Air Quality Monitoring Using Internet of Things: A Review

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ABSTRACT: ***Air quality is a significant problem for the whole globe, and numerous studies are being conducted to regulate and monitor air quality. The primary goal of this suggested system is to enhance the quality of air for humans and all other living creatures that live on our planet. The proposed embedded system architecture includes sensors that detect hazardous chemicals such as benzene, CO2, SO2, NH3, NOx, temperature and humidity sensors, and noise level detectors. It collects data from sensors about the surrounding environment, such as gas, smoke, temperature, and humidity, and feeds it into a microprocessor, which then stores all of the data in a database, determining the quality of the air so that precautions may be taken. Data may be seen remotely thanks to a GSM modem included into the microprocessor that allows data to be sent wirelessly to a web server or user interface device.***

KEYWORDS: ***Air, GSM Modem, IOT, Indoor, Sensor.***

1. INTRODUCTION

Because of the advancement of civilization and rising pollution emissions from cars and businesses, the state of the environment is deteriorating year after year. Air pollution is one of the main contributors to global warming and climate change, which has resulted in a rise in the earth's surface temperature as well as a slew of health issues [1]. Indoor air quality is a phrase describing the air quality of a building, and it is particularly beneficial to the comfort and health of residents [2]. It refers to the ambient air quality that pervades a certain region or place where people live and work. Indoor air quality suggested method for monitoring air quality is based on an IoT in this article [3]. Which consists of a gadget made up of several air quality sensors that detect air pollutants and hazardous substances [4]. This device uses IoT and database technologies to remotely monitor indoor air quality at any time and from any location. A GSM modem, a microprocessor, and air pollution detecting sensors make up the system. The system in this research study is intended to monitor the quality of air by measuring the concentration of all pollutants such as aerosol, VOC, CO, CO2, temperature, and humidity. In Table 1 shown the air quality index.

Table 1: Color code of Air Quality Index.

Air Quality Index Value	Level of Health Concern	Colors
Range	Air quality condition	Symbolized by color
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive group	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Despite this, there are no gas sensors that can detect a single gas 100 percent of the time. As a result, equipment that utilize analytical methods to detect gases are required. Fourier transform infrared (FTIR) instruments, gas demonstrated significant, and mass spectrometers are examples of such instruments. Table 2 compares and contrasts the features of gas sensors and analytical equipment.

Table 2: Comparison between gas sensor and analytical instruments.

Features	Analytical Instrument	Gas Sensor
Resolution	Excellent	Comparable
Cost	Very High	Fair
Size	Bulky	Compact
Rigidity	Fragile	Rigid
Process Control	Difficult	Easy
Mass Production	Difficult	Easy
Measurement	Instantaneous	Continuous

2. LITERATURE REVIEW

Many creative measures are being done nowadays in order to get healthy air. The suggested system is based on the Arduino UNO microcontroller, which is an IoT device. The Arduino UNO is a popular and widely used microcontroller. In this article, IOT is used to gather data on temperature and humidity levels at a set interval of time, and users may utilize this information to determine the overall average temperature and humidity level for a given day. The user may use this model to not only monitor and record the temperature and humidity levels within the home, but also to determine their values outside the house. The proposed system also allows the user to monitor carbon monoxide levels within the home, which aids in being aware of the concentration of pollutants present in both indoor and outdoor air, allowing one to take appropriate action to manage it.

The suggested system's most essential aspect is accurate data gathering of both outside and interior air quality. As a result, the suggested system is intended to gather accurate and efficient data for monitoring indoor air quality. Because the monitoring area changes, the device was created with an extensible interface that allows it to be readily adapted to the environment. As a result, several kinds of sensors are placed in the system to monitor both interior and outdoor air quality. A GSM modem is also included in the system, which allows gathered data to be sent immediately to the user interface or web server for air quality observation and monitoring. Microcontrollers and databases are placed in most IoT-based suggested systems to gather and send data wirelessly to the user interface and web server. The most essential goal of this suggested system is to detect air quality effectively.

Air pollution is one of the most pressing issues today; the entire world is grappling with the issue of air pollution as a result of rising levels of harmful gases in the environment, which cause a slew of health issues, as well as rising levels of harmful gases in the environment and rising surface temperatures in the atmosphere, which contribute to global warming. Because people spend 80-90 percent of their time inside, such as at school, work, or at home, it is critical to have high quality air in these areas because indoor air pollution causes serious health issues such as sickness, cancer, and a variety of other ailments. The concentration of various gases and particle contaminants in indoor air determines the quality of the air. Many causes contribute to the rise of air pollution. Humidity and high temperatures may also raise the concentration of some contaminants in indoor fresh air. Ventilation and air filtration may be used to manage indoor air pollution sources. The main ways of obtaining high quality air in buildings, workplaces, and any other indoor establishments are ventilation and air filtration.

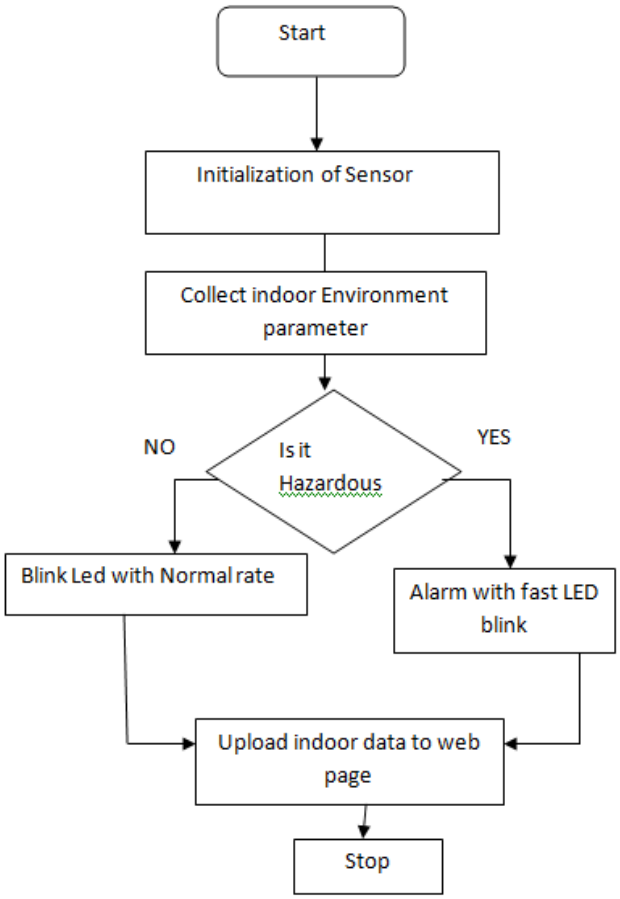

Figure 1: Flow chart of designed system.

Figure 1 shows the flow chart of the proposed indoor air system, When the system first starts up, all of the sensors are initialized, and all of the interior environment characteristics are collected [5]. If the air quality is poor, the system will sound an alert, the led will flash rapidly, and data will be sent to a web server [6].

Indoor air quality monitoring systems provide many benefits and applications.

- *Advantages: -*

1. Sensors are inexpensive and readily accessible.
2. It is simple to use, operate, and implement.
3. The system monitors both interior and outdoor air quality.
4. It detects the pollutant as well as other variables such as temperature and humidity, CO2 levels, and a variety of other contaminants.

- *Applications: -*

1. 1.It is extensively utilized in the manufacturing industry.
2. 2.It may be accessed from anywhere.
3. 3.The proposed system is now in use at a hospital and a clinic.
4. The system is used to monitor indoor air quality in homes and workplaces.

3. DISCUSSION

Carbon monoxide is a significant contaminant that deteriorates indoor air quality. Incomplete combustion of anything, cigarette smoke, cooking, and many more sources of carbon monoxide may be found within a structure or a home [7]. Carbon monoxide is a colorless, odorless, and tasteless atmospheric contaminant, making it difficult to detect without the use of sensory equipment [8]. Carbon monoxide lowers blood oxygen

carrying capacity because binds to hemoglobin more quickly than oxygen, forming carboxyl hemoglobin[9].

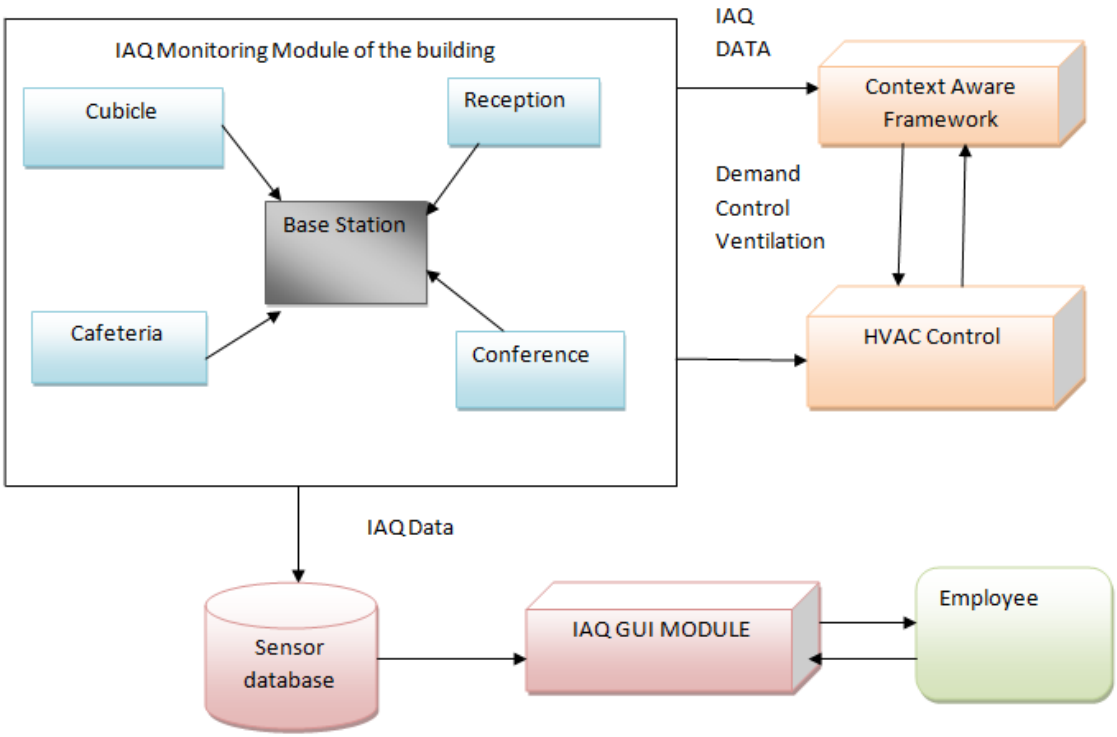

Figure 2: Diagram of proposed Indoor air quality monitoring system.

Figure 2 shows the proposed diagram of Indoor air quality monitoring system. The Indoor Air Quality monitoring system is designed to collect data of different air quality parameters; gases (CO, CO2), aerosols (PM2.5, PM10) along with other parameters like temperature and humidity because humidity and high temperature can also increase the level of some pollutants in indoor fresh air [6].

An indoor Air Pollution Monitoring System is used to monitor the concentration of air pollutant harmful gases in indoor fresh air. The indoor Air Pollution Monitoring System uses air pollutants with help of cost efficient semiconductor gas sensors with help of GSM modules. concentrations of air pollutant gases like CO, CO2, SO2 and NO2 is measured by this indoor system using semiconductor sensors [10]. The sensors collect different parameter data of the environment and provide it to the Microprocessor which functions as a main station. Different parameters of environmental data collected by sensors and sent to base stations which further provide the information collected to user mobile phones with help of GSM module [11].

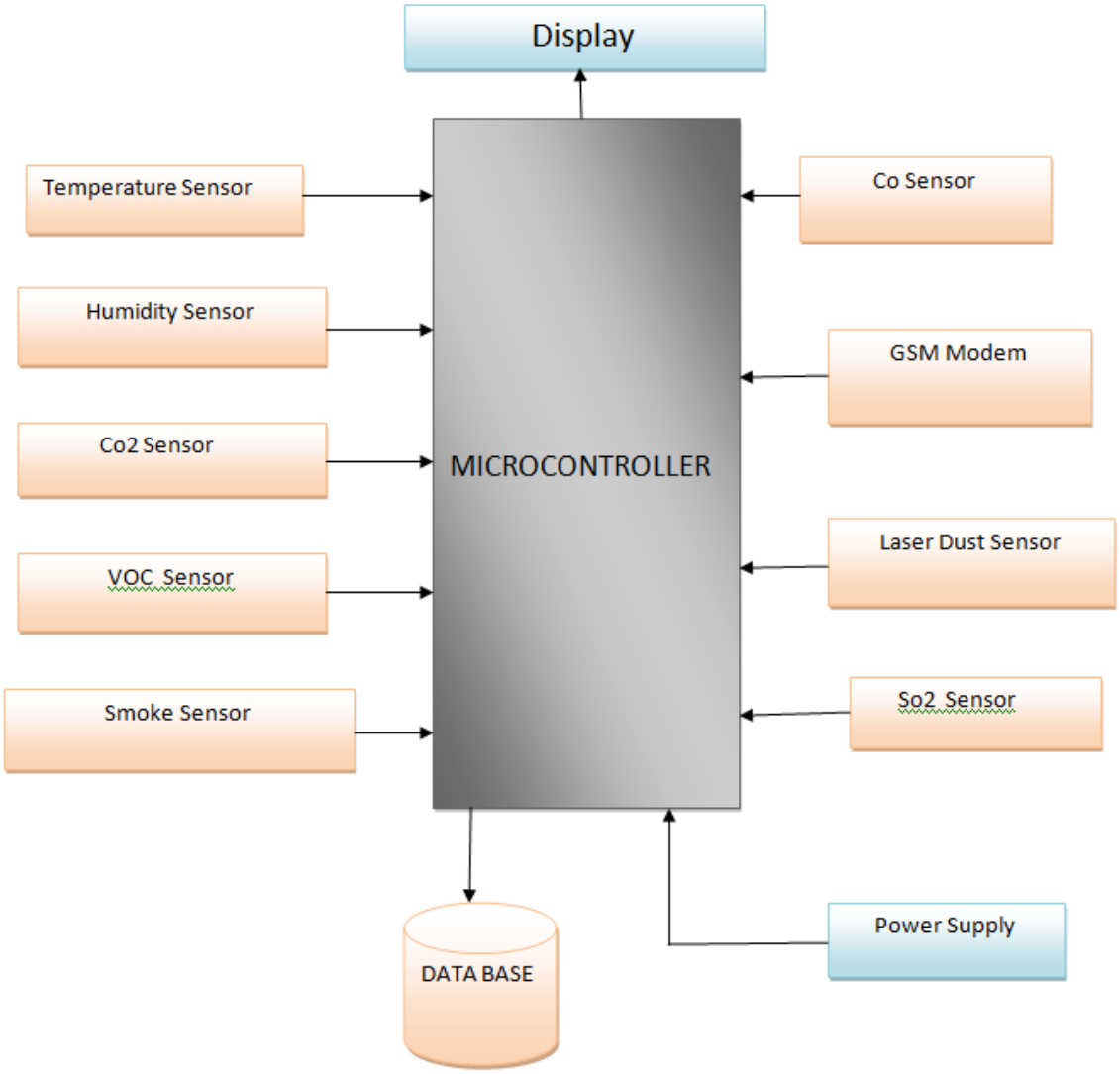

Figure 3: Systematic Block diagram of Different types of Sensors.

The schematic Block design of Different kinds of Sensors for monitoring indoor air quality based on IOT is split into two categories: healthy air and database servers (see Figure 3). Different sensors connected to a microcontroller evaluate air quality. Sensors gather data and transmit it to the microcontroller, which is then recorded in a database. Data is then sent to the user's mobile phone through the GSM module, from which they may monitor air quality at various parameters. Different sensors are utilized to sense different characteristics, such as a CO sensor for detecting carbon monoxide concentration in indoor air, a temperature and humidity sensor for measuring temperature and humidity, and a VOC sensor for calculating VOC concentration. All gathered data is sent to a database and linked with the database server; data is then delivered to the user's mobile phone through the GSM module, from which they may remotely monitor air quality at different parameters at any time and from any location. The suggested system's IOT structure is made up of three layers: perception layer, presentation layer, and network layer. Data is collected using the perception layer with the assistance of various measurement devices and sensors. The Network layer is in charge of sending the gathered data. Finally, the presentation layer provides for data display and monitoring storage.

This research study is about using IoT to monitor indoor air quality in real time. Because a wireless sensor network is used to send, analyze, monitor, and process data, the system functions autonomously. This new suggested system enhances indoor air quality and has a number of benefits, including the ability to detect pollutants as well as other factors such as temperature and humidity levels, CO2 levels, and a variety of other contaminants. As a result, this study presents an IoT-based indoor air quality monitoring platform based on database and IoT integration. A suggested wireless system that goes beyond the capabilities of hotspots to provide wireless access in remote places at a cheap cost.

A microcontroller is an open source electrical platform that reads the sensor's input light and sends it to GSM for wireless communication. A laser dust sensor is a device that detects aerosol in the air. The suggested system's Laser Dust Sensor calculates and monitors the concentration of aerosol in indoor air. Sensors can

detect PM 2.5 and PM 10 particle mass concentrations. In a specific range of 0 to 10000 um/m3 and for aerosol particle sizes of 0.3 to 10um, this sensor is more sensitive and accurate. The laser dust particle sensor's specifications are shown in Table 3.

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Table 3: Laser dust particle sensor specifications.

Specification	Value
Particle Size	0.3 to 10 um
Measurement Range	0 to 1000 um/m3
Time in first Reading	< 8s
Working Temperature	-10 to 50 C
Working humidity	0 to 95% RH
Signal output	UART- TTL, PWM,IIC

Volatile organic compound sensor detects products that are hydrocarbon-based and readily evaporate at high vapour pressure, such as petroleum products, paraffins, and aromatic compounds. All of these chemicals are detrimental to one's health and may induce nervous system issues. Many kinds of volatile organic chemicals, such as xylene, toluene, and other organic solvents, are detected using volatile organic compound sensors.

Carbon Monoxide sensor: Carbon monoxide sensor detects toxic products which produce due to incomplete burning of compounds made of carbon like coal, petroleum and many more carbon compounds. Carbon monoxide is mainly generated by human activity like cooking, smoking and heating systems. Carbon monoxide decreases the oxygen carrying capacity in blood because carbon monoxide attaches with hemoglobin rapidly than oxygen which forms carboxyl hemoglobin.

The experiment's aim was to test a prototype of the proposed system for monitoring indoor air quality. The Interior Air Quality Monitoring System is intended to gather data on a variety of air quality parameters, including gases (CO, CO2), aerosols (PM2.5, PM10), temperature, and humidity, since humidity and high temperatures may raise the amount of certain pollutants in indoor fresh air. With the assistance of various kinds of sensors placed in the system, data on pollutant or hazardous gas levels in indoor air quality may be collected. With the assistance of a GSM modem, collected data is wirelessly sent to the user's mobile phone or web server, allowing them to be aware of the quantity of pollutants present in interior air as well as in the atmosphere, allowing them to take appropriate action to manage it.

4. CONCLUSION

The design of an IOT-based home air quality monitor is monitored remotely from anywhere in this research study. The suggested system is intended to be a low-cost pollution detection system. Gas sensors such as VOC sensors, CO sensors, and a variety of others have been effectively used to monitor pollutant concentrations in indoor air. The use of gas sensors has many benefits for the suggested systems, including cost efficiency, rapid response, minimal maintenance, continuous monitoring, and so on. One of the main advantages of indoor air quality monitoring is that it can be done remotely and in real time utilizing IoT and database technologies.

REFERENCES:

[1] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A survey," *Comput. Networks*, 2010, doi: 10.1016/j.comnet.2010.05.010.

[2] S. Brienza, A. Galli, G. Anastasi, and P. Bruschi, "A low-cost sensing system for cooperative air quality monitoring in urban areas," *Sensors (Switzerland)*, 2015, doi: 10.3390/s150612242.

[3] S. Li, L. Da Xu, and S. Zhao, "The internet of things: a survey," *Inf. Syst. Front.*, 2015, doi: 10.1007/s10796-014-9492-7.

[4] K. Zheng, S. Zhao, Z. Yang, X. Xiong, and W. Xiang, "Design and Implementation of LPWA-Based Air Quality Monitoring System," *IEEE Access*, 2016, doi: 10.1109/ACCESS.2016.2582153.

[5] J. H. Liu *et al.*, "An air quality monitoring system for urban areas based on the technology of wireless sensor networks," *Int. J. Smart Sens. Intell. Syst.*, 2012, doi: 10.21307/ijssis-2017-477.

[6] J. H. Ziegeldorf, O. G. Morchon, and K. Wehrle, "Privacy in the internet of things: Threats and challenges," *Secur. Commun. Networks*, 2014, doi: 10.1002/sec.795.

[7] K. S. E. Phala, A. Kumar, and G. P. Hancke, "Air quality monitoring system based on ISO/IEC/IEEE 21451 standards," *IEEE Sens. J.*, 2016, doi: 10.1109/JSEN.2016.2555935.

[8] F. Popescu, I. Ionel, N. Lontis, L. Calin, and I. L. Dungan, "Air quality monitoring in an urban agglomeration," *Rom. Reports Phys.*, 2011.

[9] A. Augustin, J. Yi, T. Clausen, and W. M. Townsley, "A study of Lora: Long range & low power networks for the internet of things," *Sensors (Switzerland)*, 2016, doi: 10.3390/s16091466.

[10] A. Whitmore, A. Agarwal, and L. Da Xu, "The Internet of Things—A survey of topics and trends," *Inf. Syst. Front.*, 2015, doi: 10.1007/s10796-014-9489-2.

[11] K. Christidis and M. Devetsikiotis, "Blockchains and Smart Contracts for the Internet of Things," *IEEE Access*. 2016. doi: 10.1109/ACCESS.2016.2566339.