Air Quality Monitoring System in South Tangerang Based on Arduino Uno: From Analysis to Implementation

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Abstract.
Pollution is a major factor in reducing air quality. A decrease in air quality can cause many problems such as global climate change, environmental damage, asthma and lung cancer. In this paper, we present an air quality monitoring system based on the Arduino Uno at Tangerang City. Air quality measured was carbon monoxide (CO), butane (C₄H₁₀), particulate matter (PM₂.₅) and ozone (O₃). The types of sensors used were MQ-131 for the ozone sensor (O₃), MQ-7 for carbon monoxide (CO), GP2Y1010AU0F for the particulate matter (PM₂.₅), and MQ-2 for butane (C₄H₁₀). This tool was built using Arduino and data from the sensor was sent to a Liquid Crystal Display (LCD) which visualized in numeric form. Data collection was carried out at Jalan Cabe Raya Pondok Cabe, South Tangerang. The test results showed the carbon monoxide (CO) had an average concentration of 2.79 ppm, the ozone gas concentration (O₃) was 0.08 ppm, particulate matter concentration (PM₂.₅) was 35.51 µg/m³ and butane average concentration (C₄H₁₀) was 35.05 ppm. Based on the data obtained, South Tangerang, Indonesia had a high level of pollution in particulate matter (PM₂.₅).

1. Introduction
Air pollution is a condition in which the presence of one or more chemical, physical or biological substances in the atmosphere in dangerous quantities [1]-[2]. It harms human, animal and plant health, disturb aesthetics and comfort, or damage property. Air pollution is one type of environmental pollution besides soil pollution, water pollution, and sound pollution.

Among the impacts of air pollution are infant mortality [3], pregnancy complications [4], chronic respiratory diseases [5], climate change [6], allergic diseases [7], asthma and rhinitis [8], neuroinflammation and neurodegeneration [9], central nervous system pediatric impact [10], tuberculosis [11], oxidative DNA damage [12], morphological characteristics of Eucalyptus camaldulensis [13], cardiovascular disease [14], bronchiolitis obliterans syndrome and mortality after lung transplantation [15].

Various important studies involve the quality air monitoring system based on Arduino uno microcontroller. Karami et al conducted a toolbox which provides low-cost for indoor environmental quality (IEQ) monitoring based Arduino [16]. Kumar and Jasuja developed a real-time standalone air quality monitoring system which includes various parameters: PM₂.₅, carbon monoxide, carbon dioxide, temperature, humidity and air pressure [17]. They built the system with Raspberry Pi and
Internet of Thing. Gunawan et al presented a cost effective and portable air quality measurement system using Arduino Uno microcontroller and four low-cost sensors. It is capable to measure the concentration of carbon monoxide (CO), ground level ozone (O₃) and particulate matters (PM₁₀ & PM₂.₅) [18]. Husain et al constructed air quality monitoring based on Arduino Uno microcontroller and android [19]. However, Further research related to air quality monitoring should be developed as a literature on improving equipment quality.

In this work, we proposed a low-cost Arduino uno microcontroller-based air quality monitoring system. The Arduino is connected to four sensors and the measured data is displayed on the LCD. The sensors used are Mq-131 for the ozone sensor (O₃), Mq-7 for carbon monoxide (CO), GP2Y1010AU0F for the particulate matter (PM₂.₅), and MQ-2 for butane (C₄H₁₀).

2. Architecture

The Microcontroller reads all sensors using Analog Digital Converter (ADC) based on 8 bits digital data (0 to 255 of digital data) [20]. ADC hardware was not needed in the architecture because the ADC feature included inside the Microcontroller’s features. The Microcontroller converted the ADC data to voltage value using general equation. The voltage data was added to sensor equation using sensor datasheet and sensor company equation that implemented to Microcontroller’s program (See Figure 1). The hardware of the air quality monitoring system can be seen in Figure 2.

**Figure 1.** Microcontroller based air quality monitoring block diagram

**Figure 2.** Architecture Hardware air quality monitoring system
3. Methodology

We have created an air quality monitoring system that is low cost and easy to use. **GP2Y1010AU0F** is a PM sensor connected to digital pin A5 Arduino, MQ-7 is a carbon monoxide sensor connected to the Arduino A2 digital pins, MQ-131 (ozone sensor) and MQ-2 (butane sensor) connected to analog pins A4 and A0 of the Arduino.

We connect 4 sensors to the Arduino uno board. The data read from the sensor will be processed by the Arduino Uno microprocessor, then the data will be displayed on an LCD in the form of numbers. The results obtained will be analyzed according to the measured air quality threshold. The steps of this research can be seen in Figure 3.

![Figure 3. Methodology of our research](image)

4. Result and Discussion

Data collection was carried out at Cabe Raya Pondok Cabe, Pamulang subdistrict, South Tangerang City. Data were collected in the morning (10.00 AM) with a large volume of vehicles. In addition, we took 10 samples of data on each sensor. The results of air quality monitoring can be seen in Table 1.

### Table 1. Result of Monitoring Quality air in Tangerang

| Data | Carbon Monoxide (CO) (ppm) | Butane (C₄H₁₀) (ppm) | particulate matter (PM₂.₅) (µg/m³) | ozone (O₃) (ppm) |
|------|---------------------------|----------------------|-------------------------------|-----------------|
| 1    | 2.40                      | 35.42                | 29.20                         | 0.02            |
| 2    | 3.20                      | 35.20                | 35.10                         | 0.04            |
| 3    | 3.40                      | 34.21                | 38.25                         | 0.08            |
| 4    | 2.52                      | 35.23                | 39.42                         | 0.20            |
| 5    | 1.54                      | 35.24                | 39.38                         | 0.14            |
| 6    | 2.84                      | 35.64                | 40.68                         | 0.16            |
| 7    | 2.80                      | 35.19                | 34.87                         | 0.08            |
| 8    | 1.40                      | 35.11                | 33.25                         | 0.04            |
| 9    | 3.60                      | 34.12                | 32.40                         | 0.06            |
| 10   | 3.20                      | 35.14                | 32.54                         | 0.04            |
| **Average** | **2.79**                    | **35.05**               | **35.51**                      | **0.08**        |

The carbon monoxide (CO) had an average concentration of 2.79 ppm. At this value, conditions in the city of South Tangerang were good because it is still below the predetermined threshold. For butane (C₄H₁₀) and ozone (O₃) were 35.05 ppm and 35.51 ppm, respectively. Finally, particulate matter (PM₂.₅) was 35.51 µg/m³. This value is close to the threshold of particulates. Therefore, South Tangerang had a high level of pollution in particulate matter (PM₂.₅).
5. Conclusions

This paper discusses the process of air quality monitoring based on the Arduino Uno microcontroller. The sensors used were MQ-131 for the ozone sensor (O$_3$), MQ-7 for carbon monoxide (CO), GP2Y1010AU0F for the particulate matter (PM$_{2.5}$), and MQ-2 for butane (C$_4$H$_{10}$). The results showed that there was a significant value in the particulate matter (PM$_{2.5}$) of 35.51 µg/m$^3$. This indicated that South Tangerang had a high level of particulate matter. So, we will focus on monitoring particulate matter for further research.

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