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Network of Interconnected Devices for the Assessment of Air Quality

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Abstract:

Illnesses and the greenhouse effect are two of the major environmental problems brought about by the exponential rise in pollutant emissions from vehicles and factories, which in turn are a direct outcome of human civilization's rapid industrialization. Since most individuals aren't very good at perceiving subtle changes in air quality, they have no idea whether the air quality inside their homes is unhealthy. Given the above, it is critical to have an interior air quality monitoring system that is easy to use, accurate, and accessible so people can get a feel for the air quality in their homes and other indoor spaces. A mechanism to monitor air pollution is being considered for this project. The wireless sensor network system was built around the Arduino Uno microcontroller. The air pollution monitoring system was specifically designed to track and evaluate air quality in real-time, upload data to a distant server, and continuously update the data via the internet. The air quality measurements were obtained in parts per million (PPM) and then evaluated in Microsoft Excel. Accessible over the cloud on any intelligent mobile device, the outcome was shown on the interface of the intended hardware.

Key words: ***Air, Air Quality, ppm, The Internet of Things (IoT), Sensor, Arduino Uno, microcontroller***

INTRODUCTION:

Atmospheric conditions continue to deteriorate each yeardue to the growth of civilization and increasing unclean emissions

from industries and automobiles. This has resultedto the creation of serious environmental issues likegreenhouse effect and diseases. Although air is anindispensable resource for life, many people are indifferent tothe severity of air pollution or have only recently recognizedthe problem [1]. Air pollution is the presence of one or morecontaminants in the atmosphere such as gases in a quantitythat can harm humans, animals and plant [2]. Any change inthe natural composition of air may cause grave harm or life-threatening diseases to life forms on earth. The effect of airpollution ranges from difficulty in breathing, coughing,bronchitis, pneumonia, lung cancer and other respiratorydiseases [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 for7 million people every year [5-6].

Average person spends an estimated 90% of their time indoorsso that poor indoor air quality (IAQ) poses a substantial risk topublic 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].

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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, effectiveand 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 thevarious gases

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

RELATED WORKS

Several monitoring system have been proposed recently forair pollution monitoring both in homes and the external environment. For example, a low-cost indoor air quality monitoring wireless sensor network system was developedusing 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 suchas CO, CO_2, SO_2 and NO_2. 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 inwireless communication and sensor technology**.** The creation of smart environments in which objects interact and cooperatewith 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 betterin 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.

I. METHODOLOGY

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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.

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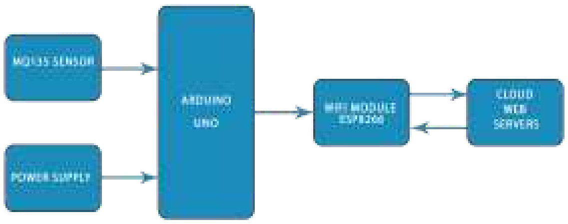

Fig 1. Block diagram of proposed air quality detection and monitoring system

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 pollutantsbeing 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 Detectionand 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 ppm = 1.145 mg/m^3

1 mg/m^3 = 0.873 ppm

1% = 1/100

1 ppm = 1/1000000

1 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

II. RESULTS AND DISCUSSION

The measured results for pollutants parameters such as SO2and CO are displayed below in Fig.2 and Fig.3.

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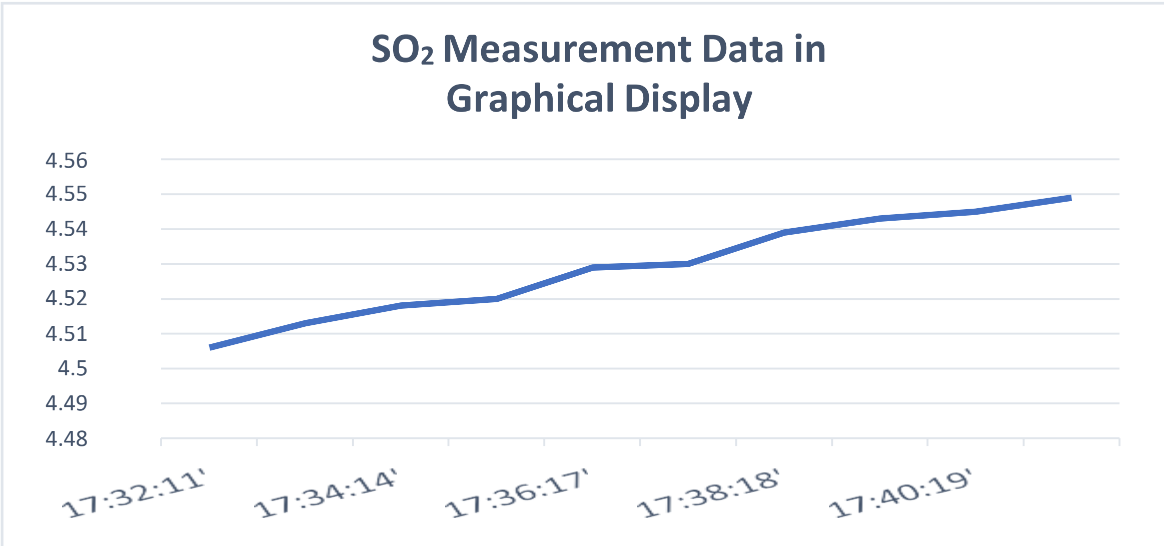
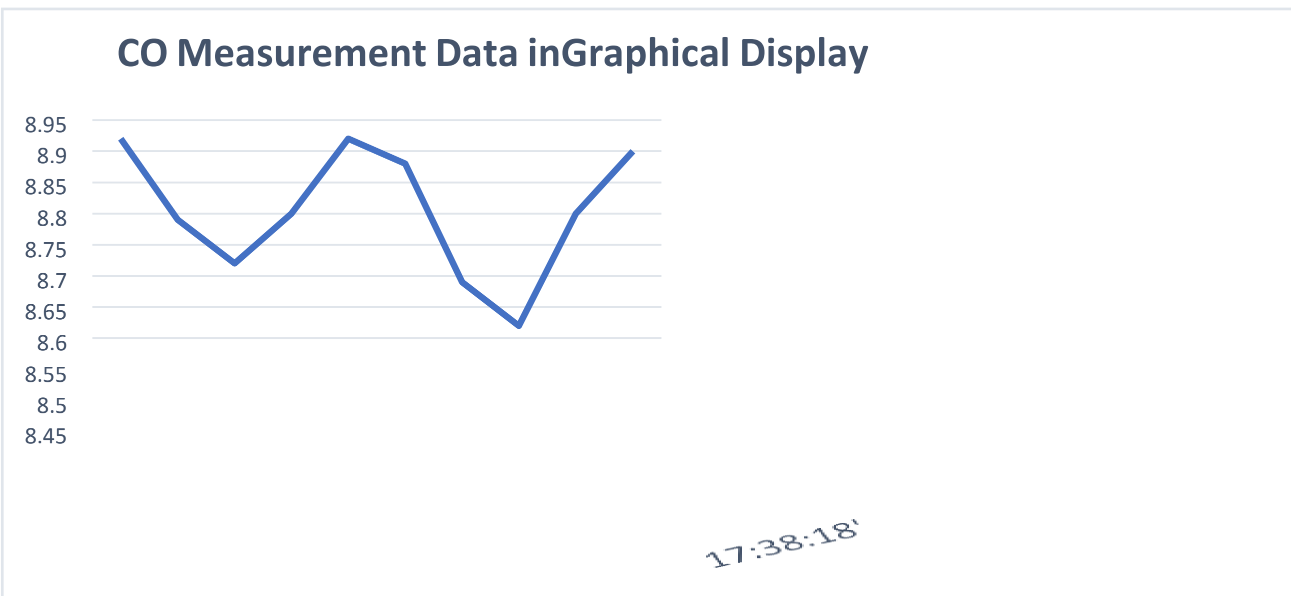


Fig 2. SO_2 Measurement Data in Graphical Display



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 SO_2 and CO. Fig. 2 shows that SO_2 steadily increases from 4.506 to 4.549ppm, whereas CO fluctuatesbetween 8.92 and 8.9ppm. There is no visible correlation between the pollutants SO_2 and CO.

CONCLUSION

The suggested system for detecting and monitoring air quality makes use of a wireless sensor network to

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record data and information on the air quality in various locations in near real-time, which can be accessible by smartphones and other web-enabled devices. To that end, this initiative

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