressure sensor. Taking environment conditions in consideration, detection is not the only task to be performed it also needs to be monitored. The monitoring of the live data is performed with the use of IOT and Cloud computing. In this phase, ThingSpeak comes into action. With the help of ThingSpeak, the obtained data can be monitored live simultaneously. MQ-135 gas sensor is interfaced with Arduino UNO board and readings will come as per the concentration of CO2 gas present in the air. The gas sensor as mentioned interfaced with Arduino will require an external Wi-Fi module to deliver data to cloud. Though there is a humidity, temperature and air pressure module that is interfaced with Raspberry pi it does not require the external element, the data can be fetched and uploaded to the cloud. The parameters are recorded as the outcome.

The drawbacks in the standard monitoring systems are enormous dimension, abundant weight and prodigious extravagant. These leads to sporadic disposal of the superintend stations. In order of being effective, the whereabouts of the superintend stations need deliberate placing due to the air pollution conditions in suburban areas are tremendously connected to human activities (e.g. construction ventures) and orientation-dependent (e.g. the traffic check-points are much worse in air quality index than average). IOT Based Air Pollution Monitoring System that track the Air Quality means when there are amount of hazardous gases available in the air like CO2[10]. The system will show the air quality in PPM on the serial monitor of arduino IDE software and as well as on cloud so that it could be monitored very efficiently. Temperature and Humidity is detected and monitored in the system. For further readings of air pressure will be taken by pressure sensor HW-280SC. In this DIY IOT based project the Raspberry pi weather station is being designed and constructed.

II. BACKGROUND

A. Global warming

Here is a general denotation of global warming. In the past 50 years the standard global temperatures have risen at the swift rate in registered history. And experts are looking at accelerating that trend: one of NASA's 134-year record, with the exception of one of the 16 hottest years since 2000.

Those who condemn climate change have argued that rising global temperatures have led to "stagnation" or "sluggishness," but numerous current researches disprove this claim, counting the 2015 research paper published in the journal of Science. Scientists say that if global warming does not emit, the average American temperature could rise to 10 deg F by the coming century.[9]

Global warming happens when CO_2 and dissimilar air pollutants and greenhouse gas gather in the atmosphere and retain sunlight and solar radiation that bounces the Earth's

surface.[12] Typically, this radiation escapes into space but these pollutants remain in the atmosphere for centuries, trapping heat and causing the planet to warm up. This is called the greenhouse effect.

In the United States of America, glazing fossil fuels to generate electricity is the largest origin of heat-trapped pollution, which produces two Billion tons of Carbon Dioxide every year.[1] Coal based fired power plants industry by far the largest pollutants. The transportation industry, the 2nd largest origin of carbon emission pollution in the country, emits 1.7 billion tons of CO_2 a year.[13]

B. Air pollution

Air pollution leads to the existence of hazardous and harmful chemicals and gases present in the air, which disqualify air from plants and animals for general purposes. Changes in the nature of physical, chemical or biological air can lead to deterioration of the quality of life in the stratospheric environment.

There are many reasons for air pollution. Human activity is the 1st and only reason for any kind of environmental air pollution. Anything or everything done by burning any material, let it be household electrical appliances or industrial harmful chemicals, releases harmful gases that can cause air pollution. Road traffic, which emits or generates large amounts of toxics, and the use of refrigerators that release hydrofluorocarbons into the atmosphere are causing air pollution. Another major origin of air pollution in the atmosphere is industries.[3]

Air pollution can cause respiratory issues, cancer and cardiovascular issues in humans. Children may get through from diseases such as pneumonia and asthma. Climate Change and Climate Change The environment is vulnerable to global warming.[5] Acid rain is another effect, causing farmland to lose its fertility. Animals also bear the burn of air pollution also move their habitat from one stay to another, disrupting the ecosystem.[6]

C. Effect of temperature and Humidity on environment

The congregation of air pollutants in atmospheric air is controlled by atmospheric parameters such as wind speed, direction of wind, relative humidity & temperature.[2] This research analyzes effect of temperature and relativity of humidity in the surrounding SO_2, NO_2, and SPM concentrations in the Indian coastal city of North Chennai during the monsoon, summer and winter seasons from 2010–11 gone. The study results indicate that both SO_2 and NO_2 are correlated in summer (for SO_2 and NO2) and moderately and positively after rainy season (for SO_2 and NO_2).[4] RSPM & SPM have positive associations with temperature in all seasons except after the rainy season. Due to the high temp range scale, these observations indicate that the temperature in air pollutants (SO_2 & NO_2) is more affective in summer season than in other seasons, but in the terms of particles, the correlations is founded to be contradictory.[14]

The correlation between temperature and ambiguous pollutant concentration in all the weather conditions is very weak, indicating the effect of unstable thermal variability in the coastal arena. On the basis of statistics, significant -ve correlations got found between moisture & particulate matter RSPM,SPM during the all four seasons, but the correlation levels were found to be moderate along in the rainy season (and) compared to the other three seasons, and no significant correlation was found between moisture, humidity and SO2.[8] Knuckles all season. From this study it has been suggested that the moisture effect may have an impact on the livelihood of particulate matter along the coast.[11]

D. Impact of Air Pressure in Air Pollution

Air pressure also affects whether pollution levels increase. During high pressure systems, air is usually allowed to increase pollution levels, but during low pressure systems the weather is often damp and windy, causing pollutants to spread through rain or weather

III. PROPOSED METHOD AND METHODOLOGY

In this paper, various sensors are used to identify humidity, environment temperature, atmospheric pressure and Carbon dioxide gas present in the air. Raspberry pi 3 and Arduino UNO are boards used in interfacing above mentioned sensors. MQ-135 is air pollution gas sensor interfaced with Arduino uno, so as DHT11 temperature and humidity sensor is interfaced with Raspberry pi 3 along with HW-611 e/p 280 atmospheric pressure detection sensor. [7] As soon as atmospheric pressure sensor detects air pressure with humidity and temperature the result obtained will automatically get feed in ThingSpeak IOT app. After wards it can read our derived value on IOT. To run Arduino Uno board i have used Arduino IDE software application. Arduino IDE software is an open source software application that makes easy code writing, compiling and then it uploads the code on the basis of circuitry designed in UNO board. In Raspberry pi installation requires a long running process and to run the circuitry a software named Putty is required. Putty work with python and code is also programmed in python also.

A Installation of Raspberry pi3

1) Flashing of Raspbian OS into SD card:-

STEP-1: First I took a fully formatted SD card to install operating system in it. Then I had inserted SD Card into SD card reader and plugged it inside the USB port of the laptop.

STEP-2: Then I downloaded the Raspbian operating system and flashed SD card with the help of SD card formatter app.

STEP-3: Then I had flashed Raspbian OS into SD card with the help of Ethcher. Now our Raspbian OS has been installed in the SD card.

2) Powering up Raspberry pi3:-

STEP-1:- Connected Raspberry pi and system with Ethernet cable so that it can obtain the access of Wi-Fi in pi3. Also connect Raspberry pi 3 with system using android USB cable. Now still our Raspberry pi 3 is not power up, further steps will explain the powering up of USB cable

STEP-2:- Then it will be moved to network and sharing center > Ethernet settings > Properties > TCP/IPv4 after this found out IP address of LAN cable

STEP-3:- Then I went to Wi-Fi settings > Properties > Sharing. Now selected both the sharing Check boxes > Ok > Back.

STEP-4:- Downloaded the Advanced IP scanner and scanned the IP address of Raspberry pi.

STEP-5: Downloaded DHCP Server. This server basically assigns IP address, parameters and gateway to the client systems. IT works on and respond to the queries of the clients.

STEP-6: Downloaded XMing application it allows the windows to display a graphical linux program.

STEP-7 Now the most important step, downloaded PUTTY Desktop application. Now coming back to SD card, remove SD card from pi3 and insert it again into card reader and insert again into system. Now go to This PC > BooT(H) file. Now open the file and create new text document named SSH. Coming back to putty, it requires IP address of Raspberry pi to start the application. After giving required information the software opens and require to set new user ID and pass code, after login into the PUTTY a set of library in require to start the configuration.

STEP-8 Now following the process to write library to start configuration of the system

- sudo apt-get udate>
- sudo apt-get upgrade>
- sudo apt-get installtight VNCserver>
- Vncserver:1

B. Designing and Interfaing of MQ-135 Sensor with the Arduino

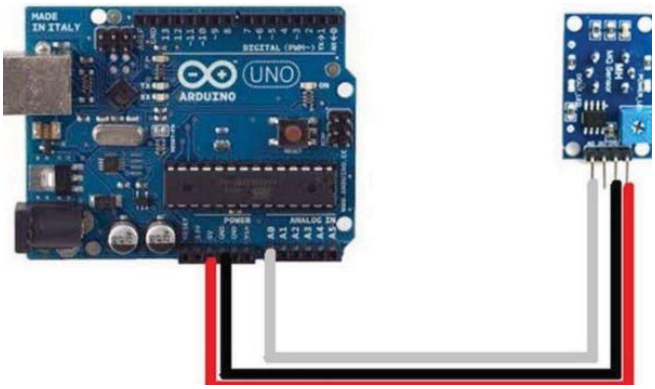

Fig. 1 MQ-135 interfacing with Arduino uno circuit

- STEP-1: Ardunio A0 pin to MQ135 A0
- STEP-2: Arduino D0 pin to MQ135 D0
- STEP-3: Arduino 5V pin to MQ135 Vcc

C. Designing Interfacing of HW-166 E/P and DHT-11 Sensor with Raspberry Pi 3

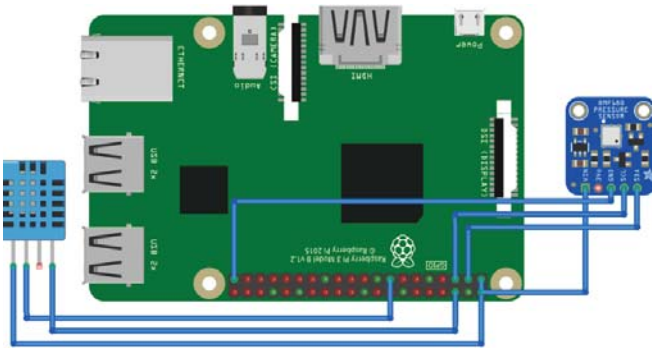

Fig. 2 DHT-11 and HW-166 E/P 280 interfacing with Raspberry pi 3

- STEP-1: HW-166 E/P Pin VINN to Raspberry pi Pin 5V
- STEP-2: HW-166 E/P Pin GND to Raspberry pi Pin GND
- STEP-3: HW-166 E/P Pin SCL to Raspberry pi Pin GPIO3
- STEP-4: HW-166 E/P Pin SDA to Raspberry pi Pin GPIO2
- STEP-5: DHT-11 Pin VCC to Raspberry pi Pin 5V
- STEP-6: DHT-11 Pin GND to Raspberry pi Pin GND
- STEP-7: DHT-11 Pin Data to Raspberry pi Pin GPIO22

IV. RESULTS AND OBSERVATIONS

The Fig. 3 shows complete working model. It shows the connection between the Raspberry Pi sensors and the laptop. Raspberry Pi is connected using WIFI. Fig.4 shows interfacing of Raspberry pi and DHT-11, HW-166 E/P 280

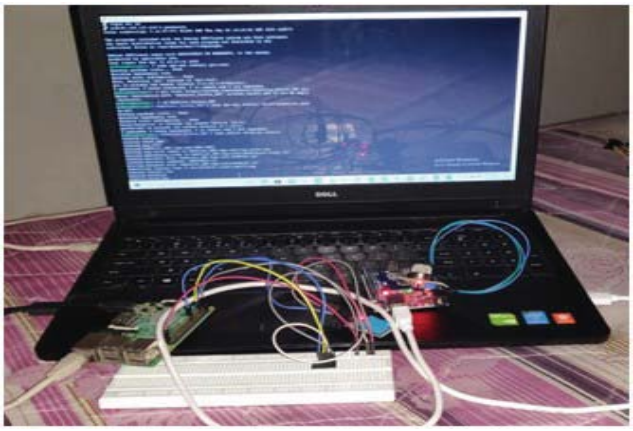

Fig.3. Working Model

Fig.5 shows Arduino connection with hardware, Fig. 6 and Fig.7 shows Values obtained on Putty and Arduino respectively

Fig 4. Raspberry pi and DHT-11, HW-166 E/P 280

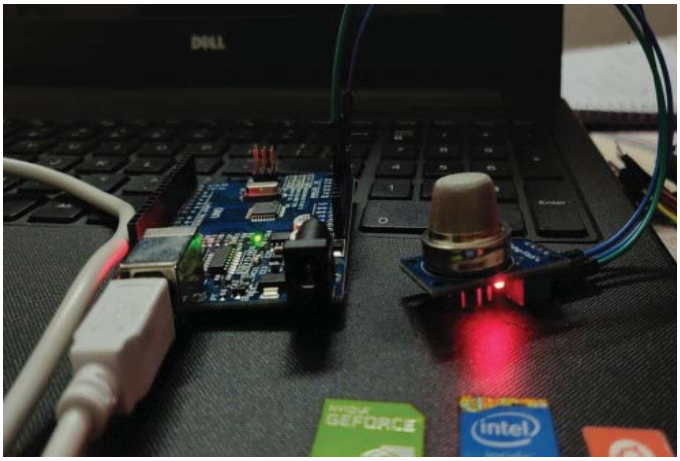

Fig5.Arduino connection with hardware

```
pi@raspberrypi:~ $ sudo nano weather.py
pi@raspberrypi:~ $ sudo python weather.py
System Ready...
Wait....
https://api.thingspeak.com/update?api_key=2TGQM466HIOVOUD5&field1=24&field2=32&field3=967.55
24 32 967.55
https://api.thingspeak.com/update?api_key=2TGQM466HIOVOUD5&field1=23&field2=32&field3=967.56
23 32 967.56
https://api.thingspeak.com/update?api_key=2TGQM466HIOVOUD5&field1=23&field2=32&field3=967.55
23 32 967.55
https://api.thingspeak.com/update?api_key=2TGQM466HIOVOUD5&field1=23&field2=32&field3=967.46
23 32 967.46
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24 33 967.58
https://api.thingspeak.com/update?api_key=2TGQM466HIOVOUD5&field1=23&field2=32&field3=967.51
23 32 967.51
https://api.thingspeak.com/update?api_key=2TGQM466HIOVOUD5&field1=23&field2=32&field3=967.39
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Fig6. Values obtained on Putty

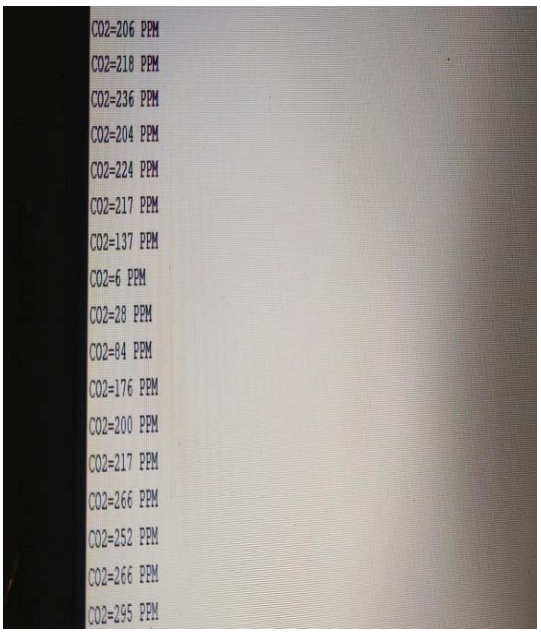

Fig7. Result obtained on Arduino IDE

The results are obtained using two different application software that is PUTTY software using raspberry pi and Arduino IDE software respectively. The PUTTY software obtained values for temperature, atmospheric pressure and humidity. On the other side IDE software obtained CO2 values present in the atmosphere.

DATA RETRIEVED ON THINGVIEW MOBILE APPLICATION

The Thing view app help us to visualize the data received from the ThingSpeak cloud application. It is just required to enter the public channel id need to be entered the recorded real time data on mobile phones from any corner of the world can be observed. The real time data analysis on thing View application retrieved from the cloud application.Fig 8, Fig.9 and Fig. 10 represents ThinkSpeak Humidity, Temerature and pressure values respectively.

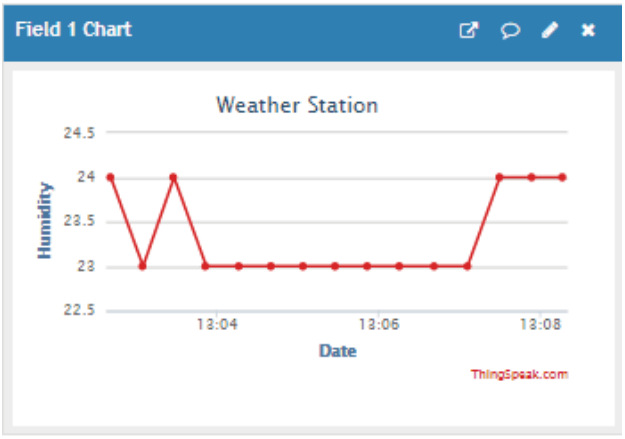

Fig8. ThingSpeak Humidity values

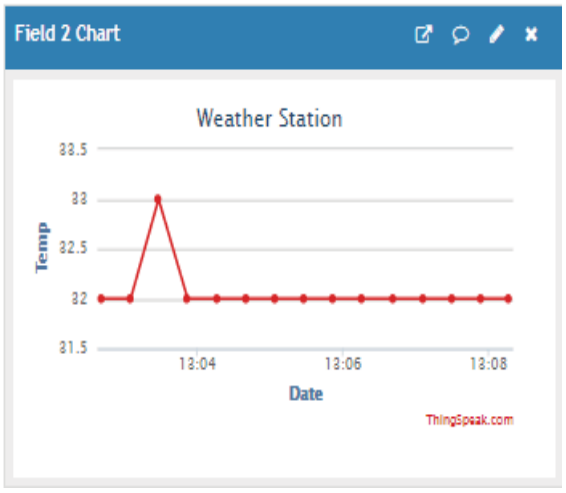

Fig9. ThingSpeak Temperature values

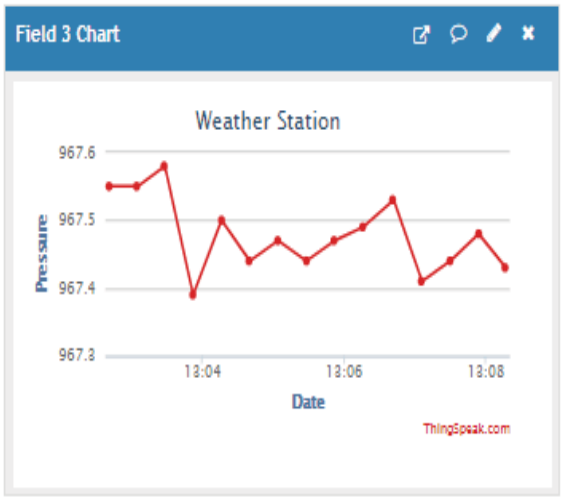

Fig10.Thingspeak Pressure values

V. CONCLUSION

This project deals with the temperature humidity and atmospheric pressure of the environment and also detected the CO2 using MQ-135 and Arduino Uno board. Also, the effect of temperature is also explained, and current temperature is also measured using DHT-11. Temperature is major cause, or it can say only cause of Global Warming. With the use DHT-11 humidity present in the environment is also measured and can be monitored on ThingSpeak as well as temperature and Air pressure.

There have been numerous attempts at different levels of society to prevent the causes of air pollution. It should also become responsible for maintaining a safe environment.

VI. FUTURE SCOPE

With the help of ThingSpeak the updated dated live data can not only be lively updated also monitored. A person sitting in any corner of the world can access the data feed into this software.

The effect of this project is that it is a low cost and long-life running device. Though Raspberry pi 3 ARM board is used in this paper, which is a very well sufficient device, that makes this project more vulnerable. Keeping future use in consideration this device can be operated from anywhere not the hardware but for IOT use.

ThingSpeak is a platform that provides a variety of services specifically designed to create IoT applications. It provides real-time data collection, visualization of data collected in charts, and the ability to create plugins and applications to collaborate with web services, social networks and other APIs. In addition , cloud security can be taken into consideration for future scope.

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