

IoT Based Air Quality Detection and Monitoring System

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Abstract- The tremendous increase in the level of unclean emissions from industries and automobiles including the growth of civilization has resulted to the creation of serious environmental issues like greenhouse effect and diseases. Poor air quality is extremely difficult for human beings to feel or sense; thus, most people cannot tell whether or not indoor air quality is bad. In light of the aforementioned, there is an imminent need for an efficient, effective and widely-accessible indoor air quality monitoring system that can provide an intuitive sense of air quality conditions in indoor environments. In this project, an air pollution monitoring system is proposed. Arduino Uno microcontroller was used as the backbone to develop the wireless sensor network system. In order to monitor and analyze air quality in real-time and log data to a remote server whilst keeping the data updated over the internet, the air pollution monitoring system was designed for this particular purpose. Parts per Million (PPM) was used as a metric to obtain air quality measurements which was analyzed using Microsoft Excel. The result was displayed on the designed hardware's display interface and could be accessed via the cloud on any smart mobile device.

Key words: Air, Air Quality, Parts per Million, Arduino Uno, Microcontroller, Internet of Things (IoT), Sensor

I. INTRODUCTION

Atmospheric conditions continue to deteriorate each year due to the growth of civilization and increasing unclean emissions from industries and automobiles. This has resulted to the creation of serious environmental issues like greenhouse effect and diseases. Although air is an indispensable resource for life, many people are indifferent to the severity of air pollution or have only recently recognized the problem [1]. Air pollution is the presence of one or more contaminants in the atmosphere such as gases in a quantity that can harm humans, animals and plant [2]. Any change in the natural composition of air may cause grave harm or life-threatening diseases to life forms on earth. The effect of air pollution ranges from difficulty in breathing, coughing, bronchitis, pneumonia, lung cancer and other respiratory diseases [3-4].

According to the World Health Organization (WHO), recent studies have shown that 90 percent of the population now breathes polluted air, and air pollution is the cause of death for 7 million people every year [5-6].

Average person spends an estimated 90% of their time indoors so that poor indoor air quality (IAQ) poses a substantial risk to public health. Indoor air pollution has been consistently

ranked by the US Environmental Protection Agency (EPA) and its Science Advisory Board to be among the top five environmental public health risks [7].

Poor air quality is extremely difficult for human beings to feel or sense; thus, most people cannot tell whether or not indoor air quality is bad. Most people think indoor air quality is better than outdoors, while studies indicate that indoor levels of pollutants may be two to five times higher than outdoors [7].

Therefore, there is an imminent need for an efficient, effective and widely-accessible indoor air quality monitoring system that can provide an intuitive sense of air quality conditions in indoor environments. An effective monitoring system will help to identify the presence of harmful gases if any. This can be realized by implementing sensors which can detect the various gases

In this paper, we present a low-cost wireless IAQ sensor network system developed using Arduino, WIFI modules, and micro gas sensors that can monitor, analyze and log data about air quality to a remote server and keep the data up to date over the internet

The remainder of the paper is structured as follows. Section 2 presents the review of related work. Section 3 describes the methodology of the proposed Indoor Air Quality (IAQ) system. Section 4 discusses the result. Finally, Section 5 concludes the work.

II. RELATED WORKS

Several monitoring system have been proposed recently for air pollution monitoring both in homes and the external environment. For example, a low-cost indoor air quality monitoring wireless sensor network system was developed using Arduino, XBee modules, and micro gas sensors in [8]. The system developed is capable of collecting six air quality parameters from different locations simultaneously. A linear least square estimation-based method was used for sensor calibration and measurement data conversion.

Similarly, [9] proposed a low-cost pollution monitoring system. The system utilized semiconductor gas sensors with Wi-Fi module to measure concentration of target gases such as CO, CO₂, SO₂ and NO₂. A Raspberry Pi micro-computer was also provided to act as a base station to handle data

transmitted from the nodes and act as a webserver for data visualization.

Recent times have witnessed a changing kaleidoscope of the air pollution monitoring paradigm due to advancements in wireless communication and sensor technology. The creation of smart environments in which objects interact and cooperate with each other has been enabled by Internet of things (IoT) [10]. The researchers in [11] employed Raspberry-Pi and IoT to monitor the leakage of toxic gases and hence the level of pollution in order to prevent fatal accidents. MQ135/6/7 gas sensors were used to sense the poisonous gases and a Wi-Fi module connects the whole process to the internet and LCD is used for the visual Output. The authors in [12] implemented a model that monitors and analyze air quality in real-time and log data to a remote server, keeping the data updated over the internet. The model obtained air quality measurements based on the Parts per Million (PPM) metrics using an Arduino Uno microcontroller, Wi-Fi module 8266, MQ135 Gas Sensor and a 16 by 2 liquid crystal display (LCD) Screen.

In [13], an IoT based air pollution monitoring system was designed in conjunction with a web server that triggered an alarm whenever the air quality drops below the threshold. To achieve real-time monitoring, the air quality in parts per million was displayed on a Liquid Crystal Display (LCD) screen as well as on a webpage by the model.

In likewise manner, [14] proposed an air pollution and noise monitoring system that was IoT based. Raspberry Pi was used to detect the noise and the level of air pollution in the environment. An IoT based air pollution monitoring system together with an upcoming, long-range communication medium LoRa was used to display real time data at all critical locations in the city [15]. The authors argued and went on to perform an empirical study to prove that LoRa performs better in case of large deployment areas, is beneficial and also cost effective.

[16] designed an IoT-based indoor air quality monitoring platform, consisting of an air quality-sensing device called "Smart-Air" and a web server. This platform is dependent on IoT and a cloud computing technology to monitor indoor air quality in real time and anywhere. Smart-Air has been developed to efficiently monitor air quality and transmit the data to a web server via LTE in real time. The device is composed of a microcontroller, pollutant detection sensors, and LTE modem to measure a concentration of aerosol, VOC, CO, CO₂, and temperature-humidity.

III. METHODOLOGY

The project is aimed at developing a system capable of monitoring the level of pollutants in the air. The proposed system was developed using Arduino Uno, WIFI module and MQ135 gas sensor. This air quality detection and monitoring system provides real time data which can be accessed from computers and mobile devices. The block diagram of the proposed system is illustrated in Figure 1.

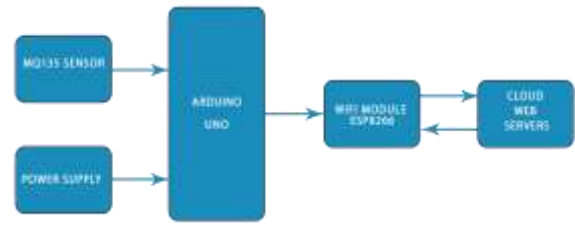


Fig 1. Block diagram of proposed air quality detection and monitoring system

3.1. System Design

The MQ135 Gas sensor was used to collect air data. The sensor was calibrated to ensure that the analogue output from the sensor is proportional to the concentration of the pollutants being measured in parts per million (ppm). The data is transmitted via WIFI module using the internet to the cloud servers, this information can be retrieved via Smart phone or web enabled devices. The transmission and retrieving of data happens in near real time. The data of the parameters being measured are displayed on a 16*2 LCD screen. An alarm would sound in the event that any pollutant reaches dangerously high levels or if the WIFI module fails to transmit information collected to the Cloud.

3.2 Mathematical Analysis of Proposed Air Quality Detection and Monitoring System

Pollutants make up a small percentage of air we breathe and their level of concentration is measured in parts per million (ppm) or percentage.

Conversion factors include the following:

$$1 \text{ ppm} = 1.145 \text{ mg/m}^3$$

$$1 \text{ mg/m}^3 = 0.873 \text{ ppm}$$

$$1\% = 1/100$$

$$1 \text{ ppm} = 1/1000000$$

$$1 \text{ ppm} = 0.0001\%$$

Table 1 shows PPM to percentage conversion.

Table 1. PPM to Percentage conversion

Parts per Million (ppm)	Percent (%)
0	0
5	0.005
50	0.005
500	0.05
1000	0.1

IV. RESULTS AND DISCUSSION

The measured results for pollutants parameters such as SO₂ and CO are displayed below in Fig.2 and Fig.3.

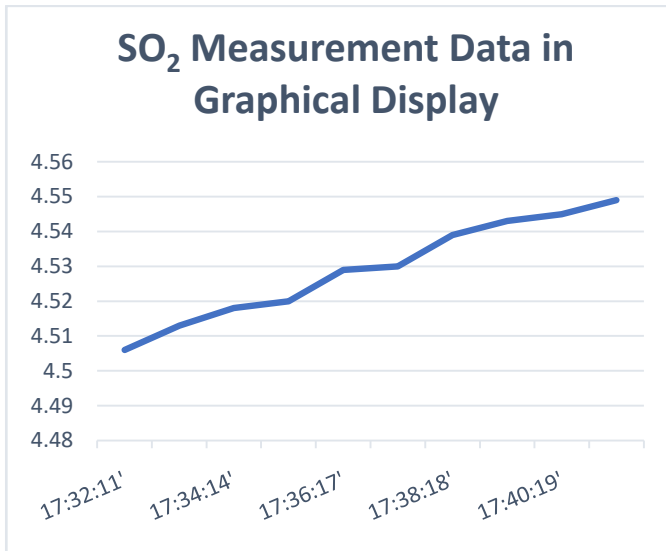
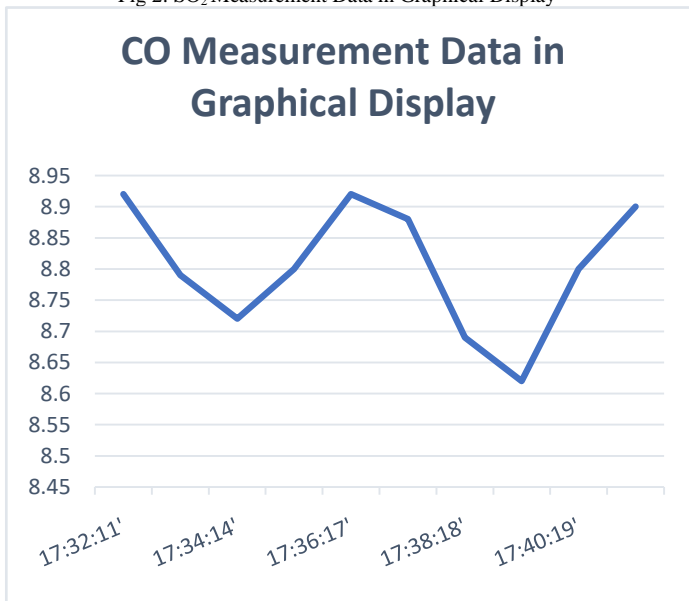
Fig 2. SO₂ Measurement Data in Graphical Display

Fig 3. CO Measurement Data in Graphical Display

The testing of the equipment was carried out over a period of 10mins. Fig. 2 and Fig. 3 show that the set-up was capable of measuring SO₂ and CO. Fig. 2 shows that SO₂ steadily increases from 4.506 to 4.549ppm, whereas CO fluctuates between 8.72 and 8.92ppm. There is no visible correlation between the pollutants SO₂ and CO.

V. CONCLUSION

The proposed air quality detection and monitoring system adopts the use of wireless sensor network to keep track of the air quality in different areas, also generating near real time data and information that can be accessed via smart phones and web enabled devices. Hence this project allows

individuals to be able to keep track of the kind of air they breathe, especially those with previous underlying health conditions.

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