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A Prototype of Air Substance Quantity Monitoring System Using Internet of Things (IoT)

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Abstract: The biggest issue facing the planet now is air pollution. Because harmful chemicals like CO2, SO2, NO2, and CO are released into the atmosphere, the globe is becoming more polluted. These dangerous gases are dissolved in the air and are unpredictable. Consequently, a device is needed to measure the air quality. IoT devices that operate over the internet can be used to monitor air pollution. Devices connected to the Internet of Things (IoT) can gather data and analyze it to make predictions, such as whether the air is of acceptable quality or not. As a result, sensors and IOT-based devices like Arduino and Raspberry Pi can be used to monitor the air quality in a specific area. The goal of this research study is to comprehend information on environmental variables and also to enable simple integration into any other type of internet-based architecture (IoT) that permits the use of sensors capable of gathering information on sensors related to smart city environment measurements, with the goal of providing data on information relating to environmental pollution.

Keywords: Air pollution, IOT, Sensors, MQ-2, MQ-135.

1. Introduction

According to the Globe Health Organization, pollution is the main issue in every country in the world (WHO). Therefore, in order to stop pollution, we must first identify certain gases, such as CO, O3, NO2, etc. These gases pollute the environment and are more harmful to human health, which can result in lung cancer, lightheadedness, coughing, etc. Simple vision cannot identify these gases. Due to the release of gases from both industries and motor vehicles, pollution has become a major issue in the majority of urban areas. Scientists have been utilizing some rudimentary techniques, such as taking air samples in certain locations and analyzing those in labs, to find these kinds of gases. However, these techniques are costly and ineffective. Scientists then utilized IoT and sensing equipment, which is mostly created by IoT technology [1-5]. The Internet of Things (IoT) today is crucial in the age of technology. As a result, IoT, which is deeply ingrained in human existence, opens up a vast array of opportunities for sensors to detect these hazardous chemicals and assess the quality of the air. The Internet of Things is used to create sensors and other IoT devices (IoT). These sensors aid in both monitoring the air quality and the dangerous gases that are dissolved in it. We can easily track the level of environmental pollution by using sensors. For instance, in a crowded metropolis, if these sensors are attached, they may detect the information about the air quality and pollution levels in a specific location and send it to the cloud for monitoring and forecast of pollution. High amounts of particle matter have been linked with an increase in human heart problems in society. The burning of fossil fuels and the release of carbon dioxide into the atmosphere are causing global warming [6–9]. Water and plants absorb the toxic substances that are released into the environment. Industries that release harmful chemicals into the air and water pollute civilization. The harmful diseases that are spread by this pollution affect all earthly life. Pollution destroys our ecosystem and gives us dirty groundwater or air, such as air that is filled with sulphur, which causes lung and skin cancers. Pollutants also include animal waste, plastic bottles in our oceans, and trash that is washed up from our streets. It causes serious human diseases like cancers by contaminating and poisoning food and drinking water. By

destroying the ozone in the stratosphere, it also depletes the atmosphere. Acid rain is a plant byproduct that increases the amount of sulfuric and nitric acids in the soil to dangerous levels. Like Tel Aviv, air pollution has several negative effects on the environment, most of which are hazardous to human health. (Note that this is GP's paraphrase.) Sulfur dioxide and nitrogen oxide react to form nitric oxide and sulfur dioxide, respectively. Due to the release of dangerous substances into the environment, this pollution effect also contributes to the ozone layer's thinning. The wildlife population in our civilization has been declining for a long time due to pollution. Numerous wildlife communities were decimated as a result of pollution. Many people in our society are afflicted with many deadly ailments. Infants' lung development is also slowed down by breathing in dirty air. Asthma and respiratory illnesses are most commonly brought on by pollution because of the poisonous gases that are inhaled. Humans' immune systems and reproductive systems are also harmed by these harmful chemicals. In order to protect ourselves, the pollution issue in society needs to be reduced. IoT can be used to detect hazardous gases [10–13].

2. Methodology

Our IoT-based air pollution control system uses air quality control over a web server to display the results online. If the air quality reaches a certain level of toxicity and there are adequate concentrations of harmful gases such as CO2, smoke, alcohol, benzene, NH3, and NO2, a notice will be issued. The system detects and transmits data from air sensors to the microcontroller. The data is then stored on the web server by the microcontroller.

The approach of monitoring air pollution via IoT is depicted in Figure. 1. The graphic depicts how polluted air particles can be easily monitored using sensors. The air sensor generates the output of air samples in that area, while the noise sensor functions as a filter, removing noise from the air particles. The outputs of the air and noise sensors are supplied into the Arduino as inputs.

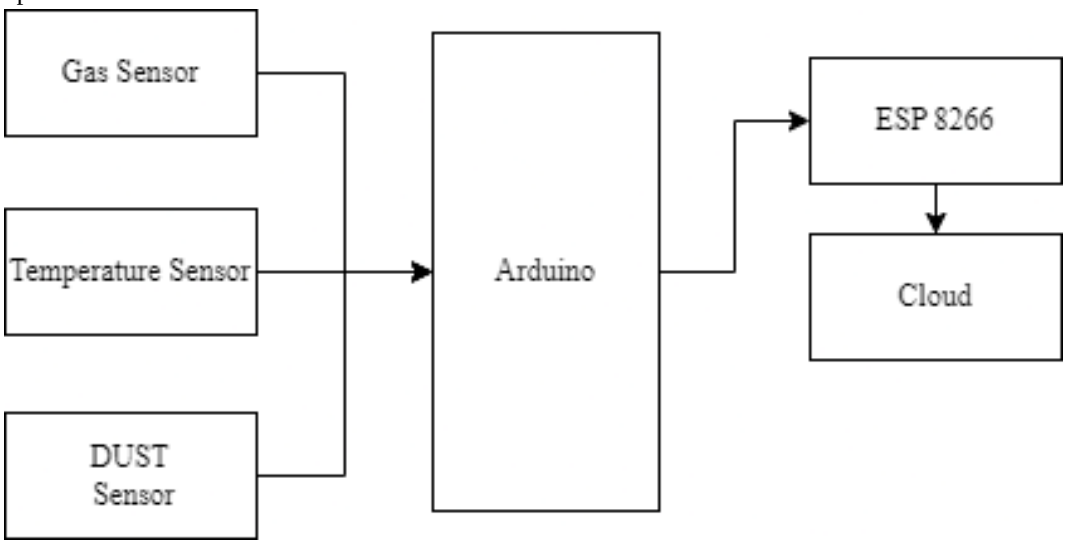

Fig 1: Block diagram of IoT based air quality monitoring system.

3. Literature review

An IoT-based air pollution monitoring system was investigated in this debate. This technology can be used to track air pollution in a specific location. Analysis and forecasts were also being carried out. This was accomplished through the use of a machine learning method known as recurrent neural network, specifically long short term memory (LSTM) [1]. Air pollution is relatively high in urban areas. The discharge of smoke from automobiles and hazardous gases from industries impairs urban air quality. As a result, wireless sensor networks (WSN) and low-cost ambient sensors were deployed for real-time monitoring of air quality in urban areas [2]. Pollution identification and monitoring is a critical duty in today's world. This research proposed employing wireless sensors and a data mining method to monitor air quality. Microcontrollers were used in this procedure to send data to web servers. For connecting the server to the internet, a Bluetooth module was developed [3]. An air quality monitoring system (AQMS) in accordance with IEEE standards was present. The GSM wireless communication module was employed in this process. The IoT sensor arrays were utilized to monitor harmful gases such as CO2, CO, NO2, and SO2 in real time. To plot the gas values in it, a graphical user interface (GUI) was created [4].

The Internet of Things-based environmental monitoring system for smart cities can now analyze air quality, humidity levels, and weather conditions. The data sent from the transmitter was received at the receiver, and the received data was then monitored and recorded using a graphical user interface. In addition, an Android app was created to monitor that data via a smart phone [5]. This research presented a system for monitoring and forecasting air pollution levels in urban areas. Air quality in urban areas was monitored and forecasted using IOT-based wireless sensor networks. Using a machine learning technique, the dissolved hazardous gases CO, CO2, and NO2 were measured [6]. An IoT application for low-cost wireless air quality monitoring was created. This system was implanted with electronics as well as software sensors capable of wireless connectivity, allowing for real-time monitoring of air quality. The Arduino technology was also used to link the server directly to the internet [7]. In this research, an IoT-based air pollution monitoring system that can observe air quality data without regard to location or space was proposed. The air quality measuring device and analyzer were employed in this system to monitor pollutants via LTE communication network and compare them to the results of the National ambient air quality monitoring information system (NAMIS) [8]. Because air pollution has become a big issue all over the world, this study was proposed to monitor the air quality in Pandacan, Manila. In order to communicate the data through this e-mail, a hardware consisting of a dust sensor, carbon monoxide sensor, and raspberry pi was utilized to monitor the air quality [9]. The goal of this article was to create air pollution monitoring systems based on the internet of things (IoT). Because pollution was causing people to become ill, IoT sensors and devices were proposed to monitor air quality in various areas of a smart city. Thus, we can eliminate pollution by using IoT-based sensors [10].

4. Proposed System

The proposed Air Quality Monitoring System is depicted in Figure 1 as a block diagram. MQ135 gas sensor and MQ2 LPG gas sensor identify air data. The MQ135 sensor is capable of detecting NH3, NOx, alcohol, Benzene, smoke, and CO2. As a result, it is dynamically sensored gas for our air pollution monitoring system. When linked to an Arduino, it will detect all gases and report the pollution level in PPM (parts per million). MQ135 gas sensor output will be in the form of voltage levels, which we must convert to PPM. So we utilized a library for the MQ135 gas sensor and the MQ2 sensor to convert the output to PPM.

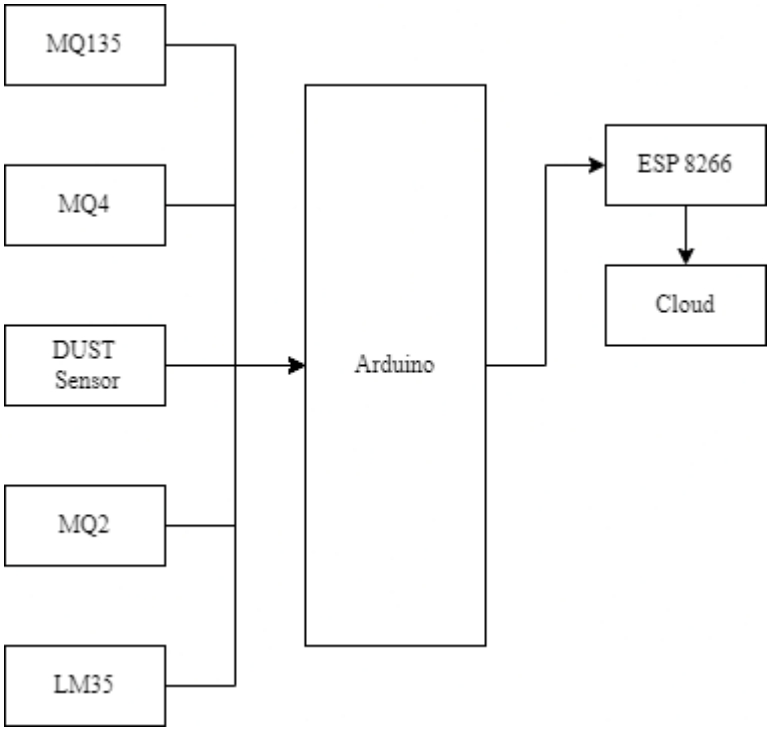

Figure 2: Proposed system of air quality monitoring system

The fundamental idea behind this system is to identify the gas using MQ135 and MQ2 gas sensors. The MQ135 sensor is capable of detecting NH3, NOx, Alcohol, Benzene, Smoke, and CO2. When the components are wired together in an Arduino, it detects all gases and provides the gaseous level in PPM (Parts per Million). The output of the gas sensor is converted to PPM using a library function of MQ135 gas sensor. The safe level of air quality is 350PPM. If the air quality level surpasses 1000ppm, it causes tiredness, headaches, and stuffy air. If the reading exceeds 2000PPM, it causes an increase in heart rate and other ailments.

4.1 Hardware components

Arduino UNO

The ATmega328P-based Arduino Uno is a microcontroller board. It contains 14 digital I/O pins (of which 6 can be used as PWM outputs), 6 analog inputs, a ceramic resonator operating at 16 MHz, a USB connection, a power jack, an ICSP header, and a reset button.

MQ-2 Sensor

MQ-2 is a flammable gas and smoke sensor that detects combustible gas concentrations in the air and outputs the reading as an analog voltage. The sensor can detect combustible gas concentrations ranging from 300 to 10,000 ppm. LPG, butane, propane, methane, alcohol, hydrogen, and smoke are all detectable by the MQ-2 gas sensor.

MQ-4 Sensor

MQ-4 detects methane concentrations in the atmosphere. The analog pin of the sensor then generates an analog signal proportional to the amount of CH4 in the air. An ADC microcontroller can be used to measure the analog output of a sensor.

MQ-135 Sensor

Ammonia (NH3), sulfur (S), benzene (C6H6), CO2, and other dangerous gases and smoke can be detected by the MQ-135 Gas Sensor. This sensor, like the others in the MQ series, has a digital and analog output pin. When the level of these gases in the air exceeds a preset limit, the digital pin swings high. The on-board potentiometer can be used to set this threshold value.

Dust Sensor

By detecting the concentration of dust, the Dust Sensor provides an excellent indication of the air quality in a place. The PM level in the air is calculated by counting the Low Pulse Occupancy time (LPO time) in a particular time unit. The LPO time is related to the concentration of PM. This sensor can offer reliable data for air purifier systems; it is sensitive to particles with a diameter of 1m.

ESP8266 Wi-Fi Module

Espressif's ESP8266 is a Wi-Fi-enabled system on chip (SoC) module. It is mostly used to create IoT (Internet of Things) embedded applications.

5. Implementation Technique

The entire system is designed using the block diagram of Figure 2. This system's software implementation followed the pattern shown in Figure 3.

In this implementation technique Arduino platform is being used to instruct the microcontroller monitoring the air quality in different area. The sensing part of this implemented circuit is MQ2, MQ135, MQ6 and dust sensor. Here the sensor not only measure the single parameter or single gas but also measure different parameters. The detected value of the sensor is sent by the Arduino Uno and Wi-Fi module to the Thingspeak server. The implementation technique of the air quality monitoring proposed system in Figure 3 shows that the sensor data and value is being ready after getting the power from power supply.

After detecting the sensor data, the microcontroller unit collect the data with the help of sensor and send it to the cloud through ESP8266 module. As this module is Wi-Fi based so the wireless network has to be established before operating this proposed system.

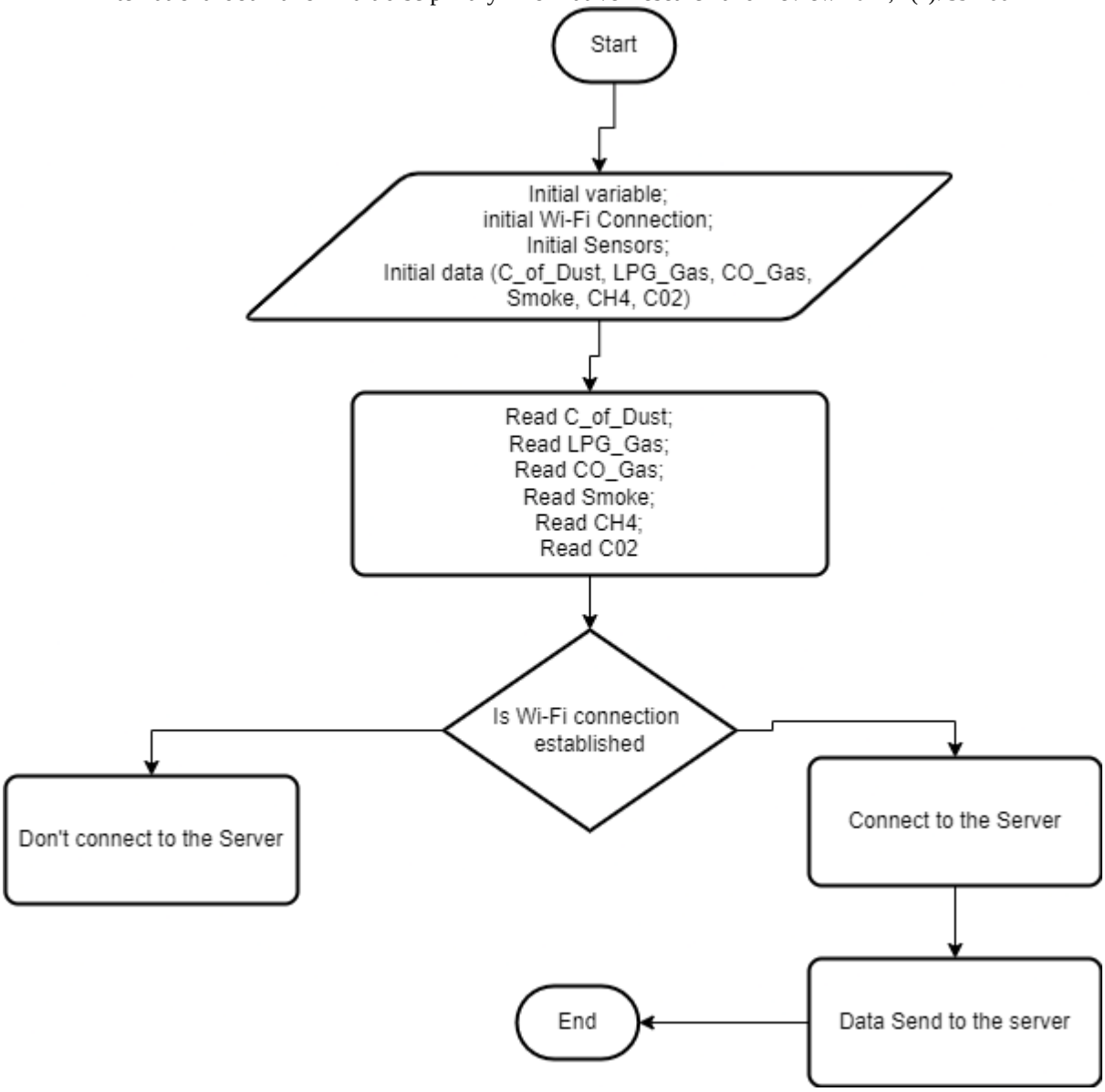

Figure 3: Flow diagram of Air quality monitoring system

6. Results and Discussion

6.1 Result

As a result, the objective of our research is to assess the quality of the exposed level in air quality. Our proposed system was created to assist a person in detecting, monitoring, and testing air quality in a specific location. The kit includes a smartphone application that predicts the degree of pollution throughout the user's whole path. This proposed air quality measuring kit, coupled with the integrated web app, can assist users in determining their degree of exposure to air pollutants. The app included the following features: real-time air quality indices, daily air quality reports based on user travel distance, and specific reports for air quality measurements based on locations. Air pollution is the most serious threat to our environment. Not only does it have an impact on the environment, but it also has an impact on human health. The smartphone application was created to monitor the system, which tracks how much the human has exposed in a day. The gas sensors were used to detect leakage gases, carbon monoxide, smoke, and propane. The sensor detects the gases, converts them from analog to digital, and shows the results in the application. The exposure level is expressed in parts per million (PPM) (Parts per Million). From the data Table 1 of device output we show that for different value of Carbon monoxide, carbon di-oxide, methane, LPG and dust sensor the processing device remark that which area's air is good for human and which area's air is not good for human being.

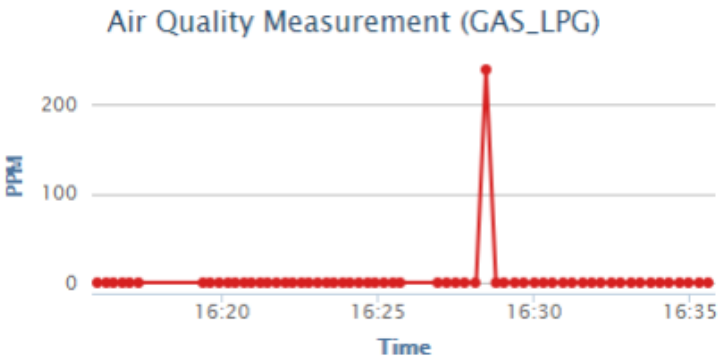

Figure 4: Sensor value for measuring LPG gas

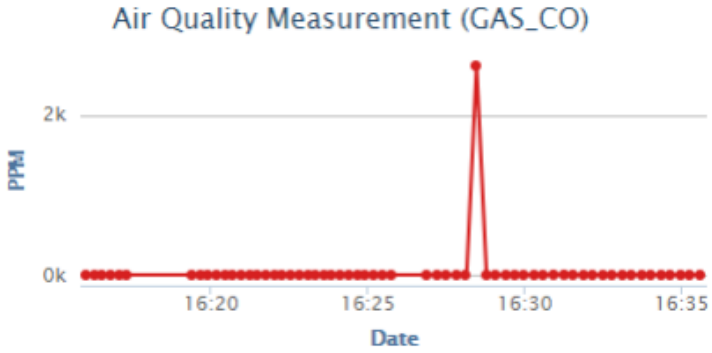

Figure 5: Sensor value for measuring CO gas

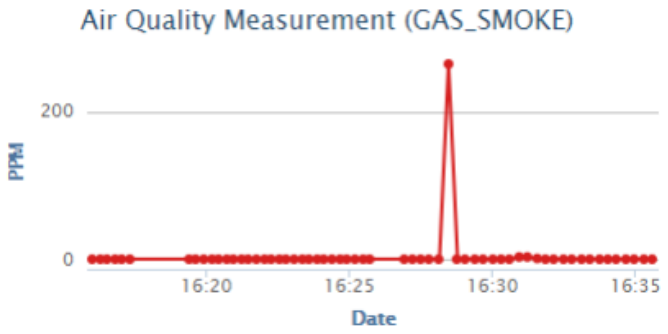

Figure 6: Sensor value for measuring Smoke

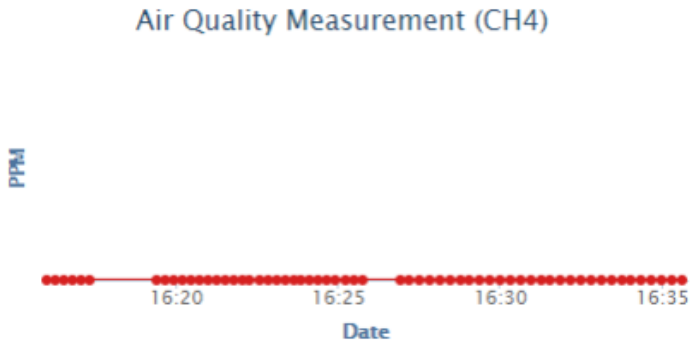

Figure 7: Sensor value for measuring CH_4 gas

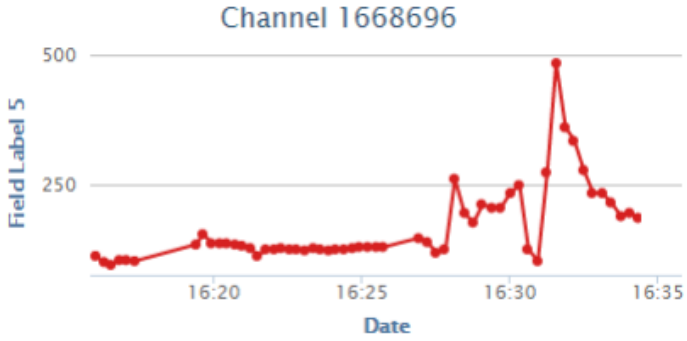

Figure 8: Data response in the server for DUST sensor

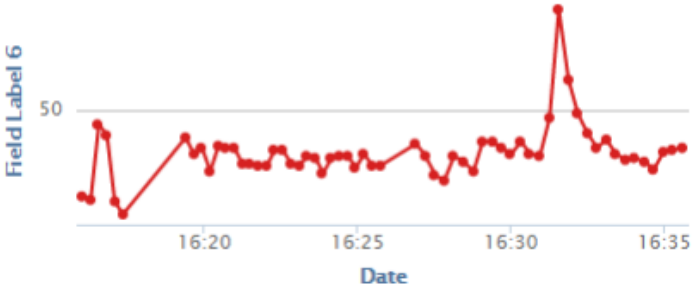

Figure 9: Data response in the server for Co2 gas

Table 1. *Sample data outputs from proposed system*

CO_2 (ppm)	CO (ppm)	LPG (ppm)	CH4 (ppm)	Dust sensor	AQI
42	1	284	22	31	Good
42	0	291	22	31	Good
45	1	295	24	32	Good
71	5	340	28	31	Moderate
74	8	364	28	32	Moderate
77	10	389	28	32	Unhealthy for sensitive people
78	15	460	30	34	Unhealthy for sensitive people

6.2 Discussion

Pollution was the most serious issue in smart cities and metropolitan areas. Many people had been ill as a result of the pollution. To solve the pollution problem, harmful gases in the air must first be detected. IoT technologies can be used to monitor these contaminants. IoT devices and sensors detected the harmful substances. It has been discussed that IoT sensors linked to certain places provide information to Arduino about the air quality in that area, and the Arduino then allows the data to be provided to a web server by connecting directly to the internet. The air quality in that area can be easily checked using a web server. As a result, it was found that employing an IoT-based air pollution monitoring system, pollution might be easily detected.

7. Conclusion

Every day, new invention and new technologies surround the planet. IoT is one of those things that takes all of these breakthroughs to the next level. IoT is a potential new technology that enables device interoperability and machine-to-machine communication to astounding levels. These characteristics compel me to greatly expand the accommodation of any electronic contraption used in normal everyday presence or in had some skill in distress by retrofitting IoT abilities to them. The Air & Sound control system is a step forward in contributing to a solution to the most serious threat. The air and sound monitoring system addresses the major issue of severely contaminated locations. It promotes innovative technology and effectively promotes the healthy lifestyle philosophy. This system includes elements that allow consumers to monitor the quantity of pollution.

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