Design of Microcontroller Based Fire Detector with Output Warning SMS Information and Automatic Extinguisher

Abdul Zain[1,a] , Rudi Hartono[2,b] dan Sri Handani W[3]
[1,2] Departement of Electrical Engineering, Sekolah Tinggi Teknologi Bontang, Jl Letjen S. Parman No 65 Bontang
[3] Departement of Informatics Engineering, Sekolah Tinggi Teknologi Bontang, Jl Letjen S. Parman No 65 Bontang
[a] jainbtg2013@gmail.com
[b]11rudi.hrt @gmail.com

Abstract— Conflagration is an unpredictable tragedy. It may occur whether in the woodland areas or in the residential areas. Typically, it would only be recognized if indeed the flames spread and the smoke intensified. This study aims to detect fires using the MQ-2 smoke sensor, DS18b20 temperature sensor, and fire sensor. Using Arduino Uno as the controller, this system's output is in the form of an alarm buzzer, Short Message Service (SMS) information using SIM800L, and an automatic fire pump. This system operates to detect the temperature shifts, the smoke concentration and the existence of a fire point which triggers an alarm in the form of a siren if two out of the three sensors are activated. It, then, sends information by Short Message Service (SMS) and automatically triggers the pump as the result. The fire sensor can detect hotspots with a maximum distance of 80 cm and the DS18b20 temperature sensor has an average reading error of 0.27 ° C with a maximum reading error of 0.5 ° C. The MQ-2 smoke sensor can detect smoke where the change in smoke concentration is directly proportional to the sensor output voltage. There are three conditions to determine fire conditions, namely the temperature sensor reads more than equal to 55 ° C and the fire sensor is active, or the temperature sensor reads more than equal to 55 ° C and the smoke sensor reads more than equal to 1000 ppm, or the fire sensor is active and smoke sensor reads greater than equal to 1000 ppm.

Keywords—component; conflagration, MQ-2 smoke censor, fire censor, DS18b20 temperature censor, Sim800L, automatic extinguishing.

I. Introduction

Fire is an oxidation process of three elements air, fuel, and heat source [1]. Conflagration is an unpredictable tragedy [2]. This disaster can occur in the forest areas as well as in residential areas, this incident is not expected by the community because it will cause material, psychological losses and allow for casualties. The fires in urban areas are generally caused by an electrical short circuit (short circuit) on the power cable, a leak in the LPG gas cylinder pipe, or human negligence, such as throwing cigarette butts carelessly. Apart from those caused by human factors, fire disasters can also be caused by natural factors such as lightning, earthquakes, volcanic eruptions, long droughts etc [3].

In general, the fires will only be known if the flames have enlarged and smoke has risen. These conditions will cause casualties, the detriment which are not small and the cessation of business activities or causing environmental damage [4]. When the fires occur, the community worked together to extinguish before the firefighters arrived, the real fact that, the problems were often occurred when firefighters arrive at the location are due to several factors, are delay in information, congested roads to the location, areas that are difficult to reach and the readiness of the officers [3].

To suppress the fire numbers, it is need to take an action which prioritizes safety. Warning of signs of fire is one solution to fire hazards. Signs of fire can be detected because every fire always emits smoke and heat [5]. Based on the above conditions, a fire detection device is designed with information output of an SMS gateway and automatic extinguishing.

This tool is designed for early detection of fire symptoms by using several censors such as, MQ-2 smoke censor, fire censor, DS18b20 temperature censor

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with the Arduino Uno microcontroller as a data processor. By this censor sensing, if two of the three censors detect early signs of fire, it will activate an alarm in the form of a siren and SMS will be sent to the contact which has been set as information and it will turn on the pump to spray water into the area where the fire is happening so it does not enlarge.

II. Research Methodology

A. Research Schedule

The research has been conducted on January 2020 to July 2020. This research activity consists of two parts; (1) design the tools and (2) test the tools. The research was conducted at the Laboratory of Electrical Engineering Program Study, Bontang Engineering College.

B. Research Stages

Steps of the research can be seen in figure 1.

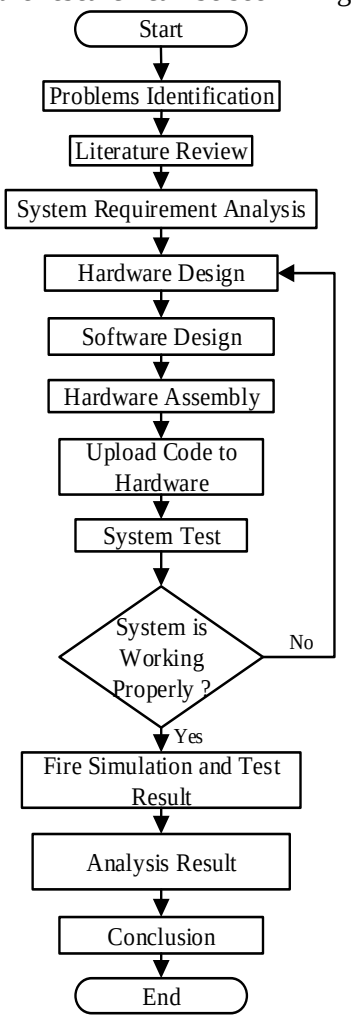

Figure 1. Research Flowchart

C. System Architecture

System architecture is a general description of the system to be designed and built. Figure 2 shows the fire detection device design model which will be built in accordance with literature review and system requirement analysis.

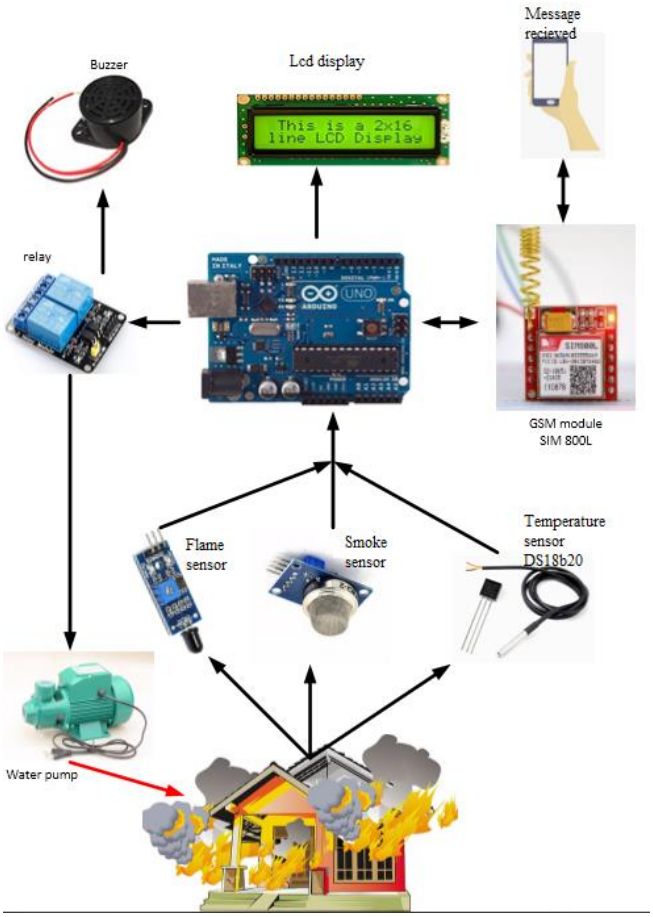

Figure 2. System Architecture

In figure 2, it can be seen that the configuration of the fire detection and automatic extinguishing devices to be built consists of input, process, and output. From the input side, this research using several censors consisting of a DS18b20 temperature censor, MQ-2 smoke censor and flame censor. Arduino Uno is used as a data processor which will receive data from censors and will be processed to determine conditions that are indicated as conflagration. The output of this system is in the form of a buzzer alarm, Sim 800L module to sent information of conflagration, the LCD is used to display censor data and automatic start of the pump.

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D. System Design

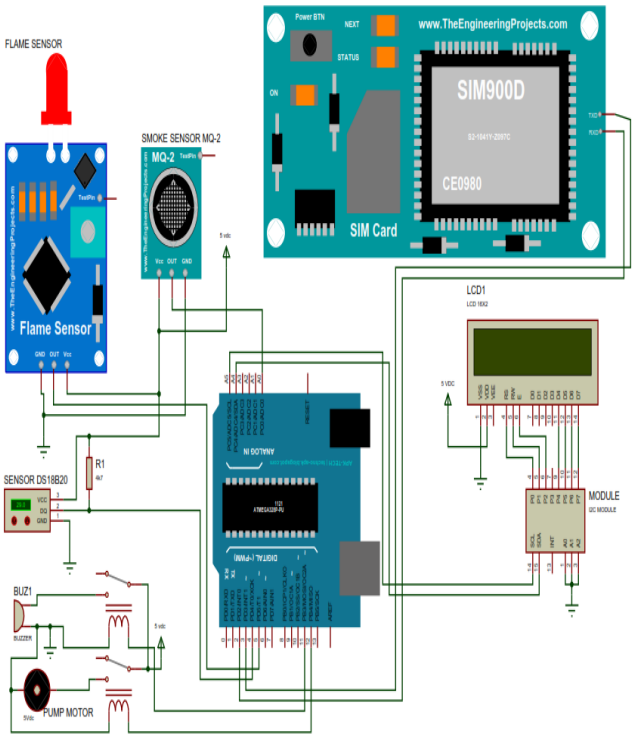

Figure 3. System Design

Figure 3 is a built system design. The Arduino Uno microcontroller pin configuration for the censors is set up as follows:

1. The Flame censor output signal is a digital, the DO censor pin is connected to pin 5 of the microcontroller.
2. The DS18b20 censor output signal is a digital, the pin Out censor is connected to pin 4 of the microcontroller.
3. The MQ-2 censor output signal is an analog, the pin A out censor is connected to pin A0 on the microcontroller.
4. The I2C module combined with LCD 16x2 to economize pin of microcontroller. on the SDA and SCL pins I2C the LCD module is connected to the A4 and A5 pins of the microcontroller.
5. The Sim 800L module can be communicated with the microcontroller by using serial communication, the pin RX, TX module is connected to the pin 2 and pin 3 on the microcontroller.
6. To activate the buzzer and water pump, an automatic switch in the form of a relay is used. The signal relay pins are connected to pin 11 and pin 12 on the microcontroller.

E. Flowchart System

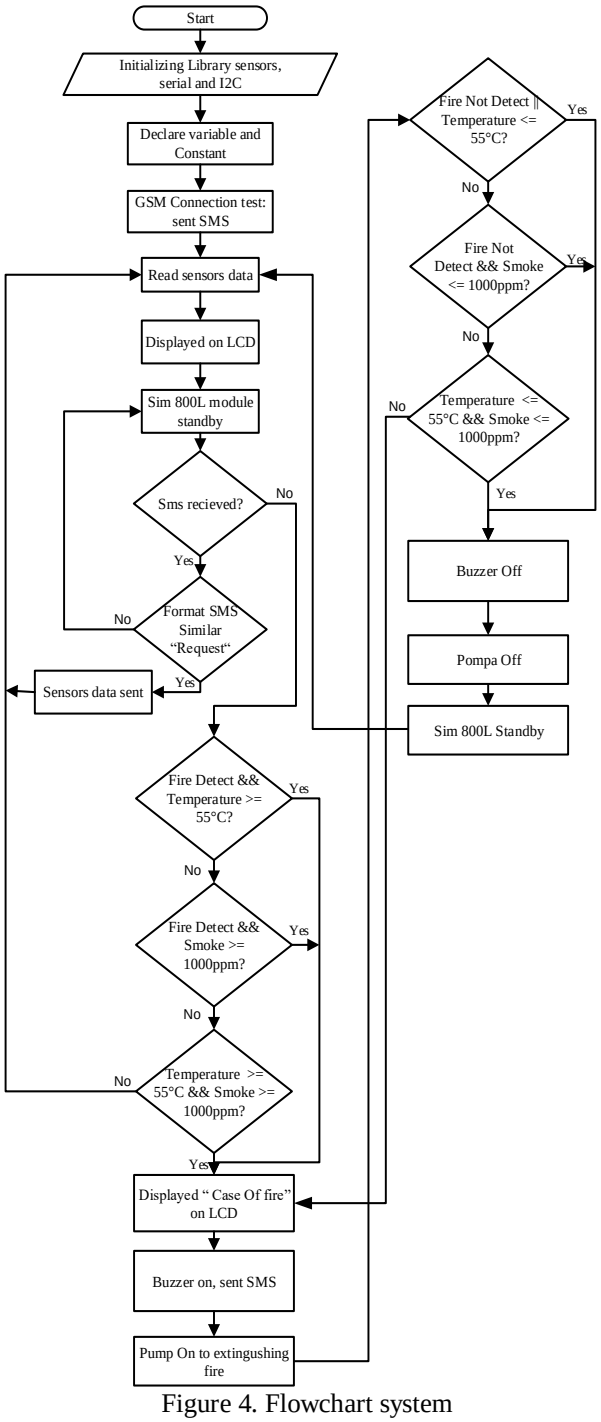

Figure 4. Flowchart system

Fire alarm system and automatic extinguisher are designed with basic capabilities based on Self-Monitoring, Analyzing & Reporting Technology (SMART) [6]. The SMART system is a system designed

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to detect potential fires, analyze in the presence of three censors are used, if two of the three censors are active, so the microcontroller will give commands to send information to the contact number that has been previously arranged. The microcontroller will activate the pump automatically to make extinguisher. The Information is received in the form of SMS is fire warning information to call the authorities to further handle the fire. There are how to the system is built as follows:

1. Initializing library, serial communication and I2C communication.
2. Declared variables.
3. Sent SMS "Test connection SMS" the first time the system is turned on.
4. Read and process the data from censors and displayed on the LCD.
5. Censor of the data can be accessed through via mobile phone by sending an SMS with the format "Request".
6. Set point of value censor to indicate the fire
   a. The flame censor is LOW
   b. The temperature censor is more than equal 55°C [5].
   c. The smoke censor is more than equal 1000 ppm [7].
7. There are three conditions are indicated as fire conditions:
   a. The flame censor is LOW and the temperature censor is more than equal set point value.
   b. The flame censor is LOW and the smoke censor is more than equal set point value.
   c. The temperature censor and smoke censor are valued more than equal to set point value.
8. If one of the conditions above is achieved, it will activate the buzzer, it sends message fire warning information to the contact number that has been set, displays the status “case of fire” in LCD, it will activate the pump to perform a extinguisher.
9. If the censor value is less than the set point value, the system will deactivate the pump, the buzzer and LCD will display the value censor.
10. The system will return to monitoring mode.

III. Result and Discussion

A. *Hardware Assembly*

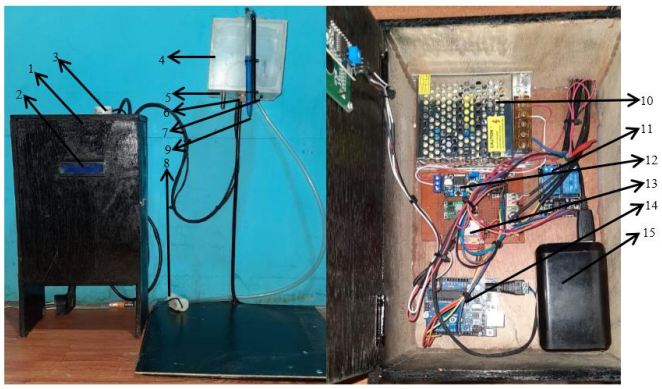

Figure 5. Hardware Assembly

The design of the fire detector above is still a prototype. Figure 5 is the result of the hardware assembly used in this research.
caption 5 as bellows :

1. Box panel
2. LCD 16x2
3. Buzzer
4. Censors box
5. Censor DS18b20
6. Censor MQ-2
7. Flame censor
8. Pump
9. Sprinkle
10. Power supply
11. Relay
12. DC-DC converter
13. Sim 800L
14. Arduino Uno
15. Battery

B. *Sim 800L Test Result*

In this research, using by the Sim 800L module as a component that functions to send SMS information to the contact number that has been set. It aims to ensure to send the SMS information which can be received to the contact number that has been set. In module of operation uses a Led indicator as a cellular network signal status. The indicators are as follows:

1. It is blinking every second it indicates that the module is running but has made connection to the cellular network yet.

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2. It is blinking every two seconds it indicates that *General Package Radio Service* (GPRS) data is active.

3. If it is blinking every 3 seconds indicates the module is connected to the cellular network and can send and receive calls or Short Message Service (SMS).

Table 1. AT Command Sim 800L module

Syntax	Description
AT+COPS	*Operator Selection*
AT+CREG	*Registrasion Network*
AT+CSQ	*Signal Quality Report*
AT+CFUN	*Set Phone Functionality*
AT+CMGF	*Select SMS Message Format*
AT+CMGS	*Send SMS Message*
AT+CMGR	*Read SMS Message*
AT+CNMI	*New Message Indication*

Table 1 above is some of the commands are used to access the Sim 800L by means of serial communication or has been written in the code program. The result of the test are as in figure 6.

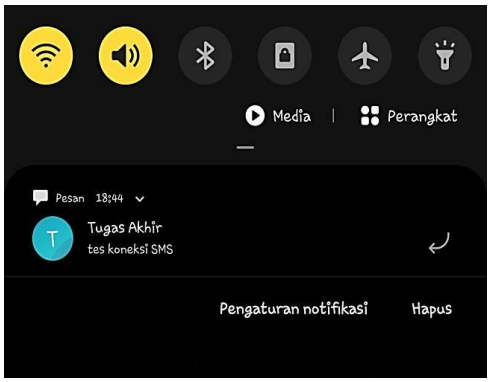

Figure 6. SMS Recieved

C. *Temperature Censor Test Result*

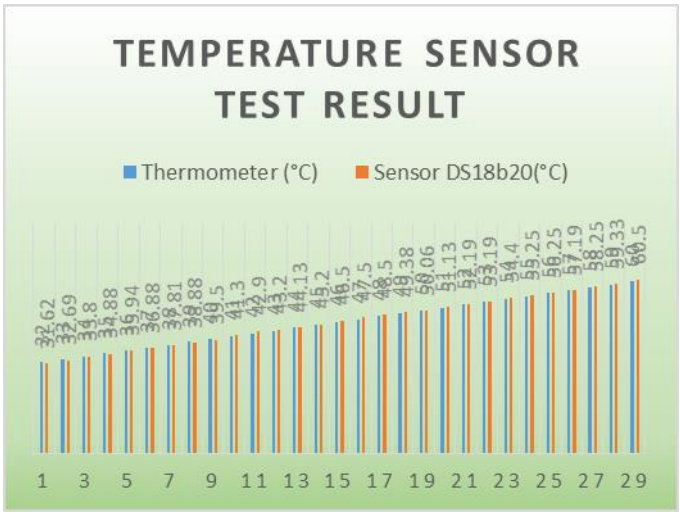

Figure 7. Temperature Censor Test Result

The results shown in figure 7 are a test of the DS18b20 temperature censor which is compared with a mercury thermometer by blowing hot air using a heat gun.

D. *Flame Censor Test Result*

Table 2. Flame Censor Test Result

Ranges	Flame Censor	Buzzer	LCD Display
10 cm	*LOW*	On	Fire Detected
20 cm	*LOW*	On	Fire Detected
30 cm	*LOW*	On	Fire Detected
40 cm	*LOW*	On	Fire Detected
50 cm	*LOW*	On	Fire Detected
60 cm	*LOW*	On	Fire Detected
70 cm	*LOW*	On	Fire Detected
80 cm	*LOW*	On	Fire Detected
90 cm	*HIGH*	Off	Fire Not Detected
100 cm	*HIGH*	Off	Fire Not Detected

This test is done by providing a fire point just below the flame censor and measuring the maximum distance the flame censor can detect fire. The test results are shown in table 2.

E. *Gas Censor Test Result*

Table 3. Gas Censor Test Result

Condition	Censor MQ-2	Censor Volt
Without Smoke	0 ppm	0,16 volt
Thin Smoke	334 ppm	0,80 volt
Medium Smoke	2345 ppm	1,13 volt
Thick Smoke	4141 ppm	1,19 volt

The test is done by giving smoke to the smoke censor with different levels of concentration. The conditions change in smoke concentration directly proportional to

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the increase PPM value that will be displayed on the LCD. The test results are shown in table 3.

F. Third Conditions Fire Detector Testing

1. Condition 1 Test Result

Table 4. Condition 1 Test Result

Temp. Censor	Flame Censor	Sim 800L	Buzzer	Pump	LCD display
52,68°C	Low	Stand by	Off	Off	Censors data
57,19°C	High	Stand by	Off	Off	Censors data
55,18°C	Low	Sent SMS	On	On	Case of Fire
56,38°C	Low	Sent SMS	On	On	Case of Fire
57,20°C	Low	SMS sent	On	On	Case of Fire
61,28°C	Low	SMS sent	On	On	Case of Fire

2. Condition 2 Test Result

Table 5. Condition 2 Test Result

Flame Censor	Smoke Censor	Sim 800L	Buzzer	Pump	LCD display
High	0 ppm	Stand by	Off	Off	Censors data
Low	441 ppm	Stand by	Off	Off	Censors data
High	1338 ppm	Stand by	Off	Off	Censors data
Low	2125 ppm	SMS sent	On	On	Case of Fire
Low	2133 ppm	SMS sent	On	On	Case of Fire
Low	1153 ppm	SMS sent	On	On	Case of Fire

3. Condition 3 Test Result

Table 6. Condition 3 Test Result

Temp. Censor	Smoke Censor	Sim 800L	Buzzer	Pump	LCD display
30,81C	0 ppm	Stand by	Off	Off	Censors data
59,20° C	300 ppm	Stand by	Off	Off	Censors data
47,69° C	1720 ppm	Stand by	Off	Off	Censors data
57,50° C	1574 ppm	SMS sent	On	On	Case of Fire
60,15° C	3140 ppm	SMS sent	On	On	Case of Fire

G. Discussion

From the test results of table 4 to table 6 above, it can be concluded that when two of the three censors detect more than the same set point value, it will indicate a fire and the system will activate the buzzer, send an SMS and activate the pump, the received SMS information is as in figure 8. But if one of the two censors is less than the set point value, the system will return to monitoring mode

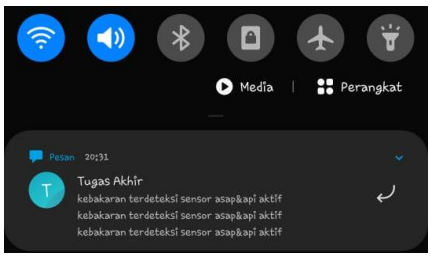

Figure 8. SMS Recieved

IV. Conclusion

Based on the design and testing of fire detector with output warning information and automatic extinguisher which have been carried out and the problems which have arisen, there are some conclusions can be drawn, including:

1. It has been designed successfully and made a fire detector with warning information and automatic extinguisher using the DS18b20 temperature censor, MQ-2 smoke censor, fire censor, sim 800L module, buzzer, pump, and relays based on Arduino Uno microcontroller can work according to the design and program made.
2. The flame censor can detect hotspots or fire with a maximum distance of 80 cm and the DS18b20 temperature censor has a maximum reading error of +/- 0,5°C.
3. The MQ-2 smoke censor can detect smoke where the change in smoke concentration is directly proportional to the censor output voltage.
4. There are three conditions for determining fire conditions, are temperature censor reads greater than equal to 55 ° C and active fire censor, or temperature censor reads greater than equal to 55 ° C smoke censor reads greater than equal to 1000 ppm, or active fire censor and smoke censor reads more than equal to 1000 ppm.
5. The output of this system is a buzzer alarm, SMS information with the sim800L module and automatic shutdown can work as expected and it can help fight fires

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