Smart Warning System Using SIM800L and ESP32

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Abstract. Temperature affects to quality of the food stored. For that, it needs a refrigerator which can store food to preserve the food. From the survey at Food & Beverage store, to make sure a refrigerator operate at proper temperature, the temperature measurement must be conducted regularly every day and it can take quite a bit of time. However sometimes this measurement not done regularly cause of load of the crew. Therefore, the Smart Temperature Warning System using SIM800L and ESP32 is important to help crew to measure the temperature of refrigerator automatically, compare it with threshold temperature and give a warning in sound and notification via email and SMS when the measured temperature is not appropriate with the reference temperature. Using this Smart Warning System at F&B stores can maintain food quality and increase crew efficiency and also can alarm if any error with freezer temperature. The result is system will operate 24 hours and will alarm if any temperature error without any crew intervention.

Keywords: Temperature, Refrigerator, Warning System, Refrigerator, Email, SMS

1. Introduction

The Smart Warning System is intended to help daily operational activities both at industrial and household scale, such as measuring, comparing the temperature in the freezer and alarm if any problem with temperature. Maintaining the temperature stability of the freezer and therefore keep the quality of food ingredients in good condition. [1]

The system is built to check temperature conditions in the refrigerator and help daily operational activities at an industrial scale, such as measuring temperature, and sending a warning if temperature in the refrigerator does not match with temperature of standard food storage. So this system can maintain the quality of food ingredients in good conditions. [2]

Temperature is a critical part of maintaining food quality [3]. Some food items will spoil quickly if stored at ordinary temperatures where bacteria will grow rapidly [4]. The refrigerator will produce and maintain the temperature in the reference room so that it slows down the growth of bacteria, so food can last a long time [4]. The presence of destructive bacteria is harmful to human health. Evidence shows that more than 70% of cases of food poisoning occur due to poor food storage that gives the potential for the development of microorganisms [3].

The use of a refrigerator for food is to maintain the freshness of food ingredients during storage, this is because food storage is intended to prevent the growth of bacteria, fungi, and other microorganisms [5]. But it's not just preserving food, the refrigerator also plays a role in determining
the taste and texture of stored food. Foods that are preserved by freezing can have a similar quality to fresh food [4].

To make sure refrigerator work properly Alternatively, one can create an alarm system so that the crew knows when to measure the freezer temperature while he is busy working on his job and doesn’t miss the timing to measure it

2. Methodology
The Smart Temperature Warning System will monitor the temperature and provide alerts in the form of sounds and notifications via email and SMS when the measured temperature does not match the standard desired by the user. This warning system, using ESP32 – which is a low cost Microcontroller that include WIFI to connect to the network. Also easily to connect to other device to create IOT application. [6]

As shown in the block diagram Figure 1. System Block Diagram, the system is processed by the ESP32 microcontroller that include WIFI. The microcontroller will receive input from the DS18B20 temperature sensor [7, 8]. Then as the system output is the OLED SSD1306, buzzer, SIM800L module. The output of system has a role to display temperature, Sound alert, and GSM transmitter.

![Figure 1. System Block Diagram](image)

ESP32 act as a Microcontroller that capture input from sensor, calculate the input and send a response to output device.[6]. The LM7805 regulator produce 5 Volts to supply voltage to the microcontroller, this makes the microcontroller operate and provide a VCC voltage of 3.3 volts to the system input and output.

Sensor temperature required in the system to get the refrigerator temperature. System uses a temperature sensor DS18B20 that have several characteristics like being waterproof, temperatures measured range from -55 °C to +125 °C, and operates at a voltage of 3 to 5.5 volts.
The temperature will be displayed using OLED SSD1306 with 4 pins (VCC, ground, SDA and SCL). Through the I2C communication protocol, SDA and SCL OLED pins will be connected to the microcontrollers SCL D22 and SDA D21 pins.

A function warning system – microcontroller captures and compute the temperature with standard given – it will then inform the user if the temperature of the refrigerator does not match with temperature reference. This warning system using buzzer that produce sound to attract attention. Modul SIM800L to send warning via SMS (Short Message Service). The microcontroller will give an order to SIM800L as the GSM module to send an SMS to the user's number.[9] Another warning system send by Email, warning statement will be sent using ESP32 to the Clients Mail using SMTP Servers.[6]

Figure 2. Application Flow Diagram

Figure 2. Application Flow Diagram, shows a flow diagram of the warning system on ESP32, after the Process Initializes, ESP32 will trigger the module temperature sensor DSB1820 to capture the temperature and display the temperature to OLED SSD1306.

After displaying the temperature at OLED SSD1306, microcontroller will compare the temperature with the threshold temperature that has been set in the program for the maximum and minimum temperatures according to the desired reference temperatures for maintain food safety.
If the temperature is between the reference temperature, the system will wait for x second, then the process will return to the iterative process such as temperature taking using DSB1820, temperature display on the OLED SSD1306, and subsequently checking the temperature results according to the threshold temperature.

On the other hand, once the temperature measurement does not match to the threshold temperature, the system will create a notification using communication protocol SMS (Short Message Service) and Email communication protocol. Next the system will sound the buzzer for 30 minutes then proceed to the looping process again, starting from taking the temperature.

If the system in a warning function, the system will sound a buzzer, system will have a button that will mute the sound from the buzzer for up to 5 minutes from the first sound of the buzzer.

The system will continue loop the process, starts from taking temperature data, displaying it and compare the temperature capture with reference and initiate the warning function.

When sending warning temperature data to SMTP Mail using the internet, System (ESP32) will start from checking the WIFI connection, if the system is not connected to the internet, the system will wait until it is connected. After that the system will send warning to recipient mail, and also send SMS warning using GSM module.

3. Results

![Figure 3. Device Temperature Monitoring & Alarm](image-url)

The physical of the systems is shown in Figure 3. Device Temperature Monitoring & Alarm. This temperature warning device is designed as small as possible so that it can be placed in a small place. The cable from the main system to the temperature sensor is made long enough to facilitate installation.

The application at microcontroller ESP32 will run and monitor temperature that is captured from DS18B20, compare it with temperature threshold, initiate warning function by activate buzzer, send temperature warning using WIFI to mail recipient, and also send Short Message Service to phone number specified in the system.
Table 1. Temperature Measurement

| ID  | Temp (°C) | Time (WIB)    | SMS Alert | E-mail Alert |
|-----|-----------|---------------|-----------|--------------|
| 1544| -8.56     | 6/27/2019 14:57 | No        | No           |
| 1545| -9.75     | 6/27/2019 15:01 | No        | No           |
| 1546| -3.52     | 6/27/2019 15:06 | No        | No           |
| 1547| -9.45     | 6/27/2019 15:10 | No        | No           |
| 1548| -10.69    | 6/27/2019 15:14 | No        | No           |
| 1549| 0.33      | 6/27/2019 15:19 | Yes       | Yes          |
| 1550| 3.88      | 6/27/2019 15:24 | Yes       | Yes          |
| 1551| -3.29     | 6/27/2019 15:28 | No        | No           |
| 1552| -4.41     | 6/27/2019 15:33 | No        | No           |
| 1553| -3.35     | 6/27/2019 15:37 | No        | No           |
| 1554| -5.78     | 6/27/2019 15:42 | No        | No           |
| 1555| -7.2      | 6/27/2019 15:46 | No        | No           |

As shown in Table 1. Temperature Measurement. System automatically capture temperature with internal 5 second. Show temperature error at 15:19 and 15:24 on 27 June 2019.

For warning system, Protocol SMTP will be used to send email with warning message from system to mail respondent that is set up at the system.[10,11]

Figure 4, displays email that is sent to recipient mail, the receiving time almost same with mail send by system. And Figure 5 displays SMS warning that is sent by the system using SIM800L. Email dan SMS send after the system found non-matching temperature between the captured value and threshold.

Figure 4. Email Alert Send by Systems
4. Conclusion

Smart Temperature Warning Systems captures the temperature of the refrigerator, compare it with threshold temperature, initiate warning function by sending SMS and email and will also activate sound alarm, it can help an operational Refrigerator healthy, to maintain food fresh and safe for consuming.

The system can operate 24 hours and can send a warning when the Refrigerator is not in a good operational condition, so the user knows instantly if there is something wrong with the refrigerator temperature.

To enhance this warning system, the next step the system can take is sending notification using other messaging systems like WhatsApp and also save captured temperature data so that those data can be used to create preventive maintenance before the refrigerator is in disrepair condition.

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