A Cost-Effective IoT Device for Protecting People from the Dangers of Environmental Risk in Bangladesh

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A Cost-Effective IoT Device for Protecting People from the Dangers of Environmental Risk in Bangladesh

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***Abstract*—The factors of population growth, unplanned urbanization, vehicles, factories, and brick kilns are constantly making air quality concerns. In addition, due to lack of public awareness, people are continually facing various kinds of unintended accidents, for example, gas cylinder poisoning. The main objective of our paper is to create a low-cost Internet of Things (IoT) based system that can measure atmospheric air quality and gas leakage. Sensitive data will be stored on the server via the Internet of Things (IoT) device, which will visualize the data from the server via the website and the Android app. Moreover, by understanding the state of the environment, the user will be informed about the environment through Android apps and websites to protect himself from the grip of air pollution and protect himself before an accident like a gas cylinder.**

***keywords*— Air Pollution, Environment, Gas sensors, IoT, Web and Android Application**

I. INTRODUCTION

Global air pollution is a rising hazard to human fitness and the naturalistic environment. Air pollution destroys an evaluated seven million people worldwide an individual year. Concerning the WHO, 99 Percent of humans breathe air. Lower-middle-income countries are prone to high pollution levels due to breathing that exceeds WHO guidelines[1]. Bangladesh is a low-middle income country and also is developing day by day. According to a global report (DS, March 18, 2021), Bangladesh's air quality was the worst globally, with the Dhaka becoming the second most polluted city in 2020. According to a recent report, the mean yearly PM 2.5 concentration in Bangladesh is 77.10 mcg/m3 of air, seven times greater than the WHO disclosure recommendation [2]. Polluted air can cause allergies, coughs, asthma, bronchitis, high blood pressure, headaches, lung cancer and other serious diseases. All in all, if air pollution continues to rise, the place becomes uninhabitable. Therefore, air pollution reasons extreme harm to people's health and the atmosphere. The Bangladesh Ministry of Environment has recognised 20 reasons for air pollution. These include street construction, brick kilns, reconstruction and restoration, construction and drilling of service organisations, significant development projects (metro rails), construction of diverse placing including multi-storey buildings at government and personal levels, sand extraction and gathering on a commercial basis along roads or highways, trucks or open transport of cement, soil, sand and other construction equipment in lorries, dumping of domestic and urban garbage on the roadway, disposal of garbage from drains and leaving on the road, distribution of trash while sweeping the street dirt and dust from the wreckage of road, hazardous fumes from unworthy transportation, clay from the wheels of different cars, burning of garbage from diverse educational institutions and government territories, debris from multiple shopping malls, markets and mercantile buildings. Junk in the area, disposal of hospital trash in the roadways, high sulphur diesel and shortage of public understanding. Consequent to a study by the Department of Environment, brick kiln smoke is liable for 56 per cent of Dhaka's air pollution. Dust from construction, repairs, smoke and expired vehicles accounted for the remaining 42 per cent. In Bangladesh, a gas leakage killed 21 people in an air-conditioned blast in Narayanganj. There was gas leakage for many days, but there was no gas leakage detection system, so the AC exploded [3]. In a lower middle-income country like Bangladesh, there are many more incidents besides gas leakage that we cannot detect. So, we want to create a model for measuring air quality, carbon dioxide gas, LPG gas, smoke, temperature and humidity so that we can protect our nature from air pollution and adverse events. Using this model, we also can detect air pollution in the environment and prevent adverse even.

II.RELATED WORK

The researchers [4] accurately estimates the level of air pollution in metropolitan areas through mobile sensors. One method model has been implemented in this paper such as Estimation System. This approach can generate an exact air pollution hypothesis and expand the air pollution map decisiveness and large-scale air pollution-related disease analysis.

This paper [5]creates a sensor-based IoT model for city air pollution detection which makes it possible to detect city air pollution. Web Monitor was used to visualizing the data. The researcher has worked on different parameters of the environment. The Air Quality Monitoring (AQM), the Sound Detection Module (SDM), and the Cloud-based Monitoring Module (CMM) have been developed using IoT sensors.
Another author presented a system for monitoring, analysing, and forecasting air pollution in his paper [6]. The main purpose of the system was to alert experts to protect against the health problems associated with air pollution in children. An IoT-based air pollution monitoring and forecasting system is proposed. The technique operates air sensors to detect and transmit data to the microcontroller, and it keeps data on the webserver.
In this study[7], a structure of distributed air quality monitoring technique was proposed where the full advantages of IoT were used for data collection. The system used multiple sensors that were inexpensive, with an ESP 32 microcontroller interface to the mobile hardware device.
In this paper [8], using a 5G wireless network and blockchain, a real-time air pollution exponent calculated medium is suggested. The proposed technique was essentially blockchain technology used to prevent data fraud and deception, to encrypt and transmit to the cloud. In this paper, observations and forecasts of ambient real-time air quality are presented. Controlling stations intercommunicate with the backend server using GPRS transmission in an M2M fashion. Website and mobile apps have been developed to privilege employees to access data.

III. SYSTEM OVERVIEW

The system overview divides the whole system into two ways so that the system does fully describe.

A. *System design and methodology*

Figure 1 discloses the system depiction of our proposed technique for air pollution detection, and Figure 2 shows the flowchart of how our system flows. Lastly, the algorithm of our full system has been shown. How our system works has been described step by step through workflow (Figure 3).

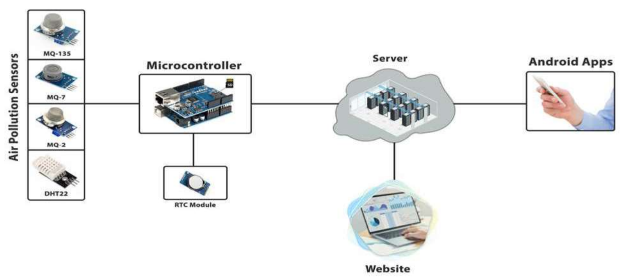

Figure 1: System diagram

1. System diagram: Our system collects data from the environment through various sensors such as MQ135, MQ7, MQ2, DHT22, processes the data through a microcontroller, transmits the data to the server, and the website and Android Apps can visualize data.

2. Workflow: The flow chart of the Air Pollution Detection model is depicted in Figure 2. The Arrow signs show how the system flows.

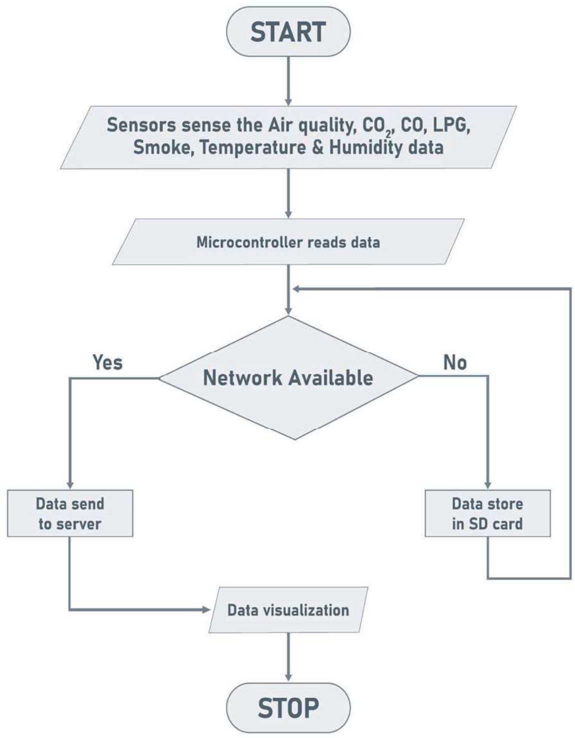

Figure 2: Workflow

B. *System Component:*

Our System component is divided into two categories: Hardware system, Software system.

1) Hardware Component: This system uses some sensors to sense the environment. MQ-135 sensors measure the air quality of the environment, determination of ambient temperature and humidity through DHT-22, MQ-7 for carbon monoxide detection and MQ-2 for LPG gas and smoke detection. We used Arduino Uno and Ethernet Shield as microcontrollers. We have used Arduino Uno for data processing and Ethernet Shield for data transfer to the server, and an SD card used for data storage. A real-time module clock was used to obtain real-time data.

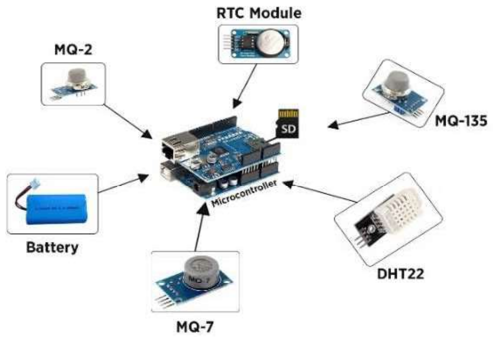

Figure 3: Hardware device

2)Software Component: The PHP framework is used for Websites, and the React Native framework is used for Android applications. The MySQL database is used on the server because it is easy to implement. Data in JSON format from the server comes through API in the Website and Android Apps. The value of the data in the Website and Android apps have been compared with the standard value, and the data has been visualized with different warning symbols. Figure. 4 shows the Android Apps.

Figure 4: Android Apps

IV. RESULT AND IMPLEMENTATION

Figure. 5 shows the implemented Model. After implementing the model, data was collected on the roof of our house. Figure. 6 shows how the data is shown on the serial monitor.

The implementation of our complete system is shown in Figure 5 and the sensor is used. Arduino and Ethernet Shield are connected, and all sensors are connected to Ethernet Shield. When power is given by assembling the sensor, the sensor indicator light is turned on, as depicted in the figure. 5.

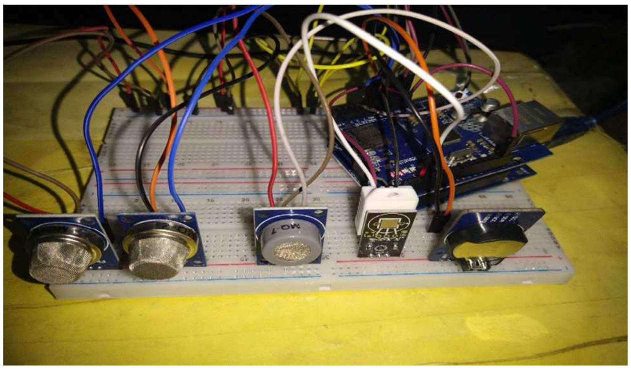

Figure 5: Implementation Model

Figure 6 depicts the output result on the serial monitor by uploading the code to the Arduino to test whether the implementing model is working correctly. Humidity, Temperature, Air Quality, and Carbon Monoxide data are readily available from the environment, but LPG & smoke data is not available, so our model has been tested by supplying LPG gas and smoke from outside. We took one week of test data to see our system was working correctly or not. We have taken fresh data from the environment and also taken the data by corrupting the environment LPG and smoke are not always available, so we provided data from outside and tested the sensor to see it worked adequately. Whether our sensors can sense low and high data, we have shown the graph by drawing the collected data after collecting the data as per the index of Table-1. How much the collected data is harmful to the environment and human beings is shown in colour in the graph by matching with Table 1. The Air Quality, Carbon Monoxide (CO), LPG and Smoke and Temperature & Humidity data graphs are shown in Figures 7, 8, 9 & 10, respectively.

```
23:17:16.636 -> Humidity: 87.90 Temperature: 31.90
23:17:17.103 -> LPG: 26.00 Smoke: 126.00
23:17:17.150 -> Air Quality: 27.57  PPM
23:17:17.150 -> CO(MQ7): 15.93
23:17:17.197 ->
23:17:20.113 -> Humidity: 87.80 Temperature: 31.90
23:17:20.628 -> LPG: 25.00 Smoke: 116.00
23:17:20.675 -> Air Quality: 26.47  PPM
23:17:20.675 -> CO(MQ7): 15.73
23:17:20.722 ->
23:17:23.621 -> Humidity: 87.80 Temperature: 31.90
23:17:24.136 -> LPG: 25.00 Smoke: 116.00
23:17:24.183 -> Air Quality: 27.57  PPM
23:17:24.183 -> CO(MQ7): 15.93
23:17:24.230 ->
23:17:27.139 -> Humidity: 87.80 Temperature: 31.90
23:17:27.654 -> LPG: 25.00 Smoke: 116.00
23:17:27.701 -> Air Quality: 28.02  PPM
23:17:27.701 -> CO(MQ7): 16.01
23:17:27.747 ->
23:17:30.694 -> Humidity: 87.90 Temperature: 31.90
23:17:31.165 -> LPG: 25.00 Smoke: 116.00
23:17:31.210 -> Air Quality: 28.02  PPM
23:17:31.210 -> CO(MQ7): 16.01
23:17:31.257 ->
23:17:34.200 -> Humidity: 87.80 Temperature: 31.90
23:17:34.714 -> LPG: 24.00 Smoke: 123.00
23:17:34.714 -> Air Quality: 28.02  PPM
23:17:34.760 -> CO(MQ7): 16.01
23:17:34.760 ->
23:17:37.712 -> Humidity: 87.80 Temperature: 31.90
23:17:38.227 -> LPG: 25.00 Smoke: 113.00
23:17:38.227 -> Air Quality: 28.25  PPM
23:17:38.273 -> CO(MQ7): 16.01
```

Figure 6: Serial Monitor Data

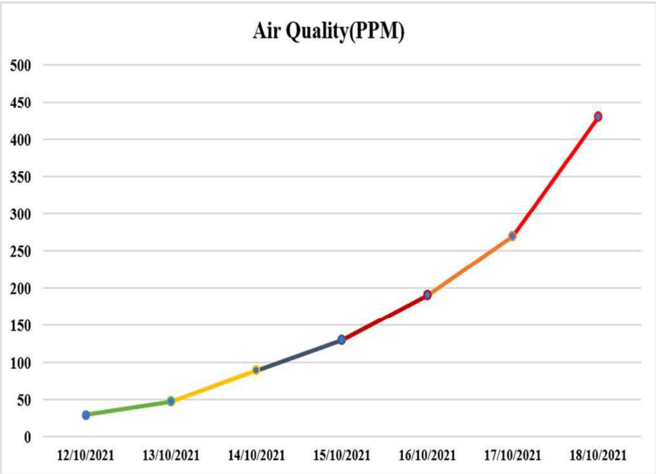

Figure 7: Air Quality (PPM)

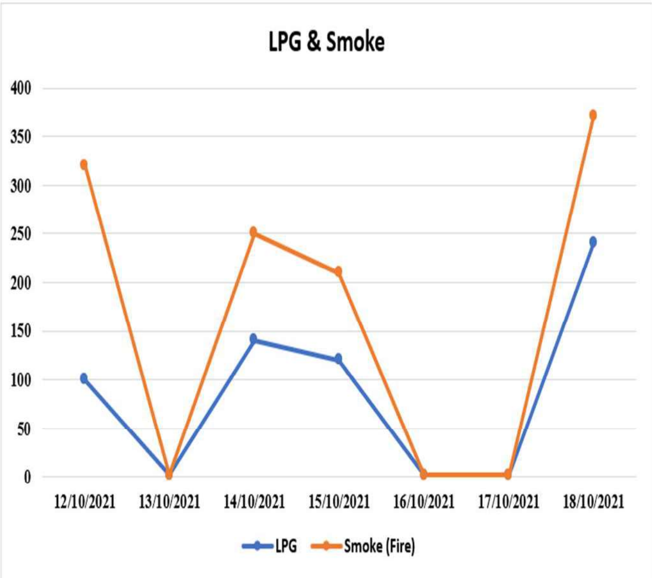

Figure 8: LPG & Smoke

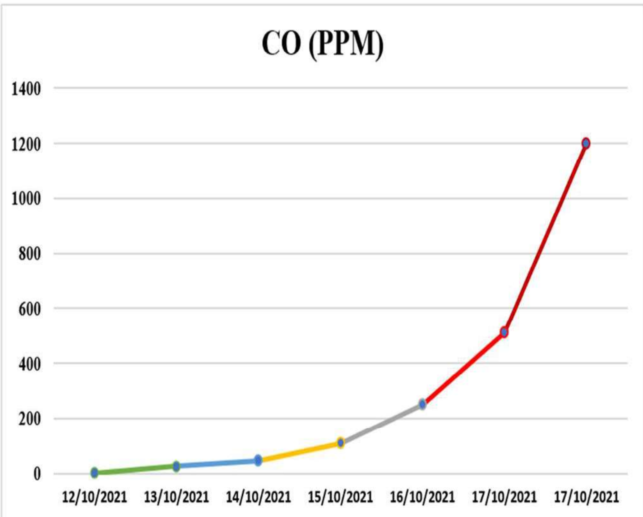

Figure 9: CO (PPM)

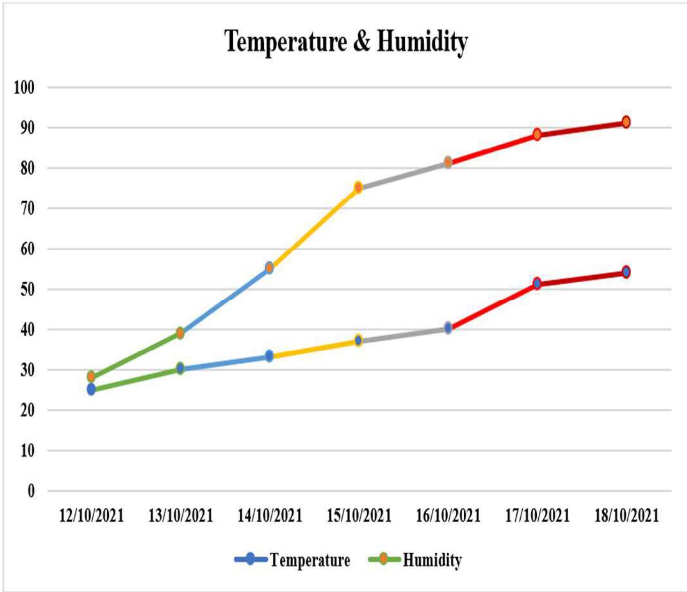

Figure 10: Temperature & Humidity

Cost Analysis: The cost of our device is $23.92 which is present in Cost Analysis Table I. The price of our device is lower than the price of this paper [6] device, which was earlier implemented in Bangladesh. This paper[6] proposed system cost was $45 instead of $23.92 with more gas sensors. Our system is much more affordable for Bangladesh than the previously implemented system.

Table I: Cost Details

Serial number	Name	Quantity	Price ($)
1	Arduino UNO	1	$3.62 [9]
2	Ethernet shield	1	$8.05 [9]
3	MQ-2 Gas sensor	1	$0.92 [9]
4	MQ-7Gas sensor	1	$1.07 [9]
5	MQ-135 Gas sensor	1	$1.16 [9]
6	DHT-22 Temperature Humidity Sensor	1	$2.59 [9]
7	DS3-231 Real-Time Clock Module	1	$2.00 [9]
8	Jumper Wire	40	$0.97 [9]
9	SD card (32GB)	1	$1.72 [9]
10	Rechargeable li-ion battery	1	$1.80 [9]
	TOTAL =	1	$23.92

Table II: Quality Index

Air Quality (Value index and level of level concern) [10]	**Carbon Monoxide (Value index and Human Effect)** [11]	**Temperature (Value index and level of level concern)** [12]	**Humidity (Value index and level of level concern)** [13]
0-50 = Good	1-3 = normal	27–32degree ^{0}C= Caution	0-30 = Too Dry
51-100 = Moderate	25 = Occupational exposure Limit Averaged over up to 8 hours	32-41 = Extreme Caution	40-60= Comfort Zone
101-150 = Unhealthy for Sensitive Groups	30-60 =Exercise tolerance reduced	41-54 Danger	70-100 = Too Humid
151-200 = Unhealthy	100= Frontal headache shortness Of breath on exertion	54 over Extreme danger	
201-300 = Very Unhealthy	150-300 = Throbbing headache, dizziness, nausea, and confusion and collapse		
301-Higher = Hazardous	300-650 = several headaches		
	Above 2000 = Rapidly fatal		

V. CONCLUSION

In this paper has developed a system to determine the air quality in the environment at a low cost and prevent unwanted incidents like gas leakage. As a result, people will understand the state of their environment and be aware of the unfortunate events before they happen. The gas leakage notification system will significantly reduce the number of cylinder blasts in the home. In future work, we will use machine learning in our system; consequently, this system will predict the state of air pollution and before any untoward incident occurs.

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