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IOT Based Handheld Device for Air Quality Monitoring

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Abstract: *The IoT (Internet of Things) based handheld device for air quality monitoring is a portable device designed to monitor the air quality of indoor and outdoor environments. The device utilizes a combination of sensors, wireless communication, and cloud computing to provide real-time air quality data to the user. The sensors measure various air quality parameters such as temperature, humidity, particulate matter, and gaseous pollutants. The data collected by the sensors is transmitted wirelessly to the cloud, where it is processed and analyzed. The device also provides a user-friendly interface that allows the user to monitor and analyze the air quality data in real- time. This device can be used by individuals, organizations, and government agencies to monitor air quality and take appropriate measures to improve it. The parameters that are affecting the quality of air volume of CO, volume of CO2, detection of leakage of any gas - smoke, alcohol, LPG. as these parameters hold importance to everyone. This devices helps to monitor all these parameers with the help of a standard MQ-135 Sensor along with an Alert buzzer activates whenever its volume exceeds a particular safe limit intended for a particular application.*

Keywords: Handheld Device

I. INTRODUCTION

Air pollution has become a major concern for public health and the environment. The harmful effects of air pollution on human health and the ecosystem have been well documented. In recent years, there has been an increasing interest in monitoring air quality, both indoors and outdoors. The Internet of Things (IoT) technology has enabled the development of portable and low-cost air quality monitoring devices that can be used by individuals, organizations, and government agencies. In this context, an IoT-based handheld device for air quality monitoring has been developed. The device is designed to measure various air quality parameters such as temperature, humidity, particulate matter, and gaseous pollutants. The device uses wireless communication to transmit the data to the cloud, where it is processed and analyzed. The user can access the air quality data in real-time through a user- friendly interface provided by the device. This device has several advantages over traditional air quality monitoring systems. It is portable, low-cost, and easy to use. It can be used to monitor air quality in various settings such as homes, offices, schools, and public spaces. The real-time data provided by the device can help individuals and organizations take appropriate measures to improve the air quality. The data stored at the memory can be retrieved any time and the scenarios can be Analysed in a better way leading to the solutions for controlling air pollution to some extent.

Health problems have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of gaseous pollutants. Harmful effects of pollution include mild allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. According to a survey, due to air pollution 50,000 to 100,000 premature deaths per year occur in the U.S. alone whereas in EU number reaches to 300,000 and over 3,000,000 worldwide. Various kinds of anthropogenic emissions named as primary pollutants are pumped into the atmosphere that undergoes chemical reactionand further leads to the formation of new pollutants normally called as secondary pollutants. For instance, according to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), nearly all climate- altering pollutants either directly or indirectly (by contributing to secondary pollutants in the atmosphere) are responsible for health problems. Almost every citizen spends 90% of their time in indoor air. Outdoor air quality of the cities of developed countries improved considerably in recent decades. In contrast to this, indoor air quality degraded during this same period because of many factors like reduced ventilation, energy conservation and the introduction to new sources and new materials that cause indoor pollution. This increases the need for indoor air quality (IAQ) monitoring Due to this fact anduse of new building materials, IAQ often reaches to unacceptable levels. Overall, the IoT- based handheld device for air quality monitoring is a promising solution to the growing problem of air pollution. The device can contribute to improving public health and the environment by enabling real-time monitoring and data analysis of air quality.

II. LITERATURE REVIEW

A Wi-Fi-enabled indoor air quality monitoring and control system:

Published in: Control & Automation (ICCA), 2017 13th IEEE International Conference.

Authors: Xiaoke Yang, Lingyu Yang, Jing Zhang (School of Automation Science and Electrical Engineering, Bei hang University, Beijing, 100191, China**)**

This paper proposes an open platform of a Wi-Fi-enabled indoor air quality monitoring and control system, which could be incorporated into such a 'smart building' structure. The complete software and hardware design of this system is presented, along with a series of control experiments. The proposed system operates over an existing

Wi-Fi wireless network utilizing the MQTT protocol. It can monitor the indoor air quality as well as controlling an air purifier to regulate the particulate matters concentration. Experiment results under a real- world office environment demonstrate the effectiveness of the proposed design.

A low-power real-time air quality monitoring system using LPWAN based on LoRa:

Published in: Solid-State, Integrated Circuit Technology (ICSICT), 2016 13th IEEE International conference.

Authors: Suyuan Liu, Chui Xia, Zhenzhen Zhao(College of Electronic Information and Control Engineering, Beijing University of Technology, 100124, China)

This paper presents a low-power real-time air quality monitoring system based on the LoRa Wireless Communication technology. The proposed system can be laid out in a large number in the monitoring area to form sensor network. The system integrates a single-chip microcontroller, several air pollution sensors (NO_2, SO_2, O_3, CO, PM1, PM10, PM2.5), Long-range (LoRa) - Modem, a solar PV-battery part and graphical user interface (GUI). As communication module LoRa sends the data to the central monitoring unit and then the data would be saved in the cold. The range tests at an outdoor area show that LoRa can reach to approximately 2Km.

IoT enabled proactive indoor air quality monitoring system for sustainable health management:

Published in: Computing and Communications Technologies (ICCCT), 2017 2nd International Conference

Authors: M.F.M Firdous, B.H Sudantha, P.M Karunaratne (Dept. of Information Technology, University of Moratuwa, Sri Lanka)

This paper proposes an IoT based indoor air quality monitoring system for tracking the ozone concentrations near a photocopy machine. The experimental system with a semiconductor sensor capable of monitoring ozone concentrations was installed near a high-volume photocopier. The IoT device has been programmed to collect and transmit data at an interval of five minutes over blue tooth connection to a gateway node that in turn communicates with the processing node via the Wi-Fi local area network. The sensor was calibrated using the standard calibration methods. As an additional capability, the proposed air pollution monitoring system can generate warnings when the pollution level exceeds beyond a predetermined threshold value.

A wireless system for indoor air quality monitoring: - Published in: Industrial Electronics Society, IECON 2016 - 42nd Annual Conference of the IEEE

Authors: R du Plessis, A Kumar, GP Hancke (Department of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa)

This paper describes the development of a wireless monitoring system which can be deployed in a building. The system measures carbon dioxide, carbon monoxide and temperature. The system developed in this paper can serve as the monitoring component of a HVAC control system and function as an indoor air quality monitor independently.

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Pollution: An efficient cloud-based management of IoT devices for air quality monitoring: -
Published in: Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI), 2016 IEEE 2nd International Forum
The Internet of Things paradigm originates from the proliferation of intelligent devices that can sense, compute and communicate data streams in a ubiquitous information and communication network. The great amounts of data coming from these devices introduce some challenges related to the storage and processing capabilities of the information. This strengthens the novel paradigm known as Big Data. In such a complex scenario, the Cloud computing is an efficient solution for the managing of sensor data.

2.1 Problem Definition

Air pollution is one of environmental issues that cannot be ignored. Inhaling pollutants for a long time causes damages in human health. Traditional air quality monitoring methods, such as building air quality monitoring stations, are typically expensive. This project is monitors air quality detection in real time. To design a portable tool which will sense pollutants present in air and display the percentage of concentration of pollutants in PPM (Parts Per Million) along with temperature and display it in degree Celsius present in atmosphere surrounding the system.

2.2 Objectives of the Project

The main objective of the project is to

- To combine detection technologies to produce an air quality Sensing system with enhanced capabilities to provide comprehensive monitoring.
- To display the sensed data in user friendly format in 16*2 I2C lcd display panel.
- To alert with the help of buzzer if the concentration of pollutants exceeds beyond theexpected range in the measuring environment.

III. METHODOLOGY

A methodology is proposed to determine the pollutants of surrounding environment for the primary purpose of compliance with air quality standards. This project uses the senors to display with data from an air quality gas sensor to process for ascertaining the optimal pollutant detection in our proposed system the MQ135 Gas Sensor is used,. The MQ135 Gas Sensor is an all_in_one sensor for detecting ammonia, benzene, alcohol, smoke, CO2 and a myriad of other gases. It is the best available multipurpose gas sensor on the market. The I2C 16*2 LCD display connected to Arduino module is used to give a measure of concentration of pollutants where the system is implemented. As the device is powered, the Arduino board loads the required libraries, flashes some initial messages on the 16*2 LCD display screen and start sensing data from the MQ-135 sensor. The sensor can be calibrated so that its analog output voltage is proportional to the concentration of polluting gases in PPM. The analog voltage sensed at the pin A0 of the Arduino is converted to a digital value by using the in-built ADC channel of the Arduino. The Arduino board has 10-bit ADC channels, so the digitized value ranges from 0 to 1023. The digitized value can be assumed proportional to the concentration of gases in PPM. The data received form the Gas Sensor(In PPM) is monitored and displayed on the 16*2 LCD display.
To give us an example, We have taken a case where the pollution caused in cities and vehicles emitting pollutants.
The data are collected once the IoT device is built with the appropriate sensor calibration.
To describe the air-pollution phenomenon, seven specific data collection schedules (information obtained from government agencies) were established according to vehicle density and the hours of highest traffic flow (8h00, 13h00, and 17h00), normal traffic flow (10h00, 13h00 and 20h00), and reduced traffic flow (2h00). The data acquisition process starts taking 50 samples every two minutes in the above-mentioned schedules, while the vehicle is driven around the city for approximately two months.
Additionally, due to the warming-up condition of low-cost sensors, the system waits 5 min to start taking samples. After that, the data are sent to the InfluxDB database. In this case, the number of samples sent to InfluxDB is equal to 140,000. Moreover, each obtained datum has been classified according to the defined schedule. At this point, it is important to mention that in this paper, the data set was divided according to the similarity of the values of the different

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variables into subsets. Therefore, we call classes to these subsets of data, as is carried out in machine learning. For us, a class is a set of data that have the same characteristics. Thus, once the classes were defined, algorithms were trained to generate rules that associate new data with the corresponding class. That said, in the event that there are values close to two classes, the algorithm makes its decision based on the variable that has the greatest weight or significance. In this way, the data are classified by criteria or functions defined by the algorithm itself. Taking into account everything said above, the measurements of each variable are now categorized within different air-pollution levels. Above mentioned classes were defined as follows:
Class A: High levels of pollution with increased incidence of high temperatures.
Class B: Acceptable levels of pollution and moderate temperature.
Class C: Low levels of gas concentration and suitable environmental conditions.
It is important to mention that the National Transit Agency of Ecuador imposes the maximum speed in cities at 50 km/h. In addition, the IoT application is focused on collecting data in city zones with high vehicle density, which reduces the chance that the IoT device has inaccurate measures by medium/high vehicle speeds. Furthermore, smoothing algorithms eliminate those errors by comparing samples taken with the same sample rate.

IV. REQUIREMENTS OF THE PROJECT

The proposed project carries into parts namely hardware and software part. They are

Hardware:

- Arduino UNO Microcontroller
- 16*2 i2c LCD display
- Gas Sensor MQ-135
- Lithium Ion Battery
- Buzzer
- Node MCU ESP8266

Software:
Arduino IDE (Version 1.8.2)
Open-source electronic prototyping IDE platform to provide real time interactive environment for various components connected along with Arduino microcontroller.
It consists of two main parts:
Editor: used to write the required code.
Compiler: used for compiling and uploading the code

V. ALGORITHM AND WORKING PROCESS

IoT devices have limited computational resources. Therefore, it is necessary to work with lightweight network protocols and services. In summary, the functionality of each block of the proposed IoT architecture is described as follows:

- **IoT node:** Collect sensor data and send messages via to the edge server.
- **Edge:** Has the MQTT broker, which receives data from IoT nodes. Then, it stores data in a time series database identifying each node.
- **Cloud:** We use a public data viewer to securely connect to the database allocated in the edge and make querying from the cloud side.

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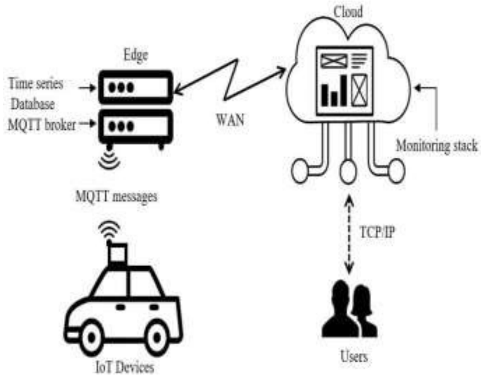

Fig 1. Proposed architecture.

I We have connected the MQ135 gas sensor with the Arduino. Connected the VCC and the ground pin of the sensor to the 5V and ground of the Arduino and the Analog pin of sensor to the A0 of the Arduino. Connected a buzzer which is start to beep when the condition becomes true. The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2 and some other gases, so it is faultless gas sensor for our Air Quality Observing Detection Project. When I connect it to Arduino then it senses the gases, and I get the Pollution level in PPM (parts per million). MQ135 gas sensor gives the output in form of voltage levels and I need to convert it into PPM. Sensor is giving us value of 34 ppm when there is no gas near it and the safe level of air quality is below 130 ppm and it is not exceeding 250 PPM. When it exceeds the limit of 250 PPM, then it starts cause Headaches, sleepiness and stagnant, stale, stuffy air ,can cause increased heart rate and many other diseases . When the value is being less than 130 PPM, then the LCD and displays "AQ Level Normal". Whenever the lue is increased beyond 130 PPM. If it is increased beyond 250 PPM, then the buzzer is kept beeping and the LCD is displayed "AQ Level Danger.

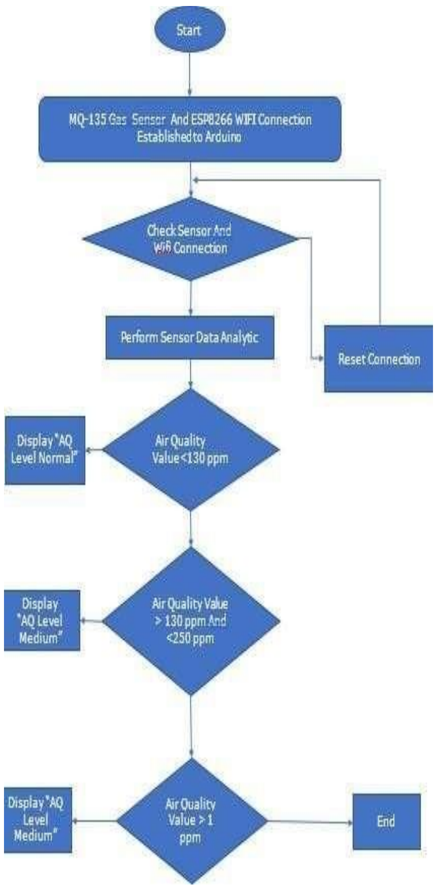

Fig 6 : Algorithm And Working Process

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VI. PERFORMANCE ANALYSIS

The MQ135 sensor can sense CO2 and some other gases, so it is perfect gas sensor for my Air Quality Monitoring System Project. When I connect it to Arduino then it senses the gases, and I need the Pollution level in PPM (parts per million).

MQ135 gas sensor gives the output in form of voltage levels for change in resistance values based on the concentrations of pollutants measured. We are calculating the voltage variations with respect to the pollution content in the air. If the output of the MQ sensor is 130 ppm, we considered it a normal amount of pollution content present in the air. If the voltage is increased and stabilizes in the range of more than 130 ppm to less than 250 ppm, then it is considered as a medium amount of pollution content present in the surrounding air. If the output voltage increases more than 250 ppm of the maximum value, then it is considered as dangerous level.

MQ135 Sensor Detect	Air Quality Index	Display Results
Air QualityIndex	AQI<130 PPM	AQ Level Normal
Air QualityIndex	AQI>130 & AQI<250 PPM	AQ Level Medium
Air QualityIndex	AQI>250 PPM	AQ Level Danger

Table 1: AQI levels and Connected Health Impacts

VII. RESULTS

Fig 1,2,and 3 shows the amount of AQI, Temperature and humidity respectively. This work is further extended to show the air quality of different locations of Mysuru city as shown in Tale from which we can analyze the highly polluted sites of Mysuru. Since we had only air quality monitoring device, we took those data from different locations, from different time periods of the day. With the help of air quality monitoring set up, located at different locations, we could be able to see the air quality of different locations at the the same time.

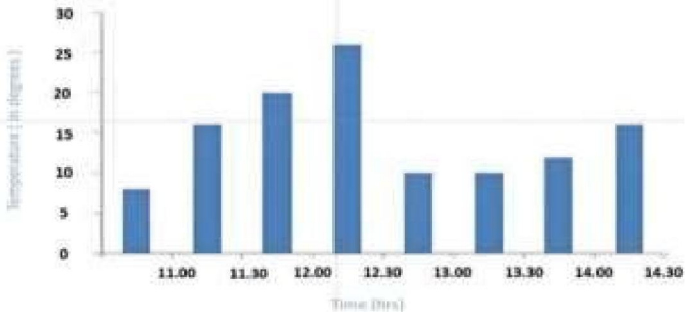

Fig 1: Graphical view of Temperature Monitoring

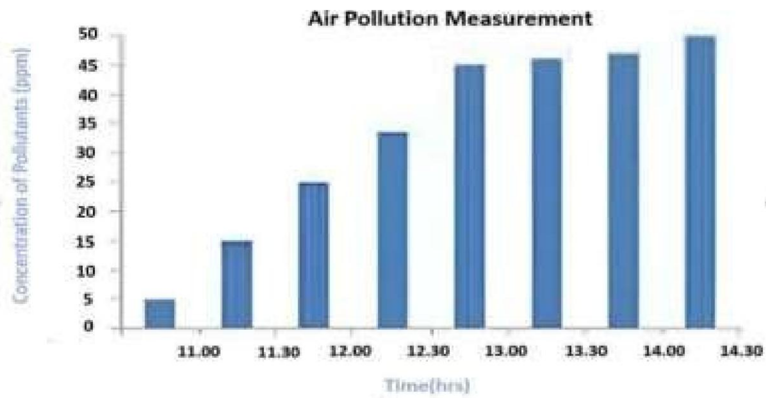

Fig 3: Graphical view of Air Quality Monitoring

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Location	AQI	Temperature (in degrees)	Humidity	Date	Time
Mysore Palace	52	26	52 %	13/04/2022	02:30 pm
Sri Chamundeshwari Temple	40	28	59 %	13/04/2022	02:50 pm
Karanji Lake	43	27	49 %	13/04/2022	03:15 pm
St. Philomena's Cathedral	49	28	53 %	13/04/2022	03:35 pm
Sanjeevini Park	42	25	54 %	13/04/2022	04:00 pm
Columbia Asia Hospital	46	24	57 %	13/04/2022	04:50 pm
Infosys	46	29	55 %	13/04/2022	05:30 pm

Table 2: Data Table of Different Locations In Mysore

Results drawn by this low-cost air quality monitoring system, are verified by comparing the data with thr data of AQI-Mysore. AQI.com is an online website run ny the government of India to monitor air quality in different locations of India. The comparative results are shown below, where it can be seen that our proposed air quality monitoring system shows almost the same results at any given time. The performance of the sensors were very similar.

Name	Measure Value	AQI - Mysore	Date	Time
AQI	26	26	13/04/2022	02:30 pm
Temperature	28	29	13/04/2022	02:30 pm
Humidity	52	54	13/04/2022	02:30 pm

Table 3 : Comparison of the measured values of the device with the AQI-Mysore

VIII. EXPECTED OUTCOME

Our proposed device to monitor pollutants in the atmosphere will be able to

- Monitor and display the temperature level of the environment on a LCD screen.
- Combine the detection technologies of MQ135 sensor with capabilities of Arduino Uno module to provide comprehensive monitoring.
- Alert with the help of buzzer if the concentration of pollutants exceeds beyond the expected range in the measuring environment.
- Advantages of the project
- Quality of air can be checked indoors as well as outdoor.
- Detecting a wide range of physical parameters.
- To make this data available to common man.
- To make the general public aware of quality of surrounding environment.

IX. APPLICATIONS

- Indoor air quality monitoring.
- Industrial emission monitoring.
- Roadside pollution monitoring.
- Hospital AQI monitoring.

X. CONCLUSION

Wireless sensor monitoring of air quality has numerous advantages over the conventional environment. This system has its benefits such as cost-effectiveness, ease of installation and real time data transmission. The proposed monitoring station is used for studying and processing real- time pollutant data from road from various areas of view , which needs a broad infrastructure segment the level of pollution according ro the region so that t can be better tracked and better solutions can be provided. In the future, a web-based monitoring system incorporated with Google Maps can be implemented to see the live map view of air diseases will be benefited by checking the level of pollution in Google

Maps t choose an alternative safe route to their destination. The proposed system can be updated with additional sensors to sense the existence of other gases such as Oxygen, Hydrogen and pH etc, These reading will provide the real-time condition of the atmosphere and further preventive measures can be taken accordingly.

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