Detection and Monitoring of Carbon Monoxide (Co) Toxic Gases in Old Vehicle Cabin (Odometer> 300k Km) and Its Relationship to Vehicle Density Using Fuzzy Method

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ABSTRACT

Carbon monoxide (CO) gas in the cabin of a vehicle affects the health of passengers and can even cause death. This is caused by poor ventilation so that the exhaust that leaks into the car and is slowly inhaled by the person in the car. Carbon monoxide is an odorless, colorless, tasteless and non-irritating gas. Carbon monoxide gas is a material commonly found in industry. This gas is the result of incomplete combustion from motorized vehicles, heating devices, equipment that uses carbon-based fire materials and flames (such as wood stoves), smoke from trains, gas combustion, and tobacco smoke. However, the most common source is engine combustion residue.Based on these problems, it is necessary to do research on the engineering of a control device for carbon monoxic gas levels in a car cabin based on fuzzy logic. In this research, a microcontroller will be used to carry out the process. With this tool, it is hoped that carbon monoxide levels will be obtained in the car so that it can notify drivers. In the end, cases of poisoning by passengers due to CO gas in vehicles can be minimized.

Keywords: Toxic Gases, Fuzzy Method, Odometer, Carbon Monoxide

1. INTRODUCTION

Older vehicles are more likely to produce more toxic gas emissions due to incomplete combustion systems. This gas is very dangerous because it can cause health problems even at a more severe level, it is the cause of human death [1][2]. Many cases of sudden death are caused by this gas, especially in four-wheeled vehicle users.

The exhaust gas in the vehicle is the residue from combustion in the form of water ($H2O$), Carbon Monoxide (CO), Carbon Dioxide ($CO2$), Nitrogen Oxide (NO), Sulfur Dioxide ($SO2$) and Hydrate Carbon (HC) compounds as imperfect combustion processes and loose particles [2]. In old age vehicles, leakage problems from the AC system are common [3] [4]. If incomplete combustion occurs and will produce CO gas, the gas will enter through the leaky AC (Air Conditioner) hole [5]. In addition, the adhesive rubber on the car door that has shrunk and the joints of some parts that are not perfectly adhered are often the source of the entry of toxic emission gases into the car cabin. In some cases many passengers tend not to know for sure that the vehicle contains a lot of carbon monoxide gas, because it is colorless, smelly, and tastes.

The presence of CO gas will be very dangerous if inhaled by humans because the gas will replace the position of oxygen related to hemoglobin in the blood. CO gas will flow into the heart, brain and vital organs. The bond between CO and hemoglobin forms a carboxy hemoglobin which is 200 times stronger than the bond between oxygen and hemoglobin. The results were fatal. First, oxygen will be unable to compete with CO when it binds to the hemoglobin molecule. This means that the oxygen level in the blood will decrease. Even though it is known that oxygen is needed by the body's cells and tissues to carry out metabolic functions. Second, CO gas will inhibit the cytochrome oxidation complex. This makes intracellular respiration less effective. Finally, CO can bind directly to heart muscle cells and bones. The most serious effect is direct poisoning of

these cells, as well as causing disorders of the nervous system.

The main danger to health is causing blood disorders, the limit of carbon monoxide exposure allowed by OSHA (Occupational Safety and Health Administration) is 35 ppm, while that allowed by BSN (National Standard Agency) is 25 ppm where there are workers who can be exposed chemicals daily for no more than 8 hours per day or 40 hours per week. Levels that are considered to be immediately harmful to life or health are 1500 ppm (0.15%). Exposure of 1000 ppm (0.1%) for several minutes can cause 50% saturation of the carboxy hemoglobin and can be fatal.

2. METHODS

The research method starts from the stage of making the flow chart of the system to be built, the research stages as shown in Figure 1. Furthermore, the data collection is carried out by looking for the average data, data before processing is in the form of sensor measuring instrument data that records CO levels every 2 minutes once in 1 hour. 12 minutes. So in a day there are 36 times the CO pollution data recorded. The following is the output of the MQ 7 tool used to detect vehicles that are under 5 years old and vehicles over 5 years old.
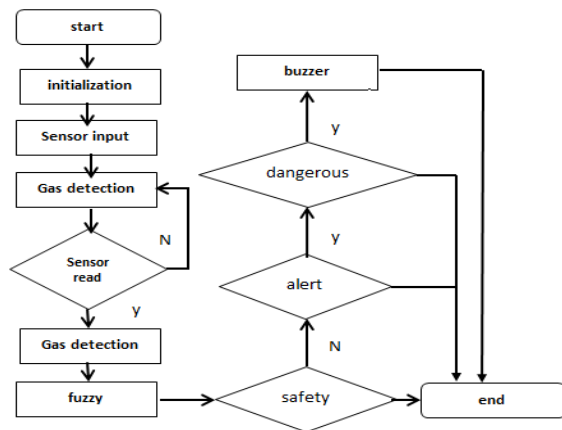

Figure 1. Flow diagram.

The data used is the data from the measuring device for the CO content sensor in vehicles under 5 years old and vehicles over 5 years old. Data is taken within 2 days, data is taken for vehicles under 5 years of age at 18 to 21 at night, and data is taken for vehicles over 5 years of age at 18 at 21 at night. The data collected will then be searched for the possible hazard values using the fuzzy method. The fuzzy logic method workflow process can be explained as follows:

1. Fuzzification is the process of converting crisp input into fuzzy input, which is a linguistic value that is determined based on a certain membership function.
2. Interference is reasoning using fuzzy input and predefined fuzzy rules to produce fuzzy output.
3. Defuzzification is changing the output function to a crisp value based on a predetermined membership function.
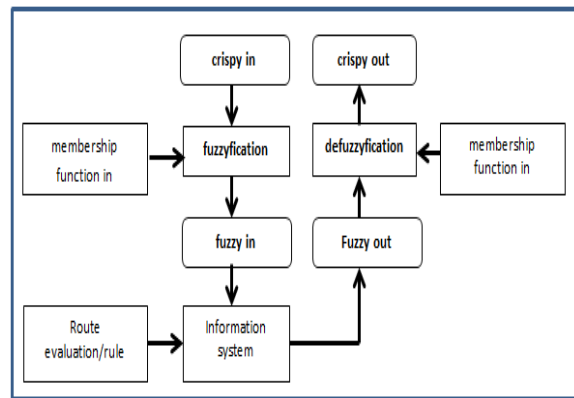

Figure 2. Fuzzy Logic Flow.

3. RESULTS AND DISCUSSION
3.1. Testing the MQ7 Gas Sensor

Testing at this stage uses a vehicle that is more than 5 years of use as a source of carbon monoxide gas. In this test, the measurements were carried out 36 times on the same car in 2 days. Data before processing is in the form of sensor measuring instrument data that records CO levels every 2 minutes. The data used is the data from the measuring device for the CO content sensor in vehicles under 5 years old and vehicles over 5 years old in a healthy and unhealthy condition. Data is taken for vehicles under 5 years old at 18 to 21 at night, and data is taken for vehicles over 5 years old at 18 at 21 at night. In the data collection process, the average data search was carried out. To find an error or the difference between the vehicle when the fan is off and the vehicle when the fan starts using equation 1.

$$Error = fan\ measurement\ result\ in\ off\ condition - measurement\ result\ in\ on \quad (1)$$

After calculating the error, what must be done is to calculate the average error using equation 2 and the percentage error in equation 3. Calculate the average error using the formula:

$$ave\ error = \frac{number\ err\ in\ the\ exp}{number\ of\ measurement\ taken} \quad (2)$$

$$\%\ error = \frac{ave\ error}{100} \quad (3)$$

Table 1 is the result of testing of CO gas measurements that have been carried out.

Table 1. Gas CO measurements result.

Trial	Fan Off	Fan On	Error
1	13	15	2
2	13	16	3
3	14	14	0
4	12	15	3
5	13	14	1
6	14	14	0
7	13	12	1
8	13	14	1
9	20	14	6
10	11	14	3
11	9	14	5
12	11	13	2
13	12	15	3
14	13	13	0
15	15	13	2
16	14	13	1
17	13	13	0
18	14	13	1
19	15	13	2
20	17	14	3
21	10	13	3
22	15	12	3
23	15	12	3
24	16	12	4
25	16	11	5
26	15	12	3
27	15	11	4
28	16	11	5
29	16	11	5
30	16	11	5
31	16	12	4
32	16	12	4
33	16	10	6
34	16	11	5
35	15	12	3
36	15	11	4
Total			93

Average error	2,91667
Percentage of errors	0 , 029

3.2. Overall System Testing

Table 2. Overall tool test result.

Trial	Fan Off	Fan On	Condition
1	13	15	Turn on the fan
2	13	16	Turn on the fan
3	14	14	Turn on the fan
4	12	15	Turn on the fan
5	13	14	Turn on the fan
6	14	14	Turn on the fan
7	13	12	Turn on the fan
8	13	14	Turn on the fan
9	20	14	Turn on the fan
10	11	14	Turn on the fan
11	9	14	Turn on the fan
12	11	13	Turn on the fan
13	12	15	Turn on the fan
14	13	13	Turn on the fan
15	15	13	Turn on the fan
16	14	13	Turn on the fan
17	13	13	Turn on the fan
18	14	13	Turn on the fan
19	15	13	Turn on the fan
20	17	14	Turn on the fan
21	10	13	Turn on the fan
22	15	12	Turn on the fan
23	15	12	Turn on the fan
24	16	12	Turn on the fan
25	16	11	Turn on the fan
26	15	12	Turn on the fan
27	15	11	Turn on the fan
28	16	11	Turn on the fan
29	16	11	Turn on the fan
30	16	11	Turn on the fan
31	16	12	Turn on the fan
32	16	12	Turn on the fan
33	16	10	Turn on the fan
34	16	11	Turn on the fan
35	15	12	Turn on the fan
36	15	11	Turn on the fan
Total			93

Average error	2,91667
Percentage of errors	0 , 029

The test was conducted by comparing the value of the vehicle when the fan in the condition of the dead and the vehicle when ignition fan. It aims to determine the control system run by good or not. The control system functions to control and maintain the air condition in the vehicle space. The test results of the tool as a whole can be seen in Table 2.

3.3. Fuzzy calculations

The fuzzy calculation process starts from the process before and after the fan turns on. Vehicles before fan ignition (Input 1) = 9 ppm and vehicles after fan ignition (Input 2) = 7.7 ppm , to calculate the X side with equations 4 and 5.

Input 1
μ Safe CO $= (10 - X)/5;$
        (4)
        $= (10 - 9) / 5;$
        $= 0.2$
μ CO Alert $= (X - 8) / 6.5$
        (5)
        $= (9 - 8) / 6.5$
        $= 0.15$

Input 2
μ Safe CO $= (8 - X) / 4$
        $= (8 - 7,7) / 4$
        $= 0.075$
μ CO Alert $= (X - 7.5) / 5.25$
        $= (7,7 - 7,5) / 5,25$
        $= 0.038$

Furthermore, for f unction i mplikasi used is the value of Min, so that the value of a turn off and turn on the fan as the results of equations 6 and 7.

Turn off Fan = Safe Input 1 $\cap$ Safe Input 2   (6)
        = Min (Input 1 Safe [9] $\cap$ Input 2 Safe [7,7])
            = Min (0.2; 0.075)
            = 0.075
Turn on Fan = Safe Input 1 $\cap$ Input 2 Alert   (7)
        = Min (Input 1 Safe [9] $\cap$ Input 2 Alert [7,7])
            = Min (0.2; 0.0 38)
            = 0.0 38

Based on the results of the calculations turn off the fan and turn on the fan is taken the value of the highest and later on made in the form of curves image 3 and the results can be seen in equations 8 and 9.

Turn on Fan = Input 1 Alert $\cap$ Input 2 Safe   (8)
        = Min (Input 1 Alert [9] $\cap$ Input 2 Safe [7,7])
            = Min (0.15; 0.075)
            = 0.075

Turn On Fan = Input 1 Alert $\cap$ Input 2 Alert   (9)
        = Min (Input 1 Alert [9] $\cap$ Input 2 Alert [7,7])
            = Min (0.15; 0.038)
            = 0.038

3.4. Calculation of defuzzyfication

To get a firm value from the MOM (Mean of Maximum) method is to get the mean or middle value of the highest curve as in the equation 10.

X = (a + b) / 2 (10)
a = 10 - turn off the fan x 5; b = 6.5 + Turn on fan x 6.5
X = ((10 - 3.75) + (6.5 + 4,875)) / 2
    = (6.25 + 11,375) / 2
    = 17,625 / 2   = 8.82 (Result)

4. CONCLUSION

From the research that has been done it can be concluded that:

1. Control system for carbon monoxide gas levels in the car cabin based on fuzzy logic can work according to needs.

2. Before taking measurements, the sensor must be heated for approximately 20 seconds until the sensor can be used for measurement. Because the sensor cleans the remaining gas contained in the sensor, after that the voltage on the sensor is stable and measurements can be made.

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