Air Pollution Monitoring for Bogor Smart City Based Internet of Things and Social Media (Twitter)

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Abstract. The increasing number of vehicles has affected the air quality of Bogor city, one of them is CO gas (Carbon monoxide). CO is included in air pollution variables when the levels are higher than 100 - 300 ppm [1]. In line with one of smart city development strategy City of Bogor is Smart Living to realize a decent, comfortable, and efficient living environment. Bogor City Government conducted traffic engineering around Bogor Botanical Gardens and Bogor Palace with the introduction of One Direction System (SSA) around the clock [4]. This has an impact on the concentration of air pollution around the SSA. The development of sensor and internet technology makes it easy to develop integrated pollution monitoring systems [3]. An Arduino-based air pollution monitoring system is used to detect CO gas. If the concentration of exposure received by the MQ-7 sensor module exceeds the prescribed normal limit the CO gas concentration will be transmitted over the internet and aired on a text-based social media twitter. The device is designed using some components consisting of Arduino, Ethernet Shield, and MQ-7 sensor module. Programs are written and uploaded using C programming languages and the Arduino IDE 1.0.6 compiler. This prototype has been tested in the laboratory and applied to measure CO gas in five subdistricts of Bogor City-road. The results of this system are expected to be used by policymakers as basic information for decision making to reduce pollution level of Bogor City.

Keywords : Air Pollution Monitoring, Bogor Smart City, Internet of Things, Social Media (Twitter)

1. Introduction

Along with the increasing physical development of the city, and motorized vehicles, air quality has changed. This is due to excessive air pollution. The number of motorized vehicles in the city of Bogor has continued to increase over time. In 2010 the number of motorized vehicles in the region was 270,845 units. In 2012, the number of motorized vehicles increased to 310,184 units. In a period of two years, the growth of motor vehicles increased by 12.7 percent [6].

An increase in the number of motorized vehicles is judged to be proportional to the increase in pollutants in the air. The pollution is one of undesired effect for human’s health [11] since it has produced by vehicles [2] contains chemical residue of numerous pollutants [15]. Exhaust emissions such as NOx, SO2, CO2, and especially CO (Carbon monoxide) and others which could harm healthy life such as eye irritation, agitated, lung infection [7] and heart disease [13]. Motorized vehicles are the main source of CO pollutants which is around 59.2% [17]. This condition encourages the research for monitoring technology of air pollution in order to estimate the presence or absence of CO gas levels in the Bogor area.
Seeing the above problems, the design of a CO gas level monitoring tool is made that can provide information. This tool works based on the principle of local time and features, when detecting CO gas it will be processed by Arduino Uno and displayed through social media Twitter.

Previous research is monitoring of Carbon dioxide (CO2) in a room model based on the Atmega 8535 [1]. Input using TGS 4161 sensor to measure the absorption of CO2 gas [8], and the LM35 temperature sensor to measure temperature. The results of the design are then displayed on the LCD (Liquid Crystal Display) so that the user can read the pollutant measurement results. In this research a tool designed using Arduino Uno as a data processor, MQ-7 sensor to measure carbon monoxide gas, and an Ethernet shield as data communication to twitter. System testing was carried out on the highway which consisted of five districts in the city of Bogor which focused on measuring CO gas levels, the output was then arranged in the form of Twitter tweets.

2. Background

2.1. Air Pollution

Pollution is the entry of substances, energy, or other components in the environment that cause changes in the environmental order by human movements. Pollution means the entry of pollutants as a result of human activities or natural rules found in place and improper amounts. Pollution can be found, for a case on land, water, air, even noise from motors, engines, and others. Air pollution is the presence of one or more physical, chemical or biological substances in the atmosphere in an amount that can endanger human [12], animal and plant health, disrupt aesthetics and encouragement, or damage property. Pence, air circulation can be caused by natural sources or human activities.

2.2. Carbon Monoxide (CO)

CO is an odorless and natural compound, which is combined into Carbon and Oxygen. This mixture is the result of incomplete combustion, often occurs in the combustion process in the engine. Carbon monoxide is formed when there is a lack of oxygen in the combustion process. Carbon monoxide can be bound to blood hemoglobin more strongly than oxygen which can form carboxyhemoglobin (COHb), which causes the supply of oxygen to the body's tissues to be blocked along with a range of ppm (parts per million). A few of people is not known about the relationship between exceedances of air quality standards for carbon monoxide and respiratory health disorders [18]. Table 1 explains the relationship between pollution levels and air quality

| Category       | Range (ppm) | Carbon monoxide                                      |
|----------------|-------------|------------------------------------------------------|
| Good           | 0-50        | No Effect                                             |
| Medium         | 51-100      | Blood chemistry growth but not detected               |
| Unhealthy      | 101-199     | Increase in cardio vascular in smokers who have heart disease |
| Very Unhealthy | 200-299     | An increase in cardio vascular in non-smokers seems a real weakness |
| Harmful        | More than 300 | Very dangerous levels                                |
2.3. **MQ-7**

MQ-7 is a gas sensor that is quite easy to use, this sensor has great sensitivity and gas selectivity. This sensor has high sensitivity and fast response time. The sensor output is analog resistance. MQ-7 can detect CO-gas absorptions everywhere from 20 to 2000 ppm [16]. The output in the form of analog stability is required only to supply 5V power to the heater coil, add load resistance (RL), and connect the output to the ADC. MQ-7 gas sensor structure and arrangement is the sensor material, tin dioxide (SnO2). MQ-7 has 6 pins, 4 pins are used to pick up the signal, and 2 pins are used to provide heating of the sensor material. [9]

2.4. **Arduino Uno**

Arduino UNO is a microcontroller board based on ATmega328. Arduino UNO has 14 digital input/output pins (6 of them as PWM outputs) [10], 6 analog inputs of a 16MHz Crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino UNO contains everything needed to support the microcontroller, easily connect it to a computer with a USB cable or supply it with an AC adapter to DC or use a battery to start it. [14]

2.5. **Twitter**

Twitter is a website that offers microblog social networking, allowing users to send and read messages. The word twitter actually means 'tweet'. Microblogging is for short update about something (whether it's an ongoing event or an update news) that is presented in a short character. Twitter is appear as a medium of choice for scientists research [5].

3. **Method**

This research was conducted from February 2016 to April 2016. The research was conducted in the city of Bogor. **Research Material**: *Arduino Uno R3, Modul MQ-7, Ethernet Shield*

3.1. **Flow System**

This system uses Arduino UNO that communicates with serial communication via an Ethernet shield. The system input is an MQ-7 sensor module that functions as a component to detect carbon monoxide gas concentrations. The general description of this system consists of 3 aspects, namely the system input using the MQ-7 sensor module. Control the system using Arduino Uno. The system output is the display of monoxide gas concentration on Twitter.
In this process of integration, component-based software, mechanical design, electronic software, and design are carried out. Assembling is done by uniting all the parts. In this stage programming and configuration between hardware and software is done using the Arduino IDE application. The following is the program or source code compiled using the Arduino IDE application via the Arduino upload board

// Ethernet Shield
byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
IPAddress dnServer (192, 168, 88, 254);
IPAddress gateway (192, 168, 88, 254);
IPAddress subnet (255, 255, 255, 0);
IPAddress ip (192, 168, 88, 100);
// TOKEN for Log in to Twitter
Twitter twitter("212564141w5J6efG8aoZZcQ5zD2gyHxjTcRz60vI81BiAzlJX");
char tweetText[140];
void setup() {
  delay(100);
  Ethernet.begin(mac, ip, dnServer, gateway, subnet);
}
This sensor will cover gas resistance in the air. The higher the gas reserve in the air. The output of Arduino is that value of CO gas intensity in the air. Data will be transmitted through an Ethernet shield that is connected to the internet and access the twitter.com to be seen. [20]

4. Result

In this study, the system workflow will be explained from the initial stage to the final stage. At the initial stage, it starts by powering the Arduino Uno, the active power indicator is indicated by turning on the indicator light on the Arduino board, then the MQ-7 sensor will activate and detect carbon monoxide gas in the air. If the sensor detects CO gas, it will be sending data to Arduino Uno. After being processed by Arduino Uno it will be sent via the internet by Ethernet Shield and display on twitter.

On the Arduino test Uno R3 is done by giving a voltage of 6V - 12V. After that the output voltage is checked on the 5V pin which is connected to positive phobe and the GND pin which is connected to the negative multimeter. This test is done by uploading the program to the Arduino Uno board with the status / tweet display in the form of carbon monoxide levels.
4.1. Ethernet Shield Validation

At this stage the MQ-7 Sensor Module is tested as a system input on the A0 pin connected to the A0 pin on the Arduino board, then the value can be seen in the Arduino IDE Serial Monitor. Validation test is carried out by giving motor vehicle exhaust (exhaust) to the system input.

| Resistance Value | Respond Time (s) | Result |
|------------------|------------------|--------|
| <300             | 0.3              | Working |
| >300-400         | 0.6              | Working |
| >400             | 0.9              | Working |

Based on the test data in Table 2, can be seen that the sensor response time depends on the presence of vehicle exhaust gas.

4.2. Testing phase

The system testing was carried out for 7 days on the road 5 sub-districts of Bogor City including: South Bogor, East Bogor, West Bogor, Central Bogor, and North Bogor.

a. On March 28, 2016, a study was conducted in East Bogor precisely in Baranang Siang area (in front of KFC).

b. On March 29, 2016 a research was conducted in South Bogor precisely in Heroes’ / Empang’s jln.

c. On March 30, 2016, a study was conducted in West Bogor precisely at Jl. Batu Batu.

d. On March 31, 2016, a study was conducted in North Bogor precisely at jln. KH. By Iskandar.

e. On April 1, 2016, a study was conducted in Bogor Tengah precisely at jln. KH. Sholeh Iskandar / SAMSAT Office.

f. On April 2 - 3, the study was conducted again in East Bogor and North Bogor, this study aimed to determine the value of monoxide gas on Saturday and Sunday or the increasing number of vehicles on weekends. East Bogor is the main entrance to Bogor City and North Bogor is the exit of Bogor City.

The test results are obtained in the form of graphs which have been averaged as follows:

![Figure 5. Graph of CO gas levels in Bogor City.](image-url)
5. Conclusion
The conclusion of this study is the Arduino Uno-based Real Time Index of Air Pollution Standards (ISPU) through Media Social (Twitter). This system uses Arduino Uno, and Ethernet Shield. The system input uses the MQ-7 Module which will be displayed via the internet using the ethernet shield to the Twitter status. MQ-7 module needs to warm up for 2 hours to initialize the sensor. Tests conducted in this study, the data generated from the study differed (not constant). The number of vehicles and congestion affect the increase in CO gas levels from the same place, the system designed in this study is still manual operation. Based on testing, if the test time is 1 minute, while the tweet is programmed once every 10 seconds, then the tweet that will be displayed is 6 sentences or commonly called 6 tweets.

Tests carried out on several roads in the city of Bogor, the highest CO 2 gas levels were found at Baranangsiang afternoon road with a CO gas value of 43.51939444 ppm with Normal Category on Saturday 2 April 2016 at 16.00-17.00, while the highest data was after the System was enacted. One Direction occurs in Baranang Siang Street, East Bogor with an average value of 42.56527222 ppm, this value is still categorized as Normal.

6. Suggestion
The Real Time Index of Arduino-Based Bogor City Air Pollution Standardization (ISPU) Through Social Media (Twitter) is still not perfect, so it needs improvement. Some suggestions that can be developed in the design network using wireless sensor network topology [19], besides being able to use social media twitter this system can be applied through interfaces such as websites, because in making this system using an Ethernet shield that can store its own data.

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