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MONITORING AIR QUALITY SYSTEM BASED ON SMART DEVICE INTELLIGENT

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ABSTRACT

Life on Earth can no longer be free from pollution. Pollution has an unfavorable impact, especially for health. Air pollution, for example, besides being able to trigger lung health problems, can also increase the risk of glaucoma which can result in blindness. Air pollution is pollution in the air by the presence of various contaminants beyond the threshold. A journal published by LAPAN said that some of these pollutants have the chemical elements CO, NO, SO, SPM (suspended particulate matter, O) and various heavy metals such as lead. Globally, the contributors to air pollution come from the transportation sector. In this study a design was designed. a system that can monitor air quality in a place, using the MQ-135 sensor, which is a gas sensor that has a relatively high sensitivity to ammonia, benzene, alcohol, CO2, smoke and other gases. And the MQ-7 sensor is a gas sensor used in equipment to detect carbon monoxide (CO) gas in everyday life, industry or cars. This system is based on the ATMega8 microcontroller as the main processor, and monitoring results are displayed on a 2 x 16 character LCD. So that the system becomes portable but still reliable to use. flat shape which makes it easy to lift up and causes losses to increase.

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1. INTRODUCTION

Air pollution is pollution of the air with the presence of various pollutants beyond the threshold. A journal published by LAPAN states, some of these pollutants have chemical elements CO, NO, SO, SPM (suspended particulate matter), O and various heavy metals such as lead. Globally, the contributor to air pollution comes from the transportation sector.

Air pollution is also called PM2.5 (particles that are 2.5 microns or even smaller). These particles are invisible to the eye and can be inhaled and accumulate in the lungs which can cause premature death in a person. PM2.5 particles come from pollution from various motor vehicles, forest fires, burning wood, oil, coal, factory smoke and so on. PM2.5 can also be indoors, this can be triggered by cigarette smoke, the combustion process when cooking, burning candles and so on [1]. ISPU is a unitless number, used to describe ambient air quality conditions at certain locations and is based on the impact on human health, aesthetic value and other living things.

2. LITERATURE REVIEW.

2.1 Air Pollution Standard Index

In 2020, the Ministry of Environment and Forestry has issued Regulation of the Minister of Environment and Forestry number 14 of 2020 concerning the Air Pollutant Standard Index which is a substitute for Minister of Environment Decree No. 45 of 1997 concerning Calculation and Reporting and Information on Air Pollutant
Standard Index. In this replacement regulation, it is stated that the ISPU calculation is carried out on 7 (seven) parameters namely PM10, PM2.5, NO2, SO2, CO, O3, and HC. There are the addition of 2 (two) parameters namely HC and PM2.5 from the previous regulations. The addition of these parameters is based on the magnitude of the risk of HC and PM2.5 to human health.
ISPU calculations are performed based on the values of upper limit ISPU, lower limit ISPU, upper limit ambient, lower limit ambient, and ambient concentration measurement results. The mathematical equation for calculating ISPU is as follows:

$$I = \frac{I_a - I_b}{X_a - X_b}(X_r - X_b) + I_b \qquad \text{... (2.1)}$$

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Where,
I = calculated ISPU
Ia = ISPU upper limit
Ib = ISPU lower limit
Xa = upper limit of ambient concentration (µg/m3)
Xb = Lower limit of ambient concentration (µg/m3)
Xx = real ambient concentration measurement results (µg/m3)

ISPU (Air Pollution Standard Index) in Indonesia has been regulated by the Minister of Environment and Forestry Regulation 2020 No. 14 by being categorized into 5 categories as shown in table 1

Table 1. Air Pollutant Standard Index Category (ISPU)

Rentang	Kategori	Penjelasan
1-50	Baik	Tingkat mutu udara yang sangat baik, tidak memberikan efek negatif terhadap manusia, hewan dan tumbuhan
51-100	Sedang	Tingkat mutu udara masih dapat diterima pada kesehatan manusia, hewan dan tumbuhan.
101-200	Tidak Sehat	Tingkat mutu udara yang bersifat merugikan pada manusia, hewan dan tumbuhan.
201-300	Sangat Tidak Sehat	Tingkat mutu udara yang dapat meningkatkan risiko kesehatan pada sejumlah segmen populasi yang terpapar
301+	Berbahaya	Tingkat mutu udara yang dapat merugikan kesehatan serius pada populasi dan perlu penanganan cepat.

ISPU monitoring is useful to find out how good or bad the air quality is in a location, so that air quality can be maintained for public health, with the hope that ISPU is always in the green category with a value below 50.

If the ISPU value is above a good value, then it can be used as a consideration for efforts to control air pollution to reduce the number of pollutant parameters that exceed the specified threshold.

2.2 Materials and Materials

In this study there are several main components used, namely as follows:
1. Microcontroller ATMega8
2. Sensors MQ-135
3. MQ-7 sensors
4. LCD 2 x 16 characters

ATMEGA 8 is a low power 8-bit CMOS microcontroller based on an enhanced RISC architecture. Most instructions are executed on one clock cycle, ATMEGA 8 has a throughput close to 1 MPS per MHz allowing the design of the system to optimize power consumption versus processing speed.

The pin arrangement of the ATMEGA 8 microcontroller IC is shown in the figure below. This IC is composed of 28 pins which have several different functions either as ports or as other functions.

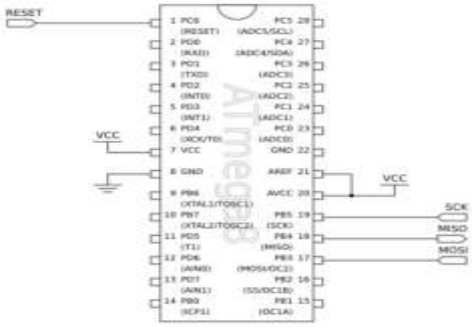

Figure 1. ATMega8 Pin Configuration

The MQ135 sensor is a type of chemical sensor that is sensitive to compounds NH3, Nox, alcohol, benzol, smoke (CO), CO2, and others. This sensor works by receiving a change in resistance value (analog)

when exposed to gas. This sensor has good resistance for the use of pollution hazard markers because it is practical and does not consume a lot of power. Adjustment of sensor sensitivity is determined by the different resistance values of the MQ-135 for various gas concentrations [10]. The unit of gas is ppm (parts per million). Furthermore, to calibrate so that the sensor reading value becomes a ppm (gas unit) value, you must first know the Rs/Ro versus ppm graph from the MQ-135 datasheet.

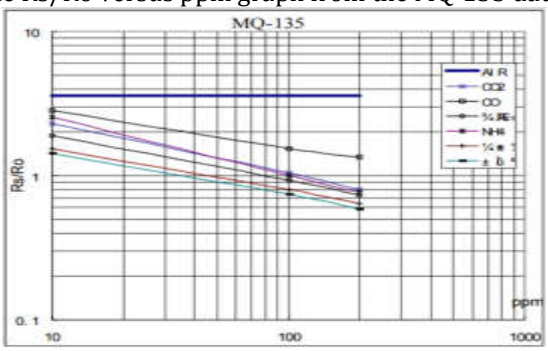

Figure 2. Graph of MQ-135 Sensitivity Characteristics

Figure 3 MQ-135 Sensors

- Pin 1 = Vcc (+5Volt)
- Pin 2 = Ground
- Pin 3 = Digital Out, and
- Pin 4 = Analog out

One way to calculate ppm for the MQ-135 sensor is by calibrating it. The graph above is a reference for calibrating the sensor so that you can find the ppm value. To find the Rs/Ro value, you need to find the Rs value and the Ro value. Where Rs is the sensor resistance value at gas concentration and Ro is the sensor resistance at clean air. Rs/Ro can also be referred to as a ratio. The following table 2.4 shows the characteristics of the MQ-135 sensor.

Table 2. Characteristics of the MQ-135 Sensor

No	Part MQ-135	Details
1	Voltage Source	5 Volts
2	Gas Detection	Benzene, Ammonia (NH3), Smoke, Carbon Dioxide (CO2), Nitrogen Oxide (Nox), Alcohol and others.
3	Measurement Level	10-100 PPM Benzene, 10-300 PPM Ammonia, 10-300 PPM Alcohol and others.
4	Output	Analog

The MQ-7 sensor is a sensor that has a high sensitivity to Carbon Moxide (CO) gas and the calibration results are stable and durable. The MQ-7 sensor is composed of a micro-ceramic tube, a sensitive layer of tin dioxide (SnO2), measuring and heating electrodes as a skin layer made of plastic and a stainless steel grid surface.

Figure 4. MQ-7 sensors

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- Pin 1 = GND
- Pin 2 = Digital Out
- Pin 3 = Analog Out
- Pin 4 = Vcc (+5 Volts)

The MQ-7 sensor has the characteristics of having good sensitivity to flammable gas types, having high sensitivity to natural gas (O2), strong sensor resistance and at a lower cost, having an easier circuit. The graph of temperature and humidity characteristics is shown in Figure 2.2. Ordinat means the ratio of the resistance of the sensor (Rs/Ro), Rs means the resistance of the sensor under 100 ppm CO at different temperatures and humidity. Ro means sensor resistance in a 100 ppm CO, 20 oC/65% RH environment.

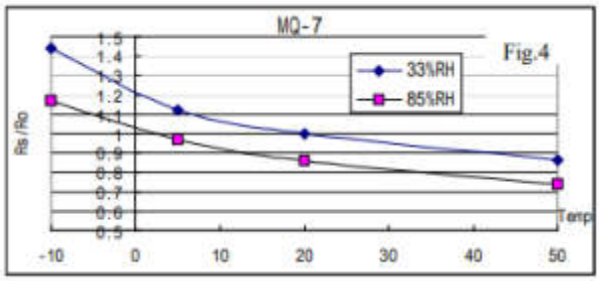

Figure 5. Graph of Comparison of Temperature and Humidity on the MQ-7 Sensor

3. METHOD

The research methodology developed is a quantitative method using a Research and Development (R&D) approach. Research and Development is a research that is used to produce a particular product. In the problem solving stage, this research uses the ADDIE (Analysis, Design, Development, Implementation and Evaluate) stage. The stages in designing an air quality monitoring system can be seen in the flowchart below.

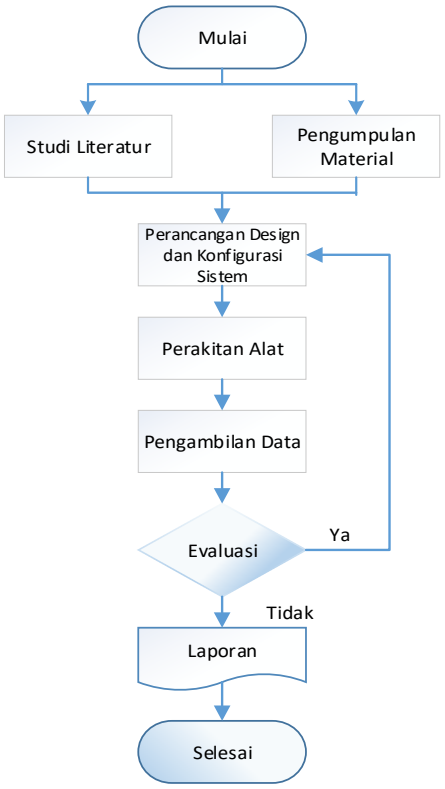

Figure 6. Research Flowchart

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The circuit schematic used in this study is shown in Figure 3.2

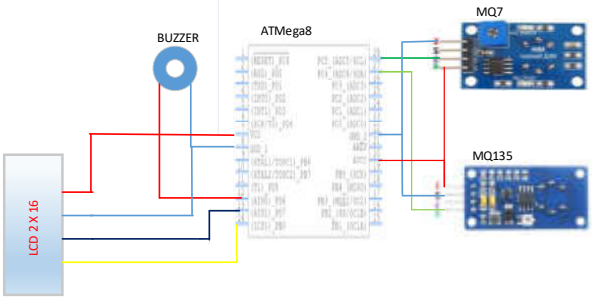

Figure 7. Circuit Schematic

4. RESULTS AND DISCUSSION

Air qulithy Monitoring

This air quality monitoring system consists of two sensor units, namely MQ135 and MQ7, ATMega8 microcontroller and ISPU reference which is used as the sensor conversion value (µg/m3) to become the official ISPU unit.

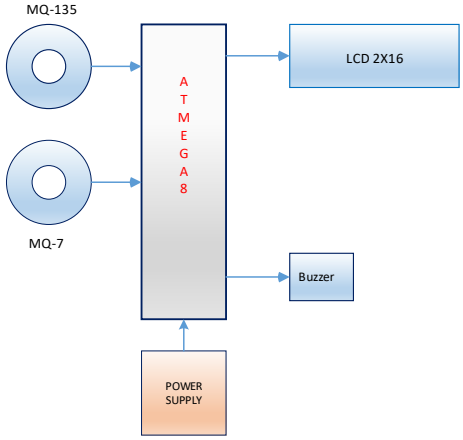

Figure 8. System Block Diagram

The work concept flowchart of the device being built is as follows:

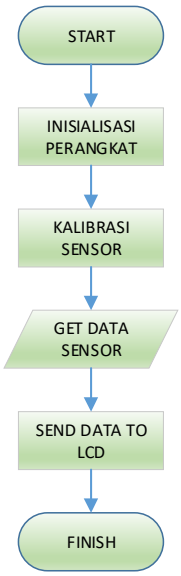

Figure 9. Device Work Concept Flowchart

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The system will perform continuous readings. If the system detects gas exceeding a predetermined threshold, it will produce an output in the form of a reading on the LCD and a buzzer will sound

Implementation

When the system is turned on, the sensor will take continuous readings. If the sensor detects the presence of gas at a certain limit that has been set, the system will issue an output in the form of a buzzer sound and display text on the LCD.

When the sensor detects a dangerous gas that has crossed the threshold and the user presses the button, the system will activate interrupt mode so that the timer will count down for the time that has been set. But if in the middle of the calculation the system status returns to

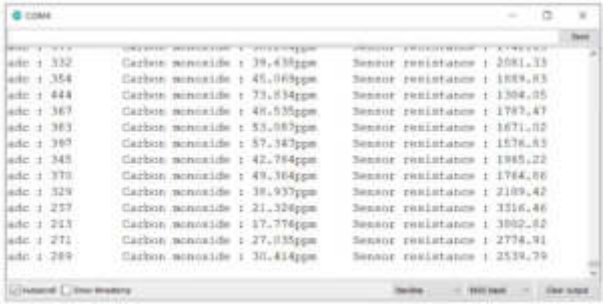

Figure 10. CO Sensor Reading Results in the Program

the condition is "safe" then if the condition is "dangerous" the buzzer will sound again.

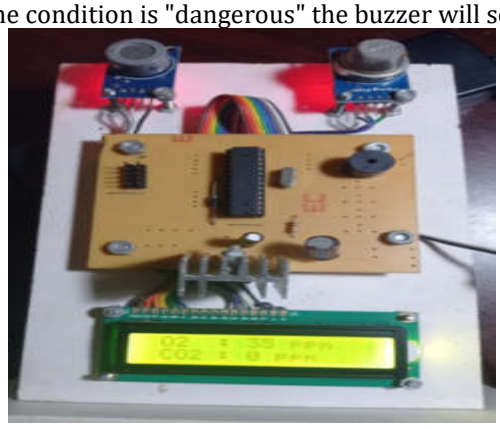

Figure 11, device research

Figure (a) shows an O2 level of 35 ppm and image (b) the LCD displays clean air. In figure (c) the LCD shows CO2 levels of 36 ppm and the results can be seen in figure (d) where the LCD shows that the air is polluted.

Analysis

Based on the Regulation of the Minister of Transportation Number 7 of 1964 concerning requirements for health, hygiene and lighting in the workplace and the Regulation of the Minister of Manpower and Transmigration Number PER.13/MEN/X/2011 concerning Threshold Values for Physical Factors and Chemical Factors in the workplace, limit levels of monoxide that is inhaled is 25 ppm if it exceeds that it will be harmful to humans.

Table 2 Data on O2 Content Test Results

No	O2 content (ppm)	Information
1.	25	Less Oxygen
2.	27	Less Oxygen
3.	29	Less Oxygen
4.	30	Less Oxygen
5.	31	Less Oxygen

6.	33	Less Oxygen
7.	36	Clean Air
8.	38	Clean Air
9.	45	Clean Air
10.	57	Clean Air
11.	68	Clean Air
12.	70	Clean Air
13.	74	Clean Air
14.	79	Clean Air
15.	81	Clean Air

Table 3 Table of Test Results for CO2 Levels

No	CO2 content (ppm)	Information
1.	36	Clean Air
2.	55	Clean Air
3.	79	Clean Air
4.	103	Clean Air
5.	159	Clean Air
6.	179	Clean Air
7.	195	Clean Air
8.	200	Clean Air
9.	205	Polluted Air
10.	278	Polluted Air
11.	301	Polluted Air
12.	335	Polluted Air
13.	365	Polluted Air
14.	390	Polluted Air
15.	407	Polluted Air

Based on the article by the Center for Hazardous Substance Research at Kansas State University with the title "Understanding Units of Measurement", it is explained that:
Concentration in air (ppm) = 24.45 x concentration (mg/m3) ÷ molecular weight.

In this testing process, the substance used for the simulation is butane gas (which is usually used to fill lighters). This test method was chosen due to time constraints during the research process and limitations on circuits that only use digital signals.

From the several tests carried out, it can be seen that the use of the MQ-7 and MQ-135 sensors is ideal enough to detect dangerous gases at certain limits through digital readings. However, to make measurements with high accuracy, the sensor must go through a heating process and separate configuration via the analog pin.

This is because if the RS/R0 measurement from the sensor can be calculated then the limits can be set more accurately following the existing datasheet. Whereas in a simple experiment using a digital pin, setting the sensitivity of the sensor detection is done through a potentiometer setting where the voltage can be measured. In addition, digital readings only provide 2 types of output (HIGH and LOW) can provide readings that are unstable and change continuously under certain conditions,

5. CONCLUSION

The large number of harmful gases that cannot be smelled or seen are causing low levels of public awareness about the dangers of air pollution. To overcome this, the government has launched various programs that can warn the public about the air quality conditions around them. With the times and the high level of community mobility, an air quality detector is needed that is easy to carry anywhere.

The air quality monitoring system using the MQ-7 and MQ-135 is one solution to overcome this. This system is capable of detecting various gases in the air and providing warnings to the public. This system is enough to detect dangerous gases at the levels we want. The system is easy to carry around because it can use a 18650 battery. However, this device cannot perform detection with a high accuracy value, this is due to the sensor configuration not being done.

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