International Journal of Innovative Engineering (IJIE)
Vol. 01, Issue. 1, May 2023, pp. 16 ~ 22
ISSN: xxxx-xxxx, DOI:

Air Quality Monitoring Device

Shubhankar Mandal

School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, China

Article Info

Article history:

Received : April 25, 2023
Revised : May 16, 2023
Accepted : May 22, 2023

Keywords:

Air
Monitoring
Gas

ABSTRACT

Air is an important element of the earth, the atmosphere was formed thousands of years after the creation of the earth. After approximately 4.6 billion years, this atmosphere is made up of different types of gases. Even though the atmosphere was created, people didn't live then, instead of humans, huge animals lived on earth because that atmosphere was not suitable for humans, nowadays, with the excellence of science, people can now know that our atmosphere is 78% nitrogen, 21% oxygen, 0.04% carbon. Dioxide also contains neon, helium, methane, krypton, hydrogen, and water vapor with 1% of the total composition. If this quality is normal in the air, it is positive for the environment, animals, and people. But unfortunately, due to the activities of human advanced living, carbon dioxide in the atmosphere day by day is also changing the composition of the atmosphere, which has a negative impact on humans and animals along with other harmful gases in the air. Considering that negative aspect we have developed Air Quality Monitoring Device. Through this, we can determine the quality of air as well as take the right decision regarding the prevention of air pollution.

Corresponding Author:

Shubhankar Mandal
School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, China.
No.28, Xianning West Road, Xi'an City, Shaanxi Province, PR China.
Email: shuvomandol71@gmail.com

1. INTRODUCTION

Air is an important element of the earth, nowadays, due to population growth and urbanization various pollutants are mixed in the air and the level of air pollution is increasing day by day. Electricity is a wonderful invention of human life. 100 million tons of carbon dioxide are mixed in the air to generate this incredible energy and cause a lot of air pollution [4, 5, and 7]. Air pollution is a major public health issue that causes millions of premature deaths each year. According to the World Health Organization (WHO), outdoor air pollution was responsible for an estimated 4.2 million premature deaths worldwide in 2016 [4, 15]. Indoor air pollution also causes a significant number of deaths, with an estimated 3.8 million premature deaths in the same year [1, 2, 5, 4, 15]. In total, air pollution is responsible for an estimated 7 million premature deaths worldwide each year [15, 4]. It's worth noting that these estimates can vary depending on the source and methodology used, but the consensus among experts is that air pollution is a significant contributor to global mortality. Air is an important element of the earth, nowadays due to population growth and urbanization various pollutants are mixed in the air and the level of air pollution is increasing day by day. Also, 21% for air pollution as reported by the United Nations Environment Programme.Chronic obstructive pulmonary disease, 17% of strokes, 15% of Tracheal, bronchus, and lung cancer, 15% of Ischemic heart disease, 13% of

Type 2 diabetes, 13% of lower respiratory infections, and 7% of neonatal disorders are directly related to air pollution [5,14]. For some years, Bangladesh has been among the top air polluters in the world. With intense heatwaves sweeping over Bangladesh for the past few years, a report on air pollution in Bangladesh's first-class newspaper said the deaths of nearly 40,000 children under the age of five in 2021 were directly linked to PM2.5-related air pollution [3,5,16]. Currently, Bangladesh is undergoing industrialization. Due to this, the level of air pollution in factories is increasing. Therefore, we have developed air quality monitoring devices to measure the level of air pollution in the factory, through which the factory will help prevent the deaths of skilled workers as well as keep the working environment safe for the workers.

2. METHODOLOGY

The Air Quality Index, or AQI, is a number used by government agencies to communicate to the public how polluted the air currently is, or is likely to become. As AQI increases, an increasingly large percentage of the population experiences severe adverse health effects. Different countries have their own air-quality indices corresponding to different national air-quality standards. Some of these are the Air Quality Health Index (Canada)[4,12], the Air Pollution Index (Malaysia)[4,11], and the Pollutant Standards Index (Singapore)[4,10]. The national AQI was launched in New Delhi on September 17, 2014, under the Swatch Bharat Abhiyan. There are six AQI categories (Table 1) of the same. The proposed AQI considers eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term (up to a 24-hour averaging period) National Ambient Air Quality Standards are prescribed.

Table 1. AQI Categories.

AQI category(Range)	PM10(24hr)	PM2.5(24hr)	NO_2(24hr)	CO(24hr)	SO_2(24hr)	NH_3(24hr)	Pb(24h)
Good(0-50)	0-50	0-30	0-40	0-1.0	0-40	0-200	0-0.5
Satisfactory(51-100)	51-100	31-60	41-80	1.1-2.0	41-80	201-400	0.6-1.0
Moderately Polluted(100-200)	101-250	61-90	81-180	2.1-10	81-380	401-800	1.1-2.0
Poor(201-300)	251-350	91-120	181-280	11-17	381-800	801-1200	2.1-3.0
Very poor(301-400)	351-430	121-250	281-400	18-34	801-1600	1201-1800	3.1-3.5
Severe(401-500)	430+	250+	400+	34+	1600+	1800+	3.5+

We consider the criteria in the table above to be the standard criteria for our device. Our device will measure air pollution according to this table.

Our system is developed on two primary components: hardware and software. Here, we'll take some ideas about our system's hardware and use a block diagram and flow chart to try to understand how our system works by integrating the software with the hardware

A. Hardware Specifications

Here we used the (PIC16F877A) as a microcontroller chip. Which is working as the brain of our device, some sensors are used to determine the air quality, among them the humidity & temperature sensor (HSM-20) used with gas sensors (MS-135) & (MS-5)[9]. Which will help to detect and measure the content of different gases in the air. Also, important components are air quality sensors, which are used for indoor air quality testing besides detecting carbon monoxide, alcohol, acetone, thinner, formaldehyde, and other less toxic gases. Able to automatically trigger the internal ventilation system and alarm system. Besides, we have a battery as a power supply to the whole system, an LCD display to see all the information, some resistors and capacitors to protect our device, and an electrical wire to connect each sensor has been deployed.

B. Block Diagram and Flow Chart of the Model

We have loaded all the information into the microcontroller 16F877A using the C programming language, and now the device will work according to the program we have created. We need to focus on the block diagram and flow chart to understand how the device works.

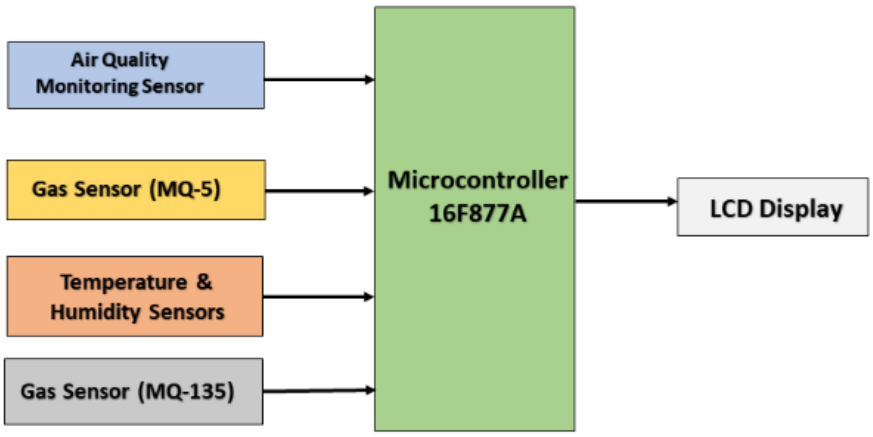

Figure 1. Block Diagram

We can see in the block diagram above that all the information on our device's important sensors like the air quality sensor, temperature & humidity sensor, and the gas sensor(MQ-5 &MQ-135) is going to the brain microcontroller (16F877A) of our device and the output from the microcontroller is going to the LCD display.

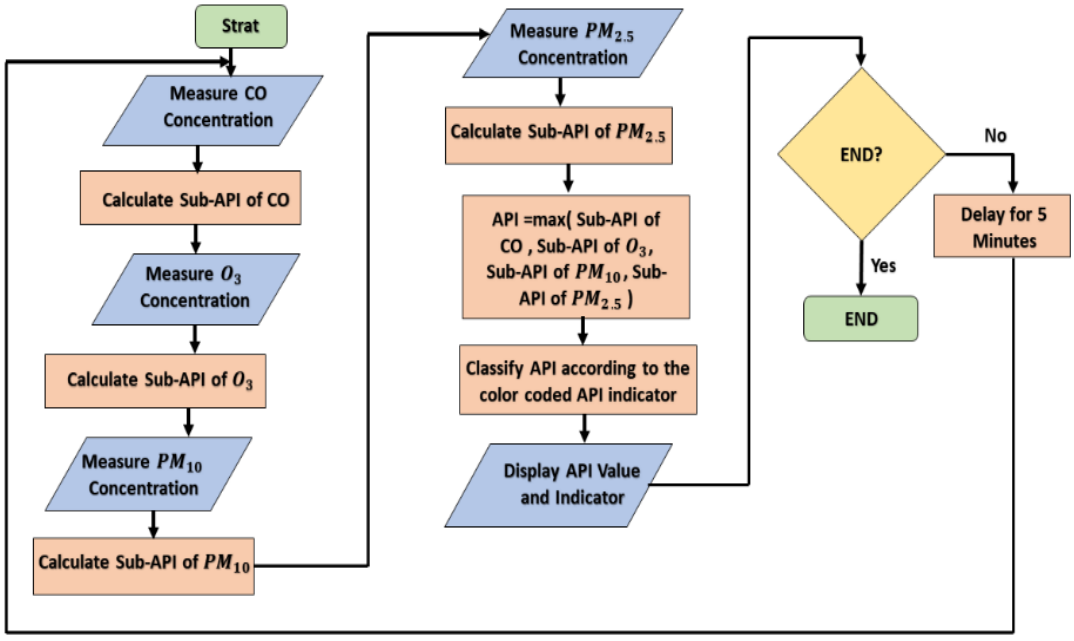

Figure 2. Flow Chart

As we can see in the flowchart above, our device starts by measuring carbon monoxide CO, the ozone layer, and PM10, PM2.5, from the air, then measures each element with the criteria we set, then averages all

the elements and displays the air pollution level. The indication appears in the form thus continuing in a cycle.

3. RESULTS AND DISCUSSION

Our device has set the value as an international standard for air pollution, but there is a stander value to measure some harmful gases for air pollution in our country. We set up tests in the Chittagong Export Processing Zone (CEPZ) area for a day. And in that area, carbon monoxide (CO), nitrogen dioxide(NO_2), carbon dioxide(CO_2), sulfur dioxide(SO_2), and all are attached to the bottom in the form of the table.

Table 2. National AQI Categories. [3,5]

Pollutants	Objectives	Average Time
Carbon Monoxide(CO)	10 mg/m^3 (9ppm)	8-hour
Nitrogen Dioxide(NO_2)	100µg/m^3 (0.053ppm)	Annual
Carbon Dioxide(CO_2)	40 mg/m^3 (35ppm)	1-hour
Sulpher Dioxide(SO_2)	365 µg/m^3(0.14ppm)	24-hour

Table 3. Ambient air quality in CTG EPZ (SO_2).

Time Index /Day	NAAQS of SO_2 (ppm)	Exp. Value of SO_2 (ppm)	Error of AQM device	Error value of AQM device	Accuracy of AQM device
1	0.14	0.14	No Error	0	1
2	0.14	0.15	No Error	0	1
3	0.14	0.17	No Error	0	1
4	0.14	0.18	No Error	0	1
5	0.14	0.17	No Error	0	1
6	0.14	0.20	Error Occur	0.429	0.571
7	0.14	0.19	No Error	0	1

Here, NAAQS means = National Ambient Air Quality Standard

$$\text{Error value} = \frac{[\text{Exp. Value} - \text{NAAQS Value}]}{\text{NAAQS Value}}$$

Accuracy of AQM = [1- Error Value]

Table 4. Ambient air quality in CTG EPZ (NO2).

Time Index /Day	NAAQS of NO2 (ppm)	Exp. Value of NO2 (ppm)	Error of AQM device	Error value of AQM device	Accuracy of AQM device
1	0.106	0.11	No Error	0	1
2	0.106	0.13	No Error	0	1
3	0.106	0.12	No Error	0	1
4	0.106	0.11	No Error	0	1
5	0.106	0.14	Error Occur	0.321	0.679
6	0.106	0.12	No Error	0	1
7	0.106	0.12	No Error	0	1

Table 5. Ambient air quality in CTG EPZ (CO).

Time Index /Day	NAAQS of CO(ppm)	Exp. Value of CO(ppm)	Error of AQM device	Error value of AQM device	Accuracy of AQM device
1	35	37	No Error	0	1
2	35	40	No Error	0	1
3	35	41	No Error	0	1
4	35	38	Error Occur	0.2	0.8
5	35	47	No Error	0	1
6	35	45	Error Occur	0.286	0.714
7	35	44	No Error	0	1

Table 6. Humidity data report.

Time Index/Day	Standard Humidity of AQM device (%)	Exp. Humidity of AQM Device (%)	Error of AQM device	Error value of AQM device	Accuracy of AQM device
1	70	68	No Error	0	1
2	70	69	No Error	0	1
3	70	71	No Error	0	1
4	70	72	No Error	0	1
5	70	74	Error Occur	0.0571	0.9429
6	70	71	No Error	0	1
7	70	65	No Error	0	1
8	70	77	No Error	0	1
8	70	78	Error Occur	0.1143	0.8857
10	70	80	No Error	0	1

$$\text{So, the accuracy of the device} = \frac{\text{Total accuracy of AQM}}{\text{No. of Day}} \times 100$$

$$= 95.46\%$$

4. CONCLUSION

Finally, we are still using our device as a prototype and we will continue to struggle against air pollution by attaching more new time-consuming facilities in the near future and we will work to raise awareness about preventing air pollution in the people. Not aware of if we are not aware from now on we will lose a lot of lives prematurely. We have created this air police device to prevent that premature death.

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BIOGRAPHIES OF AUTHORS

SHUBHANKAR MANDAL received a B.Sc. degree in Electrical and Electronics Engineering from the Green University of Bangladesh and a M.Sc. in Mechanical Engineering from the Beijing Institute of Technology, Beijing, China. He is pursuing a PhD in mechanical engineering at Xi'an Jiaotong University, China. He can be contacted at **shuvomandol71@gmail.com**