Air Drone Pollution Monitoring System with Self Power Generation

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Abstract. This project is to provide adequate environmental and health protection with an effective air quality monitoring system based on Internet of Things (IoT) medium. This system is simple, reliable, sensitive and low cost-effective. It used the MQ 135 sensor which a sensor that detects the surrounding Air Quality due to it compatibility and effectiveness which is easy to be used. The IoT Blynk application has been used in order to facilitate the user to control the air quality in continuously mode with easy interface structure. The best location to monitor the air quality is near to the source which is basically very high. Therefore, the drone has been used for this project and it also has been attached with the external source for increase the airborne time for the drone. At the same time, the monitoring system is to read the real air quality levels to determine the desire level of air quality to be monitored. At the meantime, time real monitoring data has been sent connected to the smartphone which is located at the ground which indicated wireless communication system has been created by using the Blynk application. This project has also combined with the forecasting techniques in order to ascertain future air quality expectations and thus enable users to know the air quality level at a particular place and time in the future. The system has been tested around the Faculty of Electrical and Electronic Engineering (FKEE) and it have prove that the monitoring can be done remotely and at the same time a simple prediction can be determined the air pollutant.

1. Introduction
Air pollution is the presence of undesirable material in air, where when the quantities are large enough it can produce harmful effect. The undesirable materials may damage human health, vegetation, human property, or the global environment as well as create aesthetic insults in form of brown or hazy air or unpleasant smells. Many of these harmful materials enter the atmosphere from sources currently beyond human control. However, in the most densely inhabited part of the globe, particular in the industrialized countries, the main source of these pollutions are human activities. These activities are closely associated with our material standard of living [1][2]. For each of these pollutants, EPA has established national air quality standards to protect public health [3] wellbeing. The purpose of the Air Quality Index (AQI) is to help to understand what the local air quality means to health is. To make it
easier to understand, the AQI is divided into six level of health concern that shown in Table 1 [4].

**Table 1.** The AQI level of health concern.

| Air quality index (AQI) values | Level of health concern |
|-------------------------------|-------------------------|
| When the AQI is in this range:| ...air quality condition are: |
| 0 to 50                      | Good                    |
| 51 to 100                    | Moderate                |
| 101 to 150                   | Unhealthy for Sensitive Groups |
| 151 to 200                   | Unhealthy               |
| 201 to 300                   | Very Unhealthy          |
| 3001 to 500                  | Hazardous               |

Due to this air quality issue, this project is been developed for real time air monitoring at the specific area which can indicate the level of air quality. At the moments there is no real time monitoring available in Universiti Tun Hussein Onn Malaysia. At the moments the real time monitoring will help the authority collect a real time data for air quality where at the same time is able to be used to forecast the air quality for the next few days. In order to combat this issue, a very smart or innovative technique should be implemented. As the world moving to Industrial Revolution (IR 4.0) a cloud computing or IoT is one contemporary technology in which the research community has recently embarked. Toward the end-goal of a comprehension of the field of cloud computing, and a more rapid adoption from the scientific community [5] and IoT platform has been introduced such as favoriot [6].

In this project, it will been developed a monitoring system for air pollution through the use of drone which been equipped with solar system as a backup energy source as shown in Figure 1. This solar generation system includes a standard solar cell string and a substandard solar cell string for prolong the operation of the drone when it is in airborne. It also involves the use of the Blynk application which allows the real time monitoring data such as the level of air pollution in the surrounding area can be monitored remotely and continuously.

![Figure 1. Block Diagram of the Project](image_url)
2. Project Development

This project consists for two parts which are the software development and hardware development. In software development it is where the real time monitoring system is been developed based on the features that can be embedded for the smartphone apps for smart mobile application. This feature will allow the user to monitor a real time data and at the same time generate the forecasting data for the future prediction. The apps also will be integrated with the security features in order to increase the safety of the system. As for the hardware part, a combination of existing drone, solar panel, sensors and microcontroller for collection of all the data, process and transfer to the IoT cloud. The usage of the solar panel is to give external power to the drone and to the microcontroller which help the components can lasting longer then the specific time given.

a) Software Development

In this section, a software based on the Blynk application has been used. As known the Blynk a open source system that enable the communication between the smartphone to the sensor. Therefore this software has been several advantages to the project such as, 1) reduce the time of developing the monitoring system, 2) less maintenance operation and 3) data recorded facility.

![Figure 2. Blynk System operation](image)

Figure 2 shows the system architecture for software communication between two parts. It is when the sensor will detect the air level while the Apps on the phone will be the real time monitoring interface. In order to be used, firstly the user has to install the Blynk Application via mobile device with the specific widget that can be developed for the Blynk application. As known the Blynk is operated as a drop and drag function for easier develop the user interface. Figure 3 shows the display of Blynk when user accesses this application for this project.

b) Hardware Development

![Figure 4. Top view drone](image)
In this project a drone has been modified in order to add the existing battery source supply with the power from the solar cell. It function is to charge the battery continuously for prolong the operation of the drone. The location of solar at the the drone is shown in Figure 4. The PV solar panels absorb sunlight as a source of energy to generate electricity to the drone battery where at the sametime it can be used as the supply to the microcontroller.

Figure 5 shows the sensors that been applied with the microcontroller for monitoring purposed. The MQ 135 Air Quality sensor has been used where it been located at the top of the drone for capturing the maximum air quality sense. This sensor will convert the air quality level into voltage signal that can been procesed by the microcontroller. In the microcontroller a process language has been embended to the microcontroller in order to interact with the signal generated from the sensor. Then this microcontroller will sent the data to the cloud system which is based to the IoT platform operation. At the end all the data can be captured and visualized at the blynx apps that been installed at the smartphone. The advantage of the microcontroller is where, the microcontroller has embended with the Wifi module where it can be connected directly to the wifi system that available.

![3.3v Power supply (Solar)](image)

**Figure 5.** Sensors connected to the microcontroller

### 3. Result of IOT Interface

All parameters obtained during the Blynk apps are been display in the real-time monitoring implementation. The monitoring performance based on the level of particle/million (ppm) versus time. By implementing this app, the authors can monitor the level of air quality at the specific area and with the specific result that can be easily monitored from the smartphone continuously. As for security purposed a barcode that already design for the authors has also been build in that apps for to indentify the user as shown in Figure 6. With this additional app, it gives user to have privacy and security access to ensure all the data in our work it can be store with the save place and can be share to only with 3 person or device at the same time.
Meanwhile Figure 7 shows the user Blynk interface in order to display real time monitoring of air quality information. The interface consists of 3 widgets for monitoring, which are widget to display Live view, forecasting graph and report graph. For the live view, the user can directly see and monitor the air quality through the gauge parameter and the live super chart parameter, with this parameter user can see the level of the air quality time by time when is needed to monitor, as long the supply is not being cut off to the system. As for the forecasting graph which can be used to predict the future air quality, the display is shown in Figure 8.
Figure 8 shows the widgets for the forecasting graph that allows the user to display the graph that has been capture and recorded. At the sometime, it used to see clearly the level of air quality and from that it can be make the assumption to see the changes of the air quality during that period that has been done. The best part of this widget is where the author can make the prediction of the changes of graph through to the forecasting formula to predict the changes of air quality in the future or another day from that equation.

4. Real Test Site
In order to verify both of the system several location around UTHM has been appointed for the study case project. The first location is at the Labs in F1, FKEE while the second location is at the most pollutant area in UTHM. Table 2 shows the real exact data when the air monitoring has been placed in the F1, FKEE.

| Time (minutes) | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Level of air quality (ppm) | 10.4  | 16.7  | **49.7** | 40.0  | 48.3  | 54.4  | 57.0  | **63.1** | 63.4  | 44.4  |

Table 2. Data air quality in lab UTHM

Figure 9 shows the result of live view of level air quality. This shows that the air quality is been plotted accordingly to the data collected. However, by using the linear equation that can give an forecasting the air quality monitoring for the next hour, which is based the equation can has been generated from

\[ y = 2.68x + 41.66 \]

| Time (minutes) | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Level of air quality (ppm) | 44.34 | 47.02 | 49.7  | 52.38 | 55.06 | 57.74 | 60.42 | 63.1  | 65.78 | 68.46 |

Table 3. Data air quality in lab after forecasting the result
Figure 10. Graph of level air quality in lab after forecast

Figure 10 shows the graph of level air quality are increase in air quality pollution with the rate of gradient on 41.66 ppm.

Next, the second location is been tested with the system. This result has been collected using MQ 135 sensor to see the level of air pollution around and also to used the forecasting method has also been done to see the expected air pollution that will occur over time.

Table 4. Data air quality at second location

| Time (minutes) | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|----------------|----|----|----|----|----|----|----|----|----|----|
| Level of air quality (ppm) | 137 | 169 | 154 | 128 | 163 | 195 | **186** | 137 | 129 | 114 |

Figure 11. Live view of level air quality at second location

Figure 11 shows the live view of level air quality in second location. By using linear equation concept as for the first test site the predicted equation can be written as the

\[ y = 3.4x + 162.2 \]
5. CONCLUSIONS

With an existing technology it has improved this project for having remotely operation, real time monitoring and forecasting prediction due to large data that can be collected. The use of Blynk app as one of the current app systems has allowed authors to control and observe the air quality. This Blynk application has made the system in wireless communication mode where it can monitor data acquired wirelessly at any time required. The use of this Blynk application has enabled the collection of data from the sensor can be easy been investigated. The data obtained is the latest and accurate data that been used to forecasting the future air quality at the specific location. The use of the solar panel that has been attached to the upper surface of the drone has enabled the extra energy that has been carried out in order to continue charge the drone battery for prolog the operation of the drone. As from the results that have been collected by combing the exiting IoT platform that available in the internet with some modification to the existing air quality monitoring, more autonomous air quality tracker has been developed.

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### Table 5. Data air quality at second location

| Time (minutes) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Level of air quality (ppm) | 16.6 | 169 | 172.4 | 175.8 | 179.2 | 182.6 | 186.0 | 189.4 | 192.8 | 196.2 |

### Figure 12. Graph of level air quality at second location
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