Design of Indoor Room Gas CO and SO_2 Detection Based on Microcontroller Using Fuzzy Logic

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Abstract. The incidence of poisoning due to carbon monoxide gas arising from drilling activities on the first floor of a building in the Kelapa Gading beauty clinic in Jakarta resulted in 17 people experiencing poisoning. In this study developing a device on the sensor used to detect CO and SO2 gas, in the air of a closed room using gas sensor MQ 135 and MQ 136. The results of testing the CO and SO2 gas gauges using samples of cigarette smoke and sulfur powder using MQ 135 and MQ 136 sensors with fuzzy rule base logic for motor speed to produce CO and SO2 gas, that obtained a value of 0.233 ppm SO2 gas safe conditions and gas input CO with the sensor obtained a value of 0.513 ppm, the condition is safe so that the output is 49.8 ppm, the condition of the fan blower does not rotate. Whereas when the reading value of 5.0 ppm is very concentrated and the CO gas input with the sensor is 13.8 ppm the condition is very concentrated producing an output of 228 ppm the very danger.

Keywords: **Gas Sensors MQ 136; fuzzy logic; Gas CO and SO2**

1 Introduction

The danger caused by explosion of sulfur dust is a major risk factor that threatens human safety, by evaluating and controlling the danger of sulfur dust generated in the wet process is very important. The results show that sulfur dust can be easily ignited and has a high explosive power. The risk of explosion and strength of sulfur dust decreases with increasing particle size. Minimum ignition energy and minimum ignition temperature increase when water content increases. The maximum explosion pressure and explosion index initially rise and fall later when dust concentration increases. Preventive and control measures for sulfur dust explosions, from two aspects of building control and process control, are proposed for the process of producing, storing and transporting sulfur produced in the wet process [3].

Because the level of carbon dioxide in the atmosphere continues to increase and encourage climate change, the problem of CO_2 poisoning is not recognized as a global risk. The toxicity of CO_2 for breathing has been well defined for high concentrations, but it is still not known effectively what level will endanger human health when individuals are continuously exposed for life. There is evidence from several low-level long-term exposure studies that permanent exposure to CO_2 levels predicted at the end of the century will have a significant effect on humans [4]

The impact of exposure to acute sulfur dioxide is a primary irritant, where the levels of sulfur in it can cause nasal and throat irritation, lung diseases such as boncoconstriction and increased resistance to active respiratory tract whose symptoms are similar to asthma [6].

Carbon monoxide (CO) is a poisonous gas that comes from incomplete combustion. It should be noted that it is very important that vehicle exhaust emissions in parking lots covered with large levels of carbon monoxide can even reach lethal levels. Cigarette smoke and traffic density represent human exposure to this substance. Carbon monoxide gas producers, especially dense urban areas with high traffic density, so tens of millions of people live in countries where air quality threatens health. The bigger problem is that carbon monoxide concentration is faced by cities with heavy traffic density and poor ventilation. [5].

From the phenomenon of the effects of the danger of toxic gases carbon monoxide and sulfur for humans, in this study how to design a device that can detect

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exposure to CO and CO_2 gas in a room so that it is conditioned whether in a closed room it is safe or dangerous for human activities. This designed tool is made using the control of the Arduino microcontroller, with gas sensor inputs MQ 135 and MQ136 that work based on the fuzzy method to provide information on safe gas exposure conditions, approaching danger, danger and very dangerous. The condition of the room when approaching danger, danger and very danger will be neutralized by a fan blower that can suck and dispose of CO and CO_2 gas gases automatically so that there is no gas deposition in the room and safe for humans [7].

2 Supporting Theory

2.1 Sensor Gas MQ-136

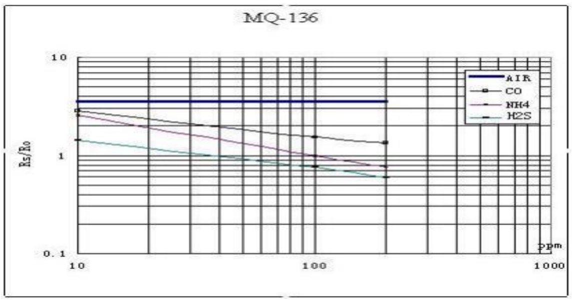

Fig. 1. Describes the character of the sensitivity of the MQ-136 sensor to detect some gases [7].

2.2 Sensor Semikonduktor MQ135

The MQ-136 sensor is a semiconductor component that functions as a sensor for the smell of tin oxide (SnO_2). The MQ-136 sensor is very sensitive to SO2. MQ136 gas sensor sensitive material is SnO_2, which with lower conductivity in clean air. When the target SO_2 gas is present, the sensor conductivity is higher as the gas concentration increases. Please use a simple electrical circuit, Convert changes in conductivity to adjust the output signal of the gas concentration. The MQ136 gas sensor has a high sensitivity to SO_2, it can also be used to detect other vapors containing sulfur. It has a low sensitivity to normal combustible gases, which are low cost and suitable for different applications. The following is a graph of the sensitivity characteristics of the MQ-136 sensor [7].

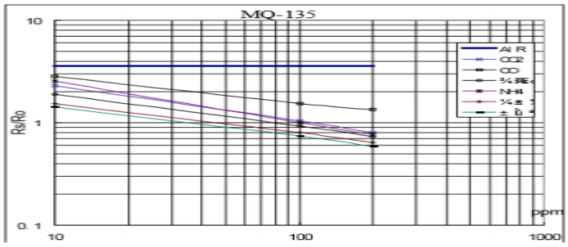

Fig. 2. Typical sensitivity characteristics of MQ-135. Temp: 20 Humidity: 65%, RL = 20kΩ Ro: resistance sensor at 100ppm NH3 in clean air. Rs: sensor resistance at various gas concentrations [7].

2.3 Fuzzy Logic

Fuzzy set theory provides a mathematical framework in which the disguised conceptual problems can be studied carefully and thoroughly [9]. Fuzzy logic is a problem solving control system methodology, suitable for implementation on systems, from simple systems, small systems, embedded systems, PC networks, multi-channel data acquisition or workstations, and control systems. This methodology can be applied to hardware, software, or a combination of both. In a more specific meaning, Fuzzy logic is an extension of multivalued logic whose purpose is estimation of reasoning rather than the right solution [10].

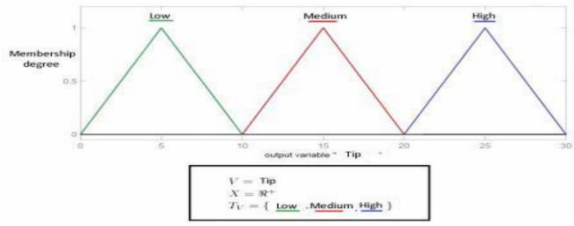

Fig. 3. Fuzzy Input Membership of Level carbon monoxide and Sulfure

3 Fuzzy Set Concept

Understanding Fuzzy Sets In the strict set of each element in a proper manner, it should always be determined whether the element is a member of the set or not. But in fact not all sets are clearly defined. For example, the student body is clever, in this case it cannot be stated explicitly because there is no one used as a measure for someone's level of intelligence. Therefore, it is necessary to define a fuzzy set that can state the event. The fuzzy set is defined as follows:
The fuzzy set A in speech universe U is defined as a set that characterizes a membership function that implies every $\in U$ with real numbers in the interval [0,1] with the value expressing the degree of

membership x in A. A fuzzy set A can be expressed by two way, namely:

$$A = \frac{\int U\mu A(x)}{x} \qquad (1)$$

where integral notation symbolizes the set of all ∈ along with the degree of membership in the fuzzy set A. This method is used in fuzzy sets whose members are of continuous value. [8]

$$A = \frac{\Sigma U\mu A(x)}{x} \qquad (2)$$

where sigma notation represents the set of all ∈ along with the degree of membership at uzzy set A. This method is used in fuzzy sets whose members have discrete values [8].

In this study fuzzy set rule base attributes, namely Linguistics, namely naming a group that represents a particular condition or condition by using the natural language of the fan blower's output is slow, medium, fast and very fast. While PWM motor uses numerical attributes, which is a value (number) that shows the size of a variable such as 100,150,200,255.

3.1 Fuzzification

Fuzzification is the process of converting non-fuzzy variables (numerical variables) into fuzzy variables (linguistic variables). Inferencing (Ruled Based), in general fuzzy rules are expressed in the form of "IF ...... THEN" which is the core of fuzzy relations. Defuzification is the process of converting fuzzy data into numerical data that can be sent to control equipment. Roslina, [1] Explained in Figure 4. The following:

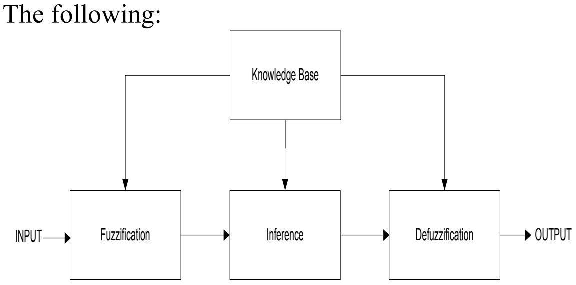

Fig. 4. Block Fuzzy Inference System Chart

In the fuzzy diagram block the above system is used as a rule for processing input data from the gas sensor CO and sensor 2 readings as input data from CO_2 gas readings. The results of sensor 1 and sensor 2 data input are described in the following Table 1 and Table 2.

Table 1. Input 1, Rule Table reading SO2 sensor based on its ppm content

No	State of detection / input	Description (ppm)
1	Normal	0-2
2	Rather thick	1-5
3	Concentrated	3-8
4	Very thick	>6

Table 2. Input 2, Rule Table reading CO sensor based on its ppm content

No	State of detection / input	Description (ppm)
1	Normal	0-5
2	Rather thick	3-12
3	Concentrated	8-17
4	Very thick	>13

He following are the results of testing measurements of carbon monoxide gas concentrations and sulfur sulfure according to Table 3.

Table 3. Rule Base table

No	INPUT		OUTPUT	
	SO_2	CO	Status	Circulation of sensor blower circulation
1	Normal	Normal	Safe	Low
2	Normal	Rather thick	Approaching danger	Sedang
3	Normal	concentrated	Danger	Fast
4	Normal	Very thick	Very Danger	Very Fast
5	Rather thick	Normal	Approaching danger	Fast
6	Rather thick	Rather thick	Danger	Fast
7	Rather thick	concentrated	Very Danger	Very Fast
8	Rather thick	Very thick	Very Danger	Very Fast
9	concentrated	Normal	Danger	Fast
`10	Concentrated	Rather thick	Very Danger	Very Fast
11	Concentrated	Concentrated	Very Danger	Very Fast
12	Concentrated	Very thick	Very Danger	Very Fast
13	Very thick	Normal	Very Danger	Very Fast
14	Very thick	Rather thick	Very Danger	Very Fast
15	Very thick	Concentrated	Very Danger	Very Fast
16	Very thick	Sangat Pekat	Very Danger	Very Fast

There are 16 (sixteen conditioning) rule bases that are in accordance with the input conditions of the clusters or concentrations of CO and SO_2 gas with normal status, rather concentrated, concentrated and very concentrated with the output of safe conditions, close to danger, danger and very hazardous. The output status is often affected by toxic levels of CO and SO_2 gases.

3.2 Designing PWM Output (Pulse Width Modulation) Fan Blower

Pulse width modulation method) is used in many application DC motor controllers. In the basic Pulse Width modulation method (PWM), the power operation to the motor is turned on and off modulating the current to the motor. The "on" time to "off" time ratio is what determines the motor speed. The microcontroller receives binary signals that are decoded and performs logical operations programmed and drives the H-Bridge. The H-bridge is used to drive a DC motor according to the microcontroller input. Our project can be programmed, using the keypad, we can choose, motor direction, speed and time of rotation. A special feature of this project is that it has added one extra circuit that calculates DC motor RPM [11].

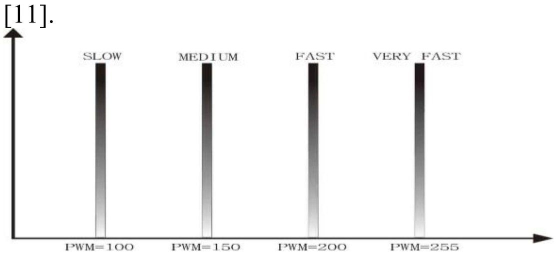

Fig. 5. Blower Circulation Control PWM Output

4 Results and Discussion

The testing test of input data from the gas sensor CO and SO_2 sensors was processed using the Fuzzy Inference System Mathlab R2009a by using the mathlab application using fuzzy mamdani and 16 rules which produced the following outputs;

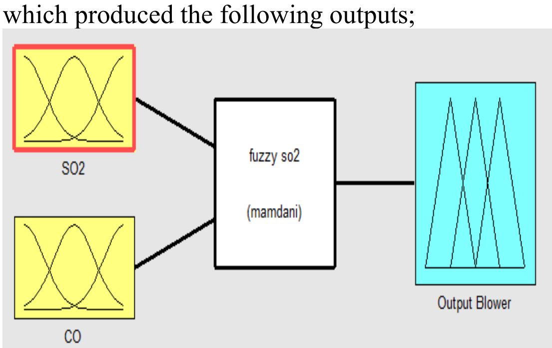

Fig. 6. Diagram of the Fuzzy Inference System Rule CO and SO_2 sensor data input with Fuzzy Mamdani

Figure 6 explaining the fuzzy system input data of the CO gas sensor and SO_2 gas fuzzy method using the fan blower graph output. The results of testing sensor readings on carbon monoxide gas slides, namely from cigarette smoke or vehicle exhaust and sulfur gas powder from heating based on 16 (sixteen) fuzzy rules consisting of CO and SO_2 gas input with fan blower speed output as suction or content neutralizer gas grating in a closed room. The test results are explained in the following figures 10, 11, and 12:

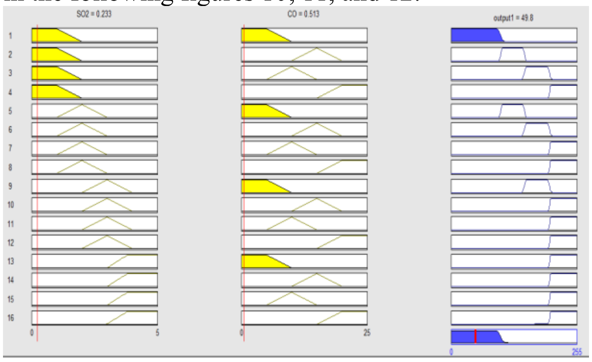

Fig. 7. Graph of Fuzzy Rule System Safe and SO_2 Safe CO sensor input data with Slow Blower Output

Figure 7 above explains the results of testing the SO_2 gas input with the sensor obtained a value of 0.233 ppm safe condition and CO gas input with the sensor obtained a value of 0.513 ppm safe conditions so that the output of 49.8 ppm is safe.

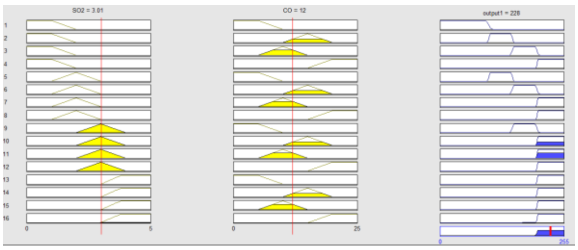

Fig. 8. Graphics of Fuzzy Rule System Data input of Solid CO sensor and Solid SO_2 with Very Fast Output Blower

Figure 8 above explains the results of testing the SO_2 gas input with a sensor obtained a value of 3.01 ppm, the condition is rather concentrated and the CO gas input with the sensor is 12 ppm, the condition is rather concentrated resulting in an output of 228 ppm very hazardous conditions.

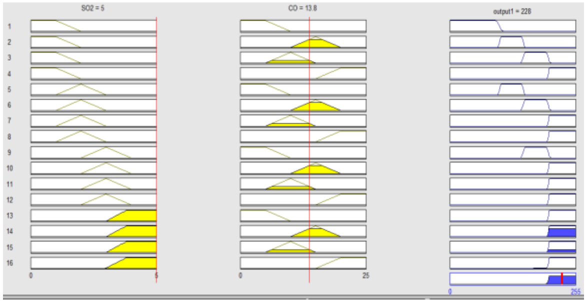

Fig. 9. Fuzzy Rule Results Graph System CO sensor data input is very concentrated and SO_2 is very concentrated with very fast output blower

Figure 9 above explains the results of testing SO_2 gas input with a sensor obtained a value of 5.0 ppm very concentrated conditions and CO gas input with a sensor obtained a value of 13.8 ppm very concentrated conditions resulting in an output of 228 ppm very hazardous conditions.

5 Conclusion

The results of this study are from the inclusion of carbon monoxide (CO) and sulfur gas (SO_2) which is detected by MQ 135 and MQ 136 sensor readings with the control process using the Arduino Uno microcontroller and fan blower output as neutralizing the amount of CO and SO_2 gas clusters, that is obtained the value of 0.233 ppm of the safe condition of SO_2 gas and CO gas input with the sensor obtained a value of 0.513 ppm in a safe condition so as to produce an output of 49.8 ppm the condition of the fan blower does not rotate. On the SO_2 value with the sensor, the value of 3.01 ppm is slightly concentrated and the CO gas input with the sensor is 12 ppm, the condition is rather concentrated, resulting in an output of 228 ppm. The danger is that the fan blower rotates rapidly. Whereas when the reading value of 5.0 ppm is very concentrated and the CO gas input with the sensor is 13.8 ppm the condition is very concentrated so that the output is 228 ppm the condition of the danger of the fan blower rotates very fast.

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