Haze Wireless Sensor System Development and Measurement

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Abstract.

Haze phenomenon often occurs in Malaysia. Haze arisen when the particles in the air such as dust, smoke, and other dry particles vague the clarity of the sky. When the dispersal of those combinations of dry particles concentrate, low hanging shroud will form that will spoil the visibility of the sky and may result with respiratory threat to human health. And thus, this work is aimed on developing a haze measurement system for detecting and evaluating the Air Pollutant Index (API). The developed wireless sensory system consists among others a microcontroller and a gas sensor module to read and evaluate the API reading. Alert message with content notification of the API readings is broadcasted to user via Short Message Services (SMS) through SIM900 GSM Module of the system. Outdoor measurement was conducted in industrial and residential area in Shah Alam, Selangor for system reliability and testing. The Outdoor testing showed the system successfully measured the API reading and sent alert message to a mobile device as expected.

Keywords. Global System for Mobile (GSM), Short Message Service (SMS), Air Pollutant Index (API), microcontroller

1. INTRODUCTION

Air pollution is worldwide phenomenon and required significant attention and need to be addressed. The haze phenomenon in South East Asia motivates the importance of providing API reading and alert system for citizen about the haze phenomenon threats. This phenomenon is sometimes caused by forest fires resulting from illegal slash-and-burn practices which then spread quickly to the neighbouring countries with the aid of a dry season. Haze phenomenon occurred when the dust, smoke and other dry particles obscure the clarity of the sky. Haze can be divided into 2 types, dry haze that consist of giant particles in the air such as smoke, dust, etc. and wet haze due to H20 condenses onto hydroscopic [1].

Haze can cause major health threat to the people. Haze can easily threat human health in short-terms and long- term affect. Examples of short-term effects are irritation of the eyes, nose, and throat in healthy individuals. Besides that, it can also affect human lungs and heart especially those people that already have chronic heart or lung diseases such as asthma and heart failure. On the other hand, the long-term effects can cause cardiovascular effects such as heart attack and reduced lung development [2].

Malaysia is one of Southeast Asia countries that regularly affected by the haze phenomenon. Haze phenomenon leads to several problems such as increasing road accidents due to poor visibility, disturbing school progress and also create hazardous effects on human health. In September 2019, half a million of face mask was sent to state of Sarawak and 409 school were closed as the air pollution index reached unhealthy level due to haze [7]. In January 2022, ASMC based in Singapore alerted for haze condition to hit the northern part of Malaysia caused by hotspots burning in Cambodia and this put Malaysia to be in standby should the haze become worst [8]. Then in August 2022, Sri Aman in state of Sarawak showed hazy condition and reported with API index value of more than 100 [9].

This paper discusses the framework of developing low-cost wireless sensor system for API measurement. A gas sensor module is used to detect and measure gas particles for the developed system after which a microcontroller will process and interpret the API readings and sent SMS alert through GSM Module. TABLE I tabulates the API index consideration values applied in this work. The following section discussed methodology involved in this work and also sample of results with discussion presented in section that follows.

TABLE I. API AND CONDITION

Air Pollutant Index (API)	**Condition**
Below 50	Very Good
51 – 100	Good
101 – 150	Moderate
151 – 200	Unhealthy
Above 200	Hazardous

2. METHODOLOGY

This system is comprised of hardware and software development. This section describes the methodology employed in this work.

2.1. System Flowchart

Figure 2.1, shows the system flowchart for this work which illustrates the process flow from the beginning to the end of the system. At initial state, the wireless sensor system is in standby mode in which the microcontroller waited for a request to activate gas sensor module for measurement. Upon receiving request through SMS containing letter ‘R’, microcontroller responded with the confirmation request and activate gas sensor module to begin the measurement. Once the reading is processed and recorded by the system, the API value is sent back to user by means of GSM module. SMS notification was then received by user containing the current.

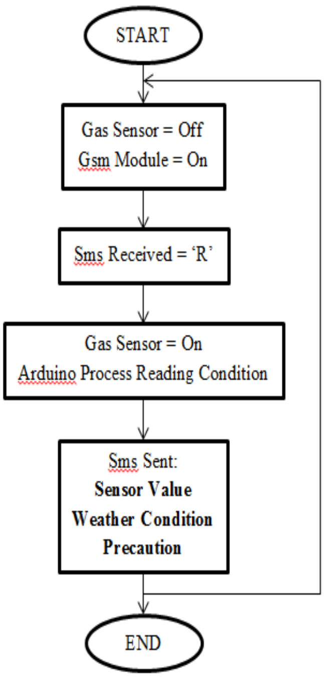

Figure 2.1. System flowchart.

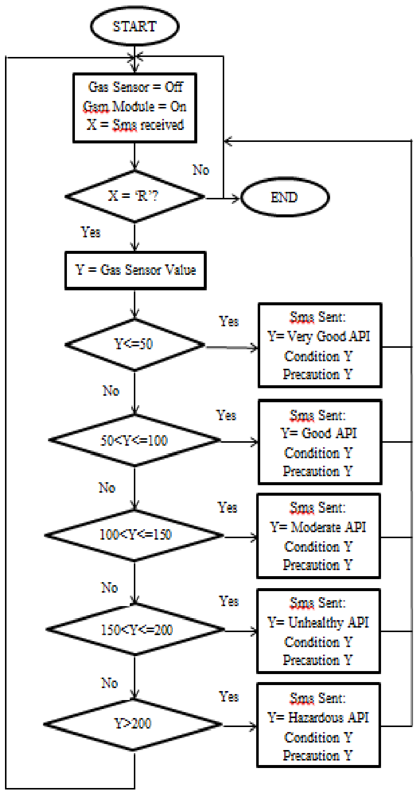

Figure 2.2. Software flowcharts.

Figure 2.2, illustrates the software flowchart developed for this project. A sketch or Arduino programming language is written following steps illustrated in the flowchart. The flowchart describes in more detail the evaluation process involved perform by the microcontroller once activation SMS received from user.

2.2. *Hardware Design*

Figure 2.3, illustrates the connections of gas sensor module and SIM900 GSM Module to Arduino UNO microcontroller board. And Figure 2.4, shows the hardware connection of this wireless sensor after assembly. The Vcc for gas sensor and GSM module (Red) is connected to the 5V pin of Arduino. Both ground (Black) pin of gas sensor and GSM module is connected to the ground pin of the Arduino board. The analog output of gas sensor (Blue) is connected to the A1 pin of Arduino board. The receiver pin (Green) of the GSM module is connected to the transmitter pin 8 of Arduino board while the transmitter pin (Brown) of GSM module is connected to the receiver pin 7 of Arduino board.

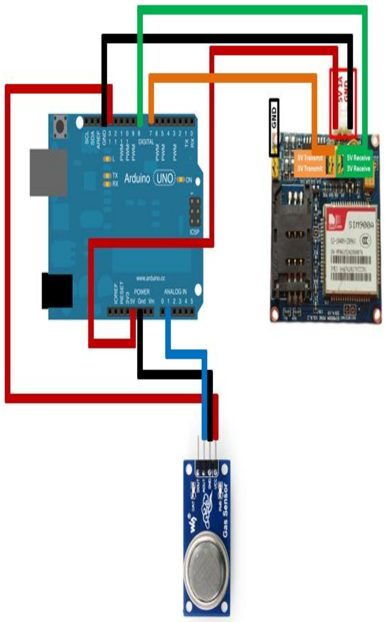

Figure 2.3. Wireless sensor circuit diagram.

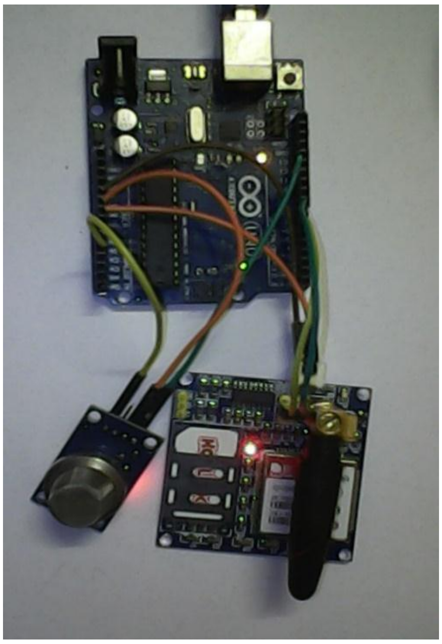

Figure 2.4. Hardware assembly for wireless sensor

3. Results and Discussions

To evaluate the wireless sensor reliability, outdoor testing has been conducted in Shah Alam, Selangor. The location chosen for testing were at a residential area Seksyen 7 Shah Alam and industrial area Seksyen 16 Shah Alam, Selangor. System testing was performed starting from 10:00 A.M until 05:00 P.M for both selected areas. The outcomes are shown in TABLE II for residential and industrial area.

Figure 2.6, illustrates comparison of API readings between the residential area and industrial area. From the collected readings, the air quality in residential area was in good and healthy condition throughout the day. However, the air quality in industrial area gave unhealthy readings starting at 2.00 PM and lasted for two hours until 4.00 PM. This may be due to industrial activities happened in the area. For instance, factory releases smoke to the open air and after certain time that particles accumulated in the air became dense and cause the reading of API to be unhealthy.

TABLE II. API READINGS FOR RESINDETIAL AND IINDUSTRIAL AREAS

Time (hour)	API Reading	
	Residential Area	Industrial Area
10:00 A.M	47	53
11:00 A.M	49	77
12:00 P.M	57	107
01:00 P.M	65	146
02:00 P.M	63	165
03:00 P.M	59	151
04:00 P.M	52	138
05:00 P.M	46	103

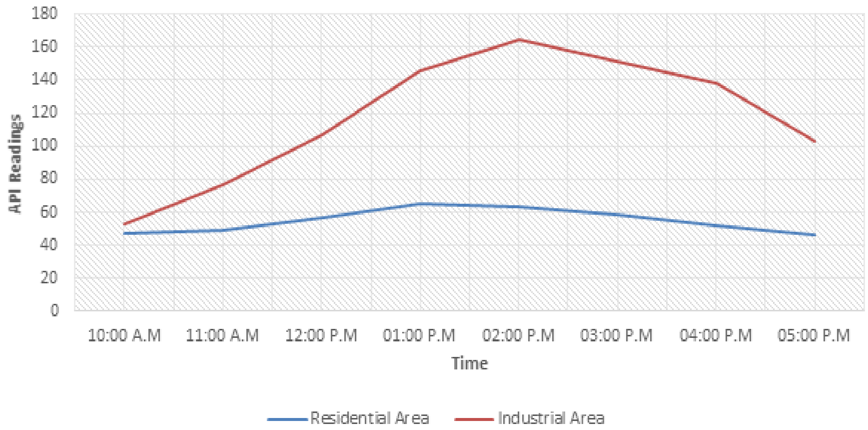

Figure 2.6. Comparison of API reading between residential and industrial area.

4. CONCLUSION

Low cost and low power Haze Wireless Sensor System is successfully implemented and tested consisting of a microcontroller, gas sensor module and GSM module. The developed system shows promising outcomes in sending out alert message related to API condition and air quality for area that regularly exposed to hazy conditions. Likewise, the systems offered ease of use monitoring of air quality and provide information and assistance in decision for outdoor activity. In all, it also promotes public safety towards harmful effect of unhealthy particles content in the air using Air Pollution Index (API) value.

5. ACKNOWLEDGEMENTS

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Biographies

Kama Azura Othman received the bachelor's degree in computer and information engineering from International Islamic University Malaysia in 1998, and the master's degree in telecommunication and information engineering from Universiti Teknologi MARA in 2007, respectively. She is currently working as a Senior Lecturer at the School of Electrical, College of Engineering Universiti Teknologi MARA Shah Alam, Selangor, Malaysia. Her research areas include Signal and Image Processing, wireless sensor system and IOT.