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IoT Based Air Quality Management using Decision Support System

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Abstract — Air pollution has increased as a result of rapid industrialization and urbanisation. Harmful gases such as carbon monoxide and sulphur dioxide are wreaking havoc on the environment. The aim of this paper is to explain how a decision support system can be used to incorporate a low-cost and energy-efficient air quality monitoring system. The air pollution monitoring system is designed to monitor and analyse accurate air quality in real-time and log data to the server, keeping the data synced over the internet. On the basis of Parts per Million (PPM) metrics, air quality measurements were taken. The result can be accessed via a webpage dashboard from any smart device. This system uses an air quality index and Arduino platform, which incorporates multiple sensors into a single device that can be mounted anywhere, can easily interpret this data. Temperature, humidity, detection of any flammable gas, smoke, carbon monoxide, and LPG are among the environmental parameters to be monitored and studied by the system. The findings of the study confirm the system's ability for real-time temperature monitoring.

Keywords – Internet of Things, Server, Expert System, Pollution, Sensors, Parts per Million, Domain Experts.

I. INTRODUCTION

People's everyday lives, as well as their jobs and the protection of outdoor sports, are inversely affected by air conditioning and its efficiency. Many variables influence air quality, which ranges from time to time. There is a need for a more effective way to observe, record, and capture air quality data as awareness of air pollution grows in many countries. Weather predictions usually provide people with knowledge about upcoming atmospheric conditions, but they only provide limited details about a certain area. Rather, there are several sophisticated instruments that can track more atmospheric parameters; however, these systems typically simplify their calculations over a wide geographic region, and we will be hesitant to trust the findings because they could be or could not be accurate. After reading numerous posts, it appears that there is currently no system on the market that can automatically measure several types of air quality parameters at the same time, especially the combination of O2, PPM (Particles Per Million), CO2 (Carbon Dioxide), temperature, and humidity. As a consequence, the whole picture/graph is represented in terms of toxic particles and gases. As a result, there is a need to create a single integrated system capable of measuring any spot. This environmental monitoring system will take real-time measurements of a variety of air parameters and save the data on a server for potential research. The system combines flammable gases, LPG, smoke, CO, PPM, temperature, and humidity sensors into a single unit, with an Arduino At-Mega Uno serving as the controller component, providing a user-friendly, low-cost, portable, and efficient solution for monitoring multiple environmental air parameters using a decision support system that makes air quality decisions based on the various air parameters.

II. LITERATURE REVIEW

Traditional monitoring instruments have many disadvantages, including their large scale, heavy weight, and extremely high cost. These happen to have a large number of tracking stations deployed. In order to achieve reliable and precise results, the location of the monitoring stations required special consideration since the air quality situation in urban areas is closely related to human activities. When the air quality rises above a certain amount, the IoT-based Air Quality Management System tracks it over the internet and sends out an alarm/notification.

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It has a microcontroller, gas sensors, a mobile unit, a memory buffer, and an internet-connected web server that captures data from various locations as well as organise data at specific times. The readings for a particular location are averaged over a shorter period of time. The Global Positioning System (GPS) module is linked to a system that displays pollution sources accurately. The data is regularly transmitted to a computer via a General Packet Radio Service (GPRS) link, and the information is then shown on a dedicated website after user approval. As a result, large number of people can access the air quality index. Air pollution monitoring system based on geological sensor network with controlled action and adaptive sampling rates also cannot be a vast deployment due to high cost.

The systems were used in public transportation, such as buses, which follow well-defined routes. The system was made up of several monitoring stations that were able to interface wirelessly with backend computers in order to capture data without the use of wires. The data gathered by the backend server was translated into usable information and made available to users through a web portal.

Fourier transform infrared (FTIR) equipment, gas chromatographs, and mass spectrometers are some of the available tools for air pollution monitoring. These devices give gas measurements that are fairly precise and selective. A gas sensor that is small, sturdy, and has a wide range of uses which equally an effective option. Electrochemical, infrared, catalytic bead, photo ionisation, and solid-state are some of the gas monitoring methods. The present monitoring system primarily employs the 1451.2 standard's smart transducer interface module (STIM) with semiconductor gas sensors. STIM was discovered to be an effective monitoring system, with the exception of the power needs and the capacity to scale up for big deployments. Environment Observation and Forecasting System is one of the large-scale sensor networks for monitoring and forecasting (EOFS). Due to the expensive cost, the air pollution monitoring system based on geo sensor network with control action and adaptive sample rates suggested, cannot be widely used.

Various air quality monitoring systems based on WSN, GSM, and GIS have been suggested by researchers in this field. Fluke CO-220 carbon monoxide metre for CO, Amprobe CO2 metre for CO2, and ForbixSemicon LPG gas leakage sensor alarm for LPG leakage detection are commercial metres available in the market. Now, each technology has restricted applications based on its intended purpose, such as Zigbee, which is only for users who have a Zigbee trans-receiver, and Bluetooth, which is only for users who have a Bluetooth trans-receiver. To monitor the pinpoints of air pollution in any location, a GIS-based system is built, installed, and evaluated. In a confined time and space, the data for a specific spot are averaged. A system's Global Positioning System (GPS) module is used to deliver precise representations of pollution sources in a given area. A General Packet Radio Service (GPRS) link is used to transport the captured data to a computer on a regular basis.

This study however, applied the principle of Biometric Fingerprint system to develop an application specific to the workforce of higher Institutions of learning using the Federal Polytechnic, Ilaro as a case study in order to curb the manipulations of manual attendance system and encourage commitment, hard work and discipline for improve service delivery.

III.PROPOSED ARCHITECTURE

The block diagram of the proposed IoT-based air quality control employing the decision support system is shown below.

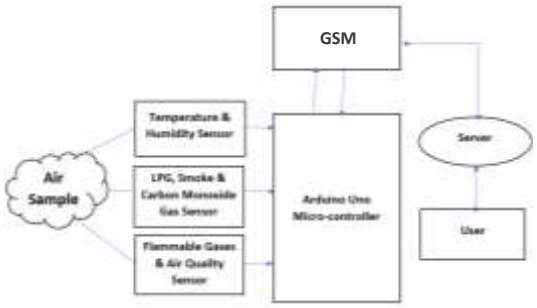

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Fig.1 Block Diagram of the Proposed System

We created a mechanism that is significant in geographical locations for this project. The following sensors are used in this project: temperature and humidity sensors, MQ2

sensor, MQ9 sensor, and MQ135 sensor. The MQ2 sensor is exposed to air to determine the amount of methane, butane, LPG, and smoke gases present. Similarly, the MQ9 sensor detects carbon monoxide and other dangerous gases, while the MQ135 sensor detects ammonia and benzene, an alcohol found in the air sample. A breadboard connects all of the sensors to the Arduino UNO Atmega328P kit. We used the Arduino to create the GSM/GPRS module since the data from these sensors has to be sent to the server for analysis.

The kit can interact with the server thanks to the GPRS/GSM module. All of the values are sent to the server and shown accurately on the web page. On the basis of the many air parameters monitored by their individual sensors, the web page can give quality of air judgments.

i. Components

The many components utilised in the project, including as modules and sensors, are explored in length in this section.

a) Arduino Uno

The ATmega328P microprocessor lies at the heart of the Arduino Uno. It has 14 digital input/output pins, six analogue input pins, a 16MHz resonator, a USB connection port, a power connector, and an ICSP header, as well as a reset button. The Arduino Uno comes with everything you need to get started with the microcontroller; all you have to do is connect it to a computer through USB, use an AC to DC converter for power, or utilise the battery. Microcontrollers implement features from the programming languages C and C++. Furthermore, the Arduino includes an integrated development environment (IDE) that is based on the Processing programming language project. In the Italian language, "uno" means "one," and it was chosen to represent the release of Arduino Software (IDE)1.0.

b) GSM Module

The SIM900A is a wireless module that is noted for its portability and dependability. It is a cost-effective comprehensive dual-band GPRS solution built into the SMT module with a tiny footprint. GSM 900/1800MHz performance is provided by the SIM900A module.

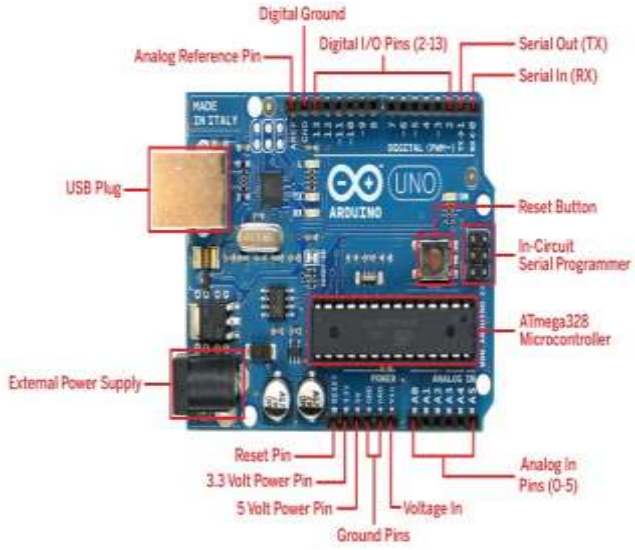

Fig.2 Arduino Uno ATmega328P kit

With its small form factor and low power usage, it can enable calls, SMS, data, and fax. The inbuilt TCP/IP stack in the GSM Modem enables you to connect to the internet through GPRS.

It contains ON and reset button, and LED indication for network status, and power, as well as a sliding SIM holder. Stub antenna with SMA connection and 12V/2A power supply.

Fig.3 GSM SIM900A Module

c) MQ135 Sensor

SnO2 is the sensitive material in the MQ135 sensor. In pure air, the conduction of this substance is decreased. The conduction of the sensing element will increase as the concentration of the target pollutant gas rises. The MQ135 can detect a variety of hazardous gases, including hydrogen sulphide, ammonia gas, benzene series steam, and CO2. With a voltage rate of around 5.0, the detection range is 10-10,000 ppm. Long life, cheap cost, a simple driving circuit, and good sensitivity to dangerous gases are all significant attributes. The MQ135 gas sensor is commonly used as a gas alarm, portable gas detector, in household and enterprises. In this approach, MQ-135 is employed to track carbon dioxide levels in the atmosphere. According to the amount of carbon dioxide in the atmosphere, the sensor is calibrated.

Fig.4 MQ135 Gas Sensor

d) Temperature & Humidity Sensor

Temperature and humidity are often measured with the DHT11 sensor. In the form of serial data, the sensor outputs the temperature and humidity values. It contains an 8-bit microprocessor and a dedicated NTC for temperature monitoring. The DHT11 sensor is also factory calibrated, making it simple to interface with other microcontrollers. With exceptional precision of 1°C and 1%, this sensor can perfectly detect temperature ranges from 0°C to 50°C and humidity ranges from 20% to 90%. It contains three pins: VCC, Data, and Ground, which are labelled as +ve and -ve outputs, respectively.

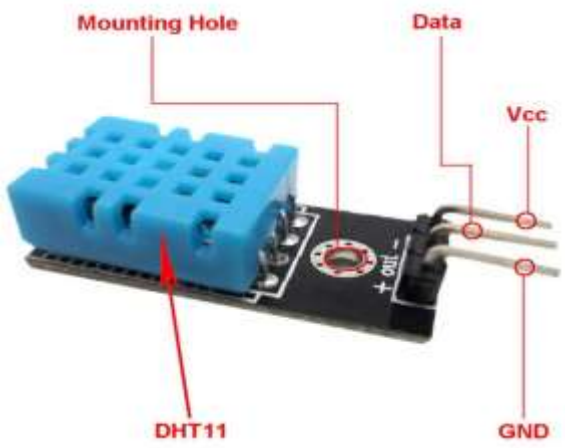

Fig.5 Temperature & Humidity Sensor DHT11

e) MQ2 Sensor

It is mostly used in homes and businesses to detect LPG, Hydrogen, i-butane, propane, alcohol, smoke, and methane. Because the resistance value of the MQ2 sensor changes depending on the kind of gas, sensitivity adjustment is required when using this component. The sensor is calibrated with a load resistance of roughly 20 KΩ and a gas concentration of 1000 ppm Liquefied Petroleum Gas (LPG) and 1000 ppm iso-butane <i-C4H10> in clean air. Furthermore, while setting the optimum alert point for gas detectors, the impact of temperature and humidity must be taken into account.

MQ2 is utilised to identify gas leaks in the proposed architecture. The device can detect LPG gas at home, i-butane, propane, and methane in factories, or smoke in situations where there is a risk of fire, depending on the gas. The buzzer linked to the microcontroller turns on as soon as a certain gas is identified, signalling that the presence of dangerous gases is high.

Fig.6 MQ2 Gas Sensor

f) MQ9 Sensor

The MQ9 sensor is a sensitive and quick-response component. Hydrogen, liquified petroleum gas, methane, carbon monoxide, alcohol, smoke, or propane may all be detected with this sensor. The use of r is for the detection of carbon monoxide (CO). This MQ9 sensor has the same form as the MQ2 sensor, but it is somewhat larger. This sensor's output is identical to that of the MQ2.

Fig.7 MQ9 Gas Sensor

ii. Software Used

Arduino Software (IDE 1.8.13): The Arduino IDE is a Java-based, platform-independent software tool that is derived from the IDE for the Processing programming language and wiring projects. "Sketch" refers to a programme or code developed for any Arduino board. The Arduino IDE uses the GNU toolchain and AVR libraries to compile the applications. AVR-dude is used to upload the compiled code to the board. The Arduino Software (IDE) is an open-source programme that enables coding and uploading code to the board simple. Because of its cross-platform interoperability with Windows, MacOS X, and Linux. The software tool's environment is written in Java and is built on Processing and other open-source applications. Any Arduino board may be used with this IDE.

IV. SYSTEM ALGORITHM

The proposed algorithm describes the operation of the system.

i. Algorithm

The algorithm of the system is given below.

Step 1 Start

Step 2 Expose all sensors in the atmosphere for acquiring the quality of air index.

Step 3 Values are sent to the Arduino kit.

Step 4 GPRS module communicates with the server To share data of acquired from all sensors.

Step 5 All the data gets display on the webpage.

Step 6 Quality of air is determined on the basis of the values.

As a result, all of the sensors are able to send their particular values to the web server through Arduino and the GPRS module. The system will evaluate the value acquired and deliver an appropriate result for the air sample. The site manages and controls a number of actions, as well as providing the proper outcomes.

ii. Flow Chart

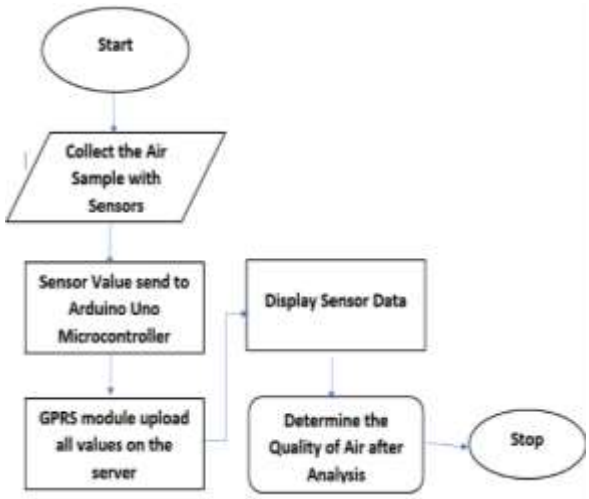

Fig.8 System Flow Chart

V. RESULT AND EXPERIMENTS

For the monitoring and analysis of the air parameter, a system approach was used in the design of the IoT-based air quality monitoring system. The findings collected from these air parameters reveal that the system's execution is simple and precise.

Air temperature and humidity sensors have shown to be highly effective in the study of the relevant air parameters in an air test experiment.

i. Connected Components and user interface

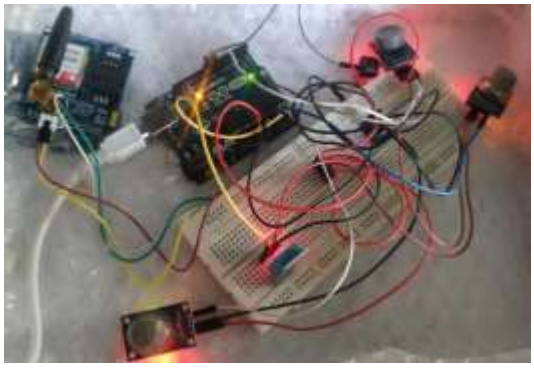

Fig.9 Sensors connected with Arduino Kit

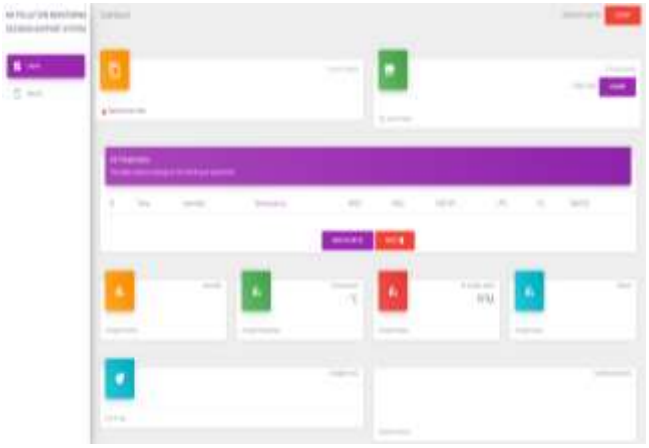

Fig.10 User Dashboard Screen

VI. CONCLUSION

The research article presented a smart and intelligent air pollution monitoring system that continuously monitors air quality and displays the measured air quality on a website. The approach aids in the development of awareness of the quality of air that one breathes on a regular basis. This monitoring device is capable of providing real-time air quality observations. This is a straightforward air quality monitoring device. This project is created to be used for pollution monitoring in any location.

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The Originality of the work has been warranted by our team and is not been published or in review elsewhere.

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