IMPLEMENTATION OF INDOOR AIR QUALITY MONITORING SYSTEM USING IOT AND GSM

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Abstract**—**Indoor Air Quality (IAQ) mainly refers to the quality of air inside buildings as represented by concentrations of pollutants and thermal (temperature and relative humidity) conditions that affect the health and comfort of people living indoors. According to Environmental Protection Agency, 96 percent of homes are victim to at least one type of indoor air quality (IAQ) issue. The most common IAQ problem could be small dust particles and paint fumes. When ignored, these contaminants can build up and increase allergies, asthma, and cause other health problems. Although poor indoor quality is pervasive among households, many homeowners aren't even aware of the problem. This paper proposes an IOT based indoor air quality monitoring system which tracks the indoor air pollutants like gases CO,NH3,temperature,humidity and tiny dust particles with the help of sensors and arduino. The collected information is displayed on the personal computer and along with dust density is provided on the LCD screen and also the data is can be accessed remotely through IOT platform and alert messages can also be sent to the administrator to warn the pollutant levels inside the building with help of GSM modem.

Index Terms-Indoor Air Quality, Internet of Things, Optical dust sensor, Dust density, GSM modem etc..,

I.INTRODUCTION

Air lets our living planet breathe—it's the mixture of gases that fills the atmosphere, giving life to the plants and animals that make Earth such a vibrant place. Broadly speaking, air is almost entirely made up of two gases (78 percent nitrogen and 21 percent oxygen), with a few other gases (such as carbon dioxide and argon) present in absolutely little quantities. It is the quantity (or concentration) of a chemical in the air that makes the difference between "harmless" and "pollution"[1]. Air pollution in and outside of people's homes is the world's biggest environmental health risk.Indoor Air Quality (IAQ) refers to the air quality of air within and around buildings, and more importantly it relates to the health and comfort of building occupants. Understanding and controlling common pollutants inthe indoors can help to reduce the risk of indoor health concerns.In India major sources of air pollution in homes are tobacco smoke and smoke from solid fuels with inefficient and leaky cooking stoves.Strong links have been established with exposure to air pollution and cardiovascular diseases,such as strokes and heart diseases,cancers, chronic obstructivepulmonary diseases respiratory diseases,including acute respiratory infections,poor birth outcomes etc..,[2].

This paper provides the unique IOT architecture for detecting the harmful indoor pollutants like CO,NH3,dust and smoke (major causes of indoor pollution) along with room temperature and humidity. It also provides the remote access of pollutant levels in the house or office environment for the administrator and process that data and if incase the certainlevelexceeded then the smart system sends an alert message to the owner.

This paper is organized into 5 sections. First one is introduction which deals with air quality and pollution meanings. Second section consists of literature survey which tells about the effects of harmful gases and also the works done previously. Third section consists of design and implementation of the indoor air quality monitoring system using IOT and GSM. The fourth section consists of result. The fifth section consists of conclusion.

II.LITERATURE SURVEY

Indoor pollutants which are of several types can be grouped into four principal sections based on sources which are combustion products, semi-volatile and volatile organic compounds released by building materials, furnishings, and chemical products. The principal combustion pollutants include carbon monoxide, Ammonia, and dust particles[3].Dust can provide critical information on consumer product chemicals in the indoor environment. First, it is a window into which chemicals are present indoors. Second, because SVOCs partition between air and dust in the indoor environment, dust concentrations can be used in equilibrium partitioning models to estimate air concentrations and characterize total residential intake with reasonable accuracy. Finally, characterizing exposures from indoor dust may have important implications for children's health[4].People may be exposed to harmful levels of CO in boiler rooms, breweries, warehouses, petroleum refineries, pulp and paper production, and steel production[5].The most common symptoms of CO poisoning are headache, dizziness, weakness, upset stomach, vomiting, chest pain, and confusion. CO symptoms are often described as flu-like. If you breathe in a lot of CO it is so harmful that it can lead to death. People who are sleeping or drunk can die from CO poisoning without any symptoms. Each year, more than 400 Americans die from unintentional CO poisoning not linked to fires, more than 20,000 visit the emergency room, and more than 4,000 are hospitalized[3]**.** NH_3 is the important factor leading to the grey haze, and one of the main causes of environmental problems of serious ecological imbalance, such as acid rain and air quality deterioration NH_3 emissions is the largest in the gas of containing N[3] . NH_3 is the only source of particulate NH4 + and alkaline gaseous substance in the gas. The NH_3 90 percent was converted to NH4 + , which was reacted with the acid in the atmosphere. There are NH4 + 84 percent photochemical reactions. NH3 exists in aerosol particles with NH4NO3, $(NH_4)_2SO_4$ and NH_4Cl binding mode(such as PM2.5)[4,5] . especially the haze formation process, they accounted for 30 percent to 70 percent of PM2.5 mass concentration[4]. Simultaneously, the NH3 accumulating in the atmosphere will be oxidized into N2O and NO, etc [6].And in indoors the major sources of NH_3 can be floor cleaning solutions which are commonly used in homes. Free water surface may generate excessive moisture and heat and have adverse effects on indoor environment and energy loss.

The works that are already done on indoor air quality monitoring had focused mainly on O3 emissions from photocopier machines[7] and CO,temperature and humidity and some other gases.In some more works some costly equipments like waspmote [8] are used in the place of gas sensors which make the equipment more costly. And also there are no efforts made for alerting the pollution levels inside the indoors. In the present work we are focusing mainly on cost effective equipment for monitoring dust(major indoor air pollutant),CO,NH3,Temperature and humidity which are mainly responsible for health effects in indoor areas.

III.IAQ MONITORING SYSTEM WITH IOT AND GSM

Internet of Things (IoT) is a network of physical as well as virtual objects that communicate with each other over the Internet[6]. In past days, all the physical objects are tagged and uniquely identified using RFID transponders and readers. In recent times, IoT has grown to the level of comprising various networks of applications, computers, devices and objects as well that are interconnected using mobile technologies like wired, wireless and mobile networks, Bluetooth, GPS system and other evolving technologies[7]. IoT consists of objects, sensor devices communication infrastructure, computational and processing unit that may be placed on cloud, decision making and action invoking system with the help of sensors, microcontroller units and actuators. Physical items are connected to the virtual world and can be controlled remotely which can serve as physical access points to Internet services which is going to rule the world in future.

3.1.SYSTEM ARCHITECTURE

This block diagram depicts the system architecture for monitoring indoor air quality fig.1.

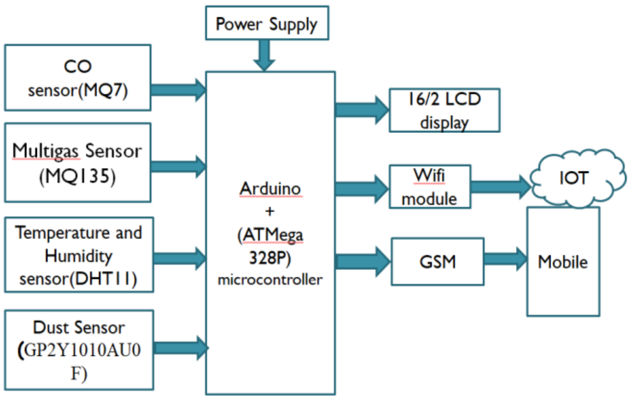

Figure 1:Block diagram of IAQ system

3.2.SYSTEM COMPONENTS

MQ-7: MQ-7 gas sensor is a low cost device that is very sensitive to CO and thus helps in the detection of this gas figure 2.The detection range is 10-10,000 ppm and heater voltage rate is about 5.0V±0.2V DC or AC(High) and 1.5V±0.1V DC or AC(Low) .The average response time is less than 150 seconds.[8]

MQ-135: The MQ-135 is a hazardous gas sensor used for air quality control and is suitable for detecting NH_3 (Ammonia), NO_x, alcohol, Benzene, smoke, CO_2, etc.figure 3.The detecting concentration scope of mq-7 for NH3 is 10ppm-300ppm.[9]

Figure2:MQ-7sensor Figure 3:MQ-135 sensor

DHT-11:Digital temperature and humidity sensor is a composite sensor contains a calibrated digital signal output of the temperature and humidity figure 4..For humidity it has accuracy at 25°C±5% RH. For temperature the range is 25°C±2°C.[10]

Figure 4:DHT-11 sensor Figure 5:dust sensor

*GP2Y1010AU0F:*It is a dust sensor build with optical sensing system figure 5.. An infrared emitting diode (IRED) and phototran-sistor are diagonally arranged into this device. It detects the reflected light of dust in air.

ARDUINO UNO: It is an open source microcontroller device with easily accessible software/hardware platform and iscompatible with many sensors available. The ATmega328 microcontroller is the MCU used in Arduino UNO R3 as a main controller. ATmega328 is an MCU from the AVR family; it is an 8-bit device, which means that its data-bus architecture and internal registers are designed to handle 8 parallel data signal. The application that arduino used in this project is shown in Fig.6. The software used with respect to arduino is arduino IDE. It connects with the arduino hardware and programs are uploaded to arduino board.

ESP8266 Module: It offers a complete and self-contained WiFi networking solution. It is used for mobile devices, wearable electronics and networking applications design.It is a low-power, highly-integrated Wi-Fi solution. A minimum of 7 external components with wide temperature range: -40°C to +125°CESP8285 — 8 Mbit flash embedded[12].

GSM SIM 900:GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine-SIM900A, works on frequencies 900/1800MHz[13].

3.3.DESIGN AND IMPLEMENTATION

This paper practically implemented is as shown in figure 6.It mainly aims in monitoring Indoor Air Quality. The implemented kit senses the harmful gases in the environment like CO gas which is sensed using MQ-7, NH_3 gas is sensed using MQ-135 sensor ,the dust and smoke levels are sensed using optical dust sensor *GP2Y1010AU0F* ,temperature and humidity are sensed using DHT-11.These sensors are connected to the arduino microcontroller ATmega 328 which is used for storing and processing the analog values output of the sensors. The arduino IDE environment is used for programming the microcontroller. With the help of code the values of the sensors are displayed on the 16/2 LCD which is used for onsite monitoring. The data of the sensor gases and dust density values are uploaded into the IOT platform where the administrator can be provided for remote access so that he can monitor the pollution levels of the home or office environments. If incase the administrator is busy so that he is unable to check levels all the time,there is also a feature of sending alert messages to the administrator if the pollution levels exceed the predetermined threshold level. The developed kit can be viewed as figure 6.

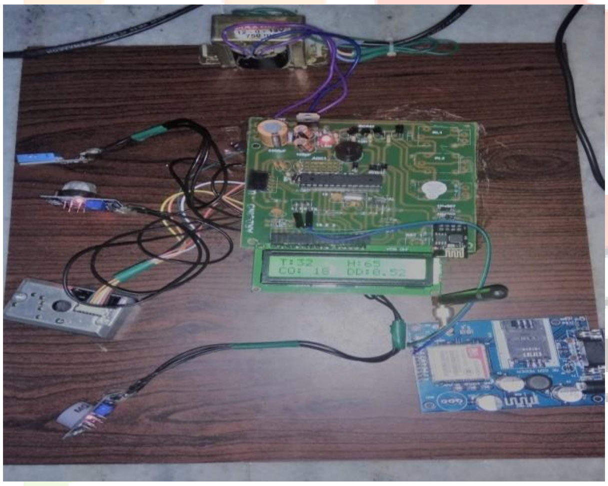

Figure 6:IAQ monitoring kit.

IV.RESULT

The result can be distinguished into three distinct parts. They are the display of data on LCD, display of data on IOT platform for remote access and also alerting the user when pollution lis high in environment. The values of temperature, humidity, CO and dust density are displayed on the LCD .

Figure 7:Output on LCD screen

The values of several gases are displayed on LCD as figure 7.The values of gases like CO,NH_3,temperature,humidity and dust density verified on different dates are shown below:

The value of CO in ppm versus date is displayed as figure 8 and the value of NH_3 in ppm versus date is displayed as figure 9.

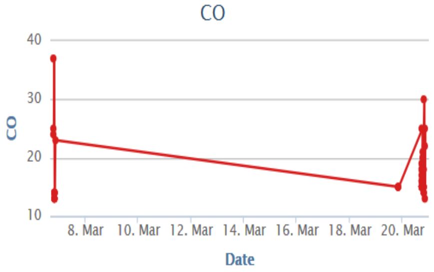

Figure 8:CO in ppm versus date

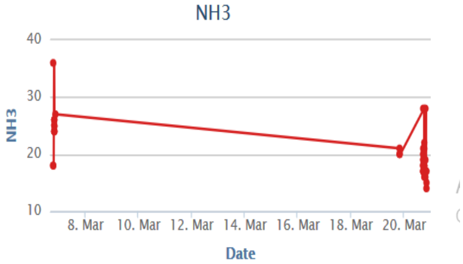

Figure 9:NH_3in ppm versus date

The values of temperature in Celsius versus date is displayed as figure 10and the values of humidity in percentage versus date are displayed as figure 11.

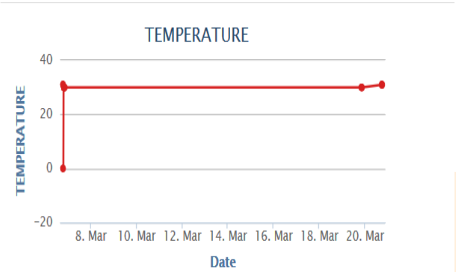

Figure 10:Temperature in Celsius versus date

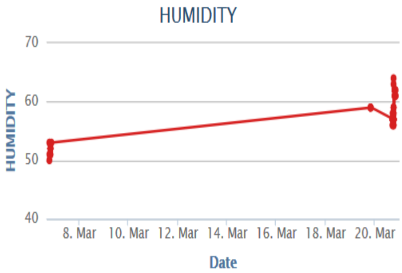

Figure 11:Humidity in % versus date

The value of dust density in mg/m^3 versus date can be displayed in figure 12.

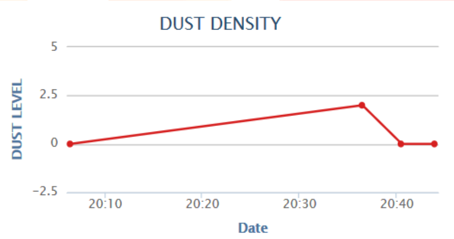

Figure 12:Dustdensity in mg/m versus date

Once the threshold levels exceed, it is indicated by the buzzer and also SMS is sent to the administrator as shown in figure 13 & 14.

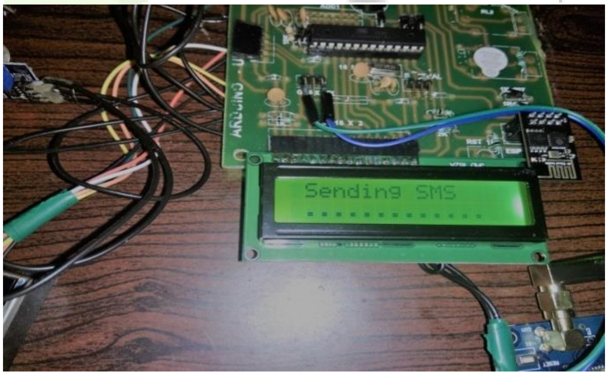

Figure 13:Sending SMS

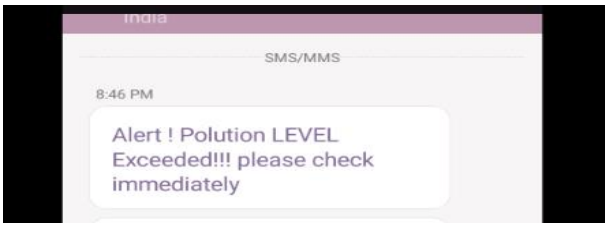

Figure 14:Generated MESSAGE

V.CONCLUSION

Hence a reliable low cost IAQ monitoring system which can measure 5 air quality parameters was developed including the dust which is a major indoor air pollutant. This system provides remote access of data in terms of graph and tabular form values for research work on pollution in required buildings and also sends the alert message to the user whenever pollution levels are high so that the indoor air environment is always under the control. The reduced cost of the system compared to the other available system may encourage more people to use this system which will ultimately help in improving the indoor quality of air.

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