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Web-Based Gas Emission Level Monitoring of Diesel Power Plant using Multi-Sensors

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Abstract*— one of the problem in Diesel Power Plant is Gas emission that contents of Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Nitrogen Oxide (NOX) and other hazardous materials.. These emitted gaseous are dangerous to the human health and potential to cause air pollution. Therefore, a monitoring of gas emission that can be accessed real-time and online through website is needed. To realize the monitoring system, electronic design based on the microcontroller ATmega16, programming environment of Code Vision AVR V2.03.4 and multi sensors are combined with real-time data management. The sensors are installed in the exhausted valve of diesel power plant. In the implementation, the information of gas emission is easy to access from the using of online information system.

Keywords: **Diesel power plant, Gas emission, Sensors, Website.**

I. INTRODUCTION

The issue of smart environment, that may involve the monitoring and control of the gas emission exhausted from the chimney of the plants, is most popular in recent years. There has been significant development in the environmental Monitoring (EM) System using sensor technology related to data gas emission [1]. The development of electronic devices technology produces new sensor generation with cheaper, more accurate and wide range detection capability. In addition, the sensor network is more flexible than other methods due to supporting by wireless communication network as media for data transformation. Wireless Sensor Network (WSN) is a new technology in EM system [2]. The usage of WSN can be used and integrated as the real-time EM system effectively [3]. The real-time EM system based WSN to detect the water level during the earthquake by using UHF/VHF and GSM/GPRS as communication media has been conducted by JICA Joint Research project in Indonesia (2008). Another successful project developed by environmental research group of BPPT in Indonesia to monitor the water quality using Online Monitoring Global System Mobile. The proposed system is basically an electronic device that consists of sensor, data logger system, data processing system combined with the advantage of GSM communication network provided by cellular telephone operator [4]. Nakamura et.al., also developed Continuous Emission Monitoring Systems (CEMS) in Gas Power Plant (GPP) by using *laser-type gas analyzer* so that the emission level of the GPP can be detected automatically [5]. The usage of UHF/VHF transceiver or GSM/GPRS as communication media in Wireless Sensor Networks (WSN) for real-time EM system is difficult to operated in long time period due to high cost investment [6]. This is worsen by the fact that the availability of GSM/GPRS infrastructure in Indonesia is limited. Real-time data can be obtained using sensor network technology, while the low cost device can be achieved by utilizing local and easy-found on market components. The designed device is very useful for the gas emission management from the power plant by controlling the polluted gas emission below the standard regulation level. In addition, The device is portable and has small dimension to allow the users to carry, operate and maintain in any location for environmental gas measurement. Therefore, the real-time EM system to monitor the emission level of Diesel Power Plant using multi sensors is proposed in this paper. The structure of this paper is as follows. In Section II, the proposed EM system is described. In Section III, the design of hardware and software of the proposed system are presented. In Section IV, the results of the EM system are discussed. And finally, Section V concludes this paper.

II. PROPOSED GAS EMISSION MONITORING (GEM) SYSTEM

Diesel power plant is one of the importance roles in our region. The main advantage of diesel power plant is able to be installed in any locations for main and back-up electrical sources closed to the supply target. Consequently, the diesel power plant may be potential to emit gas pollution, such as Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Nitrogen Oxide (NOX) and dust contains heavy metal particles [7]. It is well-known that such gas pollution may cause acid rain, global warming, diseases related to human respiratory and chemical poison to the living things. In this paper, there are two main components of the proposed EM system, i.e. hardware and software. In designing hardware, the focus is on the physical system design of monitoring device including electronic circuit. On the other hand, the software design consists of how to visualize the level of pollutant on Liquid Crystal Display (LCD) and computer programming using application of Microsoft Visual Basic 6.0. In addition, the C language is composed using *Code Vision AVR V2.03.4* including compiling and downloading process. PHP software is used in this paper in designing web to monitor the gas emission.The utilized hardware is listed as follows.

A. Gas emission sensors

There are several sensors with high sensitivity utilized to detect pollutants, such as: O_2, SO_2, CO, NOX, and SO_4, gaseous and smoke opacity from the exhausted valve of the plant including measuring the air humidity. Multi sensors are

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incorporated i.e. GS Oxygen sensor, SO_2 sensor, TGS 2201 sensor, MQ7 sensor, MQ2 sensor, and SHT 11 sensor.

B. Microcontroller ATmega16 as processing and control units.

Microcontroller Atmega16 has complete facility, fast instruction process and it is supported by Code Vision AVR Evaluation software for simulation and compiler. In addition, it has special feature, especially the facility of Analog to Digital converter. This feature is very important to convert the analog to digital voltage signals since the sensor output is the analog signal, while this signal needs to be processed as digital signal in the microcontroller. The microcontroller circuit is designed to control the overall system design.

C. LCD with 16x2 characters for output display of measurement.

D. IC MAX 232 and RS232 connector for the computer communication interface.

The sensor utilization for the monitoring and control of the gas emission from diesel power plant is rarely found. The Gas Emission Monitoring (GEM) system using CO sensor was presented in Ref. [8]. The used gas sensors for monitoring system in this paper are as followed, KE sensor for O_2, MQ136 for SO_2 , TGS 2201 for NOX , MQ7 for CO, MQ2 for smoke opacity and additional sensors like Module DT-Sense SHT 11 sensor for temperature and humidity. The configuration of the proposed EM system is shown in Fig. 1. All sensors in Fig.1 produce analog output voltage; therefore the analog data is converted to 8 bit digital data for the further processing and controlling in the ADC pin of ATmega16.

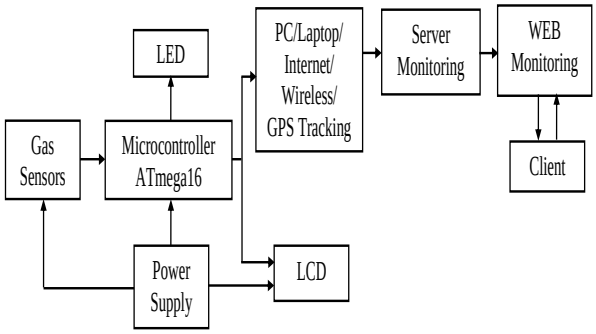

Fig.1 the Configuration of the Proposed EM System

The real-time measurement results can be monitored through visualization in Liquid Crystal Display (LCD) and computer monitor after data processing using microcontroller ATmega16 under programming environment of Code Vision AVR V2.03.4 [8]. To visualize this measurement into computer monitor, it requires serial interface systems as a communication interface between computer and microcontroller. Furthermore, all the data will be sent to the monitoring server so that the client can monitor the level of gas emissions through the existing website.

III. DESIGN OF HARDWARE AND SOFTWARE FOR GEM SYSTEM

A. Hardware Design

The hardware design is divided into physical and electronic circuit designs. The material for physical design based on Aluminum plate to cover the designed electronic circuit. The physical design and the schematic diagram of gas emission monitoring system are shown in Fig.2 and Fig.3, respectively.

Fig.2. Physical design of gas emisson tester [9]

Fig.3. Physical design of gas emisson tester (Front LED) [9]

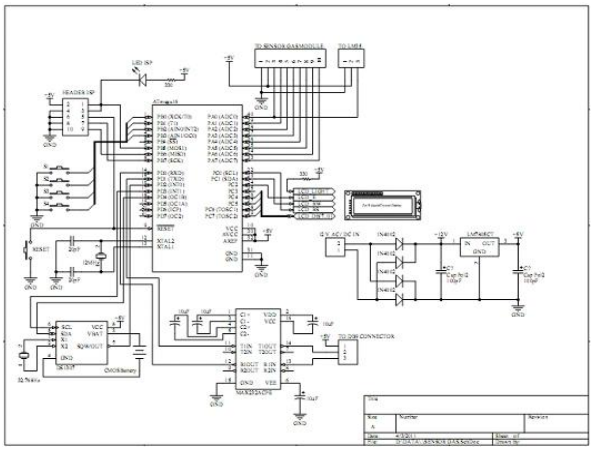

Fig.4 Schematic Diagram of Gas Emission Monitoring System [9]

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B. Software Design

The software design is divided into microcontroller program design and interface computer application design. The design of microcontroller program related to the air pollution monitoring system is shown in Fig.4. The first step is the initialization stage by setting the USART, LCD, ADC and PORT D from the electronic circuits. Then, the process continues to PORT D processing where the data processing of ADC value considered as sensor unit output. In this step, the ADC value is converted to the part per million (ppm) unit. The output value is displayed in LCD and computer in order to determine the air quality. The indicator of air quality can be accessed through LED after further processing data from the computer unit. The process continues to the initial point by reading the value from PORT D. The level of gas emission follows the regulation of air quality based on Environmental control and regulation agency in Indonesia shown in Table I. Meanwhile, the design of interface computer application utilizes the Visual Basic 6.0.

Table 1 the Environmental Control and Regulation Related to Air Pollution in Indonesia (1997) [10]

Standard Index of Gas Pollutans	24 hours Of PM_{10} $\mu g/m^3$	24 hours Of SO_2 $\mu g/m^3$	8 hours Of CO $\mu g/m^3$	1 hours Of O_3 $\mu g/m^3$	1 hours Of NO_2 $\mu g/m^3$
10	50	80	5	120	(2)
100	150	365	10	235	(2)
200	350	800	17	400	1130
300	420	1600	34	800	2260
400	500	2100	46	1000	3000
500	600	2620	57.5	1200	3750

IV. RESULTS AND DISCUSSION

After ensuring that the configurations are properly working, the performances of the GEM system based on the website are tested. Fig.4 shows the home page of the GEM system. In this paper, there are two parameters that are used to determine the performance of web-based monitoring system, i.e., response time during login and browsing. The average response time of login system is less than 2 seconds where the data are shown in Table 2. While the average response time . Seconds, respectively.

Fig. 6 Home page of the GEM system

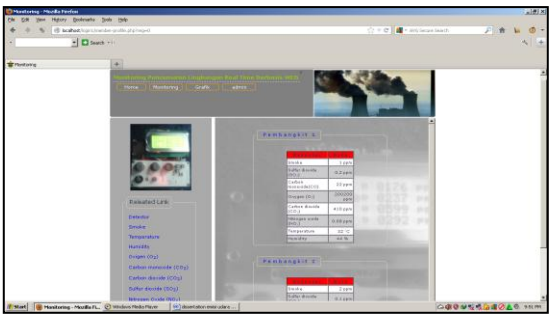
Table 2 Response time during login

Test number	Admin	User1
1	1.3	0.8
2	1.4	1.1
3	1.3	1.2
4	1.2	1.2
5	1.2	1.2
Average (second)	**1.3**	**1.1**

Table 3 Response time during browsing

Test number	Index.php	Home.php
1	2.1	0.3
2	2.0	0.4
3	2.0	0.3
4	2.2	0.3
5	2.0	0.2
Average (second)	**2.2**	**0.3**

The result example of real-time gas emission level monitoring is shown in Fig.6



(a) Gas emission level page

Detector	Data
Smoke	1 ppm
Sulfur dioxide (SO_2)	0.2 ppm
Carbon monoxide(CO)	22 ppm
Oxygen (O_2)	200200 ppm
Carbon dioxide (CO_2)	410 ppm
Nitrogen oxide (NO_x)	0.08 ppm
Temperature	32 °C
Humidity	44 %

(b) Zoom of the result example

Fig. 7 The result example of gas emission level in the web

V. CONCLUSION

Web-based gas emission monitoring system of Diesel Power Plant has been presented. The results shows that the proposed of diesel power plant emission can be monitored in real-time and easily due to the usage of the web monitoring. Response Time are also considerably low (1.3-2.2 seconds)

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on average tested on working hours. Future research would considered the development of monitoring device for easy handling and installation in the exhausted pipe of power plant.

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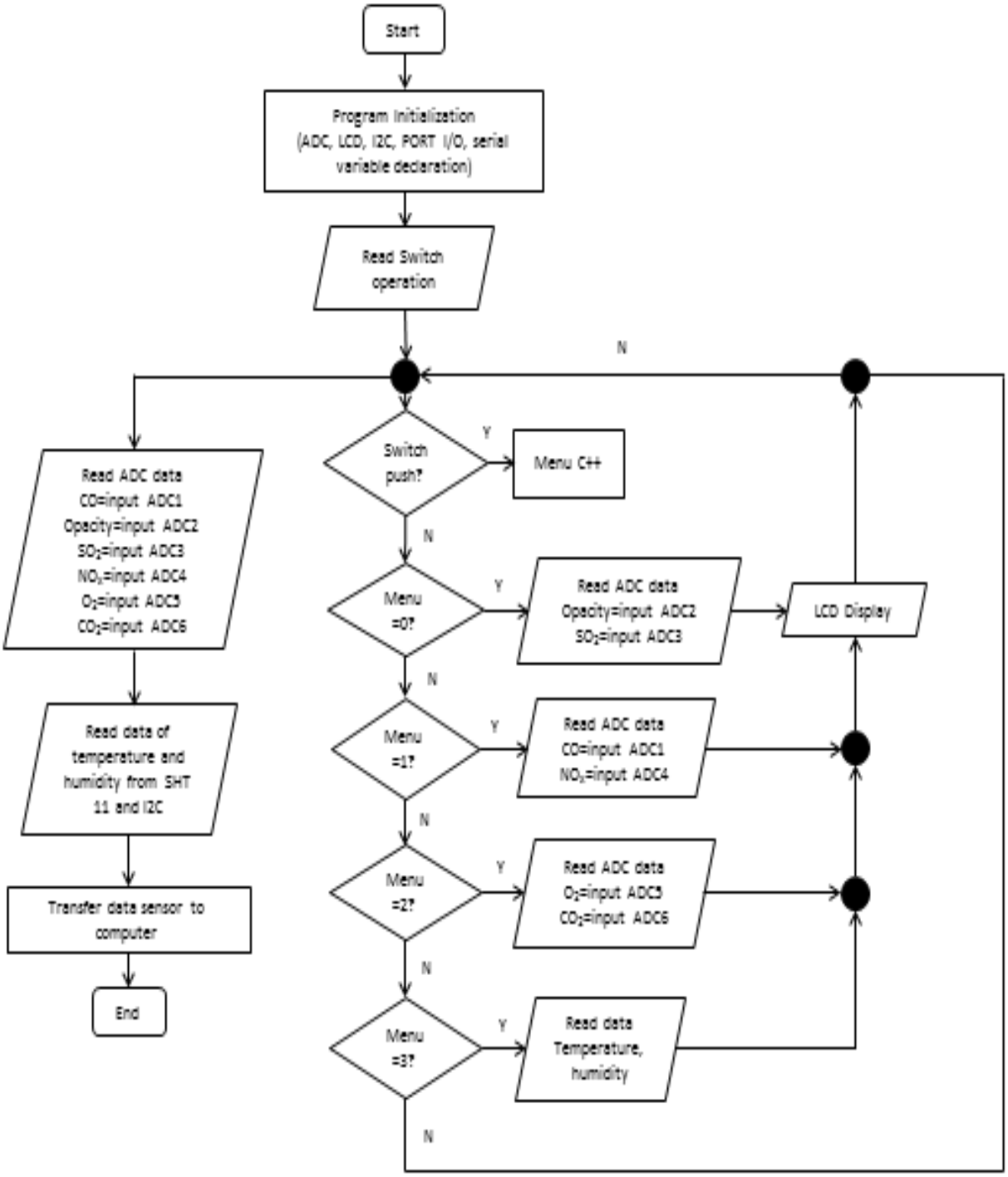

Fig. 5 Flowchart of GEM system [11]