Journal of Engineering Technology Vol. 9: 63-68, 2021
ISSN 2231-8798© 2021 UniKLBMI

Development of Blynk IoT-Based Air Quality Monitoring System

Muhammad Iffikrul Amin Suhaidi[1] & Noor Hidayah Mohd Yunus[1]
[1]Section of Communication Technology
Universiti Kuala Lumpur British Malaysian Institute

Corresponding email: noorhidayahm@bmi.unikl.edu.my

Abstract: Due to the increased emissions of hazardous gases from vehicles and industries, the density of polluted air increases in the surroundings. It leads to human health problems such as asthma, lung disease, bronchitis and even premature death if the polluted air conditions are severe. In addition, polluted air can cause global warming and acid rain that causes unhealthy crop growth and the pollution of water supply sources. Therefore, a smart monitoring system is essential to check the air quality. This paper proposes a device of air quality monitoring system to efficiently monitor air conditions in real-time and sending alert notifications via mobile Blynk application, email, and SMS. The device comprises ESP8266 module Node MCU board as microcontrollers, LM35 temperature sensor and MQ-2 detection gasses sensors such as LPG, smoke, alcohol, propane, hydrogen, methane, and carbon monoxide. The proposed system is designed with a user-friendly GUI mobile application and web based. The monitoring results can be displayed in a mobile app with integrated real-time data transmitted by connecting to Wi-Fi network and GSM through ESP8266. In this paper, the Internet of Things (IoT) based in the air quality monitoring system plays an important part. Accordingly, the users can receive updates from the mobile apps at anytime and anywhere.

Keywords: GUI, web-based, Blynk platform, Node MCU, MQ-2 gas sensor

1.0 INTRODUCTION

In this modern era, the issue of air pollution is becoming more prominent, especially when air pollution is mostly in urban areas, as almost all urban areas are affected by air pollution. This air pollution is mostly caused by human activities such as open burning, smoke emissions from vehicle exhaust, cigarette smoke emissions, and smoke emissions from industrial funnels. There are various types of harmful gases released through activity such as carbon dioxide, nitrogen oxide, carbon monoxide, ammonia, methane, some uncommon components, and many other types of gases that can harm a person while inhaling the gas [1-3].

Air quality is a major concern in developed countries and has been linked to ecosystem health effects. Furthermore, this air pollution also contributes to global warming [4]. Global warming could cause the melting of ice in the North Pole, too much melting of ice could cause major floods or the Earth's open space would be diminished [5]. This polluted air can also cause acid rain to fall on polluted air areas. When a person is exposed to prolonged acid rain, there is a possibility of fever, cough and cold and should immediately bear the cost of treatment in the hospital.

Therefore, to overcome the issues of toxic gas poisoning in the surroundings, the development of an air quality monitoring system capable of providing notification updates on the air quality levels is very important. Internet of things (IoT) based air quality monitoring with low-cost energy by using Arduino Uno microprocessor based on the integration of Blynk App is presented in this paper. IoT systems with embedded air quality sensors, microcontroller units (MCUs) and electronic software frameworks to provide data exchange and the corresponding information. Furthermore, the data outcomes can be utilized by enhancing communication technology systems to provide instant updates besides monitoring the impact of air quality levels in particular areas.

2.0 MATERIALS AND METHODS

There is a lot of research and development has been done in the development of air quality monitoring systems. The authors of the article in [6] have developed prototypes

used to detect gases using MQ-2 gas sensor. This prototype is suitable for use in laboratories, homes, warehouses, factories and industries. Once the MQ-2 gas sensor has detected the hazardous gas, the exhaust fan will work automatically to expel the hazardous gas out of the area. Next, the authors of the article in [7] discusses the development of an IoT air pollution monitoring system. This project was made because of the emergence of many air pollution problems in this day and age. Therefore, a prototype was developed to monitor air quality using the MQ-135 sensor and be able to send information immediately using the internet. In addition, the system also activates an alert when the air quality in the area exceeds a certain amount of gas and will indicate when there is an excessive concentration of toxic gases that could endanger people around the area. The development of intelligent monitoring of air quality levels is proposed by the authors in [8-10]. The authors recommend IoT -based systems through android and cloud applications so that air pollution monitoring systems work in real-time and reports can reach users quickly. The development of an IoT-based air quality monitoring system proposed by the authors in [11] focuses on the implementation of the system in industrial and urban areas. CO gas sensor and NO_2 gas sensor are used in the sensing unit. Arduino Platform is used as the MCU to convey data from the sensors. IoT platform associated with wireless sensor network (WSN) is used as the communication network tool.

Therefore, this paper aims to develop an air quality monitoring app tool that is connected to the data storage cloud and displays information. The app is developed for users to view real-time air quality information updates. Sensors are used to measure parameters such as temperature and AQI. Data from the connected sensors can be viewed by the user via a smartphone via the Blynk app and LCD. To demonstrate the effectiveness of the data received, the device comes with a user-friendly and web-based GUI mobile application.

3.0 METHODOLOGY

3.1 Project Development

Figure 1 shows the block diagram of the air quality monitoring system. A power source at 5V is required to turn on the MCU. LM35 temperature sensor and MQ-2 gas sensor are linked with NodeMCU and the communication network connected to the NodeMCU output pin. Programming by Arduino IDE is performed for the NodeMCU according to the sensor unit requirement. All the information data from the sensors are transmitted to mobile apps via the NodeMCU using the Blynk app. When the sensor detects that the surrounding air is polluted then, the buzzer will be activated for alarm notification.

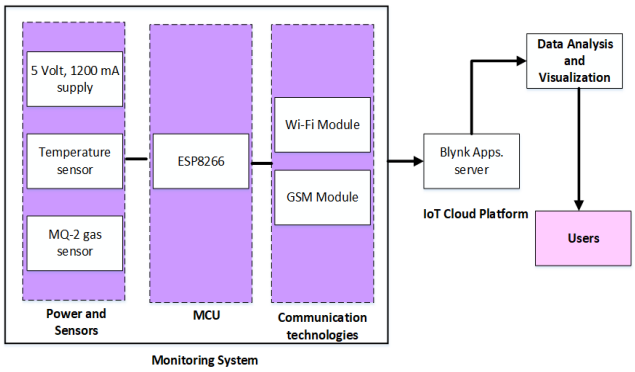

Figure 1: Block diagram of the air quality monitoring system

Figure 2 describes the functionality of the system. Firstly, the power supply at 5 V with 1200 mA is required to initialize the system. The connected sensors are ensure in active mode, so that the data from the sensors can be sent to the NodeMCU ESP8266 microcontroller. Arduino UNO SMD Rev3 is used to program the microcontroller. All the data from sensors being forwarded to Blynk server over a GSM and Wi-Fi network. Blynk is one of modern platform that give users to develop interfaces basically from iPhone Operating System (iOS) and Android computer to track and monitor the desired applications [12]. When the communication network connection cannot be detected, the process is repeated starting from the sensor placement inspection until the communication network connection problem is resolved. Then, the collected data are analyzed and employed on data visualization to receive information updates of the air quality conditions. Finally, the information results are sent through Wi-Fi for detailed monitoring by the end-users.

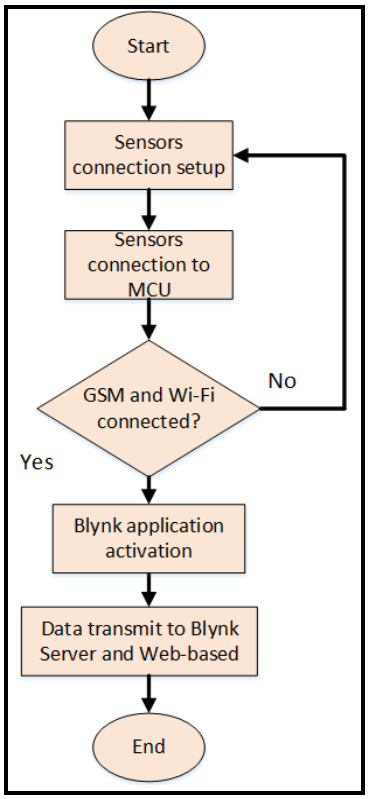

Figure 2: Flow chart of the system

3.2 Hardware Component

Figure 3 shows the circuit diagram of the air quality monitoring system which correspond to the components that have been connected for the air quality monitoring system as shown in **Figure 4**. The front end of the developed system consists of two main unit components namely the NodeMCU ESP8266 as a microcontroller and sensor unit; gas detection sensor and temperature sensor. NodeMCU is an open source for IoT development with built in support of Wi-Fi connectivity.

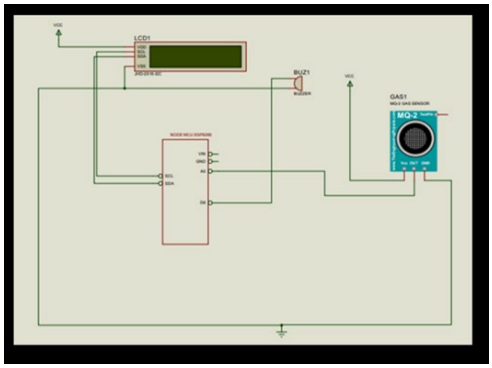

Figure 3: Circuit diagram of the system

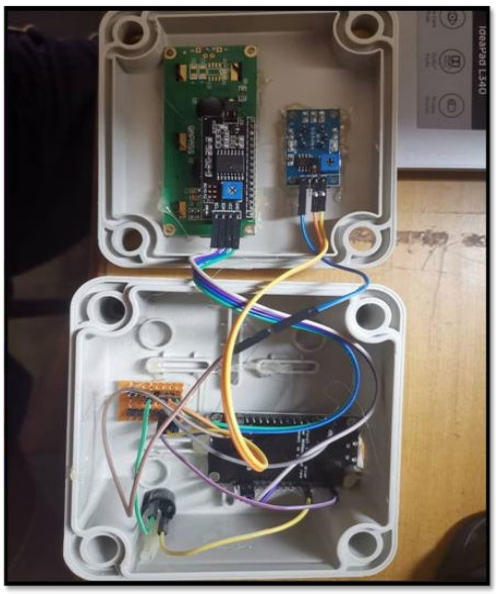

Figure 4: Components installation of the system

The Arduino UNO SMD Rev3 is an ATmega328 - based microcontroller module with 14 optical input/output (I/O) pins. There are also six analogue input pins and a crystal oscillator that has a bandwidth of 16 MHz. Some functions also include several I/O pins consisting of an ICSP header, a reset button, a USB link and a power port [13]. The Arduino UNO SMD Rev3 provides all the needs of a microcontroller, by connecting to a charging computer with a USB cable to get started with an AC-to-DC adapter or battery.

The MQ-2 gas sensor is the most important part of the system for detecting hazardous gases in the range between 200 ppm to 10000 ppm. MQ-2 sensor is also known as a sensor to detect chemicals in which to detect the concentration of gases in the air such as LPG, propane, methane, gasoline, alcohol, smoke and carbon monoxide (CO) [14]. An electric current will flow through a sensor and produce an analogue voltage value. The value of this voltage is to determine the concentration level of gas. In case the gas concentration increases, then the voltage level will be increases.

The LM35 is a sensor with analogue output temperature in which the output voltage is scaled linearly-proportional to the temperature degree [15]. The sensor has a precision integrated-circuit temperature device and is capable of measuring temperatures up to 100^0C.

3.3 Software Development.

The functions of the air quality monitoring system include the integration of the peripheral devices with software. The monitoring system includes several sensors, communication connections and MCUs that can be programmed by the Arduino UNO SMD Rev3 as the main part of the air quality monitoring system. Measurements of reliability data for temperature and gas concentrations from sensors during monitoring applications were observed. All virtual connections and hardware components must be synchronized with the Blynk application. Blynk is a platform used to control Arduino micro-controllers on the internet. Then, an Arduino IDE application is used as an editor to develop a coding called an outline that allows the system to function whenever a signal for an air quality condition is detected. Once the encoding is successfully verified and compiled, the code will be uploaded to the NodeMCU via the MCU serial interface. The sketch will allow all the sensors to send perceived data to the NodeMCU. NodeMCU will process all the collected data and upload it to the Blynk app over a Wi-Fi connection. Then, the data is sent to OLED display modules and Blynk applications. The data received is analyzed and employed on data visualization for the end-users to receive information updates of the air quality condition based on the notification alerts.

4.0 RESULTS AND DISCUSSION

For data collection, the air quality monitoring device was located in four different environments which are village, city, industrial and haze or open burning areas. The location for the village area is nearby to Kampung Sungai Pusu, Gombak, Selangor, while the location for the city area is in a high-density area around the Klang Valley. The selected industrial area is in the industrial area around Gombak. The location of garbage burning activities around the Gombak area was selected in such a way as to obtain the reading data from the open burning environments. Data collection was taken every 5 minutes during the day from 10.00 am to 2.00 pm. The specified period is selected because various activities such as cooking using a gas stove, grilling food, industrial activities, use of vehicles for transportation and burning garbage occurred actively performed by each individual in the four conditions as specified previously.

The data identified from the sensor is displayed on the LCD and then the information is sent directly to the user via a connected internet line. The users receive notifications on air quality levels through the created Blynk App. Figure 5 shows an example of an LCD module that displays the data reading collected from the MQ-2 sensor. When air quality conditions are not clean, then a notification will be sent to the Blynk apps as a reference for users to take the necessary precautions.

Figure 5: LCD module reading display

Table 1 shows the average AQI reading from the LCD module within the four different locations. Four levels of the air quality stage are classified according to the gas density in the particular area. According to the world Environmental Protection Agency [16-17], the AQI levels are described such that; Normal, AQI ≤ 50, Moderate, 51 ≤ AQI ≤ 100, Unhealthy 101 ≤ AQI ≤ 1500 and Dangerous AQI ≥ 151. The possible health implications are listed for the respective AQI reading. Users can monitor air quality remotely by any mobile apps through the Blynk apps.

Table 1: The summarization of reading results from the LCD display.

Condition, AQI	Surrounding	Health Implications [18]
Normal, 46	Village area.	Not suffering from diseases.
Moderate, 55	City area.	May have a meagre impact in case of chronic exposure.
Unhealthy, 110	Industrial area.	May have harmful impacts on peoples of sensitive groups (children, aged or at-risk person),
Dangerous, 256	Haze or open burning area.	May have a serious impact on peoples of sensitive groups (acute exposure).

The data collected from the sensors used in the air quality monitoring system are shown in Figure 6. The average of the AQI level is shown for four different environments, where it can indicate different AQI conditions. Figure 7 shows the graphical user interface (GUI) display result in the Blynk app when the MQ-2 gas sensor detected the gases in the surroundings. The AQI data log is displayed in the form of a line graph for a specified period of time. Figure 8 shows the GUI of real-time data collected by the sensor when the gas density increases according to the gas level conditions. The Blynk application interface displayed the updated data instantaneously.

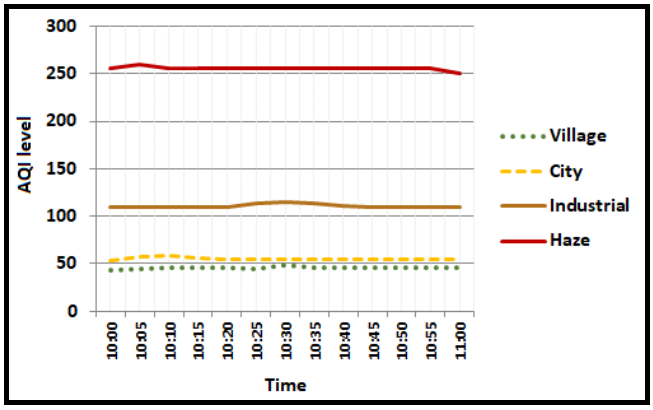

Figure 6: Test results for MQ-2 sensor

Figure 7: Blynk application output

Figure 8: Notification display given when the gas density increases according to the gas level

5.0 CONCLUSION

In this paper, the development of the Blynk IoT platform for air quality monitoring systems using Arduino Uno has been presented. Implementation by experimenting with the system was done to demonstrate the air quality monitoring system. Several valuable achievements from the air quality monitoring system were achieved, including; (1) the development of IoT -based systems that use mobile applications to provide warnings or messages depend on gas concentrations and temperatures in the atmosphere, (2) the reliability and durability of the sensors used in the expandable system allow easy installation of the platform by the user into a variety of suitable monitoring environments and (3) NodeMCU is a key component of the project and operates the entire monitoring system with Wi-Fi and LCD to display data in real-time.

In the future, air quality monitoring systems can be improved by integrating the IoT with artificial intelligence, so that, the system can be implemented as an automated system. Besides, the device system can be future improved by connecting an automated ventilation system in which the system can operate when detecting the presence of polluted air in surroundings.

Acknowledgement

The authors wish to thank UniKL BMI for the support given in facilitating and contributing to the success of this project.

REFERENCES

[1] Alhasa KM, Mohd Nadzir MS, Olalekan P, Latif MT, Yusup Y, Iqbal Faruque MR, Ahamad F, Aiyub K, Md Ali SH, Khan MF, Abu Samah A. (2018). Calibration model of a low-cost air quality sensor using an adaptive neuro-fuzzy inference system. *Sensors*, *18*(12), 4380.

[2] Khaslan Z, Yunus NHM, Mohd Nadzir MS, Sampe J, Salih NM, Alhasa KM. (2021), IoT-Based Indoor Air Quality Monitoring System using SAMD21 ARM Cortex Processor, In Proceeding International Conference on Marine and Advanced Technologies (ICMAT).

[3] Khan MF, Hwa SW, Hou LC, Mustaffa NI, Amil N, Mohamad N, Sahani M, Jaafar SA, Nadzir MS, Latif MT. (2017). Influences of inorganic and polycyclic aromatic hydrocarbons on the sources of PM2. 5 in the Southeast Asian urban sites. *Air Quality, Atmosphere & Health*, *10*(8), 999-1013.

[4] Wang, X. C., Klemeš, J. J., Dong, X., Fan, W., Xu, Z., Wang, Y., & Varbanov, P. S. (2019). Air pollution terrain nexus: A review considering energy generation and consumption. *Renewable and Sustainable Energy Reviews*, *105*, 71-85.

[5] Khan, A. A. (2019). TEMPORARY REMOVAL: Why would sea-level rise for global warming and polar ice-melt?.

[6] Omar, Abdulrafy & Ditual, Ameer & Urot, Jheryll & Dimal, Mohammad & Mamco, Nahid & Sagarino, Chris. (2019). MQ2-Tector: An Arduino Based Gas Detector, Preventing Gas-Leak Explosion.

[7] Pal, P., Gupta, R., Tiwari, S., & Sharma, A. (2017). IoT based air pollution monitoring system using Arduino. *International Research Journal of Engineering and Technology (IRJET)*, *4*(10), 1137-1140.

[8] Yamunathangam, K. P., & Varuna, P. (2019). IoT enabled air pollution monitoring and awareness creation system. *Int. Jrnl. of Recent Techn. and Eng*, *7*(4), 398-400.

[9] Carrozzo, M., Saverio De Vito, Elena Esposito, Fabrizio Formisano, Maria Salvato, Ettore Massera, Girolamo Di Francia, P. Delli Veneri, M. Iadaresta, and A. Mennella. (2018, February). An UAV mounted intelligent monitoring system for impromptu air quality assessments. In *Convegno Nazionale Sensori* (pp. 497-506). Springer, Cham.

[10] Fang, Biyi, Qiumin Xu, Taiwoo Park, and Mi Zhang. (2016, September). AirSense: an intelligent home-based sensing system for indoor air quality analytics. In *Proceedings of the 2016 ACM International joint conference on pervasive and ubiquitous computing* (pp. 109-119).

[11] Saikumar, C. V., Reji, M., & Kishoreraja, P. C. (2017). IOT based air quality monitoring system. *International Journal of Pure and Applied Mathematics*, *117*(9), 53-57.

[12] Parihar, Y. S. (2019). Internet of Things and Nodemcu. *Journal of Emerging Technologies and Innovative Research*, *6*(6), 1085.

[13] Seneviratne P (2017) Getting Ready for the Development Environment. In *Building Arduino PLCs*, Apress, Berkeley, CA:1-22.

[14] Pandey, R. C., Verma, M., Sahu, L. K., & Deshmukh, S. (2017). Internet of things (IOT) based gas leakage monitoring and alerting system with MQ-2 sensor. *International Journal of Engineering Development and Research*, *5*(2), 2135-2137.

[15] Oyebola, B., & Toluwani, O. (2017). LM35 Based Digital Room Temperature Meter: A Simple Demonstration. *Equatorial Journal of Computational and Theoretical Science*, *2*(1).

[16] Anastas, P. T., & Zimmerman, J. B. (2021). Moving from Protection to Prosperity: Evolving the US Environmental Protection Agency for the next 50 years. *Environmental Science & Technology*, *55*(5), 2779-2789.

[17] Chang, E., Zhang, K., Paczkowski, M., Kohler, S., & Ribeiro, M. (2021). Association of temporary Environmental Protection Agency regulation suspension with industrial economic viability and local air quality in California, United States. *Environmental sciences Europe*, *33*(1), 1-14.

[18] Lehman, P. K., & Geller, E. S. (2004). Behavior analysis and environmental protection: Accomplishments and potential for more. Behavior and social issues, 13(1), 13-33.