Automatic Early Warning System Design with Firefighter Synchronization Based on Internet of Things (IoT)

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***Abstract*— The fire department or DamKar is one of the important agencies which is highly needed by Indonesian people, especially when a fire occurs. However, DamKar is often judged to be late in arriving at the location because help comes to the fire when the fire has already take a set. One of the reasons why delay happens in DamKar is because the report is received late by the DamKar officer. One of the fire prevention measures is to take the preventive action or early prevention from indications of a fire. Automatic early detection is needed in an emergency and requires speed and accuracy in overcoming the problem. designs an early detection system for fires that directs to DamKar and warehouse owners. This system can detect and provide temperature information in real time. This system works if there is a drastic change in temperature and there is a puff as soon as detected by the sensor The information is in the form of a notification "Excessive CO gas detected" if the temperature is in the range of 25 °C and the gas content is 100 PPM, if the temperature exceeds 35°C and the gas content is 500 PPM there will be a notification "The warehouse temperature is too hot", then a danger notification " indicated fire above". From the experimental results, it is found that the mesh communication system can work properly.**

Keywords*— *DHT22, Early Warning System, Fire, MQ2, NodeMcu ESP8266.

I. INTRODUCTION

Based on data from the South Jakarta Fire and Rescue Agency, from January 2017 to December 2017, the total number of fires reached 348 cases [1]. This number has increased from the previous year 2016 which was only 244 cases [2]. It can be said that the number of fires in Indonesia continues to increase from year to year [3]. So that a system that can detect a fire is needed in order to prevent a fire from occurring.

Fires can be avoided in order to minimize losses by knowing the signs of an imminent fire. Rising temperature significant in a short period of time as well as the presence of a puff of smoke inside room can indicate a fire [4]-[6], but if the owner of the warehouse If you don't realize it, it can cause a big fire and expanding.

Sometimes DamKar officers came to the location late for several reasons, one of which was a late report so that when officers arrived at the location, the fire had already grown. Moreover, if the warehouse owner is not at the place so that the fire is detected late and the fire report is sent when the fire has take a set, then the risk of a very detrimental fire can occur. Avoiding fires is very necessary so that fires can be prevented as early as possible, so prevention can be done by installing a fire early detection device [7][8]. To realize this, we need a system that is able to detect signs of fire [9] and can provide notifications [10] to warehouse owners and firefighters so that fires can be handled quickly. The designs an early detection system for fires can send directly to DamKar and warehouse owners.

This system uses Microcontroller NodeMCU [11][12] as the main controller, temperature sensors DHT22 [13] and MQ-2 as smoke sensors [14][15]. This system can provide notification of signs of fire to warehouse owners and DamKar officers so that both warehouse owners and DamKar officers can know that there are indications of fire so that they can prevent fires from occurring.

II. METHOD

A. Diagram Block

The diagram block of this research is shown in Fig. 1. Based on Figure 1 In the block diagram, there are two systems, those are the location to be monitored and the monitor's location. The monitored location is the value data from the sensor consisting of the DHT22 temperature sensor and the MQ2 smoke sensor which is sent to the server using the NodeMCU as a microcontroller, the sensor value data will be processed and stored.

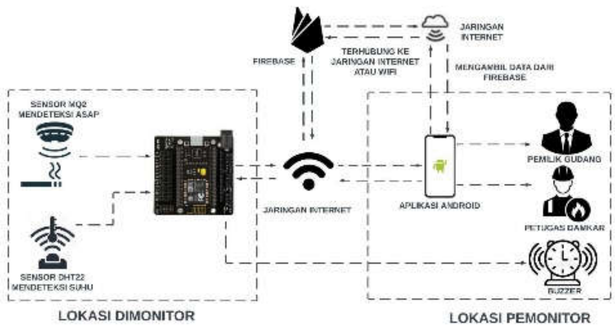

Figure 1. Diagram Block

B. Flowchart System

The flowchart system of this research is shown in Fig. 2.

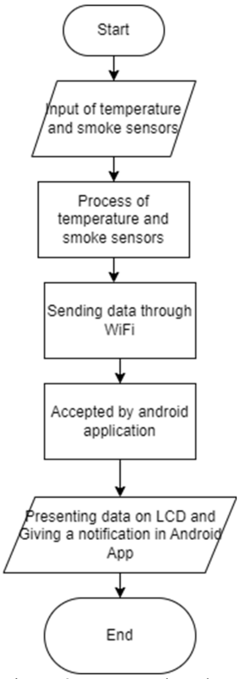

Figure 2. System Flowchart

Figure 2 describes the design of system flowchart. First, input temperature sensor DHT22 and smoke sensor MQ2. Second, process temperature and smoke sensor. Third, sending data via WiFi and received by android application module. Finally, display data on LCD and android app notifications.

C. Hardware Planning

As shown in the Figure 3 the mechanical design of a room in which the system will be placed. In each room there will be two types of sensors, namely the DHT22 temperature sensor and the MQ2 smoke sensor. Each node will contain a pair of these sensors.

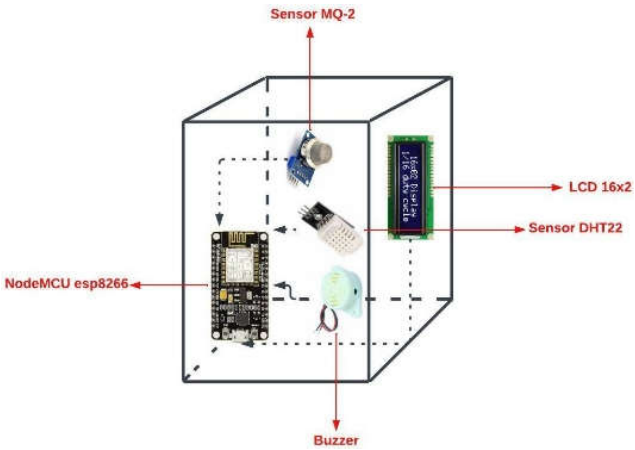

Figure 3. Hardware Design

In the hardware planning in Figure 4 shows the circuit of the components used in for the hardware. The components contained by NodeMCU, DHT22 sensor, MQ2 sensor, Buzzer, LCD 12x6, 18650 Battery x2.

The tool works if the sensors catch the change of temperature and the high rate of the smoke then the data will be sent to NodeMCU. The LCD will show the value of sensors and followed by warnings if the temperature and smoke rate are high.

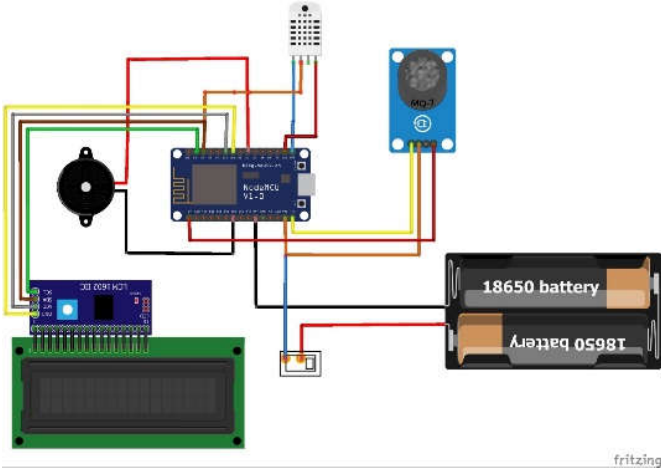

Figure 4. Wiring Hardware

D. Software Planning

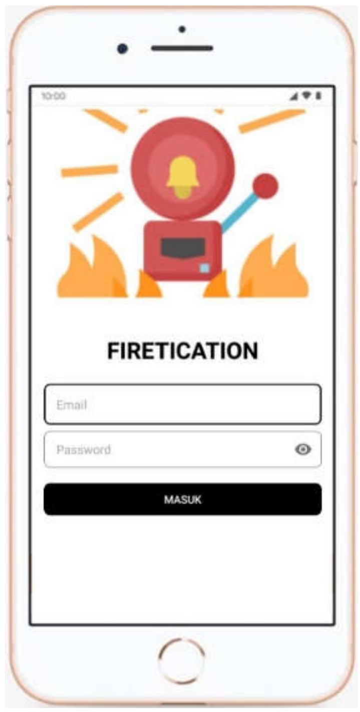

Figure 5. App Planning

Figure 5 shows the design of the application that is made for "Automatic Early Warning System Design Of A Synchronized Fire System Based On The Internet Of Things (IOT)" Figur 5 is the login page of the Firetication. Firetication is the name of the app. This app will be included by some features which are the real time of the warehouse and the notifications which can leads the user in to the location of the warehouses via Google Maps.

III. RESULTS AND DISCUSSION

A. Hardware Circuit Result

The selected components are then implemented in the form of a series of devices connected to the Node MCU microcontroller. The results of the implementation will be shown in Figure 6 below.

Figure 6. Hardware Result (Outside)

As shown in Figure 6. the components used are the DHT22 sensor as a temperature detector, the MQ2 sensor as a smoke detector, LCD as an information display and a buzzer that will sound when there is a notification. All these components are connected to the NodeMCU esp8266 microcontroller as the main controller.

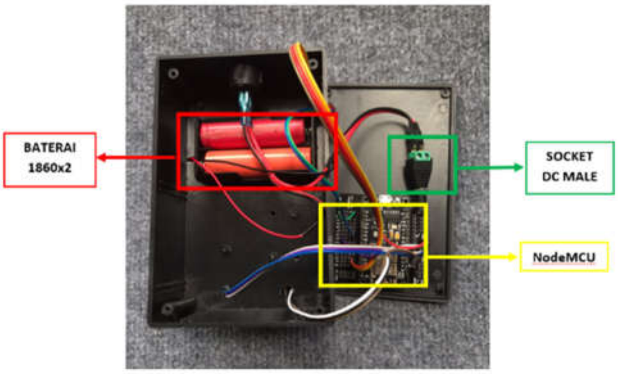

Figure 7. Hardware Result (Inside)

Figure 4.2 is an inside view of the Internet of Things (IoT)-based automatic early warning system design tool for synchronized firefighting. The components used are 2 18650 batteries as a power supply, NodeMCU esp8266 as the main controller and Socket DC male as a liaison between the NodeMCU and the power supply or battery

B. Software Result

This section will explain the results of the notification experiment in every circumstance. There are 3 notifications namely "CO gas detected excessive" with parameters when smoke is detected ≥ 100 PPM and temperature ≥ 25°C, "warehouse temperature is too hot" with parameter if smoke is detected ≥ 500 PPM and temperature ≥ 35°C and "indicated fire" with parameter if smoke detected ≥ 1500 PPM and temperature ≥ 40°C.

Figure 8. "High Smoke Rate detected" Notification

The detail of measurement is shown in Table 1.

TABLE 1
THE TESULT OF "HIGH SMOKE RATE DETECTED" NOTIFICATION

Number of Test	Degree	PPM	Status	Condition
1.	30.6	141.53	Watch out	Smoky
2.	29	129.17	Watch out	Smoky
3.	30	2230.25	Watch out	Smoky
4.	28.9	223.60	Watch oud	Smoky
5.	41 .4	112.42	Watch out	Hot
6.	29	118.53	Watch out	Smoky
7.	29.5	261.36	Watch out	Smoky
8.	30.1	173.38	Watch out	Smoky
9.	31.9	153.10	Watch out	Smoky
10.	34.9	115.54	Watch oud	Smoky

At level 2 notification the status in the warehouse is Caution and the condition is hot because the measured temperature value has exceeded the threshold value that has been determined, therefore the condition of the warehouse is declared hot, as shown in Fig. 9. The temperature reaches 38.5°C which is over the threshold for level 2 notifications, so that value triggers notifications on application. The detail of measurement is shown in Table 2.

TABLE 2
THE RESULT OF "THE WAREHOUSE IS TOO HOT" NOTIFICATION TEST

Number of Test	Degree	PPM	Status	Condition
1.	38.5	1172.90	Watch out	Hot
2.	36.3	1129.17	Watch out	Hot
3.	36	1130.25	Watch out	Hot
4.	37.9	920.60	Watch out	Hot
5.	39.4	932.12	Watch out	Hot
6.	39	918.53	Watch out	Hot
7.	39.5	761.36	Watch out	Hot
8.	36.1	1123.21	Watch out	Hot
9.	37.9	552.30	Watch out	Hot
10.	37.9	615.54	Watch out	Hot

Figure 9. "The warehouse is too hot" Notification

Fig. 10 shows at level 3 notification, the user can access the location of the warehouse indicated by the fire via a link that is connected to google maps so that the firefighters can go directly to the location of the warehouse indicated by the fire.

Figure 10. "There's fire indicated" Notification

The detail of measurement is shown in Table 3.

TABLE 2
THE RESULT OF "THERE'S FIRE INDICATED" NOTIFICATION TEST

Number of Test	Degree	PPM	Status	Condition
1.	41.5	1672.42	Emergency	Danger
2.	41.3	3129.72	Emergency	Danger
3.	42	2130.25	Emergency	Danger
4.	41.9	920.60	Emergency	Danger
5.	41.4	1932.12	Emergency	Danger
6.	41	8531.22	Emergency	Danger
7.	41.5	7161.36	Emergency	Danger
8.	40.1	1923.21	Emergency	Danger
9.	41.9	5152.10	Emergency	Danger
10.	41.9	2615.32	Emergency	Danger

C. *QoS Measurement*

The parameter for testing the success rate of data transmission used is Qos (Quality of Service), including Packet Loss, Delay and Throughput.

Delay or Latency is the time it takes for data to travel the distance from the source / sender to the destination or receiver. Delay can be affected by distance, physical media and long processing times or congestion. The delay measurement is shown at Table 4.

TABLE 3
DELAY

No	Source	Destination	Delay (S)
1	192.168.137.9	169.254.139.102	0,199474
2	192.168.137.9	169.254.139.102	0,181818
3	192.168.137.9	169.254.139.102	0,194737
4	192.168.137.9	169.254.139.102	0,190955
5	192.168.137.9	169.254.139.102	0,196296
6	192.168.137.9	169.254.139.102	0,184804
7	192.168.137.9	169.254.139.102	0,183251
8	192.168.137.9	169.254.139.102	0,187437
9	192.168.137.9	169.254.139.102	0,174272
10	192.168.137.9	169.254.139.102	0,192893
Rata – rata			0.188594

Table 4 depicts the calculation of the resulting packet - the average delay obtained is 0.188594 seconds or 188ms and is included in the good category according to ITU-T G.114. The smaller the delay, the better the quality of a data transmission because there will be no information delay.

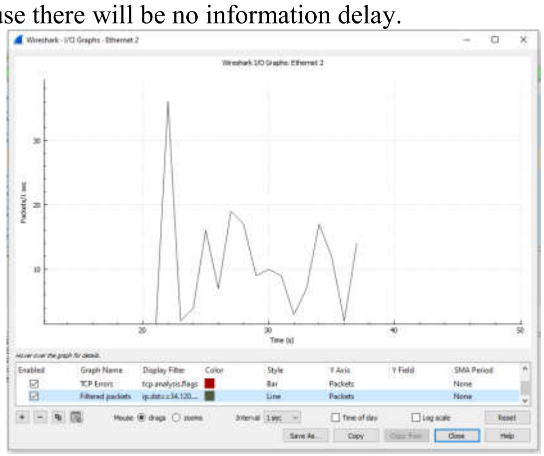

Figure 11. I/O Graph

Packet Loss is a parameter to describe lost packets, this can be affected by congestion on the network. The following is a brief procedure for calculating packet loss, as shown in Fig. 11 and Fig. 12.

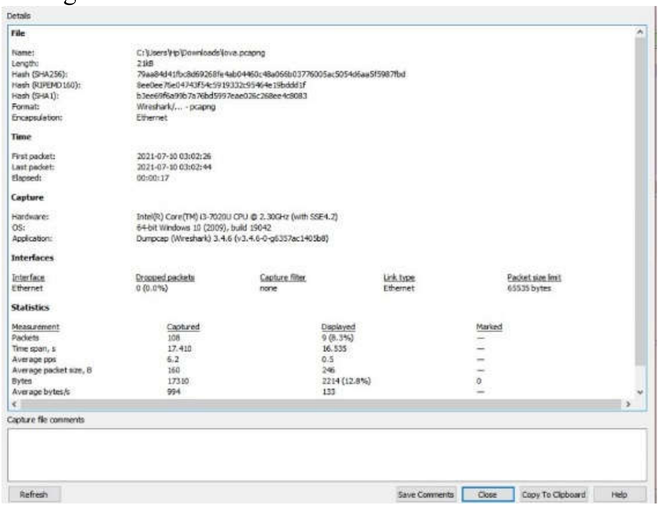

Figure 12. Capture File Properties

The test results obtained that the number of packets that were successfully sent was 190 and the packets that were not successfully received by server 21. So that the packets that were successfully received by the server were 3,348 packets. To calculate the value of packet loss using the following formula:

$$Packet\ loss = \frac{(Data\ packet\ sent - data\ packet\ received)}{(Data\ Packet\ Sent)}$$

$$Packet\ Loss\ (\%) = \frac{9}{108} x100\% = 8.3\ \%$$

IV. CONCLUSION

An early warning system designed with DHT22 and MQ2 sensors and integrated with NodeMCU esp8266 into an android application that can send notifications in real time according to a predetermined level can work well. The application is built using android studio which is connected to the Firebase Database so that the data displayed is realtime data. The microcontroller as the main controller is connected and sends data to the application using firebase. The design of the fire early warning system succeeded in sending 3 levels of notification, namely an indication of excessive CO gas, too hot warehouse temperature and an indication of fire. The first level is sent when the temperature is 25-30°C and the gas content is 100 PPM. For level 2 the parameters determined are the temperature, which is 35°C and gas content 500 PPM and for level 3, the temperature is 40°C and gas content is 1500 PPM. %. With this tool, it can make it easier for warehouse owners and DamKar officers to anticipate and prevent warehouse fires so that fires can be avoided as early as possible. Quality of System testing in the Design of an Internet of Things (IoT)-based Automatic Early Warning System for Synchronized Fires is carried out by finding the Delay and Packet Loss values. From the tests carried out, the average delay value is 0.188594, which is in the good category according to ITU-T G.114. And for packet loss testing, the packets that were successfully sent were 190 and the packets that were not successfully received by server 21. So that the packets that were successfully received by the server were 3,348 packets, with this value the packet loss value was 8.3%. The implementation of IoT applications for monitoring and controlling temperature, humidity and gas in the training room is intended to increase the sense of security by implementing means to detect and monitor warehouse space.

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