Title: IoT Based Air Quality Monitoring System

1. Introduction

Indoor air quality is a very concerning issue. People in Bangladesh, specifically in factories and chemical plants have to work in conditions where the air quality is very poor, which may lead to various health problems and financial issues as a result. Therefore, taking into account the well being of individuals as well as their productivity, it is imperative that a system is created using which one can constantly monitor the quality of indoor air and gets notified whenever the quality goes to an alarming rate. This project aims to create such a system. It consists of an ESP8266 module, MQ-7 gas sensor module, DHT11 sensor module, a Web Application and a Server.

2. Problem Statement & Related Work

One of primary health hazards results from indoor air. Its pollution is a big environmental risk that affects the health of an individual in a very serious way [1]. It is estimated that the impact from Indoor air quality can be as much as 100 times greater than outdoor air quality [2]. There is also the fact that continuous exposure to polluted air to indoor occupants leads to dramatic decrease in the productivity of the indoor occupants [3]. The issues are something people in Bangladesh have to face; having to work in poor conditions in factories or even in certain households, schools and small businesses. Therefore, these concerns necessitate the development of our proposed system where an individual can continuously check the air condition and get necessary alerts if readings go to an alarming rate.

Currently, existing solutions consist of standalone air quality monitors and HVAC integrated systems. These, however, often lack real-time data analytics and proper user-friendly interfaces. Most of them are large scale enterprise oriented and as a result, cannot be easily adopted in homes, factories, schools and small scale scale businesses

3. Idea Description

The system consists of multiple parts; an MCU, a web application and finally, a backend server. The MCU consists of the ESP8266 and it is interfaced with DHT11, MQ-3, MQ-7 and MQ135 sensors for reading temperature, humidity, alcoholic vapor levels, Carbon Monoxide and Carbon Dioxide and chemical pollutant (Ammonia and Sulfur) levels in a room. These data are continuously read and sent to the backend server via websocket protocol. The backend server processes these, stores them in MySQL database, and sends them to the frontend web application from which the users can monitor the pollutant level. If any reading goes beyond normal, the user will be notified in their web application. The web application provides 3D locations on the Map of the rooms that are being monitored. The backend also consists of a Machine Learning module to use the sensor readings as datasets in order to perform trend analysis and prediction.

Also, an SMS will be sent to their mobile phones in case the user is not currently using the web application or is having network connectivity issues. For added security the system provides an option to dial for emergency numbers through the web application itself.

4. Project Features

The list of features this project offers are given below:

- Monitoring of indoor air quality in real-time.
- Multiple parameter detection (CO_2, CO, Alcohol Vapor, Temperature, Humidity).
- LED Strip for displaying different element levels in indoor air
- Remote monitoring using a web application.
- Generation of daily reports in graphical representation
- Data Analytics for analyzing trends and prediction capabilities.
- Alert system for notifying users of abnormal pollutant levels.
- 3D Map of the location of the room.
- Offline capabilities (SMS).
- Option for dialing emergency number in case of extreme quality levels

5. Flow Diagram and System Architecture

Flow Diagram

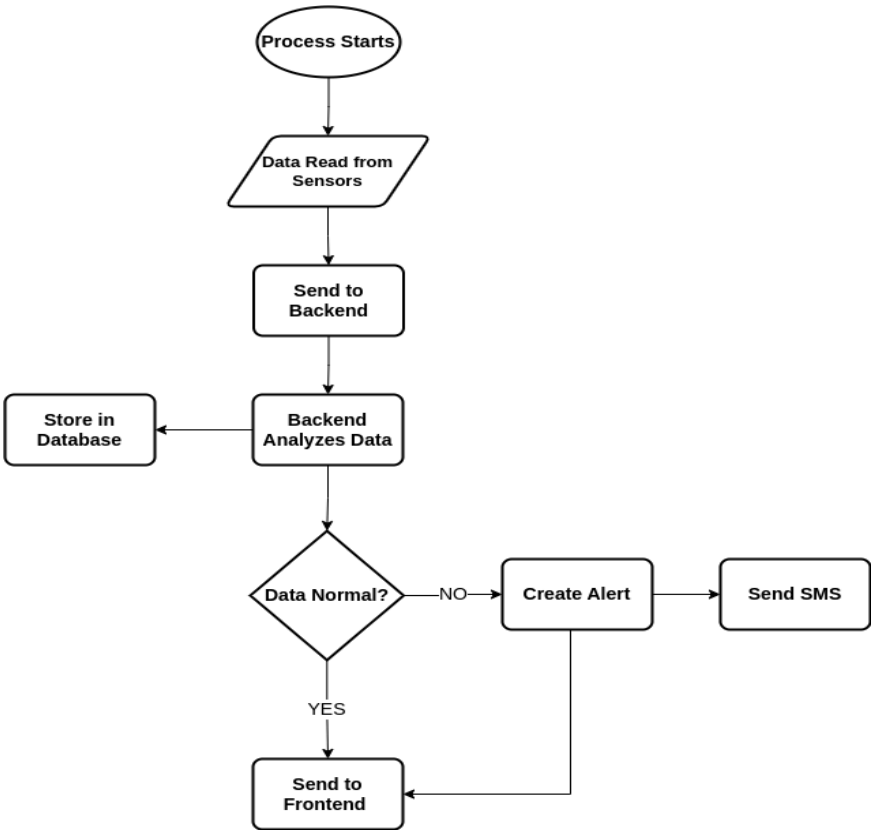

Figure 1: Flow Diagram of the system

System Architecture

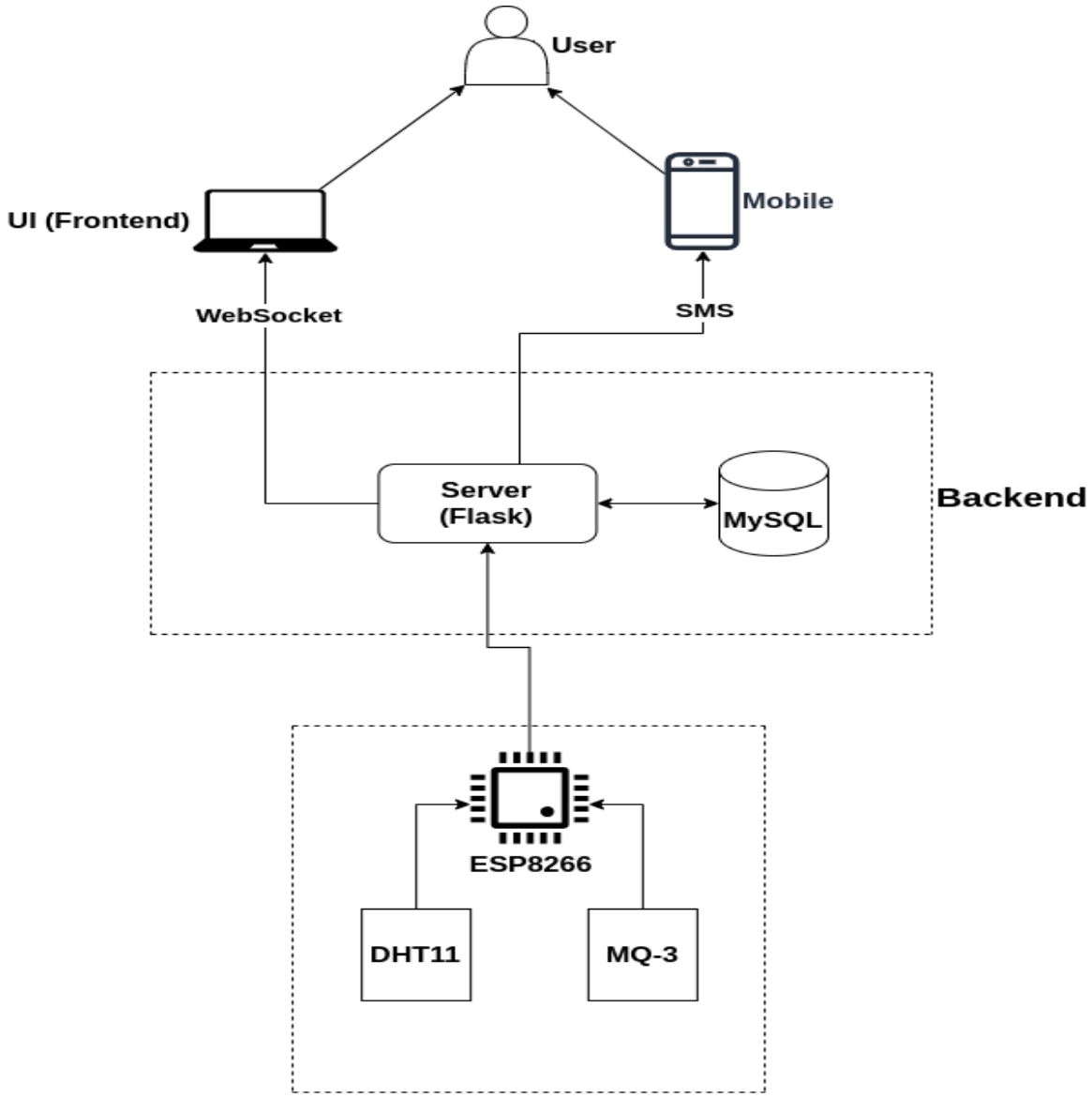

Figure 2: The system architecture of the project

6. Project Timeline

The project timeline is broken down in multiple parts across a span of 11 weeks. They are shown below:

Week No.	Work To Accomplish

1	Testing of ESP8266 and sensors individually
2	Integrating ESP8266 and sensors and perform integration testing
3	Develop the Backend Server
4	Setup the ESP8266 and the Backend Server for real-time communication
5	Develop the Frontend Web Application
6	Integrate the Frontend with the Backend for websocket communication
7	Visualize monitored data on the web application
8	Develop alert systems
9	Developing the SMS alert system
10	Full integration testing and refinement
11	Deliver

7. Target Population

This project was developed for the benefit of multiple parties; these include:

- Standard use inside households.
- For schools, hospitals and small scale businesses.
- People inside factories.
- People working inside chemical plants.

8. Social and Economical Impact

Social Impact

This project can drastically improve the well-being of individuals and raise the health standards by guaranteeing cleaner and non-polluted indoor air. The project can also be leveraged to increase greater awareness regarding indoor air pollution and thus influence behavioral changes from people.

Economical Impact

Being an affordable and easily adoptable solution, the project has the potential to ensure widespread approval. It can potentially open up new markets, prompt further research and as a result, more efficient systems can be produced in the future. This project also aids in the long term by eliminating health issues which, if left unchecked, could lead to massive amounts of healthcare costs.

9. Platforms

A project will utilize the following hardware tools:

- ESP8266 Wi-Fi module
- DHT11 Temperature and Humidity Sensor
- MQ-7 Carbon Monoxide sensor
- MQ-3 Alcoholic Vapor sensor
- MQ135 sensor
- Standard Breadboard

Result from which, the system will offer the following platforms :

- An MCU with sensors
- A Web Application
- A Backend as server and for machine learning

10. Tools, Libraries and Coding Environment

Tools and Coding Environment

- Arduino IDE (ESP8266 development)
- Visual Studio Code (Web and Server Development)
- HTML, CSS, JavaScript (Frontend)
- Python (Backend Language)

Libraries and Frameworks

- DHT11 sensor module library
- MQ-3 sensor library
- MQ-7 gas sensor module library
- MQ135 sensor module library
- Flask (Python backend framework)
- Tensorflow (Machine Learning framework)
- ArcGIS (for 3D GPS Mapping)

11. Conclusion

The IoT Based Air Quality Monitoring System provides a user friendly interface for monitoring data as well as ensuring the well-being of the occupants. It helps in the long term by preventing major diseases caused by pollutants in the air as well as huge medical expenses. It also provides

additional benefits by increasing the awareness of indoor air pollution and can enable new markets to open up and prompt further research and study.

12. References

[1] Ana, G.R.; Alli, A.S.; Uhiara, D.C.; Shendell, D.G. Indoor air quality and reported health symptoms among hairdressers in salons in Ibadan, Nigeria. *J. Chem. Health Saf.* **2019**, *26*, 23–30.

[2] Seguel, J.M.; Merrill, R.; Seguel, D.; Campagna, A.C. Indoor air quality. *Am. J. Lifestyle Med.* 2017, *11*, 284–295.

[3] Saini, J.; Dutta, M.; Marques, G. A comprehensive review on indoor air quality monitoring systems for enhanced public health. *Sustain. Environ. Res.* **2020**, *30*, 6.