IoT Based Indoor Air Quality Monitoring System Using GSM

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Abstract: **The following paper describes a model created to stop indoor hearth and different gas leakages performed because of gases like fuel, CO2, LPG, etc. As seen in variety of places like several large-scale industries, offices, buildings, activity services burst into flames that results in a large loss of life and information and different necessary materials. The dire ought to monitor air quality is incredibly obvious, attributable to raised industrial activities over the past years. Individuals ought to grasp the extent to that their activities have an effect on air quality. This project proposes a GSM primarily based pollution watching system. The system was developed by the Arduino UNO microcontroller. The pollution watching system was designed to watch, analyze and notice air quality in period applications. Air quality measurements were analysed by differing kinds of sensors, once the device detects gas or smoke the buzzer and led is activated and then the notification is sent to the registered mobile number. The air quality measurements captured by the designed system was accurate. The result was showed on the digital display and the user receives a notification if the fireplace or the gas level has exceeded on the designed hardware's display interface and could be accessed via the cloud on a smart device like a mobile phone.**

Keywords: GSM, Pollution, Arduino UNO, Air quality, Sensors, Smoke, Buzzer, LED

I. INTRODUCTION

Air pollution is major health hazard for humans and other life forms. It is deadly in nature and is responsible for lung infections, stroke, respiratory problem and impacts cognition. It exists both in outdoor environment and indoor spaces. Indoor air pollution is often under-estimated but it is 2-4 more times more than outdoor spaces. Thus, monitoring and controlling of indoor air pollution is vital. This is being done using IoT. With the advent of term IoT, roughly in 2008, enormous amount of work in environmental monitoring is being done. IAQ monitoring systems are one part of environment monitoring applications. Indoor air pollution is a risk factor for several world's leading cause of death, including heart disease, pneumonia, stroke, diabetes and lung cancer.

As a result of indoor air pollution, 1.6 million humans died prematurely in 2017 according to the Global Burden of Disease research. Further testing of the device and the platform will be implemented will be involved in future work. In this paper, the experiment focuses on testing the reliability of the device and implementing the platform, where more tests are essential to ensure data accuracy for long time periods. Ventilation system can be connected to the platform in addition. Thus, to improve the air quality whenever it is not up to the mark, the system can be automatically implemented.

Since this system is monitoring only four parameters, it can be expanded by considering additional parameters that cause the pollution especially by the industries. The developed system consumes too much power, so we can use solar power as an external source of energy in future and it will definitely improve the reliability of the system. Since we are using humidity sensor which detects moisture can be connected with Home Automation through which Air Conditioner can be started automatically.

In the future, IoT enabled air purifiers can also be developed and sync it with air quality monitoring system. Air quality monitoring systems focuses on the development of Wi-Fi systems that incorporate only one sensor.

It is a major public health concern in developed and developing nations due to the continued exposure to environments with substandard air quality. It is estimated that the pollutants accountable for substandard air quality cause nearly 2.5 million premature deaths per year world-wide. Notably, around 1.5 million of these deaths are due to contaminated indoor air and it is suggested that poor indoor air quality may pose a remarkable health risk to more than half of the world's population. Societal health problems associated with poor air quality disproportionately affects developed and developing

countries due to its link with industrialization – it is estimated that air pollution is accountable for the premature fatalities. Once airborne pollutants have been detected reformative action to improve air quality is often unchallenging to implement.

Air pollution has been a repeated health concern not only for mankind but also for animals, plants, oceans, aquatic life worldwide. Air quality monitoring is done manually via centrally located station in majority of the countries. Concurrently, many populated areas of the world lack continuous, long term air quality measurement. Due to the implementation cost, architecture, and individual requirements for monitoring stations, to date, the Geographic coverage of air quality monitoring networks has been restricted. Internet of Things (IoT) has become a very popular prototype in the modern wireless communication era. Distribution of all-over "objects" or "things" is the basic purpose of the IoT, which collects and exchanges data in order to achieve a common objective by means of mutual interactions. Access to monitored remote sensor data is provided by the networked connection of these physical objects to the Internet, so that it is possible to control the physical world from a distance. Integration with the Cloud infrastructure is a fundamental aspect of the Internet of Things, which hosts interfaces and web-based applications that enable the communication with sensors and external systems. Consequently, the Cloud computing infrastructure might provide data access and management features, for the purpose of collecting and managing data made available by smart objects. In order to check air quality status and trends, a real time monitoring of the existence and the concentration of air pollutants is necessary. IoT might help health departments to take the most suitable and effective decisions by continuous real time monitoring of outdoor pollutant levels, in case the environmental conditions become incompatible with the public health. In this dissertation work, a system is implemented for monitoring the air pollution based on Arduino and a prototype of this system has been designed, deployed it in Dept. of Civil Engineering, Dept. of Electronics, Dept. of Computer and IT, college hostel, Main entrance, Government College of engineering, Amravati. More over a website on Cloud-based platform that manages data collected from sensors and displays it has been designed. A comparison between five Cloud computing service models will be carried out. Finally, a design will be made and the system performance in terms of long-term operability, real-time measurement accuracy compared with nearby stations and feasibility for application in other location will be investigated.

II. COMPONENTS

A. Arduino Uno:

Arduino UNO: Arduino is an open source microcontroller that is easily programmable and it can be erased and reprogrammed again. It also acts as minicomputer just like other microcontrollers from which input can be taken and output can be controlled for many sending information over the internet. Arduino development board is used as hardware by Arduino UNO and Arduino IDE (Integrated Development Environment) which is a software for developing code is used. C and C++ programs are used so that the microcontrollers are easily programmable. Arduino has 14 digital input/output pins (of which 6 provides PWM output) and the microcontroller which is used is ATmega328.

Figure (1) Arduino UNO

B. DHT11 Humidity and Temperature sensor:

The DHT11 is a commonly used temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The operating voltage for the LCD Display is between 4.7V to 5.3V. It has a current consumption of 1mA.

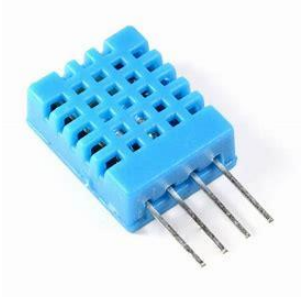

Figure (2) DHT11 Humidity and Temperature Sensor

C. MQ2 Sensor:

MQ2 gas sensor is an electronic sensor used for sensing the concentration of gases in the air such as LPG, propane,

methane, hydrogen, alcohol, smoke and carbon monoxide.MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas. This change in the value of resistance is used for the detection of gas.

Figure(3) MQ2 Sensor

D. GSM:

SIM900A GSM Module is the smallest and cheapest module for GPRS/GSM communication. It is common with Arduino and microcontroller in most of embedded application. The module offers GPRS/GSM technology for communication with the uses of a mobile sim. It uses a 900 and 1800MHz frequency band and allows users to receive/send mobile calls and SMS. The keypad and display interface allows the developers to make the customize application with it. Furthermore, it also has modes, command mode and data mode. In every country the GPRS/GSM and different protocols/frequencies to operate. Command mode helps the developers to change the default setting according to their requirements.

Figure(4) GSM

E. LCD Display:

The operating voltage for the LCD Display is between 4.7V to 5.3V. It has a current consumption of 1mA.The LCD module operates in 8-bit and 4-bit mode. The pin configuration of LCD Display is as follows LED Negative, LED Positive, Data pins from 0-7, R/W, RS, VEE, Vcc and GND.

Figure(5) LCD Display

F. Buzzer:

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (*piezo* for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. While buzzers seem to be impractical and undesirable due to the technological advancements, there are still instances in which buzzers and similar circuits may be used. Present day applications include ovens and microwave, electrical alarms, judging panels, electronic metronomes, car parkings etc.

Figure(6) Buzzer

III. SOFTWARE

A.Arduino IDE:

The Arduino Integrated Development Environment (IDE) is a prototyping platform enabling user to make different types of devices. It is a cross-platform

application for Windows, macOS, Linux which is written in functions from C and C++. This IDE is used to write and upload programs to Arduino compatible boards. With the help of 3rd party cores, the programs can be put on other vendor development boards also. It is open source software that is used for writing and compiling the code in the Arduino. It is an official Arduino software, which makes code compilation simple, even a common person with no prior technical knowledge can get their feet wet with the learning process.

IV. OBJECTIVE

Researches and policy makers are nowadays attracted to indoor air quality which is important as the external air quality. In certain sense, the air quality which is indoor must be paid more attention to than the external air quality as people mostly spend their time indoors. The environment in indoors are confined and closed as compared to external environment. Since the indoor environment is confined and closed, the gases and pollutants dilute less in this environment.

As the technology is advancing, work places have become automated using different types of machines and devices to carry out the tasks. These machines and devices emit various gases and pollutants which are exposed to the environment. The substances which are exposed are harmful to human health and if they are prolonged to these substances it can cause some serious disease. If they are exposed to the substances even for small amount of time it can cause multiple types of disease.

This paper proposes an Internet of Things (IoT) based indoor air quality monitoring system for tracking various gases and pollutants in air which are sensed by the commercially available sensors. The implementation will be done with an Arduino board connecting it with different types of available sensors. This allows the authorities to analyze and detect the air quality for a period of time and come to conclusion that is it dangerous or not. Also, the device detects the air quality and if the amount of gases or pollutants increase beyond a particular level it alerts the device holders by sending messages and mail through NodeMCU which will be connected to Arduino.

If the air quality in the surrounding goes above a particular level, the buzzer will also buzz and even message notification and mail will be sent. This will help in maintaining the air quality indoors and help everyone if there is emergency.

V. PROPOSED DESIGN

Arduino is an open source microcontroller that is easily programable and it can be erased and reprogrammed again. It also acts as minicomputer just like other microcontrollers from which input can be taken and output can be controlled for many sending information over the internet. It uses hardware known as the Arduino development board and software for developing code which is known as Arduino IDE (Integrated Development Environment). The microcontrollers are easily programable by using C and C++ language. Arduino has 14 digital input/output pins (of which 6 provides PWM output) and the microcontroller which is used is ATmega328.

The DHT11 is a commonly used temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The operating voltage for the LCD Display is between 4.7V to 5.3V. It has a current consumption of 1mA.

MQ2 gas device is AN electronic device used for sensing the concentration of gases within the air like LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide gas.MQ2 gas device is additionally referred to as chemiresistor. It contains a sensing material whose resistance changes once it comes connected with the gas. this transformation within the worth of resistance is employed for the detection of gas.

SIM900A electronic equipment will work with any GSM network operator SIM card similar to a mobile with its own distinctive signal. SIM900A GSM/GPRS electronic equipment is plug and play electronic equipment with RS232 serial communication supported. thus Advantage of victimization this electronic equipment are going to be that its RS232 port may be accustomed communicate and develop embedded applications. Applications like SMS management, information transfer, device and work may be developed. SIM900 electronic equipment supports options like voice decision, SMS, Data/Fax, GPRS etc. SIM900A electronic equipment uses AT commands to figure with supported options. Note that to be connected to a cellular network, the electronic equipment needs a SIM card provided by a network supplier.

The LCD module operates in 8-bit and 4-bit mode. The pin configuration of LCD Display is as follows LED Negative, LED Positive, Data pins from 0-7, R/W, RS, V_{EE}, V_{cc}, GND. Buzzer is used to alert people, if any gas crosses the threshold value and also if the temperature exceeds threshold value.

Using these components, it was possible to decide the air quality present indoors in places like homes, private offices, etc. MQ135 detects gases like LPG, propane, butane, etc. MQ2 gives the smoke concentration present in the room. Finally, the DHT11 humidity and temperature sensor helps in detecting the humidity/moisture and temperature present in the room. The output of the sensors is shown on the LCD display and the client gets an Email/SMS alert on his mobile if the smoke and temperature exceeds the threshold level.

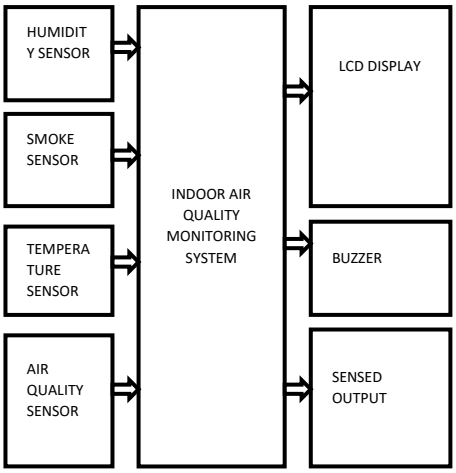

Figure. 7 Flowchart of proposed system

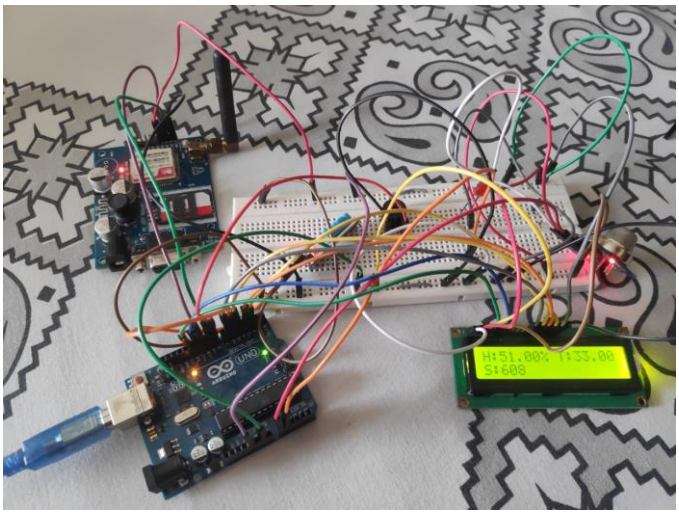

Figure.8 Arduino connections

VI. IMPLEMENTATION

We have taken many input data for our model. Arduino Uno is used which is connected with DHT 11 sensor, used to indicate humidity and temperature. We have also connected smoke and gas sensor which is MQ2. We have also used a buzzer and led. If the surrounding environment is changed i.e. if any smoke or gas leakage is detected the sensors will be activated and if the threshold value has been crossed the buzzer will buzz and led will glow and lastly we have added lcd display which will display the temperature, humidity and smoke quantity present in our environment and warn everyone if the threshold value exceeds. We have used GSM900A so when the threshold value is crossed it will also send a message to the mobile number which is registered. Different type of libraries are used to make this sensor workable with Arduino Uno like DHT, Adafruit_Sensor, LiquidCrystal. The working of the model is simple we have set threshold value for temperature and smoke. If there is any gas leakage or smoke detection in the surrounding the buzzer and led will be activated and the condition is simple first the code will check the smoke/gas and if the smoke/gas is above threshold the buzzer will be set and after that the code will check for temperature and will set the buzzer on if required. So when the gas or smoke is detected by the MQ2 sensor it will send a message “Smoke or Gas Detected”. And when the temperature exceeds a particular level it will send a message “Too Hot”, so the code will help to prevent the disaster before happening if smoke is released in house, building, society, offices, etc. It will be sensed by the MQ2 sensor and the buzzer will be set on and give more time to evacuate everyone. This will help to save more life during fire outbreak.

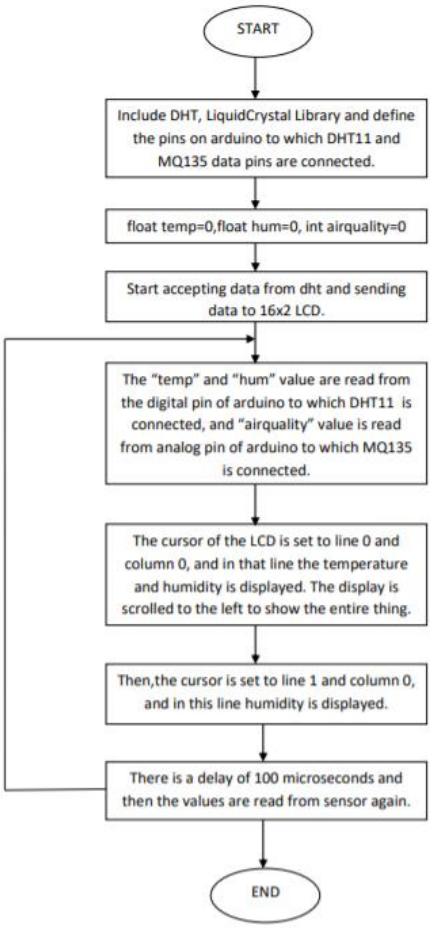

Figure.9 Flowchart of Implementation

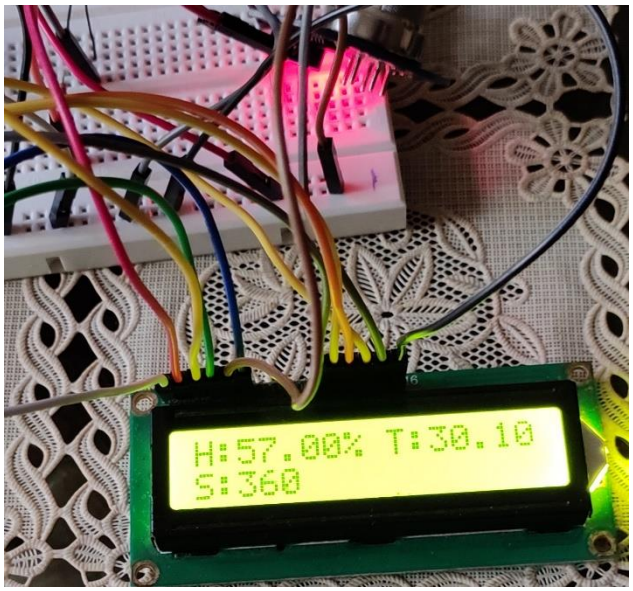

Figure.10 Display of Data

Figure.11

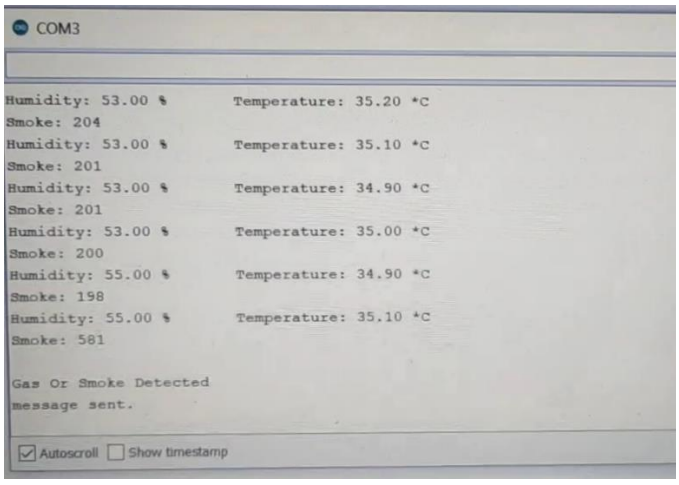

Figure. 12 Serial Monitor Data

VI. RESULTS AND CONCLUSION

The goal of the experiment was to perform an initial implementation of the platform to observe indoor air quality and avoid any quite gas outflow and hearth within the encompassing space. An air quality detector is extremely vital as a result of today pollution is simple to seek out.

For the pollution cannot be detected by human, it needs a tool as a reader of the air quality. By this analysis we are able to avoid pollution through observance the air quality frequently. The system to observe the air of atmosphere exploitation Arduino microcontroller, IoT technology is planned to boost quality of air.

With the utilization of IoT technology enhances the method of observance varied aspects of atmosphere like air quality observance and detective work venturous gases and avoiding gas outflow and hearth.

VII. SOCIAL IMPACT

Future work can involve any testing of the device and therefore the platform. During this paper, the experiment centered on testing the liableness of the device and implementing the platform, wherever a lot of tests are necessary to make sure information accuracy for very long time periods. Additionally, mechanical system are often connected to the platform. Thus, the system are often mechanically operated to boost the air quality whenever the air quality isn't good.

Successful and accurate air monitoring and control has numerous benefits to both humanity and their surroundings such as:

1. The data collected from air quality monitoring helps us assess impacts caused by poor air quality on public health.
2. Air quality information helps us confirm if a part is meeting the air quality standards devised by CPCB, United Nations agency or federal agency.
3. The data collected from air quality monitoring would primarily help us identify polluted areas, the level of pollution and air quality level.
4. Air quality watching would assist in crucial if pollution management programmes devised in a very vicinity square measure operating expeditiously or not.
5. Air quality information helps us perceive the mortality of any location because of pollution. Square measure able to conjointly assess and compare the short term and future diseases/disorders that are a results of pollution.
6. Based upon the information collected management measures are often devised for defence of atmosphere and health of all living organisms.

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