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HUMIDITY, TEMPERATURE AND CARBON MONOXIDE DETECTION INSTRUMENT IN THE AIR USING LCD MONITOR AND MICROCONTROLLER

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ABSTRACT

The humidity, temperature, and carbon monoxide detection instrument are used for safety of factory environment because the excessive of humidity, temperature, and carbon monoxide can endanger condition in the factory. While we use SHT1 1 sensor from Sensirion to detect the humidity and temperature, we use TGS5042 sensor from Figaro to detect the carbon monoxide. In this detection instrument, there are some components for maximizing the performance, i.e. relay that connected to buzzer as alarm. This alarm will be active if the humidity, temperature, and carbon monoxide are excessive in the air. In addition, we use LCD (Liquid Crystal Display; 4 x 20) and LCD (Liquid Crystal Display) monitor as a result display from all sensors detection. MicroVGA is used as connector between microcontroller and LCD monitor. TGS5042 sensor needs time for producing the voltage while starting until the stable position. This research provides significant benefits for health and safety system environments because the concentration levels of carbon monoxide (CO), humidity and temperature data in the form of numbers or letters will be shown via LCD or PC (Personal Computer). If the levels of carbon monoxide (CO), humidity and temperature exceed the maximum or minimum value has been determined then it will display a warning buzzer alarm.

Keywords: Humidity, Temperature, Carbon monoxide, Microcontroller, SHT1 1 sensor, TGS5042 sensor

INTRODUCTION

Many companies need instrument that can detect carbon monoxide gas, humidity, and temperature. Because of global warming and ISO 14001 standardization, the company should anticipate the environment pollution. Industrial and transportation sectors have increase air pollution by emission gas. Carbon monoxide gas is very dangerous for human health. Carbon monoxide is produced from emission gas that contains the carbon. Carbon monoxide gas is poison gas that can not be detected by human sense because it has no fume and colour. In the certain of concentration and time phase,

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carbon monoxide that inhaled by human will give poison effect in the blood. The humidity and temperature are also influence by carbon monoxide value in the air.
The development in first step is designing instrument that can detect carbon monoxide gas, humidity, and temperature values. These values can display number and character on LCD display character 4x20 and LCD monitor TV or Computer. We expect to the humidity, temperature, and carbon monoxide detection instrument in the air using LCD monitor and microcontroller can help the human in the company area. This condition will contribute a good impact to safety condition, especially when carbon monoxide, humidity, and temperature are excessive. Previously, we've been doing research related to the temperature control on a process control and research on the aluminum molding cooling system (Ardi, S, 2006; Ardi, et. al, 2011).

The problem of this instrument is how to design this instrument that can detect carbon monoxide gas, humidity, and temperature values based on microcontroller ATMEL AVR ATmega1280. How to read the indicator of carbon monoxide gas, humidity, and temperature that can be shown by LCD character 4x20 and LCD monitor TV or Computer with using microvga as communication between LCD Computer and microcontroller? The benefits this instrument i.e. we can know the display from this instrument those are indicator carbon monoxide gas, humidity, and temperature. Beside that, we can give a warning signal as buzzer alarm if carbon monoxide gas, humidity, and temperature excessive maximal or minimal certain limit value.

RESEARCH METHOD

Table 1 below list the needs of specification from the factory in designing the humidity, temperature, and carbon monoxide instrument are.

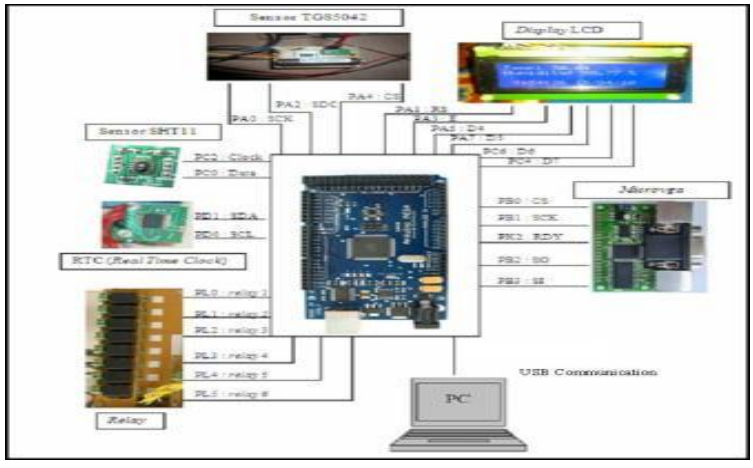
Table-1. The Specifications

No.	Specifications	Components	Descriptions
1.	Detection of CO gas	Sensor TGS5042	can detect CO Gas until 10.000 ppm
2.	Detection of humidity and temperature	Sensor SHT11	can detect the humidity from 0-100%. Can detect the temperature from – 40^{o}C until + 123,8 ^{o}C
3.	Display LCD monitor	LCD character 4x20	can display indicators of temperature, humidity, and CO gas including the date and time.
4.	Time and date	RTC circuit	To set the time and date
5.	Alarm signal	Buzzer and Relay	Alarm signal with buzzer Relay is used to switch on the indicator lamp. Relay 1 + lamp 1 : Temp Max Relay 2 + lamp 2 : Temp Min Relay 3 + lamp 3 : Humidity Max Relay 4 + lamp 4 : Humidity Min Relay 5 + lamp 5 : CO Max Relay 6 + lamp 6 : CO Min
6.	Indicator display on monitor LCD	LCD monitor and microvga	Microvga is used to communicate between microcontroller and LCD monitor Monitor display is used to display : 1. Indicator of CO Gas 2. Indicator of humidity and temperature 3. Date and time 4. Setting date and time 5. setting the alarm Temp Max, Temp Min, Humidity max, Humidity min, CO Max and CO Min
7.	Setting the alarm, date, and time by manually	Keyboard	1. to set date and time 2. to set alarm Temp Max, Temp Min, Humidity

8.	HyperTerminal communication	PC or laptop	Max, Humidity Min, CO max and CO Min To display the data, i.e. time, temperature, humidity, and CO gas.

Figure 1 shows the detail communication schematic of detection instrument as humidity, temperature, and Carbon Monoxide (CO) gas. This instrument based on microcontroller AVR ATmega1280. Microcontroller AVR ATmega1280 is used as processor of data inputs, and after that to produce the data outputs. AVR ATmega1280 receives the inputs from Computer. Computer sends the data as input that will be processed by AVR ATmega1280, furthermore will be executed by TGS5042 sensor and SHT11 sensor (Heights Arlington; Quick Start DT). These sensors will detect the humidity, temperature, and CO gas as outputs. LED, relay, and buzzer are used as outputs and indicators for communication. Whereas microvga is used for communicating between LCD monitor and keyboard to microcontroller AVR ATmega1280. RTC is used to display the date and time, while LCD display as indicator for writing display.

Figure-1. The detail of communication schematic



RESULTS AND ANALYSIS

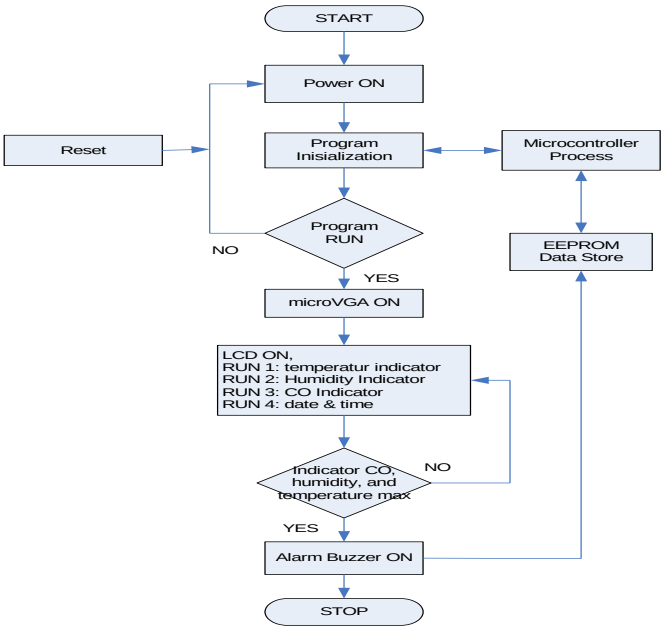
The circuit of instrument carbon monoxide gas indicator, humidity, and temperature based on microcontroller AVR ATmega1280 use 5V DC, sensor SHT1 1 module, TGS5042 sensor, and RTC circuit. The control module is connected to Computer using the serial communication. Before connecting from one module to another module, making sure that the programming has included in AVR ATmega1280 and power supply has switched on to module circuit correctly.

Method of Work the Humidity, Temperature, and Carbon Monoxide Instrument

(Alsadi, et.al, 2012) researched about modeling of relative humidity using artificial neural network. Next, (Faiq, et.al, 2012) designed an electronic system for the study of simple pendulum at large angles. In this paper, we design instrument that can detect carbon monoxide gas, humidity, and temperature values.

Figure 2 shows the outline of flow chart from instrument carbon monoxide gas indicator, humidity, and temperature.

Figure-2. Process flow chart of hardware



Work steps of this instrument are:

- Starting with power supply switch on that connecting to microcontroller. Microcontroller will be ready to communicate with all input output that installed in the instrument of CO gas indicator, humidity, and temperature. Next, LED lamp in every input output circuit will be on that shows all of I/O are connected in good condition. If not, then the process will initialize the program again.
- If initialization process is finished, next the program will execute all I/O hardware that installed in the instrument of CO gas indicator, humidity, and temperature. Firstly, microcontroller will active microvga that connected to LCD monitor. After microvga send the program, next LCD 4x20 and LCD monitor will be active and show the calculation of temperature, humidity, CO gas, time, and date.
- After that, if the indicator CO gas, humidity, and temperature show the maximal or the minimal values, automatically microcontroller will execute and active the relay that connected to buzzer for setting alarm signal warning. While the alarm signal is sounding, the execution will be continued into EEPROM as data storage.

DESIGN OF HARDWARE SCHEMATIC

We design the circuit of electrical schematic using the Eagle software. In our research, the circuits will be divided into some of parts: power supply circuit, CPU (Central Processing Unit) circuit or microcontroller, circuit of carbon monoxide sensor, RTC (Real Time Clock) circuit, push button circuit, relay and buzzer circuit. Power supply circuit is function as voltage produce, i.e. 5 VDC, +15 VDC, -15 VDC and 9 VDC that connected to PLN 220 VAC. This circuit has been rectifier using transform of CT -18 VDC…+18 VDC. Microcontroller circuit is connected to computer that using USB port. Microcontroller is function as a controller to CO gas indicator, humidity, and temperature. Microcontroller will give and send the data from and to all of I/O (input output) that connected at every pin.

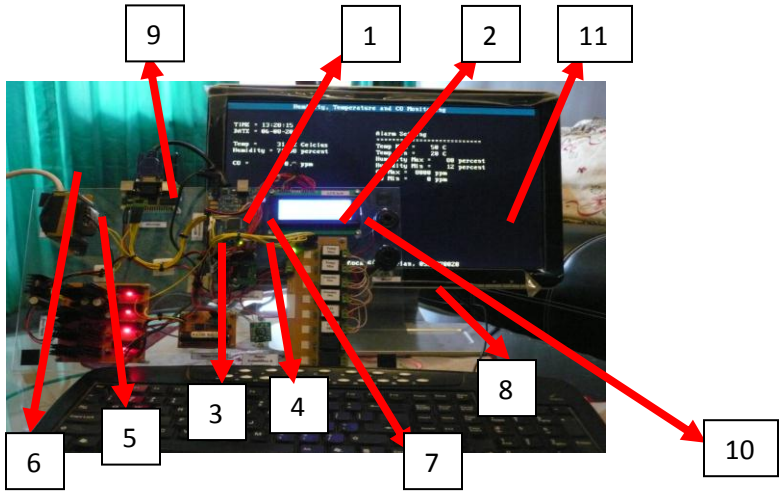
Testing Of Measurement and Calculation Displays

In this paper, testing of the measurement is measuring carbon monoxide gas. In (Roberts, et. al, 2004) have been researched about CO-sensing mechanism). What TGS5042 sensor as CO gas sensor can read CO gas in the air or can be measured or can not be measured. The measurement of humidity and temperature is using SHT1 1 sensor. What SHT1 1 sensor can read humidity and temperature values in the air, and also can be measured or can not be measured. In addition, what the testing results can be displayed by LCD monitor pass by microvga. In this testing, we use some indicators and some the locations of testing for showing consideration of CO gas, humidity, and temperature values. The indicators and locations use cigarette and emission of motorcycle uses bio-solar, premium, and bio-pertamax in the air. Before doing the testing, we should notice as follow:

- Voltage source 220 VAC connect to transform CT -18VDC… +18VDC, next from transform CT connect to supply divider circuit for giving the voltage to every components, i.e. supply to microcontroller (as data processor), CO sensor circuit, and microvga circuit.
- LCD (Liquid Crystal Display) connect to processor data circuit with insert pin 23, pin 25, pin 27, pin 29, pin 31, and pin 33 of microcontroller.
- CO sensor circuit is supplied with +15VDC, -15VDC 9VDC voltage. Ground (GND) of power supply and the output is connected to pin 22, pin 24, and pin 26 from microcontroller.
- Circuit of humidity and temperature sensor is supplied with 5 volt and 0 volt from data processor circuit, next the output is connected to pin 35 and pin 37.
- RTC (Real Time Clock) circuit is supplied with 5 volt and 0 volt from data processor, next SCL (Serial Clock) and SDA (Serial Data) are connected to pin 20 and pin 21.
- Microvga circuit is supplied with 5 volt and 0 volt from data processor, next pin RX and TX are connected to pin RX and TX from microcontroller. Microvga is connected with VGA cable to LCD monitor.
- Relay and buzzer circuit is supplied from power supply circuit; next relay and buzzer circuit are connected to L0-L5 ports of microcontroller.

Figure 3 shows description of overall the hardware testing. Figure 4 shows circuit of carbon monoxide (CO) sensor. Figure 5 shows circuit of SHT11.

Figure-3. Hardware



Testing

Explanation:

1. Data processor circuit (microcontroller).
2. LCD 4x20 as data displayer.
3. Circuit of carbon monoxide (CO) sensor.
4. Circuit of humidity and temperature sensor.

Figure-4. Circuit of carbon monoxide (CO) sensor

Figure-5. Circuit of SHT11

5. Circuit of power supply.
6. Transformer CT -18VDC…+18VDC.
7. Circuit of RTC (Real Time Clock).
8. Keyboard.
9. Circuit of microvga.
10. Circuit of relay and buzzer.
11. LCD monitor.

Steps of the Testing Are:

- Measuring CO gas degree, humidity, and temperature by using the indicators CO gas producer that located in any diverge.
- Test for setting the date, time, and alarm that can be set up from LCD monitor by using the keyboard.
- Testing the relay and buzzer by using maximal and minimal values in LCD monitor by using the alarm setting menu.
- Testing the data display by using hyper terminal.
- Testing on LCD display and LCD monitor.

Measure Levels of CO, Humidity, and Temperature by using Indicators CO Gas Producing Different Place

Figure 6 shows an image display of 4x20 LCD and LCD monitors. On the display shows the value when the CO gas sensor does not detect any carbon monoxide (CO) in CO-free air or gas is less than 10 ppm. Display on the LCD screen is 0.0 ppm. This is because if the levels of CO in the air is still below 10 ppm, the calculated 0 ppm. The humidity value is 69.18% and 32.72 ° C temperature.

Figure-6. The sensor does not detect CO gas

Figure 7 shows the CO gas sensor detects CO gas of cigarettes valued at 2736.4 ppm. While the value of humidity is 65.99% and temperature is 33.55 ° C in air.

Figure-7. The sensor detects CO gas of cigarette

Figure 8 shows the CO gas sensor that detects CO gas from the exhaust smoke bike with fuel biopertamax. CO gas is detected value 2673.3 ppm, the value of 84.63% humidity, and temperature of 41.36 ° C in air.

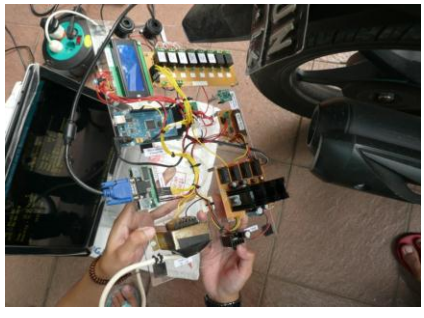


Figure-8. Sensor detect CO gas from the fuel motorcycle biopertamax

Figure 9 shows the CO gas sensor detects CO gas in the car with smoke from the combustion of biodiesel fuels. CO gas is detected value 584.2 ppm, the value of 67 670% humidity, and temperature of 37.73 ° C in air.

Figure-9. Sensor detect CO gas from the car with biodiesel fuel

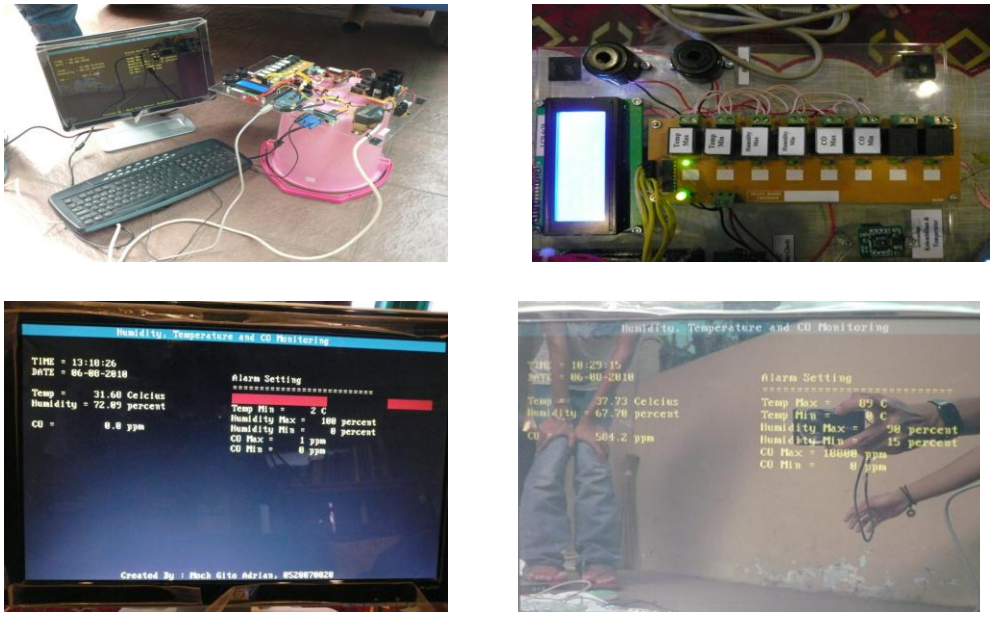


Figure 10 shows the CO gas sensor that detects CO gas in the range of more than 10000 ppm. In this case there will be an error on the LCD display.

Figure-10. CO sensors in an error

Relay and Buzzer Testing by Setting the Maximum and Minimum Values in advance on the LCD Monitor to Set the Alarm Setting Menu

Figure 11 shows the relay and the buzzer is active are characterized by the LED light up when the temperature reaches a maximum value. Figure 12 shows the display on the LCD monitor when the temperature reaches a maximum value.

Figure-11. Relay and the buzzer Max Temp is marked with LED lights up when the temperature reaches a maximum value

Figure-12. LCD screen display monitor when the temperature reaches a maximum value

Figure 13 shows the appearance of the relay and the buzzer is active when the temperature, humidity, and carbon monoxide (CO) reaches a maximum value. We can see how it looks on the LCD monitor screen that is marked with a red line on the right screen LCD monitor.

Figure.13. LCD screen display monitor when the humidity reaches a maximum value

Testing of LCD (Liquid Crystal Display)

Based on testing of LCD display, it has appropriated with the program that restores to the microcontroller. In the monitor of LCD display will appear the values. Figure 14 shows display testing in LCD character 4x20. Table 2 gives **s**creen LCD (Liquid Crystal Display) display. Figure 15 shows that LCD display will appear the values and character writing.

Figure-14. Display testing in LCD characters 4x20

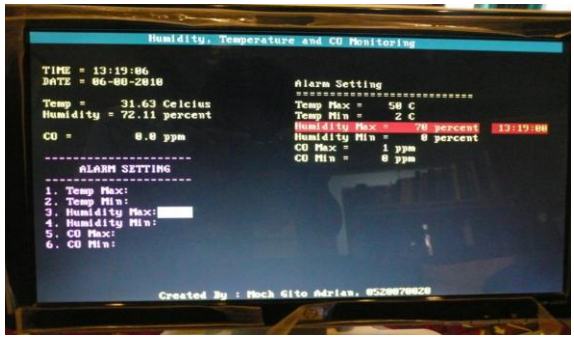


Figure-15. Testing of LCD display

Table- 2. Screen LCD (Liquid Crystal Display) Display

Hour	Minute	Second	Date	Month	Year
Temperature					
Humidity					
Carbon Monoxide (CO)					

Response Time Testing of Carbon Monoxide (CO) Gas on the Air

Response time of the TGS 5042 sensor to detect carbon monoxide (CO) is influenced by several factors, namely: wind direction, the size of the capacity of smoke containing CO gas released by cigarettes and exhaust fumes, distance.

Table 3. Response time of carbon monoxide gas

Types of Carbon Monoxide	Distance (cm)	Response Time TGS5042 Sensor (second)
Cigarette	3	00:02.3
	10	00:08.0
	15	00:27.7
	20	01:04.3
	30	00:43.4
motorcycle smoke with bio-pertamax	8	00:00.8
	15	00:02.9
	25	00:01.4
	35	00:03.0
	45	00:03.5
car smoke with bio-solar	10	00:02.2
	20	00:02.7
	30	00:02.7
	40	00:03.1
	50	00:03.2

CONCLUSION

The humidity, temperature, and carbon monoxide detection instrument are used for safety of factory environment because the excessive of humidity, temperature, and carbon monoxide can endanger condition in the factory. TGS5042 sensor needs a time for producing the voltage when the first starting is into stable position. If CO gas is excessive, the resistance of sensor will become small and output voltage will become bigger. Circuit of TGS5042 sensor needs buffer circuit and amplifier because they are used to maintain the current of TGS5042 sensor. The amplifier circuit functions for voltage amplifier. Microcontroller AVR ATmega1280 can communicate with LCD monitor by using microvga with SPI (Serial Peripheral Interface) communication path. This research provides significant benefits for health and safety system environments because the concentration levels of carbon monoxide (CO), humidity and temperature data in the form of numbers or letters will be shown via LCD or PC. If the levels of carbon monoxide (CO), humidity and temperature exceed the maximum or minimum value has been determined then it will display a warning buzzer alarm.

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