Arduino Based Air Quality Monitoring System

Jitendra Kumar[1], K. Anusudha[2]
[1,2]*Department of Electronic Engineering, Pondicherry University*

Abstract **-The level of pollution is increasing rapidly due to factors like industries, urbanization, increasing in population,vehicle use which can affect human health. IOT Based Air Pollution Monitoring System is used to monitor the Air Quality over a web server using Internet. It will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3 and NOx. It will show the air quality in PPM on the LCD and as well as on webpage so that airpollution can be monitored very easily. Indoor air quality (IAQ) isthe air quality within and around and structure. IAQ is known toaffect the health, comfort and well being of building occupants. Poor indoor air quality has been linked to sick building syndrome,reduced productivity and impaired learning in schools. IAQ can be affected by gases (including carbon monoxide, radon,volatile organic compounds), particular, microbial contaminate (mold bacteria), or any mass or energy stressors that can induce adverse health condition. Source control, filtration and the use of ventilation to dilute contaminates are the primary methods for improving indoor air quality in most building. Residential units can further improve indoor air quality by routine cleaning of carpets and area rugs.**

Keywords: Arduino, CO, LPG, MQ135, MQ7, MQ8, MQ2, MQ3.

I.INTRODUCTION

1.1 Overview

Coal was used as fuel in every development project in all over the world, it was one of the first steps to disastrousEnvironment Pollution which is the main source of Carbon Dioxide, Particulate Matter expose. In 1913 when CO2 level exceeds 300ppm and having 301.3ppm in annually mean, and after 100 years CO2 level reached to 400ppm and the yearwas 2015 (400.83 ppm). Obviously, industrialization is the reason for the instantaneously rise of CO2 concentration, the dangerously rise of the Global Temperature and the over 4 trillion of ice melting in the Antarctica since 1950. Like every industrialized city toxic contaminant Particulate Matters (PM- 10 and PM-2.5) are also exist in every city, which are beyond permissible level for human body. PM2.5 means the particleis 2.5 micrometer in size which is over 30 times smaller than human hair. It is estimated that the pollutants responsible for poor air quality cause nearly 2.5 million premature deaths per year world-wide. Significantly, around 1.5 million of these deaths are due to polluted indoor air, and it is suggested that poor indoor air quality may pose a significant health risk to more than half of the world's population. With the quality ofair degrading everyday there is a big necessity of an air quality monitoring system that not only could sense the quality of air,

Air Quality Index levels of health concern	Numeric value (ppm-parts per million)	Explanations
Good	0 to 50	Air Quality is considered satisfactory and air pollution poses little or no risk at all
Moderate	51 to 100	Air Quality is quite acceptable but some pollutants Can be dangerous for sensitive group like children, older people and people with chronic diseases.
Unhealthy for sensitive group	101 to 150	General people may not experience any health risk while sensitive group can be affected
Unhealthy	151 to 200	Sensitive group will experience serious health effect while normal people may experience some health issues
Very Unhealthy	201 to 300	This level requires health alert, everyone can experience serious health issues
Hazardous	301 to 500	This is an emergency condition for everyone, entire Population is in serious health risk.

Fig. 1: Table gives the understanding of theAir Quality Index (AQI)

but also inform people through their cellular devices, so thatthey are aware of the quality of air where they are living in. Disease like COVID-19 is turned into a global pandemic where thousands of people are dying every day for more than6 months. No one able to figure it out when the world is going to be released from this crisis .This type of global emergency is happening for first time in mankind history. We need to monitor our Air Quality whether it is in dangerouslevel or not, if it is above of comfortable state, we have totake

action to reduce the pollution. Traditional Air Quality monitor is expensive, setup and maintenance costly; where low-cost Sensors can give relief to this situation. It is easyto setup and easily maintainable, using IoT measurementdata can be uploaded to cloud and can be monitored from anywhere. We need to conduct more study on pollution impact, why we need to track our air quality, how the pollution is leading to global warming, and different types of health risks,reasons behind devastating air pollution and most harmful air pollutants around us to raise awareness.

A.*Literature Overview*

A solar powered low cost real-time wireless ambient air quality monitoring system for schools has been proposed in [6]. The air quality data is obtained from several sensor nodes that implement Arduino as microcontroller. The dataare wirelessly transmitted using ZigBee mesh network to the school's computer.

In [7], a portable and low power consumption sensor that can measure the concentration of PM2.5 has been developed. The sensor is based on light scattering. The particles are detected by light scattering signal that is sensed by the photo diode.

A sensor for public bicycle has been developed in [8] to monitor the air quality in the city. The devices consist of single chip processor, GPS receiver, and Bluetooth interface; exhaust gas sensor and PM sensor.

A low cost air quality monitoring using self-powered de- vice has been implemented in [9]. The device measures the concentrations of CO, PM and O3 and it can be operated off- grid using battery or solar panel. The device only measures theconcentration of pollutant and did not evaluate the air pollutantindex.

A vehicular air pollution monitoring system using IoT has been introduced in [10]. The system consists of Radio Frequency Identification (RFID) reader with CO2 sensor and sulfur oxides (Sox) sensor.

In [11], they presented a smart sensor system for air quality monitoring. The system consists of a microprocessor, PM2.5 sensor, CO2 sensor, CO sensor, hazard gas detector and VOC sensor. When an individual wants to measure the air quality using the device, he can run the application on his Smartphone.

B.*Air Quality Parameters*

The important parameters that are considered in the pro- posed framework include:

1.*Sulphur Dioxide (SO2):* Sulphur Dioxide is a colorless gas, detectable by the distinct odour and taste. Like CO2, it is mainly due to fossil fuels burning and to industrial processes.

2.*Carbon dioxide gas :* CO2 is colorless, odorless gas and non-combustible gas. Moreover, it is considered under the category of asphyxiate gases that have capability of interferingthe availability of oxygen for tissues.

3.*Smoke:* About 1 million people are in habit of tobacco smoking globally of which majority population is from developing countries. Every year nearly 4.9 million people died due to smoking according to 2007 report. In addition, second hand smoke is serious threat to the health of people of allage's causes 41000 deaths each year.

4.*LPG-Liquefied petroleum gas:* LPG is an odorless and colorless liquid which evaporates readily into a gas. Leakage is normally detected by adding an odorant into it.

5.*Temperature and humidity :* Measurement of temperature is important for safety of people and affects our life skills. Greenhouse effect can be monitored by measuring temperatureand comparing temperature changes. Humidity is a type of gasthat protects us from UV rays from the sun and helps trap heaton Earth, thereby making the climate on Earth, a pleasant one for living.

6.*Ozone :* Ozone, a secondary pollutant formed in the atmosphere, has serious health impacts. Ozone is a strongoxidant, and it can react with a wide range of cellular components and biological materials. Ozone can Aggravate bronchitis, heart disease, emphysema, asthma and reduce lungcapacity.

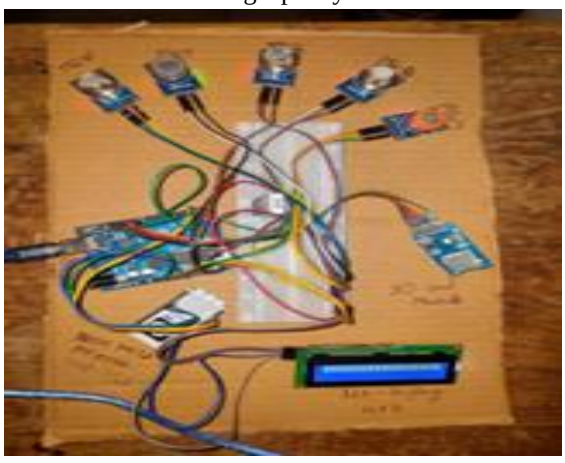

Fig. 2: Prototype of the proposed model

Fig. 3: Block diagram of proposed model

II.PROPOSED WORK

The proposed prototype model is more adaptable and flexible to monitor the environmental parameters. In the proposed Arduino based Air Quality Monitoring System consist of different types of sensors which are used for measuring the different gases and Temperature and Humidity of the surrounding environment. In proposed system the different sensorsused for MQ2, MQ3, MQ135, MQ7,MQ8 which are used for measuring different gases present in the environment. DHT22 sensor is used for measuring Temperature and Humidity of theenvironment.

The connection of Node MCU 1.0 Esp8266 with the power supply of 3.3V by connecting the Vin and the Gnd and the MQ2 and MQ9 are supplied with 3.3 V and the DHT 22 HUMIDITY and TEMPERATURE sensor is supplied with 5v using a voltage regulator.

MQ2, MQ3, MQ7, MQ8 and MQ135 all of them have 4 pinswhich are VCC or 5V, GND or 0V, DO i.e. Digital Control and AO i.e. Analog Output. Analog Output (AO) of the MQ2, MQ3, MQ7, MQ8 sensor and MQ135 sensor ranges from 0V to 5V but analog pin of ardunio Uno which can only read the potential difference between 0V to 3.3V.

A. AIR QUALITY MONITORING EQUIPMENTS

The model is for monitoring smoke levels in the atmosphereto make the environment intelligent. The proposed prototype model is shown in above which is more adaptable and flexible to monitor the environmental parameters.

1.Arduino Uno: Arduino is an open source electronics platform or board which can be easily programmed, erasedand reprogrammed at any instant of time. The Arduino IDE provides a simplified integrated platform which can run on regular personal computers and allows users to write programs

Fig. 4: Arduino Uno R3

Fig. 5: Liquid Crystal Display 16*2

for Arduino using embedded C The Arduino Uno is a micro- controller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

2.LCD (Liquid Crystal Display): LCD stands for liquid crystal display, is an electronic device which is used for data display. LCDs are preferable over seven segments and LEDs as they can easily represent data in form of alphabets, characters, numbers or animations. Numerous types of LCDs are available in market such as 16x2, 16x4, 20x2, 20x4, graphical LCDs (128x64) etc.

3.MQ2: MQ2 gas sensor is used to detect the presence of LPG, Propane and Hydrogen. It is also used to detect Methane and other combustible steam. It is low cost and suitable for different application.

4.MQ7: This is a simple-to-use Carbon Monoxide (CO) sensor, suitable for sensing CO concentrations in the air. The MQ-7 can detect CO-gas concentrations anywhere from 10 to 500ppm.This sensor has a high sensitivity and fast response time.

5.MQ135: The Sensitive material used in MQ135 gas sensor is SnO2. The conductivity of this material is lower in clean air. MQ135 can monitor different kinds of toxic gases such as supplied, ammonia gas, benzene series steam and CO2.

Fig. 6: MQ2 Gas Sensor

Fig. 7: MQ7 Gas Sensor

Fig. 8: MQ135 Gas Sensor

Fig. 9: MQ8 Gas Sensor

6.MQ8: This is a simple-to-use hydrogen gas sensor, suitable for sensing hydrogen concentrations in the air. The MQ-8 can detect hydrogen gas concentrations anywhere from 100-10000ppm.

7.MQ3: Metal oxide sensors are also known as Chemiresistors, because sensing is based on the change of resistance of the sensing material when exposed to alcohol. So by placing it in a simple voltage divider network, alcohol concentrations can be detected.

8.DHT22 (Temperature and Humidity Sensor): The DHT22 is a basic low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin.

9.SD Card Module: The module (Micro SD Card Adapter) is a Micro SD card reader module and the SPI interface via the file system driver, microcontroller system to complete the Micro SD card read and write files. Users can directly use the Arduino IDE comes with an SD card to complete the library card initialization and read-write.

10.Node MCU ESP8266: Node MCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi So C from Express if Systems, and hardware which is based on the ESP-12 module.

Fig. 10: MQ3 Gas Sensor

Fig. 11: DHT22 Temperature and humidity sensor

Fig. 12: SD card module

Fig. 13: Node MCU ESP8266

B.SOFTWARE USED

1.Arduino IDE: Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. Programming for Arduino is done on Arduino IDE which is based on C Language. Advantages of Arduino is inexpensive, open source in hardware, don't need to external programmer (Burner), programming ease, open source in software. IDE Software operate on any operating system.

2.ThinkSpeak: ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status up- dates".

C .Features of proposed work

Six gas sensors are used MQ135, MQ7, MQ2, MQ3, MQ8, DHT 22 humidity and temperature sensor to know detail content of all gases present in air. Data storage is available there is a SD card interfaced with the module to store the data.

III.RESULT AND DISCUSSION

A. RESULT and DISCUSSION

Fig. 14 shows the variation of temperature versus time through DHT22 Sensor in real time environment. This graph indicates the temperature variation in accordance with time foran indoor environment and varies with different location of the experiment. It may be noted that the variation in temperature is due to very hot environment, for which the people having diseases like asthma, dust allergy, etc. will be affected.

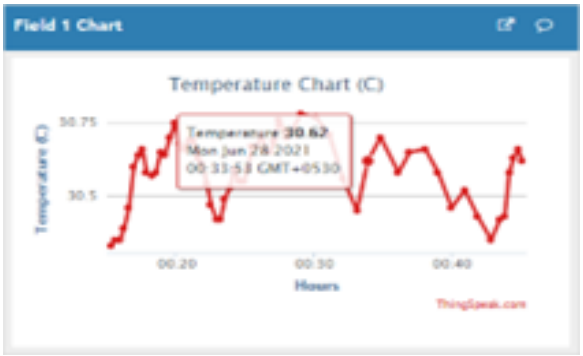

Fig. 14: Temperature Measurement

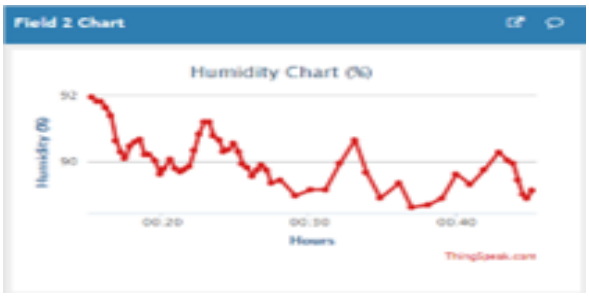

Fig. 15: Humidity Measurement

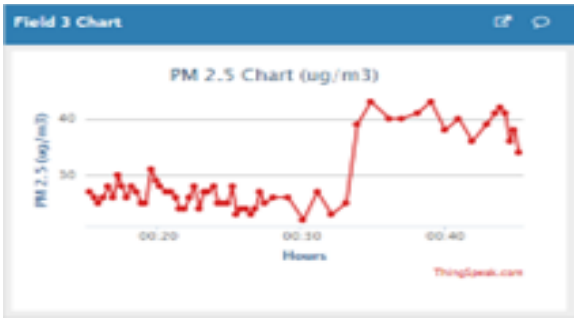

Fig. 16: PM2.5 Measurement

In Fig. 15, it has been observed that the rise in humidity is due very hot weather in that particular location is due to switching on the air conditioner inside room for which the humidity became less. High indoor humidity causes the air too dry, so people having diseases like whizzing will be more affected and also for normal people, it is difficult to stay in that environment.

Fig. 16 conveys the experimental results according to the environment for the experiment which varies accordingly. In the series of image above, the PM2.5 measurement is shown before, during and after smoke was blown into the sensor. Before adding the smoke the PM2.5 reading is below 30, but once the candle was lit and smoke was blown into the device the reading went above 40. The reading shows the PM2.5 levels' decreasing as the air was ventilated.

Fig. 17 conveys the experimental results according to the environment for the experiment which varies accordingly. In

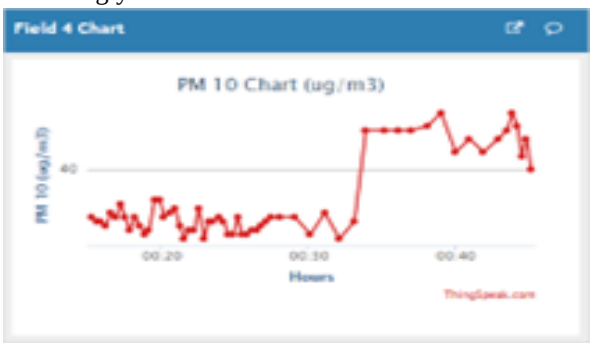

Fig. 17: PM10 Measurement

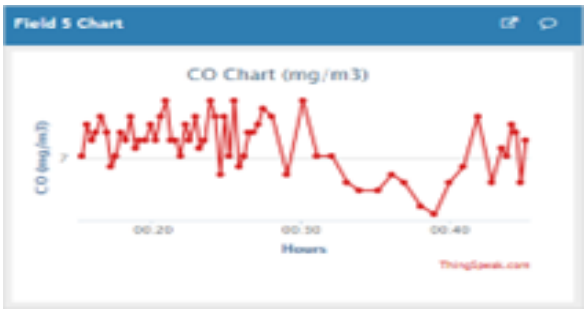

Fig. 18: Carbon monoxide Measurement

The figure above, the PM10 measurement is shown before, during and after smoke was blown into the sensor. Before adding the smoke the PM10 reading is normal once sensor sense the smoke the graph will keep on increasing and start decreasing as the air is ventilated.

Fig. 18 shows the fluctuation of carbon monoxide gas due tothe presence of any type of gas or leakage of domestic gas at that experiment location versus time in real time environment.It varies due to the gas which came by burning the domestic used match box sticks at the time of experiment, sensed through Sensor.

IV.CONCLUSION AND FUTURE SCOPE

A.CONCLUSION

Here in this work, we have proposed a cost-efficient air quality monitoring system that senses the real-time data of surrounding various parameters like smoke, carbon monoxide,and PM level and alerts the people when the quantity of these elements goes beyond a certain limit and shows the data in an easily understandable format. In the future, more sensing nodes can be added to extend the system.

The major advantage of this system is that it is portable, small and cost-efficient. The proposed system uses 'ThingS- peak', with the help of which data can be shown in graphical format and it also supports the latest technologies like Node, Ruby, etc. In this project, we have presented the implementationof a low-cost IoT based air quality monitoring system. Apart from its low cost and low power consumption, it takes less space and can be installed anywhere and provide operational efficiency and flexibility than traditional wired methods.

B.FUTURE SCOPE

Interface more number of sensors to know detail contentof all gases present in air. Design Webpage and upload dataon webpage with the data and time. Interface GPS moduleto monitor the pollution at exact location and upload on the webpage for the citizens.

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