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# Air Quality and Dust Level Monitoring using IoT

**Akshatha S[1], Jayaram M N[2]**

[1]*Post Graduate Scholar, Dept. of ECE, JSS STU*
[2]*Associate Professor, Dept. of ECE, JSS STU, India*

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**Abstract -** *Air pollution is the largest environmental and public health challenge in the world today. Air pollution leads to adverse effects on human health, climate and ecosystem. Air is getting polluted because of release of toxic gases by industries, vehicular emissions and increased concentration of harmful gases and particulate matter in the atmosphere. This paper presents a real-time standalone air quality monitoring system that can detect carbon monoxide, carbon dioxide, temperature, humidity and dust. Nowadays, Internet of things finding pro-found use in each sector. IoT plays a key role in our air quality monitoring system too. Internet of things converging with cloud computing offers a novel technique for better management of data coming from different sensors collected by Node MCU transmitted by low power, low cost Wi-Fi module. The main objective of the paper is to use various sensors and server to design an efficient air quality monitoring system without effecting the natural environment and provide live updates to avoid conflicts.*

**Key Words: Internet of things (IoT), Node MCU (Microcontroller Unit), Blynk.**

## 1. INTRODUCTION

Air pollution is caused due to the presence of particulate matter, harmful materials and biological molecules in earth atmosphere. It has adverse impact on living organisms such as humans, animals, food crops and can also damage built a natural environment. It may result in allergies, harmful diseases such as cardio vascular diseases, lungs diseases and can also cause death [1-5].

The report has estimated that every year nearly 1.2 million Indian die because of air borne pollutants [16]. Particulate matter is liquid or solid matter which is microscopic and suspended in earth's atmosphere. We are exposed to this particulate matter which is continuously affecting our heart and lungs [6-8]. Air quality in India is so poor that 1.2 million deaths in the country last year can be attributed to air pollution. At least 12.5% of deaths in 2018, or one in eight, can be attributed to unusually high rates of lower respiratory infections, heart diseases, stroke, lung cancer and diabetes, which are results of severe air pollution in a certain percentage of cases. Out of the 1.2 million who died from air pollution related causes, 51.4% were younger than 70 years old [9,10].

The Internet of Things (IoT) is a concept which has attracted the attention of both academia and industry. Internet of Things (IoT) is implemented as a network of interconnected objects, each of which can be addressed using unique id and communicates based on the standard communication protocols [11-14]. Cloud computing is a practice of consuming the resource of remote servers such as storage, virtual machines, applications and utilities that are hosted on internet rather than building and maintaining infrastructure for computing in house. Internet of Things becomes very powerful when converges with cloud computing [15,16]. Air quality monitoring without knowing the concentration of particulate matter in the atmosphere is incomplete. Formaldehyde concentration measurement sensor and dust sensor is being used for monitoring the particulate matter along with the sensors employed for sensing carbon monoxide, carbon dioxide, temperature, humidity and barometric air pressure and dust in air using Node MCU is low power less expensive, it is a good platform for interfacing with many devices at the same time.

## 2. LITERATURE REVIEW

Air quality monitoring system (AQMS) which is based on the IEEE/ISO/IEC 21451 standard concentrations of CO, $CO_2$, $SO_2$ and $NO_2$, were measured using elector-chemical and infrared sensors and the results are saved in the data server [1]. A comparative study on smart sensors, objects, devices and things in internet of things. The differences and similarities between the smart objects, smart things in IoT are presented in the tabular form [2].

The Web of Things is a concept that uses web standards and architecture as a framework for IoT applications. Web of things and CoAP protocol is used to collect data from the sensors [3]. An embedded system is used to sense and collect data from the sensors, results are stored in the MySQL database whenever the relevant information is required [4]. The semiconductor sensor was used to monitor the ozone concentration that was installed near the photocopy machine. When the pollution exceeds the predefined threshold value the warning is generated [5]. An environmental parameter with amperometry sensors and gas sensors (infrared) using the pic18f87k22 micro-controller. Sensor nodes are setup in the different areas for real time monitoring of environment and the results are displayed on the city map [6]. A business intelligence engine (APA) is proposed. The system is designed to aware the public about the quality of air being affected by different factors like pollutants, toxic gases etc. Analysis of air pollution from different perspective like meteorological data, pollutants and traffic data using APA is done. The system helps the people to realize their activities impact on

deteriorating air quality [7]. A system for monitoring the environmental parameters, model and manipulating microclimate of urban areas is presented. The system is implemented for the adaption of efficient urban infrastructure after analysis of urban micro-climate [8]. The framework for monitoring the city environment is provided. Low cost raspberry pi is used for implanting the system. Parameters like carbon monoxide, carbon dioxide, temperature and pressure are measured but no emphasis is given on particulate matter which left the environment monitoring incomplete [9]. A system for measurement and acquisition of data of water and air quality parameters and results are shown on IBM WATSON IOT platform. The system is battery powered with solar panel based charger unit [10]. Collected air quality data from different cities of south Africa. Machine learning technique was applied to the data and prediction models were generated for ground level ozone [11]. The acquired information about air pollution in surroundings is then stored on central on-line repository system periodically. It uses a wireless GSM modem connection for transferring data to a central computer. Also, the application can share the data publicly by displaying it on a dedicated website [12]. A wireless sensor network to monitor air pollution levels of various pollutants due to environmental changes. A wireless network is comprising of large number of sensor nodes. This system proposes a method which mainly focuses on longer sustain time period of sensor network by effectively managing the energy in sensor network, effectively processing of collected information and less overhead in transferring information between various sensor nodes [13]. In order to comply with requirements of oil and gas industry, an air quality monitoring system was proposed based on ZigBee wireless sensing technology. It uses ZigBee wireless network to send results to the monitoring center so that, if some abnormal situations happen, a quick warning will be generated to remind staff [14]. How road traffic is responsible to the pollution and its effects on the environment is proposed. The monitoring period was chosen to cover a period of street closures and hence attempt to isolate some of the traffic related pollutants. Traffic flow information was available for the area, from which traffic emission data was used to test an integrated model for street canyon pollution [15].

## 3. METHODOLOGY

The model was designed using Node MCU, formaldehyde sensor, dust sensor, DHT22 sensor and Organic Light-emitting diode (OLED) display. Fig. 1 shows the functional block diagram. Node MCU is the major node controlling our system. The sensors are being used for detecting different environmental parameters like particulate matter, carbon monoxide, carbon dioxide, temperature, humidity and pressure. The sensors are connected to Node MCU board. The data sensed by the sensors are continuously transmitted through Wi-Fi module to the cloud over the internet because of its good network connectivity. Formaldehyde concentration measurement sensor and dust sensors are used for measuring the particulate matter i.e. Smoke and dust present in our Environment these two sensors having the digital serial communication outputs. The fan is placed in between the formaldehyde sensor and dust sensor. The fan absorbs the gases and dust present in the air and passed to the sensor. The sensors detect either gases or dust particles present in the air and displays the output in OLED display.

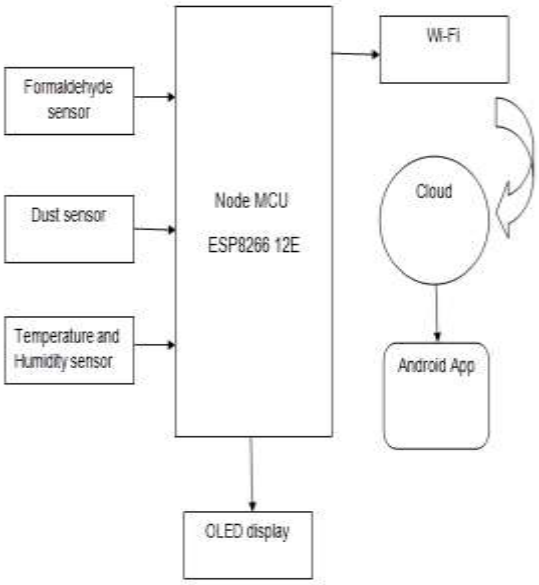


**Fig. 1:** Block Diagram of proposed system

Node MCU is a low-cost microcontroller board based on atmega-328p which can be easily interfaced with Wi-Fi module. This Wi-Fi module provides the internet to the complete system. The light weight protocol MQTT (message queuing telemetry transport). MQTT plays an important role in establishing communication between the sensors and the clients. The client can access the data that is being displayed on the android app by using the device id but the client will be not able to do any modification to the data received. The design specification of the proposed system is described in Table 1.

**Table 1:** The Design Specification

| S/N | Components Required | Quantity |
|---|---|---|
| 1 | Node MCU | 1 |
| 2 | OLED display | 1 |
| 3 | CH2O sensor | 1 |
| 4 | DHT22 sensor | 1 |
| 5 | Dust sensor | 1 |
| 6 | Logic converter | 1 |
| 7 | Fan | 1 |
| 8 | 7805 Regulator | 2 |
| 9 | Capacitor | 3 |
| 10 | Resistor | 2 |

| | | |
|---|---|---|
| 11 | Bridge Rectifier | 1 |
| 12 | Connecting Wires | Any Amount |
| 13 | PCB Board | 1 |

As described by Fig. 2, the library in the Arduino was loaded to the Node MCU and a message was sent to the OLED. Air quality data was collected using the dust, formaldehyde, temperature and humidity sensor. The calibrated sensor made the analog output voltage proportional to the concentration of polluting gases in Parts per Million (ppm). The Wi-Fi module transfers the measured data value to the server via internet. The Wi-Fi module is configured to transfer measured data an application on a remote server. The online application provides global access to measured data via any device that has internet connection capabilities. Data collected from the sensor was converted into a string and used to update the information sent to the remote server. The data is displayed in the OLED and the Blynk app simultaneously.

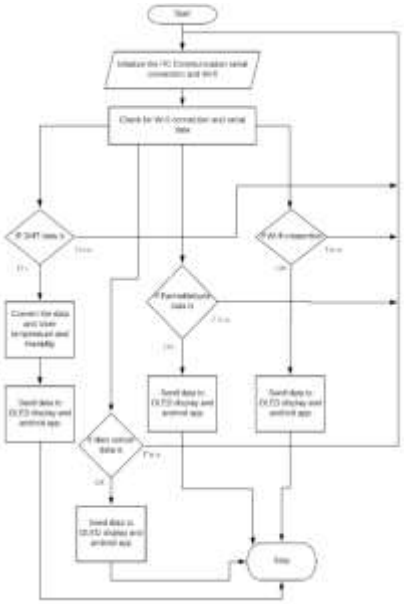

**Fig. 2:** Flow Chart of Proposed System

*A. Implementation*:

From the implementation analysis, we can able to build flourishing system that monitors the pollution causing parameters and make reliable and pollution free environment. This project is done keeping in mind the small-scale industries and hence it is affordable. Sensing systems in the environment itself will considerably raise the degree of environmental protection.

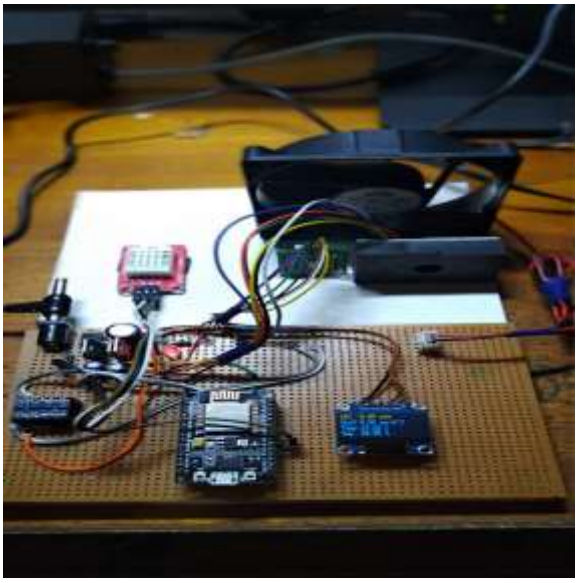

**Fig. 3:** Implementation view

## 4. RESULTS AND ANALYSIS

To verify and validate the proposed system, series of trials were taken and the graph was plotted according to the values.

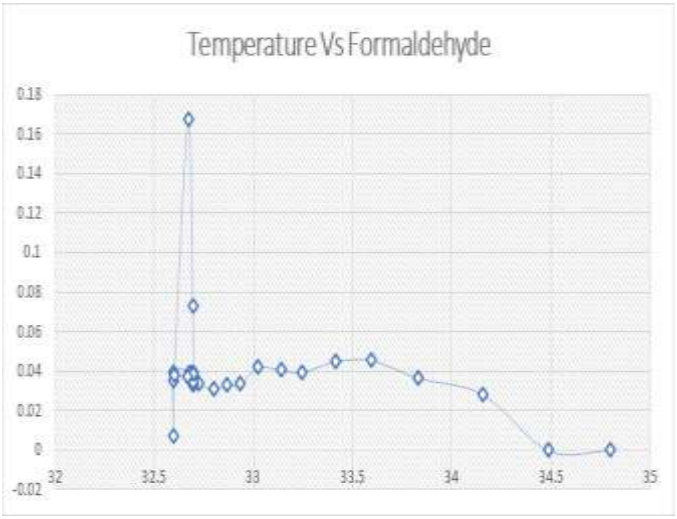


**Fig. 4:** Air quality in formaldehyde sensor

Fig. 4 shows that the variation in formaldehyde with variation of temperature. According to AQI if the ppm level of formaldehyde is between 2 to 5 then air quality level in environment is poor. From our research, we can see that air quality of the environment is between 0.02 to 0.17. This range of value shows that the surrounding environment is free from pollution and we can also observe that as temperature increases formaldehyde concentration automatically decreases.

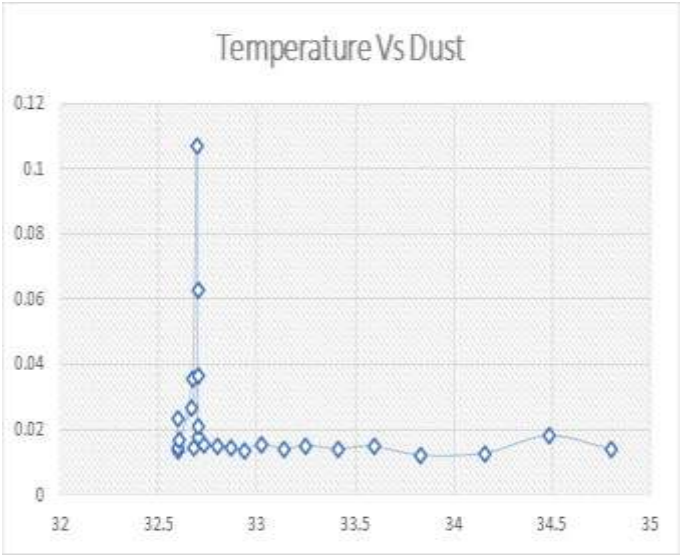


**Fig. 5:** Air quality in dust sensor

Fig. 5 shows that the dust level in the environment with respect to variation in temperature. According to our readings taken from sensors as temperature increases at certain temperature the dust level reaches maximum limit later dust level decreases continuously with respect to temperature. This maintains air quality level.

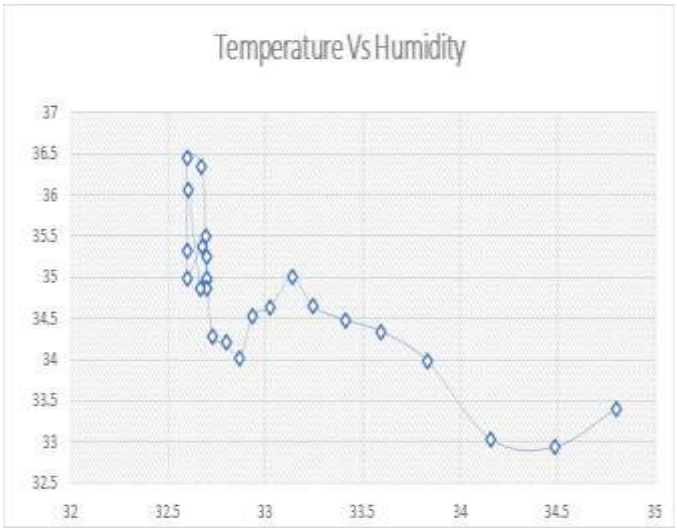


**Fig. 6:** Humidity in RH

Fig. 6 shows the humidity in the atmosphere based on temperature variation. As temperature in atmosphere increases with time humidity level automatically reduces as shown in figure 6.

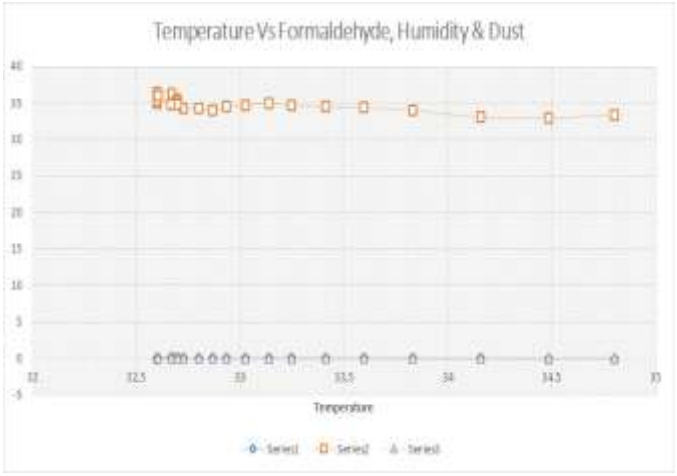


**Fig. 7:** Air Quality Dependency on Temperature Variation

The result of Fig. 7 shows the variations in the atmosphere temperature leads in variation of formaldehyde, dust and humidity. So, from the results we can clearly notice that the atmospheric air quality is considerably good based on the results tabulated.


**Fig. 8:** Results in Blynk app

## 5. CONCLUSION

In this paper, an air quality and dust level monitoring system is presented. The concentration of formaldehyde sensor, dust sensor, temperature and humidity pollution in an environment is observed. The sensor output is pushed to the server and displayed in O-led display as well as in the application. It is successfully implemented as real time system.

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