Development of Low Cost Toxic Gas Explosive Modeling System using Wireless Array Sensor Netwok

by P Destarianto

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Abstract. The Natural disasters such as floods, earthquakes, erupting volcanoes and toxic gases affect life can even result in permanent ecosystem and environmental changes. Monitoring of toxic gases is one of the important issues, it is based on the nature of the gas that is difficult to detect movement, especially in large areas. Ijen crater reportedly began spewing toxic gas on March 21, 2018, and poisoned 30 people who lived in four villages on the slopes of Mount Ijen. This study aims to develop a tool with an array sensor application that is able to adapt to environmental conditions. This detection device providing 24hour surveillance of toxic gases. In the application, the sensors will be placed in areas affected by toxic gas disasters, it aims to provide early warning if there is a toxic gas wave from Mount Ijen. It is also able to give warning to visitors and prospective visitors of Mount Ijen. So that ultimately no longer found victims of toxic gas, or at least reduce the impact of this toxic gas disaster.

1. Introduction

Natural disasters such as floods, earthquakes, volcanic eruptions and toxic gases affect life, property, livelihoods, industry, and even better. [1]. Monitoring of toxic gases is one of the most important issues in disaster management, this is done from the nature of the gas which is difficult to detect its movement, especially in large areas. Difficulties that arise cannot be seen directly, movements are difficult to read and change at any time [2].

Mount Ijen / Gunung Kawah Ijen the administrative locations of Banyuwangi and Bondowoso Regencies, East Java 8 ° 03 '30 South Latitude and 114 ° 14 '30 "East Longitude [16] Ijen Crater began to emit toxic gases on March 21, 2018, and poisoned 30 residents who live in four villages on the slopes of Mount Ijen. The vomit of poison gas from Ijen crater is unpredictable [3].

Research on toxic gases generally uses ideal conditions / conditions limited as a reference, or in other words does not reflect a changeable / adaptive environment [4]. Research conducted by [5] carried out Boundary Diffusion analysis of toxic gases in petrochemical plants, Sun Research from four distance graphs that predicted its accuracy to detect Diffusion Boundary, after the limit detection algorithm. Research [6] modeling of a growing milling environment. Research [7] developed a heat sensor designed as an array sensor, each sensor isolated and specifically designed for MEMS. Research by [8] developed a device that uses an array sensor with a variety of gas sensors (methane, carbon dioxide, carbon monoxide, hydrogen sulfide, ammonia) which serves to analyze the gas in underground channels. Research conducted by [9] [10] [11] [12] [13] [14] [15] still uses limited environmental conditions. In reality, reading about toxic gases with changing environmental

conditions [4] or in other words the developed tools should have capabilities with unstable environmental conditions.

This study aims to develop an array sensor device that is able to adapt to environmental conditions. The array sensor is a self-organizing sensor, each sensor itself, then to model the gas condition that will be used for all sensor readings, using an array sensor to provide a more complete description of the condition of a room containing smoke gas or not. In its application the sensors will be placed in areas affected by toxic gas disasters, this aims to provide early information in the event of a wave of toxic gas from Mount Ijen. In addition, it is also able to provide information to visitors and prospective visitors of Mount Ijen. Nothing else you find from poison gas.

2. Research Methods

This research method consists of several stages, such as literature review, data collection, parameter identification and data processing, application development, results and discussion, conclusions and recommendations.

1. Literature Review

Literature review is carried out to collect information from several references related to the issues to be discussed. Theories related to research problems are used as a basis for processing data. At this stage, identification and problems formulation will be conducted which will be the objectives of the research. Problem formulation to be examined based on the background of the problem.

2. Hardware Design

Based on literature studies, the deadly toxic gases found in the Gunung Ijen region are carbon monoxide and hydrogen sulfide gas. Therefore, in the hardware design, sensors MQ-7 and MQ-136. The MQ-7 sensor is used to measure carbon monoxide gas levels in the air. While the MQ-136 sensor is used to measure carbon hydrogen sulfide gas levels in the air. DHT-11 sensor is also used which serves to measure the temperature and humidity values in the ijen region.

All sensors are connected to the ATMEGA-2560 controller. The output of the system is the LED bar display, status LED, graphic LCD, 7 segment and buzzer. LED bar serves to display pollution levels in a range: good, medium, unhealthy, very unhealthy, and dangerous. Status LED functions to display the status of Mount Ijen in Normal, alert, standby, alert condition. 7 segment display is used to display the degree of temperature in the Gunung ijen area. Figure 1 is a system block diagram of the tool.

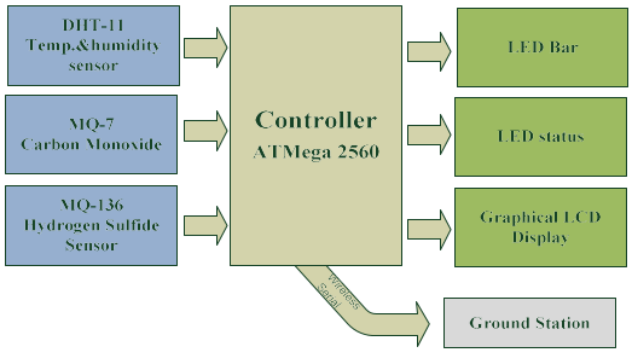

Figure 1. Diagram Block System

3. Application Development

The controller programming algorithm is made according to the flowchart in figure 2. In the initial stage, the controller will wait for 2 minutes to pause the sensor heating. Gas-based sensors, require heating for several minutes before they can be used. After the heating process is complete, the controller will read the data from the MQ-7, MQ-136 and DHT-11 sensors. Furthermore, based on the data read, the controller will give the output value in the form of air pollution level status, temperature degree (in centigrade), and the status of the Mount Ijen area. After the entire status is successfully displayed, the controller saves the data from the sensor reading on the memory card. Before, the controller will also read the time data from the RTC module. This functions as a data logger system on the device. All processing data is then sent to Ground Station through serial wireless communication.

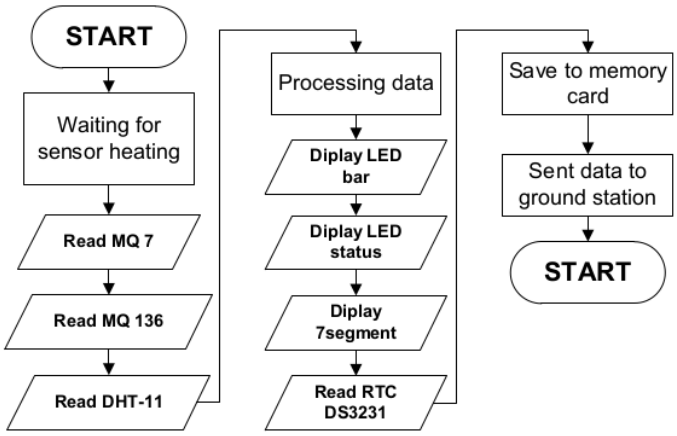

Figure 2. Flow Chart System

4. Wireless Network & Data logger

Ground station is a device that is placed at the bottom of the climbing area. In this case, visitors can monitor the condition of the Mount Ijen area before climbing. Wireless data communication module uses xbee with antenna modification. Data transmission distance can reach 2 KM. The data logger system is added using an SD memory card type device. The controller will store data on environmental conditions every 1 minute. Furthermore, data from the memory card can be read through the Excel application.

5. Results and Discussion

The results produced by the tool are then compared with the results of expert assessors. The equation that comes out shows the value of accuracy possessed by the tool. The method used by the research is Ground Turth.

6. Conclusions and Recommendations

This stage is the final stage of the research that draws conclusions from the results of the analysis of the discussion and provides suggestions for further research. This stage reviews the implementation of related technology / research, this is carried out to ensure that the research has a novelty contribution to the research fields.

3. Result and Discussion

The results of the tool design realization are shown in Figure 3. The device is designed on an aluminum box measuring 50 cm x 30 cm. The device uses a 12volt battery power supply. The device is designed to work within 24 hours non-stop. Based on testing on location, the equipment can work properly. However, the condition of the gas at a dangerous level cannot yet be monitored, because the air quality is at a safe level during the testing process.

Figure 3. System Testing

Table 1. Data Logger

Tanggal	Jam	Suhu	Hidrogen Sulfida (ppm)	Status	Carbon Monoksida (ppm)	Status
23/09/2018	10:12	18	8,0	baik	2,0	baik
23/09/2018	10:13	18	8,0	baik	2,0	baik
23/09/2018	10:14	18	8,0	baik	2,0	baik
23/09/2018	10:15	18	8,0	baik	2,0	baik
23/09/2018	10:16	18	8,0	baik	2,0	baik
23/09/2018	10:17	18	9,0	baik	2,0	baik
23/09/2018	10:18	18	9,0	baik	2,0	baik
23/09/2018	10:19	18	9,0	baik	2,0	baik
23/09/2018	10:20	18	8,0	baik	2,0	baik
23/09/2018	10:21	19	8,0	baik	2,0	baik
23/09/2018	10:22	19	8,0	baik	2,0	baik
23/09/2018	10:23	19	8,0	baik	2,0	baik
23/09/2018	10:24	18	7,0	baik	3,0	baik
23/09/2018	10:25	18	7,0	baik	3,0	baik
23/09/2018	10:26	18	7,0	baik	3,0	baik
23/09/2018	10:27	18	7,0	baik	3,0	baik
23/09/2018	10:28	19	8,0	baik	3,0	baik
23/09/2018	10:29	18	8,0	baik	3,0	baik
23/09/2018	10:30	19	9,0	baik	3,0	baik
23/09/2018	10:31	19	9,0	baik	3,0	baik
23/09/2018	10:32	18	9,0	baik	3,0	baik
23/09/2018	10:33	18	9,0	baik	3,0	baik

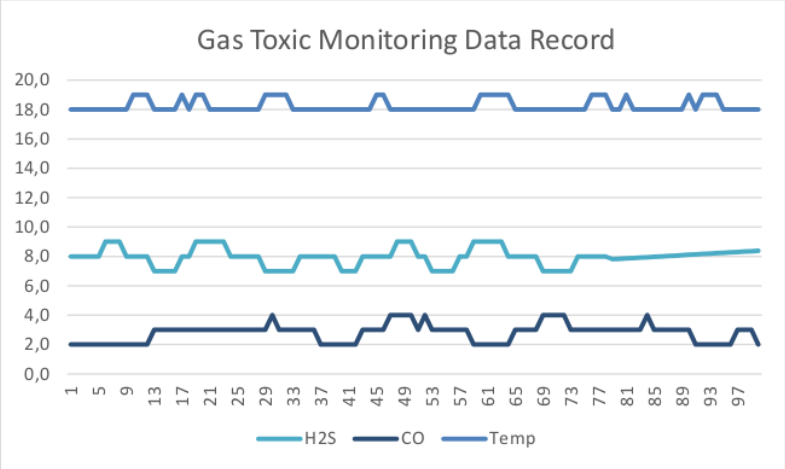

Figure 4. Data record

Besides sensors, the device is also equipped with a timing and data storage system. This consists of accurate timing by backing up the battery so that the microchip can still work even though the main power supply is off. Data storage space uses an 8GB SD card which is sufficient for data storage for more than a year. Sensor data is stored every minute on the memory card. Users can access the results of data recording through the excel application.

The tool is designed to operate in cold temperatures with a range of 2-32 degrees Celsius. The sensor mounting is designed so that it is not disturbed by splashes of rain water and dew. Table 1 is an example of the results of recording data from a tool. Based on these data, it can be made into a graph like Figure 4. The data obtained can also be used for forecasting toxic gas disasters in the Ijen area.

4. Conclusion

Based on the research that has been conducted, it can be concluded several things. The toxic gas monitoring system in the Gunung Ijen area can work 24hours a day. The data communication system at the ground station can work normally in real-time.

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