# GSM Wireless Technology Implementation in Haze Monitoring

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***Abstract*— Malaysia has periodic problems with air quality reaching hazardous levels because of smoke haze. The heavy haze, described as a pall of smoke caused widespread health problems especially among the elderlies, the young and kids. Haze is an atmospheric phenomenon where dust, smoke and other dry particles obscure the clarity of the sky. This haze pollution has serious implications to health as well as for the whole environment. This paper described a mobile monitoring system developed to detect the level of haze particulates. Data collection was achieved with the use of gas sensor, and mobile alert implementation was developed with Global System Mobile (GSM) connection and Short Messaging System (SMS).**

***Keywords-GSM; SMS; haze***

## I. INTRODUCTION

Haze refers to a light cloud of fine particles that consequently reduces visibility. The extent of the visibility loss depends on the amount of particles in the air and the thickness of the haze. Haze can be classified into four main types namely, pollution, dust, smoke and moisture hazes. The occurrence of haze leads to limitation in visibility besides having unhealthy environment. Sources for haze particles include farming in dry weather, land traffic, industrial fumes, and wildfires. In Malaysia and its surrounding neighboring countries, haze can also be caused by open burning activities to fertilize the soils for crops. Haze is likely to occur in a relatively dry air whenever dust and smoke particles accumulate. When weather conditions block the dispersal of smoke and other pollutants they concentrate and form a usually low-hanging shroud that impairs visibility and may become a respiratory health threat. Industrial pollution can result in dense haze, which is known as smog. Since 1991, haze has been a particularly acute problem in Southeast Asia, for instance the Indonesian forest fires burnt to clear and clean the land being one of the reasons. In response to this issue, the ASEAN countries agreed on a Regional Haze Action Plan (1997) and later signed the Agreement on Transboundary Haze Pollution (2002), however the haze pollution is still a problem today. Healthy environment is very important to ensure healthy living. Human body needs healthy environment to maintain balance for the internal organ systems to function properly.

Incident of haze like severe smoke pollution have occurred from time to time in many parts of the Southeast Asian region. This problem continuously occurred due to uncontrolled forest fires mainly in Indonesian states of Kalimantan and Sumatera in which affected several countries in the Southeast Asia from July to October 1997. [2] The condition is then worsened by the fact that countries close to the equator are known to have high average daily temperature and high humidity. Haze monitoring system in ASEAN countries employed the used of satellite data to locate hot spots of occurrence of fires that eventually lead to haze phenomenon. As described in [4,5,6] haze monitoring is achieved through analysis on remote sensing data. All these reported works performed haze monitoring using satellite images. Currently in Malaysia, the reading of haze is made public through government based websites and through led message boards in primary highways. Previous work reported in [1] implemented haze monitoring using a gas sensor and data was transmitted to a receiving station or personal computer. Thus, this project introduced method of haze monitoring using data obtained using gas sensor and sent it to mobile phone subscriber.

Wireless network refers to any type of computing network that is not connected by cables of any kind. It is a method by which homes, telecommunication networks and enterprise installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations.[3] Wireless telecommunication networks are generally implemented and administered using transmission systems called the radio waves. [7]

Wireless sensor networks are used in various applications such as for environmental and habitat monitoring, and healthcare application. GSM modem is one of the applications in wireless technologies and it provides the communication mechanism between the user and the microcontroller system via short-message-system (SMS) messages. This paper presents GSM wireless technology implementation in haze monitoring. The study involved developing a mobile monitoring system to measure haze particle level in the environment with GSM implementation.

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## II. METHODOLOGY

A gas sensor is mounted to measure the smoke particulates emitted in selected region known to have heavy unhealthy particles in the air. The readings produce by the gas sensor is continuous signal which is then processed digitally by a microntroller of the system. Once the data is processed and evaluated, it is then sent to the GSM modem and ready to be transmitted to the receiving mobile device. This process is depicted as shown in Fig. 1.

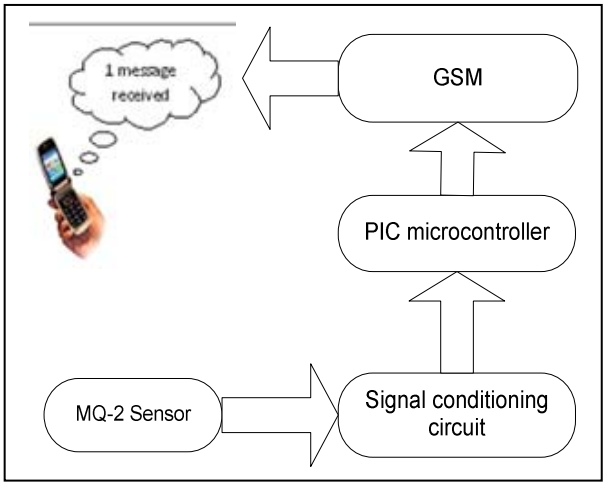


Fig. 1 Block diagram of haze monitoring process

### A. Hardware

Fig. 2 shows the block diagram of the sensor network transmitter. The hardware governing the system comprises of sections for data collection, data processing and data transmission. Gas sensor is used for data collection data processing is performed by a microcontroller and GSM modem for data transmission.

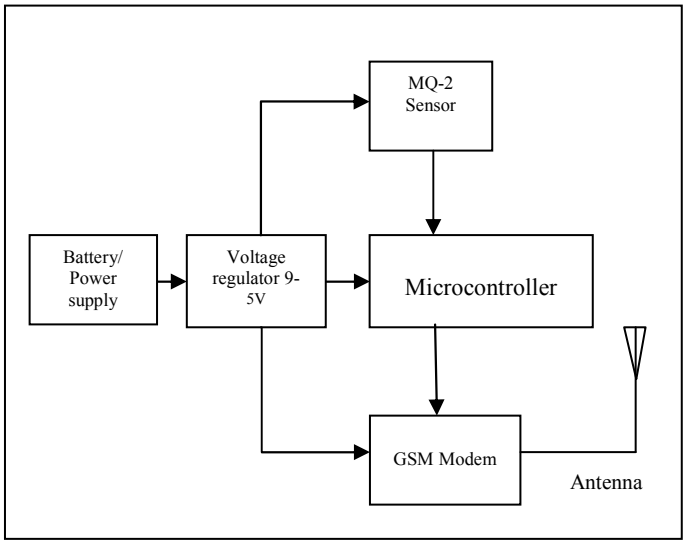


Fig. 2 Block diagram of transmitter

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like any other mobile phone. When a GSM modem is connected to a computer, this allows the computer to use it to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages [2].

SMS via GSM network is proven to be reliable due to its capability to works on a different band and can be sent or received although the phone lines are congested. It also has the advantage of sending data to multiple users.

### B. Software

Software or device driver is written to be uploaded into the microcontroller chip. The software is written in assembly language and tested using MPLAB IDE Version 8 a 32-bit application on Microsoft Windows and includes several software components for application development, hardware emulation and debugging.

Fig. 3 shows the flow chart of the microcontroller program. The first part of the program is for data measurement, data conversion of analog to digital and calculation, read from the gas sensor. The program also defined the destination in which data should be sent. The resultant output of the microcontroller is then sent to GSM modem and transmitted to mobile phone user.

Initial testing was performed to ensure that the hardware and software are error-free. The software part is tested using MPLAB IDE. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third-party software and hardware development tools. The MPLAB platform offers useful function to test drive the written assembly language program due to its features supporting checking of the content of port, special function register during simulation.

In this project, the measuring of haze particles level emitted in the environment is continuously stored in the system temporary storage. Readings is updated to subscriber for every 10 minutes set by system administrator. Therefore, subscriber will receive 6 SMS alert in an hour. However, the number of alert messages received can be altered. These readings update the users on the current particles level of haze in the environment. Short messages via GSM network is proven to be reliable due to its capability to works on different bands and can be sent or received although the phone lines are congested. Besides that, SMS also has the advantage of sending data to multiple users.

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Fig. 3 Flow chart of system software

## III. RESULTS AND DISCUSSIONS

The selected regions for data collection are Subang Jaya, Bandar Sunway and Shah Alam which are three adjacent cities in the state of Selangor, Malaysia. These areas are known to be highly congested with vehicles since these area serves as major towns in the state of Selangor. Initial observation on these three locations showed that vehicles activity happening almost 24 hours a day. Table I tabulates sample of data collected in those three places.

Data collected by the system is automatically converted into Air Pollutant Index (API) reading in parts per million (PPM). Comparatively, data collected in Bandar Sunway showed the highest readings of 0264PPM as compared to the other two. Reading in Shah Alam was 0227PPM and Subang Jaya with 0225PPM.

Table I Samples of data collected

| Location /Result (PPM) | 1 | 2 | 3 | 4 | 5 | 6 | Average Results |
|---|---|---|---|---|---|---|---|
| Subang Jaya | 0224 | 0224 | 0223 | 0224 | 0231 | 0224 | 0225 |
| Bandar Sunway | 0283 | 0271 | 0265 | 0255 | 0255 | 0255 | 0264 |
| Shah Alam | 0224 | 0195 | 0196 | 0240 | 0255 | 0252 | 0227 |

All these readings were taken after the end of office hours between 5.00PM to 6.30PM. During this time duration, town dwellers were busy commuting from their offices to get home. The highest reading recorded at Bandar Sunway support the evidence of having a lot of vehicles at that area during that time compared to the other two locations. The car exhaust emissions somehow affect the quality of air of the area under observation.

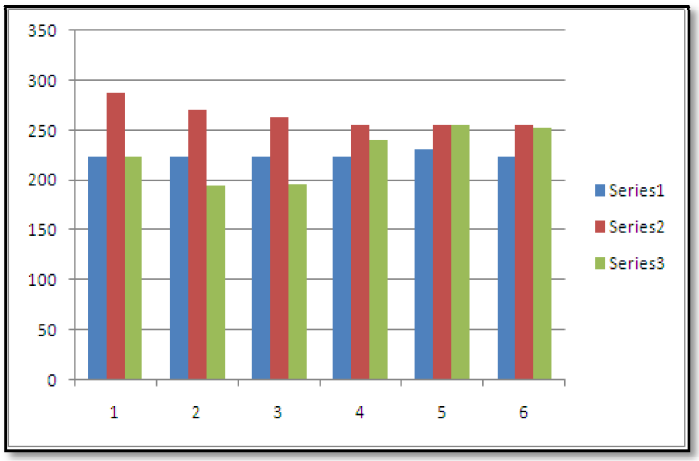


Fig. 4 Graph of samples collected data

Fig. 4 illustrates a plot of data collected from the three area. Series1 indicates reading taken in Shah Alam, Series2 is reading plot for Bandar Sunway and Series3 is data collected at Subang Jaya. From the graph, it is clearly shown that haze reading in Bandar Sunway gives the highest average value. During the selected time frame six different readings were taken for approximately every 10 minutes gap.

Fig. 5 shows the sample of SMS alert notification received through mobile phone generated by the developed system. The alert message received depends on the level of readings measured at that instance. Table II shows the category of readings to define the quality of air.

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Table II Air quality classification

| API scale | Air quality |
|---|---|
| 0 – 50 | Good |
| 51 – 100 | Moderate |
| 101 – 200 | Unhealthy |
| 201 – 300 | Very unhealthy |
| 301 and above | Hazardous |

Based on Table II, it is clearly shown that all readings taken from the three chosen places in Table I fall under the category of very unhealthy. This support the fact that, during which the readings was taken, a lot of vehicle exhaust emissions can be traced since people were busy commuting from one location to another.

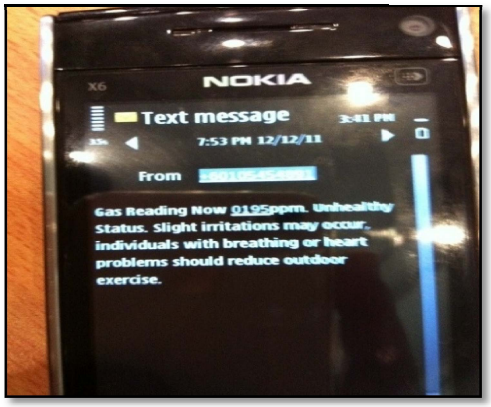


Fig.5 SMS alert for Unhealthy level

## IV. CONCLUSION

The system was completed and tested successfully and able to detect haze particles data for air quality measuring. With the implementation of SMS alert based system, user will be updated with the latest haze measurement and thus notify user whether it is safe to conduct any outdoor related activities. The developed system offers flexibility and cost effective. With the use of mobile phones, end user will have the opportunity to get the latest update on the environmental conditions.

## ACKNOWLEDGMENT

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