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Smart Temperature Monitoring System Using ESP32 and DS18B20

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Smart Temperature Monitoring System Using ESP32 and DS18B20

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Abstract. Temperature has a big effect on food quality. Storing raw food materials in the freezer can maintain food quality in good condition. In F&B stores, freezer conditions need to be ensured to work well in a certain temperature range, for that it is necessary to automatically measure the freezer temperature regularly, which will take time to measure, to increase crew efficiency. For this reason, the automatic freezer temperature measurement system is important to reduce crew workload in measuring freezer temperature. In this Research, Smart temperature measurement using the ESP32 is used in monitoring the performance of the freezer, measuring the temperature continuously with a certain period and storing the measurement results and then compute them for preventive maintenance activities. Using this Smart Temperature Monitoring System at F&B stores can maintain food quality and increase crew efficiency and also can carry out preventive maintenance properly. The result will be displayed in a regular measurement of temperature in the freezer over 24 hours a day.

Keywords : ESP32, Smart, Temperature, Monitoring, Freezer

1. Introduction

The Temperature Monitoring system is intended to help daily operational activities both at industrial and household scale, such as monitoring, measuring, recording the temperature in the freezer. Maintaining the temperature stability of the freezer and therefore keep the quality of food ingredients in good condition. [1]

Temperature control is very important in food quality as shown by the research done by J. A. EVANS [2]. Some foodstuffs will decompose faster when stored at ordinary temperatures, where bacteria will grow quickly. The Freezer will produce a temperature that makes bacterial growth very slow, so that food can last a long time [3]. The presence of bacteria is very dangerous for human health [4]. Evidence shows that more than 70% of cases of food poisoning occurs because the food is in a bad condition which has the potential for the growth of microorganisms [2].

The use of a freezer for food is to preserve food ingredients for use in the future. This is because food storage also prevents the growth of bacteria, fungi, and others [4]. But not just preserving food, freezers also play a role in the taste and texture of stored food. Cooling food can make some foods taste better like chilled fruit and drinks [1].

There are several types of freezers depending on the desired temperature requirements according to the food items to be stored. Freezers for food can function as freezers, freezers, chillers [3]. 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 Temperature Monitoring System will monitor the temperature and provide alerts in the form of sounds when the measured temperature does not match the standard desired by the user. As shown in the block diagram Figure 1, the system is processed by the ESP32 microcontroller and the Wi-Fi Module[5]. The microcontroller will receive input from the DS18B20 temperature sensor [6],[7],[8]. Then the microcontroller will output temperature data to the OLED SSD1306, buzzer, and the system cloud as a storage area for temperature data.

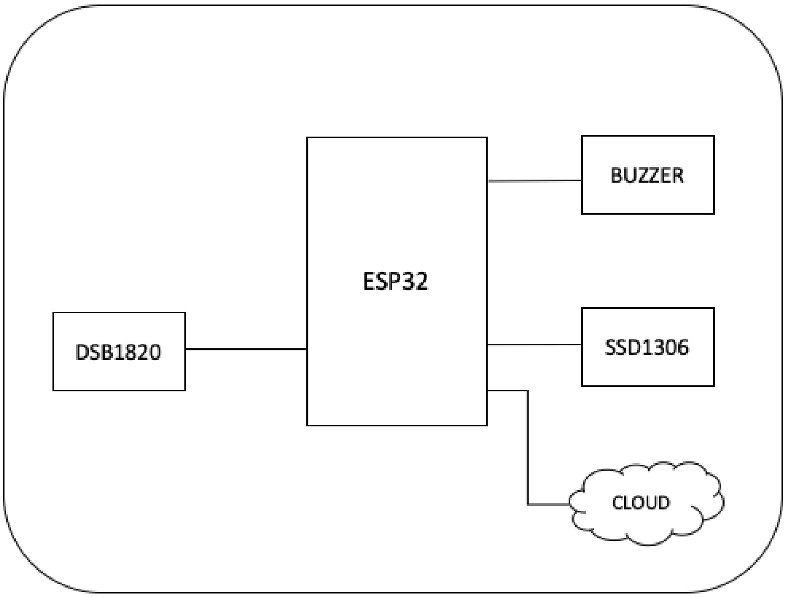

Figure 1. System Block Diagram

The LM7805 regulator is used to produce an output of 5 volts into the microcontroller input voltage, so that the microcontroller can operate and provide a VCC voltage of 3.3 volts to the input and output used by the system. To get the desired freezer temperature when storing food, system uses a temperature sensor type DS18B20 which is waterproof and has a range of temperatures measures from -55 ^{0}C to +125 ^{0}C, and operates at a voltage of 3 to 5.5 volts.

The temperature will be displayed in text and numeric form via the OLED SSD1306 [9]. OLED SSD1306 has 4 pins, namely VCC, ground, SDA, and SCL. Through the I2C communication line, SDA and SCL OLED pins will be connected to the SDA D21 and SCL D22 microcontroller.

A warning function is given by the system – which measures the temperature and compares with a given standard – to inform the user that the temperature of the freezer does not match the reference temperature. One of these warnings is the sound, where the buzzer is the component that makes the sound. The captured temperature will be sent to cloud data, ESP32 is IoT controller possessing Bluetooth and WiFi with Low Energy capabilities and compatible with Arduino Core

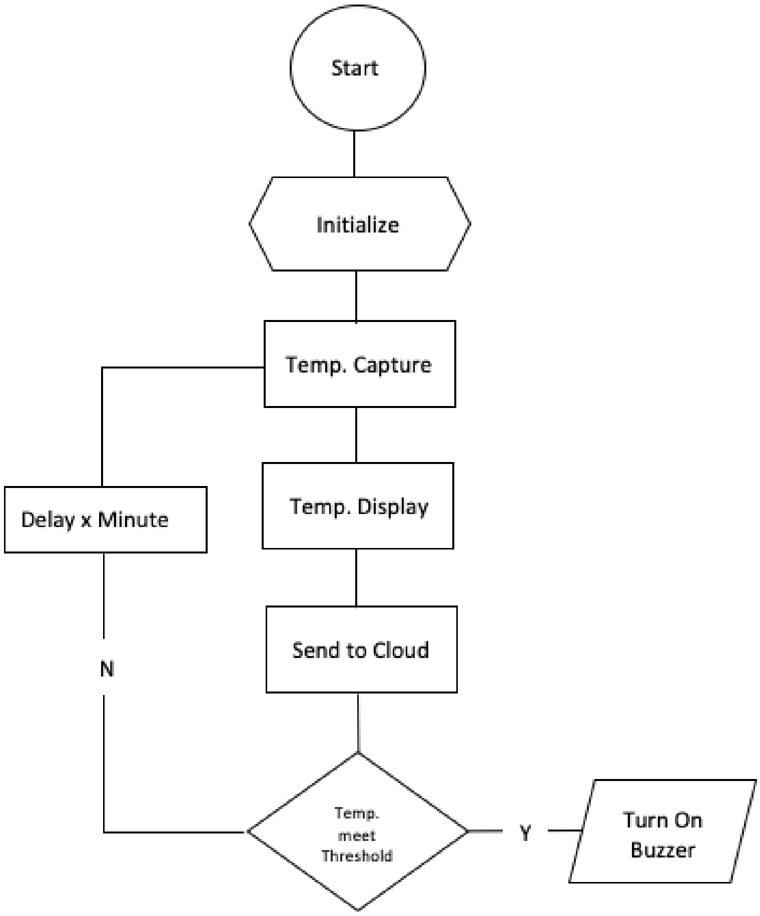

Figure. 2. Software Flow Diagram

Figure 2 shows the flow diagram of the whole system on ESP32 after the Initialize process, ESP32 triggered module temperature sensor DS1820 to capture the temperature data and display the temperature at OLED SSD1306.

After the temperature is displayed, ESP32 will send temperature data to the cloud using WIFI that is connected to WIFI Access Point. After that the temperature will be compared with the threshold temperature that has been set in the program for the maximum and minimum temperatures according to the desired reference. In this program the threshold will be set at maximum 0 ^{0}C and minimum -5 ^{0}C.

If the temperature is between the reference temperature, the system will wait for 15 minutes, then the process will return to the iterative process: taking the temperature, displaying the temperature on the OLED, sending the temperature to the database, then compare the temperature to the threshold temperature

However, when the temperature measurement does not match the threshold temperature, the system will activate the warning function which activates the buzzer for 15 minutes and then proceed to the looping process starting from taking the temperature. The buzzer will continue to be active when the temperature is outside the threshold and will only stop when the temperature results match the reference temperature for the freezer.

If the system is in a warning function, the system will sound a buzzer. There is a button that will mute the sound from the buzzer for up to 15 minutes from the first sound of the buzzer. For example, when the buzzer sound has been going on for one minute and then the button is pressed, the system will turn off the buzzer sound for the remaining 14 minutes until the looping process.

The system looping process starts from taking temperature data, displaying it and sending it to the database, and checking whether the temperature matches the reference temperature or not for activating the warning function.

To send temperature data to the database using the internet, the system (ESP32) will start from checking the if WIFI connection is already connected to the system or not, if the system is not connected to the internet, the system will continue to wait until it is connected. Then if it is connected to the database, the system will make a request to PHPMyAdmin to send the PHPMyAdmin temperature which can be opened via web hosting. The incoming temperature data will continue to be visible in the database in the form of a table whose rows continue to grow.

3. **Results**

Figure 3. Device Temperature Monitoring

This temperature measuring device shown in figure 3 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 Controller ESP32 will run and monitor temperature that is captured from DS18B20, compare it with the temperature threshold and send the temperature data using WiFi to the database. It will also send a Short Message Service to phone number specified in the system and activates the buzzer if a problem occur. The temperature captured will be submitted to cloud database to make record of temperature and the data will be submitted using WIFI.

The temperature sensor must be calibrated to make sure that the captured temperature is valid. Data testing begins with taking the temperature from our device and a calibrated thermometer with an accuracy of 0.1^0C for iced water. This calibration will capture the temperature from 0^0C to 5^0C as much as 20 times for every 1^0C. From the data that has been collected, the difference is then taken as a comparison between the system temperature sensor and the standard thermometer.

After that, the average temperature results, taken per degree from 0^0C to 5^0C between the temperature of our system and from the digital thermometer, will be collected and then input into the linear regression line equation.

From the results, the deviation equation will be obtained. It is from the deviation equation that we get a formula to apply the temperature calibration to our system. Only after that, we take the data back for temperatures 0c to 5c and then compare the difference to prove that the difference from the temperature taken after entering the formula is smaller than the difference between taking the temperature before calibration.

Figure 4 displays data capture using graphics. In this picture, we can analyze that there is some spike in temperature. The average temperature is below -10°C , but sometimes the freezer temperature is 0^0C, this indicates that something is wrong with the freezer temperature.

With this data, we can analyze and take preventive action before this Freezer stops functioning. One of the factors that influence the temperature increase is when the freezer door is not closed tightly and when freezer door is open for too long.

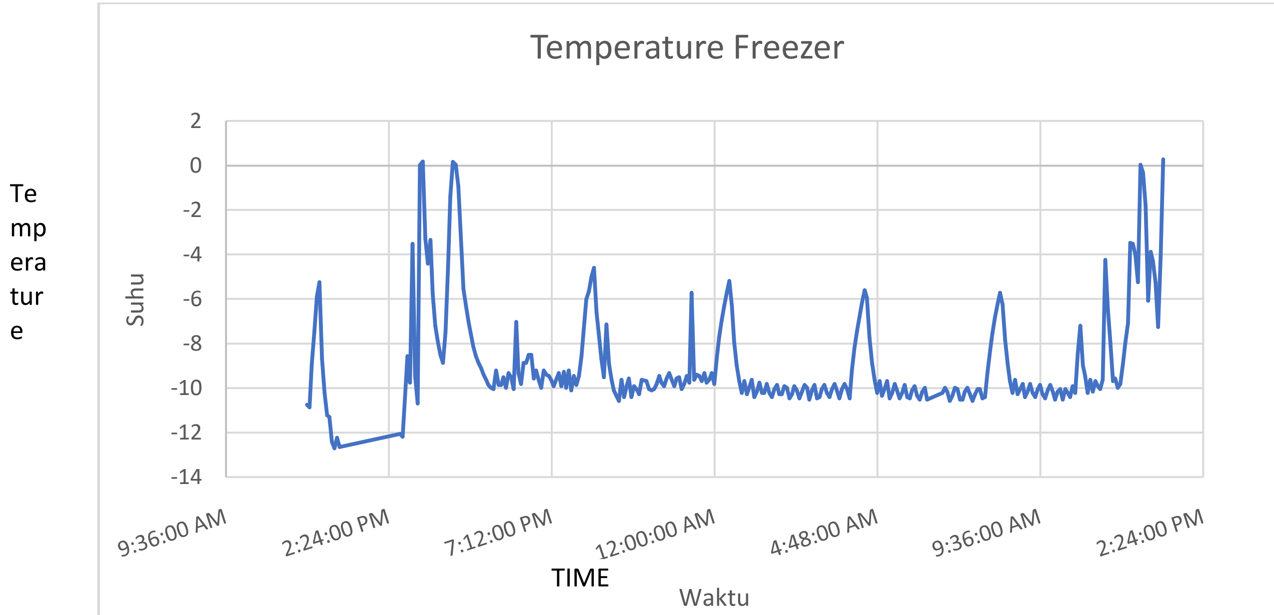

Figure 4. Temperature Capture Graphic

4. Conclusion

Using Temperature Monitoring Systems to record the temperature of the freezer, capture data, then sending it to the cloud database using Communication Data and also initiate a warning by using an alarm can help an operational Freezer healthy, so it can keep food fresh dan safe for consuming.

We can also view the operation of the Freezer in term of temperature 24 hours using a graphic, so the user can predict problems that occurs based on the history of temperature capture. The user can also start a maintenance process before the freezer is totally damaged and stops functioning.

To enhance this Monitoring system, the next step that can be taken can be something like sending a notification using other messaging systems like SMS, Email or Whatsapp.

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