International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

MONITORING INDOOR AIR QUALITY IN INDUSTRIES

Maha Lakshmi B[1], Nirmal Kumar S[2], Ilakyaah B[3], Dr Kavitha Balamurugan[4]

[1]*Maha Lakshmi, student, Dept. Electronics and Communication Engineering, KCG College of Technology.*
[2]*Nirmal Kumar, student, Dept. Electronics and Communication Engineering, KCG College of Technology.*
[4]*Dr Kavitha Balamurugan Head of the Department & Associate Professor*
KCG College of Technology, Chennai-97, Tamil Nadu, India.

Abstract - *In-today's world the rapid and frequent development of economy and production activities has led to reduce the quality of air. Many studies have shown that reducing air quality not only brings serious damage, but also causes negative side effects in human health. Till now Wireless Sensor Networks (WSNs) have been used to monitor the presence of gas in the surroundings. This system is cost efficient but it has a major drawback where a network of sensor nodes has to be developed with an appropriate routing protocol to cover a large indoor environment, but developing a network of sensor nodes for large areas like industry or a building introduces difficulty during its implementation. Since, it requires a very large area for network coverage and also, thousands of sensor nodes have to be placed in a network. This scenario also requires a multi hop communication because most of the sensor nodes are far away from the gateway so they cannot communicate directly with the base station. To overcome the above-mentioned problems, we have implemented our system using IoT where microcontroller is used as a major platform to which sensors are connected. It takes information about the surrounding environment through sensors and sends it to the cloud which can be accessed anytime and anywhere with the help of the internet. Then, it sends the information to the safety and security team in the industry through the mobile application.*

Key Words: indoor air quality, sensor, microcontroller, IOT, cloud.

1. INTRODUCTION

Even though monitoring air pollution is a complex task, it is important. According to the Environmental Protection Agency (EPA), indoor air pollution may be two to five times worse than the air outdoors. Traditionally, the data loggers were used to collect data periodically and this was very time consuming and quite expensive. The monitoring and control of indoor air quality is an important task with the aim of ensuring suitable working and living space to the workers. The air quality monitoring includes monitoring of various parameters like temperature, humidity, air quality, etc. All these parameters are not easy to be monitored and controlled. Indoor air quality can be affected by various parameters like temperature, humidity, volatile organic compounds (VOC), particulate matter (PM), Carbon Monoxide (CO) etc. Temperature and humidity range must be between 24.5 - 28 °C 23 - 25.5 °C and 30% - 60% respectively for indoor environment in industries .Particulate matter of size 2.5 (PM 2.5) is one of the important element that causes air pollution .It is formed by the combination of solid particles and liquid droplets suspended in the air which causes adverse health problems to human when they exceeds their permissible level(PM 2.5<10mg/m3).These PM 2.5 particles can also be exposed to the environment by burning candles. Carbon-monoxide is a form of gas found in air which cannot be detected by humans since it is tasteless and also not visible to human eyes. It can be exposed to the indoor environment in industry during the steel making process or through the smoke evolved from soldering. In this paper, we present our IoT solution for monitoring indoor environments in industries. We focus mainly on the parameters that determine the indoor air quality inside the industries. Our work is based on the microcontroller board and it uses various sensors to measure the indoor air quality in industries. The Arduino Uno is used as a microcontroller platform which gathers all the data from various sensors using Node MCU which is responsible for sending the recorded data to the cloud. Thing speak is an open source cloud platform to store the real time sensor data and also used to plot graphs, charts, create plugins and apps for merging with web services and firebase is used as a mobile and web application development platform.

1.1 Objective:

The objectives as follows:

- To determine the concentration of unwanted toxins and chemicals in the air that causes pollution.
- To measure the gas present in air as percentage.
- To transfer data to the cloud and to the application which gives further information to the workers?
- To provide a real time air pollution monitoring system.
- To build a cost efficient, portable system.
- Depending on the sensor data, serious health issues to the people working in industry can be avoided.

2. PROPOSED SYSTEM

The real time monitoring of indoor air quality in industries can be designed by the following hardware architecture with the help of IoT platforms. In the proposed system we have combined an Arduino Uno microcontroller with several sensors like MQ7, MQ2, MQ135, and DHT11 to detect Co, Smoke, and LPG, temperature and humidity and also other harmful pollutants. The designed system helps to monitor the indoor air quality and provide immediate solution. This system has been designed in such a way to work efficiently for monitoring air pollution in industries.

The air pollution detection system uses various sensors. These sensors are light in weight and portable which is connected to the Arduino Uno microcontroller board. The Arduino Uno microcontroller is a rapidly developing microcontroller board and also widely used in many areas which is based on the ATmega328p.It can be connected to computer with a simple USB cable and it can be charged using battery or ac-dc convertors. Each sensor is connected to the Arduino Uno using jumper wires. The sensors connected to the microcontroller board measures the concentration of unwanted particles suspended in the air and it sends the data to the microcontroller board where it is processed. The current results are uploaded in the cloud server. The mobile application will compare the current result with the permissible level and displays the necessary instruction. The permissible level is obtained from the study of a datasheet.

3. DESCRIPTION

3.1 Methodology:

The detected values by the sensors are processed by using the microcontroller board which sends the value directly to the cloud server. Then the current results are compared with the predefined values, which is already stored in the cloud and displays the final result in the mobile application.

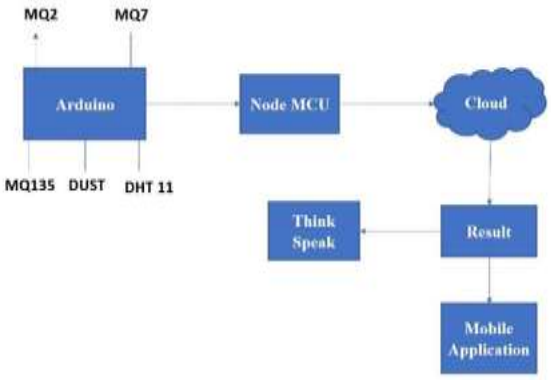

Figure 3.1 Block Diagram

Figure 3.1 represents the block diagram of indoor air quality monitoring systems. The MQ 2, MQ 7, MQ 135, Dust, DHT 11 sensors are connected to the Arduino Uno microcontroller board. Each sensor is connected to the Arduino Uno microcontroller board using jumper wires.

The sensors connected to the microcontroller board measures the gas and PM particles in the air and it sends the data to the Node MCU. Then the Node MCU sends the data to the cloud server, and then the result will be shown in web application and mobile application.

3.2 Modules description

3.2.1 Arduino Uno:

An Arduino Uno is a microcontroller used for building and interfacing various sensors and devices required for a given project. It allows uploading sketches/programs into the microcontroller memory. It consists of both a physical programmable circuit card (often mentioned as a microcontroller) and a software, or IDE.

Figure 3.2.1

Arduino Uno is very valuable and consists of a USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication by using Tx and Rx pins.

3.2.2 I2C Connection:

Inter-integrated circuit may be a serial bus interface connection protocol. It is also called as two wire interfaces, since it uses only two wires for communication. The two wires are SDA (serial data) and SCL (serial clock). I2C is acknowledgement-based communication protocol.I2C works on two modes namely:

1. Master mode
2. Slave mode

SDA wire is used for data exchanging between master and slave devices. SCL is used for synchronous clock in between slave and master devices. Master device initiates communication with the slave device. Master device requires slave device address to initiate conversation with a slave device. Slave device responds to master device when it is addressed by a master device.

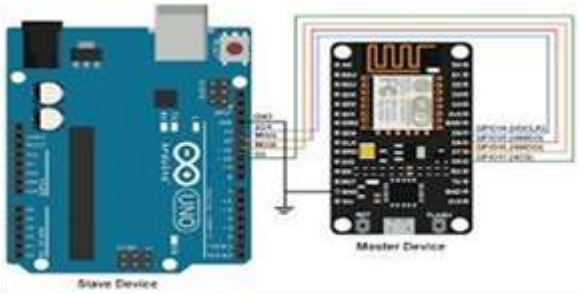

Figure 3.2.2

3.2.3 Node MCU:

Node MCU is an open source IoT platform, which incorporates firmware which runs on the ESP8266 Wi-Fi Module from Express if systems and hardware which is predicated on the ESP-12 module.

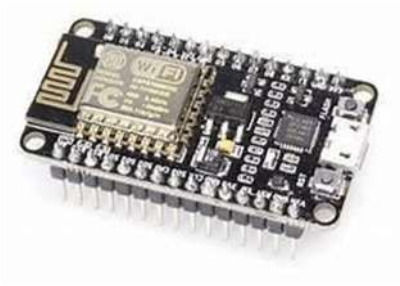

Figure 3.2.3

Node MCU board consists of ESP8266 Wi-Fi enabled chip. Node MCU has Arduino like Analog (i.e. A0) and Digital (D0 – D8) pins on board

4. SENSORS

4.1MQ2 sensor:

MQ2 gas sensor is an electronic sensor used for sensing the concentration of gases within the air like LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide gas this sensor works on 5v DC voltage. It can detect gases in the concentration from 200 to 10000ppm.

Figure 4.1.1

4.2 MQ7 Sensor:

The MQ7 may be a simple-to-use Carbon Monoxide (CO) sensor suitable for sensing CO concentrations within the air. It can detect CO-gas concentrations from 20 to 2000ppm. The sensitivity can be adjusted by the potentiometer.

Figure 4.2.1

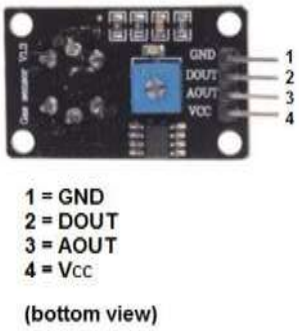

Figure 4.2.2

4.3 MQ135 sensor:

This sensor measures general air quality because it's sensitive to several gases and VOCs (Volatile Organic Compounds) including formaldehyde, benzene, ammonia (NH3), nitrogen oxides (NOx), alcohol, smoke and carbon dioxide (CO2).It consists of a small sensing material whose conductivity is lower in clean air and higher in polluted air, thus making the sensor very useful while detecting dangerous gases. The sensor ionizes the gases which are available in contact, making changes within the resistance of the sensing material.

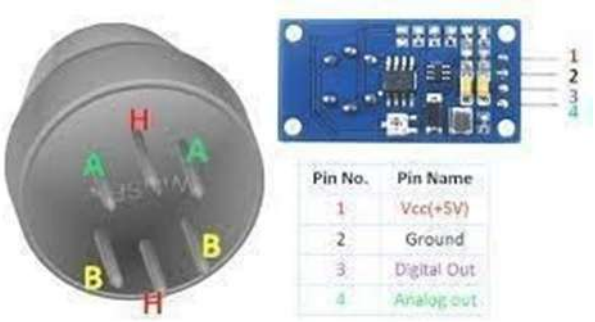

Figure 4.3

4.4 DHT11:

DHT11 sensors have been used to measure temperature and humidity levels of the surrounding. This sensor 0is often easily interfaced with any microcontroller like Arduino, Raspberry Pi etc.... to measure humidity and

temperature instantaneously. DHT11 sensor is available as a sensor and as a module.

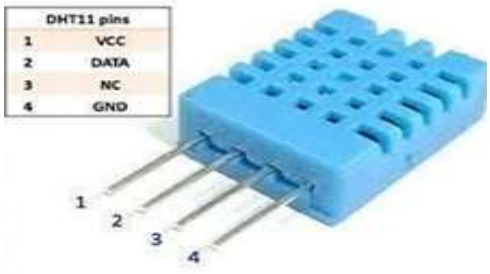

Figure 4.4

The temperature range of DHT11 sensors is from 0 to 50 degree Celsius. Humidity range of this sensor is from 20 to 80% with 5% accuracy. DHT11 is little with operating voltage from 3 to five volts. The maximum current used while measuring is 2.5mA.

4.5 Dust sensor:

Dust sensor is an optical air quality sensor, designed to sense dust particles with small size. An infrared emitting diode and a phototransistor are diagonally arranged into this device, to permit it to detect the reflected light of dust in air. To measure the ppm levels of PM 2.5 particulate matters, this sensor has been interfaced with the Arduino Uno.

Figure 4.5

5. WEB SERVICES:

One of the main aims of this research work is to make the real-time data available to authenticate users anywhere in the world. This is possible using a cloud platform which can store the real-time data readings and output is displayed in the form of graphs. In this research work, Thing Speak is chosen due to its ease of use and user-friendly interface.

5.1 Android Application:

The app designed in the MIT App Inventor is created in such a way that it fetches the data in real time from Thing Speak with the help of an API. The readings of the various sensors along with the date and time are displayed in a graphical format in the app. Applications are handy and they are easy to access through our mobile phones. A user must to simply check in with an Email or with Google to further witness the content of the appliance

6. RESULT:

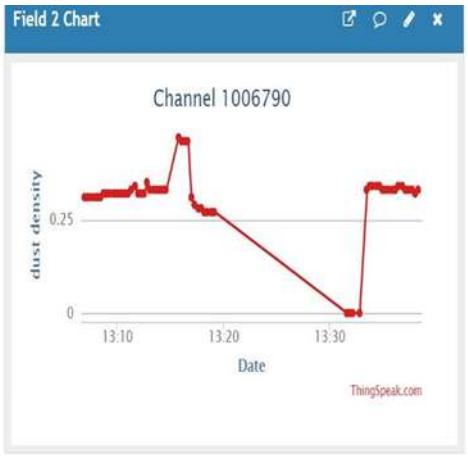

Figure 6.1

The above **Figure 6.1** shows the graphical result of Particulate matter of size 2.5(Pm2.5) density in the surrounding area using the data received from dust sensors. The above graph is resulted from an experiment that we made in the classroom and in Nokia IT solutions. The minimum peak value (0.24ppm) represents the dust density in the classroom and in Nokia IT solutions. The maximum peak value (0.58ppm) is obtained by lighting the candle which is blown off after some interval and the smoke evolved from the candle is measured which gives maximum peak value. It is understood from the graph that the minimum peak value is 0.24ppm which represents that the surrounding is suitable for human survival and maximum peak value is 0.58ppm which represents that the surrounding is moderately polluted by dust.

Figure 6.2

The above **Figure 6.2** shows the graphical result of CO density in the surrounding using the data received from MQ7 sensor. Carbon-monoxide is a poisonous gas which affects human health adversely. We have conducted an experiment in our classroom and in Nokia IT solutions in order to detect the level of CO in the air and the result is expressed in the graphical from (fig 6.2). The minimum peak value represents the CO density in the classroom and in Nokia IT solutions. The maximum peak value is obtained by lighting the candle and it is blown off after some interval and the smoke evolved from it is measured which gives maximum peak value. It is understood from the graph that the minimum peak value is 198ppm which represents that the surrounding is suitable for human survival and maximum peak value is 320ppm which represents that the surrounding is moderately polluted by carbon-monoxide.

Figure 6.3

Figure 6.3 shows the graphical result of the data received from the MQ 135 sensor. This sensor measures the air quality of the surrounding. The above graph is resulted from an experiment that we made in our classroom and in Nokia IT solution in order to detect the quality of air by measuring the pollutants suspended in the air. The minimum peak value represents the result of the experiment that is conducted in our classroom and in Nokia IT solutions. Another case is done by lighting the candle which is blown off after some interval and the smoke evolved from the candle is measured which gives the maximum peak value. It is understood from the graph that the minimum peak value is 30ppm which represents that the surrounding is suitable for human survival and maximum peak value is 140ppm which represents that the surrounding is moderately polluted.

REFERENCES

[1] Muthu Kumar.Setall "IoT based air pollution monitoring and control systems"; Proceedings of the international conference on inventive research in computer application (ICIRCA): available in: 10.1109/ICIRCA.2018.8597240: 2019.

[2]. IsmailaB.Tijanietall "Wireless sensor node for indoor air quality monitoring system"; Advance in science and engineering technology international conference (ASET) available in: https://doi.org/10.1109/icaset.2018.837 6839;2018.

[3]. Sungjun Kimet all "Development of an IoT based indoor air quality monitoring platform"; available in: https://doi.org/10.1155/2020/8749764; Republic of Korea; Jan 14 2020.

[4]. J.Duttaetall ,"Air sense: Opportunistic crowd-sensing based air quality monitoring system for smart city", In the Proceedings of the IEEE SENSORS: available in: https://doi.org/10.1109/ICSENS.2016. 7808730 30: Oct.-3 Nov. 2016.

[5]. Rui Pitarmaet all, "Monitoring Indoor Air Quality for Enhanced Occupational Health ", Journal of medical systems: available in: 10.1007/s10916-016-0667-2: February 2017.