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Monitoring Heart Rate And Temperature Based On Internet Of Things

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Abstract- **Monitoring and measurement of body temperature is very important to know the condition of the patient. The body temperature is associated with a number of the human heartbeat, little change in body temperature can significantly affect the performance of high cardiac health problems this causes the need for health monitoring. IoT helps to move from manual heart rate monitoring system for heart rate monitoring system remotely. The purpose of this study is to develop the monitoring heart rate and temperature-based Internet of Things. This tool can see the dawn of the body and the value of BPM from a distance. The way the device is very simple to use cardiac leads in Lead II to obtain the value of BPM and DS18B20 temperature sensor to measure the body temperature will be displayed on Thing-Speak through the ESP32 module.**

Keyword-Internet of Things, ESP32, Thingspeak

I. Introduction

Monitoring and measurement of body temperature are very important to know the condition of the patient. A healthy body is able to maintain a constant body temperature even if the environmental conditions change. The body temperature was associated with a number of the human heartbeat, little change in body temperature can significantly affect the performance of the heart because the farther the patient's normal temperature affect how quickly the patient's heart in pumping blood around the body[1].

At this time, health problems such as heart failure, and heart-related diseases are increasing day by day. The high concerns about heart health have led to the need for health monitoring, especially in the cardiac activity itself[2].

This heart disease requires ongoing monitoring and long term to have proper controls against him. IoT helps to move from manual heart rate monitoring system for heart rate monitoring system remotely. A doctor may not always be present at all times to provide treatment or care to the patient or guardian can not be present all the time to bring the patient to the hospital. Heart rate monitoring system used to remotely monitor physical parameters such as heart rate and heart rate were measured sent directly to the doctor[2].

Monitoring BPM (Beat Per Minute) or Heart Rate and Temperature is monitoring the patient's condition are continuously helping medical personnel to monitor the development of the patient's condition. BPM or Heart Rate is a unit to count the number of heartbeats per unit of minutes while the body temperature is the difference between the amount of heat produced by the body and the amount of heat lost to the environment.

IoT first raised by Kevin Ashton in 1999 in one presentation. Many are predicting that the influence of the Internet of Things is "the next big thing" in the world of information technology, as in the IoT devices can transmit their data directly to the server cloud that can then be analyzed/processed by the account owner can then be distributed to media and communication Internet connected to the IoT. As well as two-way communication can occur between devices, users, and between devices with the user. Internet of Things in implementation will also be able to identify, locate, track, monitor objects and trigger the corresponding event automatically and in real-time. As an example of its application in the medical field[3].

In a previous study of this tool ever made by Nur Hudatu Munawaroh entitled "Temperature Monitoring with Chart View on the PC". which is capable of monitoring the patient's body temperature. However, this tool is still not there BPM parameter. It had also created a monitoring tool BPM and body temperature by I Dewa Made and Putu Adi. Both tools use the android interface. In 2016 developed again by Nadya Nezwa Damayanti entitled "BPM and Temperature Wireless Monitoring". That adds a nurse call using the display on the PC.

With the description above, the writer intends to make an appliance-based IOT as a display of heart rate and body temperature for continuous monitoring, easier for nurses to monitor without having to visit a patient, helping specialists to access the data in real-time from anywhere and can discuss the results of such data with other specialists. The data will be displayed on the website. With the hope to be monitored through the system without using a wireless or wired media as data delivery. It is expected that the patient's condition can be monitored directly (online), through the website so that the data in heart rate and body temperature of the patient's health can be monitored at any time. IoT-based system so that the distance is not an obstacle in the monitoring process.

II. Material and Methods

A. Experimental Settings

This study uses ten normal subjects. The subject has taken randomly and data collection was repeated 5 times.

1) Materials and Tools

This study using electrodes. Instrumentation ECG built by LM324 OP-AMP. Microcontroller ESP32 used for ECG data acquisition and sensor DS18B20. A digital storage oscilloscope is used to test analog circuits. Phantom ECG is used to calibrate the analog circuit.

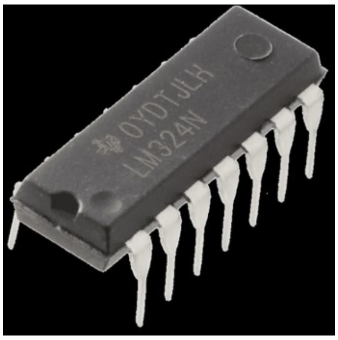

Fig. 1. IC LM324

Fig. 2. DS18B20 sensor

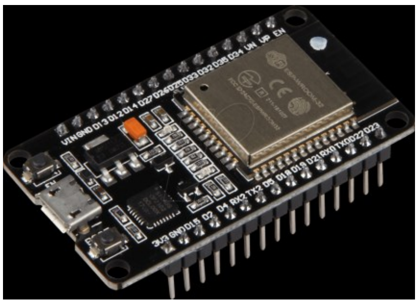

Fig. 3. ESP32 Node MCU

2) Experiment

In this study, after the design is completed then the frequency response of the device is tested using a generator function according to the specifications of the ECG signal. In the calibration phase, was tested using a simulator ECG Module (phantom) with all the range (30, 60, 120, 180, and 240 BPM). Each setting, Holter output is calculated to validate these results. Then the modules are tested on the human body.

B. Block Diagram

Electrodes attached to the patient and DS18B20 sensor paired in the armpits to detect the body temperature. Output signals from the electrode leads are leads II will enter into a series of instruments in order to get the ECG signal amplifier but still there is little noise and the signal. Then the output of the instrument amplifier into the HPF to be filtered and amplified in the non-inverting and filtered at LPF block further into the notch filter for a frequency of 50 Hz notch filter then enter the filter LPF in order to signal more clearly and there is no noise. From the LPF output back to the summing amplifier strengthened. The output of the summing amplifier entered on ESP32 ADC pin.

While the DS18B20 sensor output will go straight into the digital pin ESP32. ESP32 incoming data to be processed and shipped. The results can be seen in ThingSpeak when the temperature exceeds or BPM setting there will be a notification in the mail.

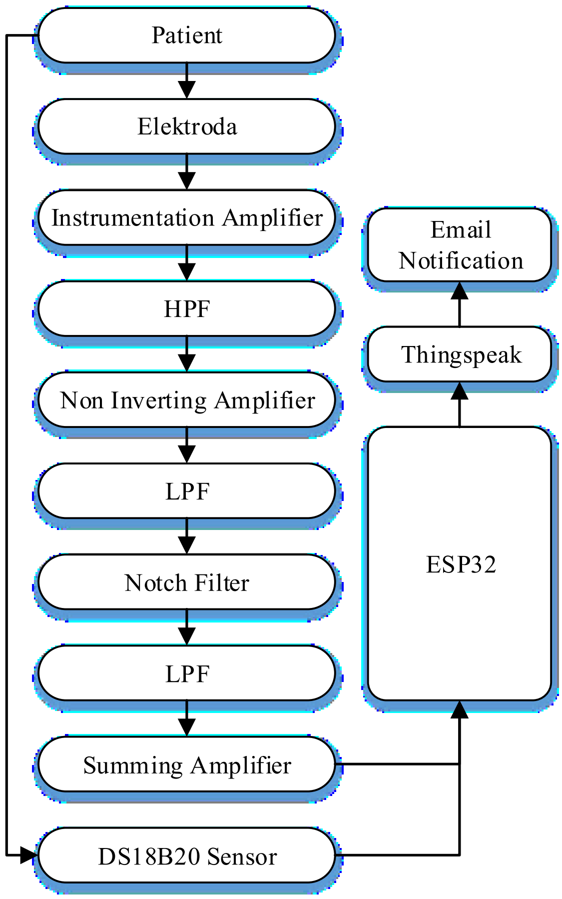

Fig. 4. Block diagram

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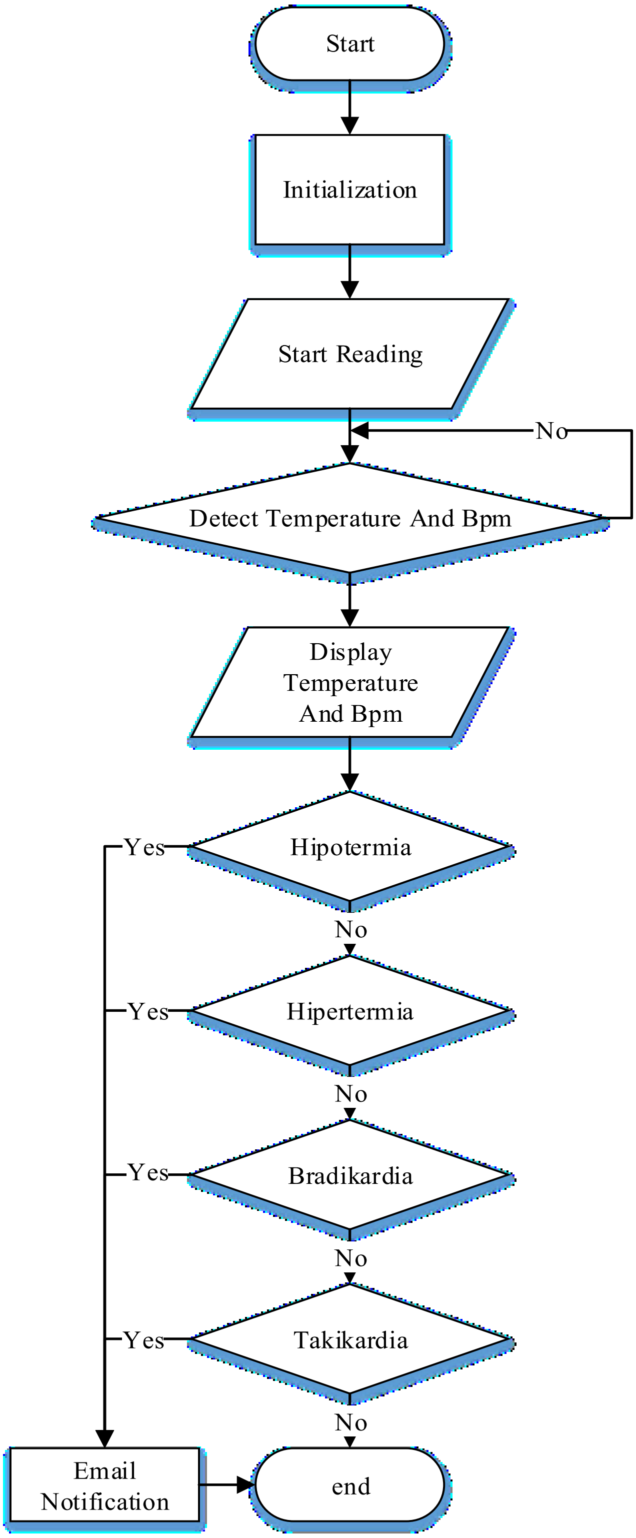

Fig. 5. Flowchart

The picture above is a flow diagram of the internet of things based heart rate and temperature monitoring module

C. Circuit

1) Instrumentation Amplifier

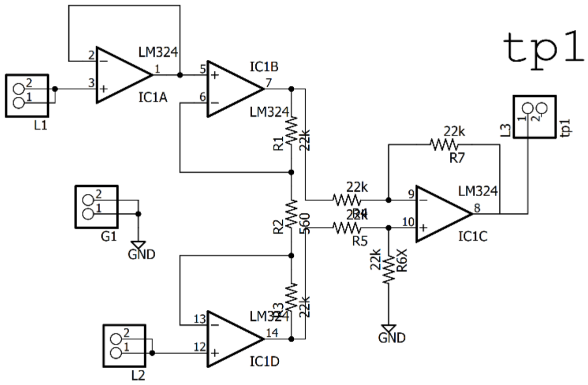

Fig. 6. Circuit instrumentation amplifier

Instrumentation amplifier circuit as shown above to get input from the lead electrodes attached to the right arm and left leg man.

2) High Pass Filter

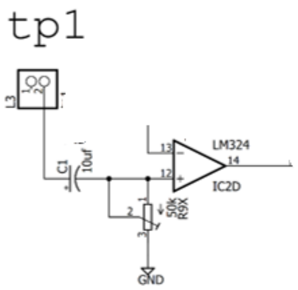

Fig. 7. *High Pass Filter*

Get input from the HPF circuit Instrument Amplifier. Minimum HPF cut-off frequency of 15.9 Hz and a maximum of 0.3 Hz.

3) Non-inverting Amplifier

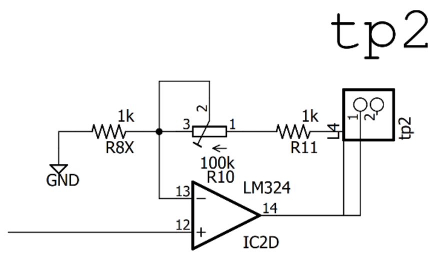

Fig. 8. Non-inverting amplifier

Non inverting amplifier circuit with a maximum gain of 101 times. By equation formula:

$$ACL = 1 + \frac{Rf}{Ra} \quad (1)$$

4) *Low Pass Filter I*

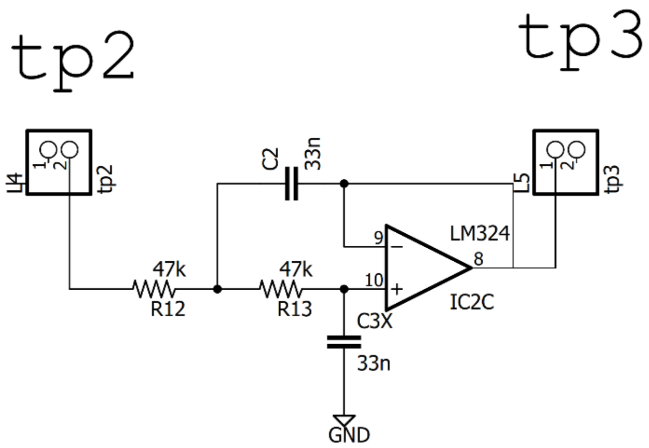

Fig. 9. Low Pass Filter I

LPF circuit gains non-inverting input of the circuit. LPF cut off frequency of 102.6 Hz. By equation formula:

$$Fc = \frac{1}{2\pi\, R\, C} \quad (2)$$

5) *Notch Filter*

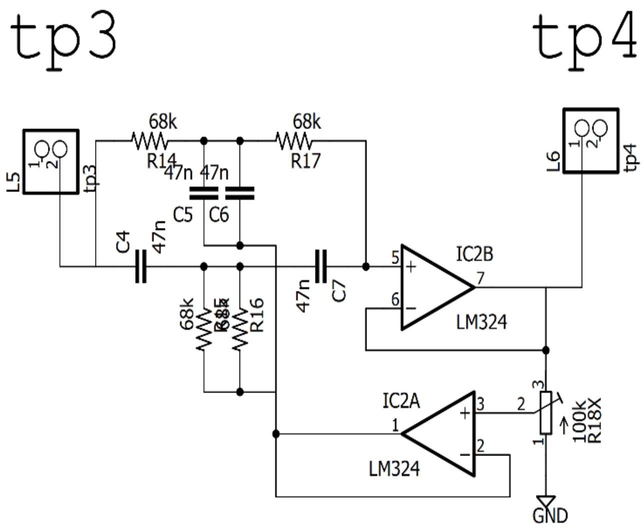

Fig. 10. Notch filter

Notch Filter circuit in the picture above using a cut-off frequency of 50 Hz. This circuit has characteristics hold signal with a frequency corresponding cut-off frequency and will pass signals outside the cut-off frequency.

6) *Low Pass Filter II*

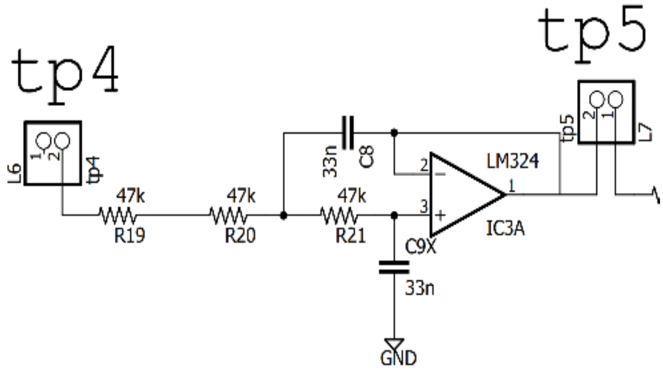

Fig. 11. Low Pass Filter II

LPF circuit gains non-inverting input of the circuit. LPF cut off a frequency of 71,1Hz.

$$Fc = \frac{1}{2\pi\, R\, C} \quad (3)$$

7) *Low Pass Filter III*

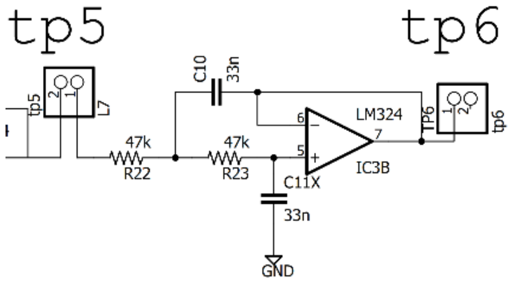

Fig. 12. Low Pass Filter III

LPF circuit gains non-inverting input of the circuit. LPF cut off frequency of 102.6 Hz.

8) *Summing Amplifier*

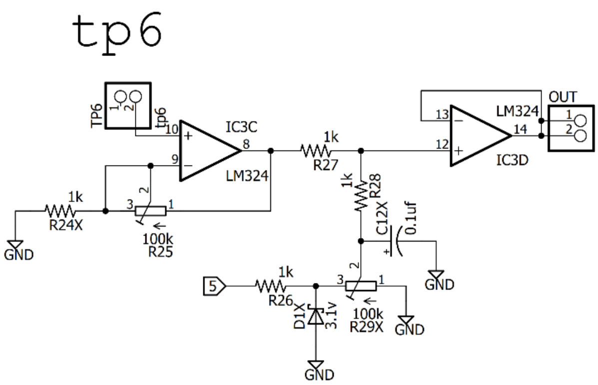

Fig. 13. Summing Amplifier

The summing Amplifier circuit is a circuit that serves to raise the ECG signal voltage levels, some of which rose to a positive ECG signal entirely.

9) The temperature sensor.

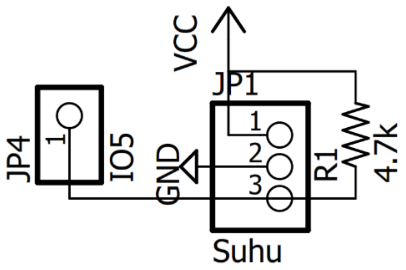

Fig. 14. Temperature Sensor Circuit

DS18B20 temperature sensor output digital form so that the sensor output is directly connected to digital pin ESP32.

III. RESULT

In this study, the Instrument has been tested using an ECG phantom, thermometer and ECG from the human body.

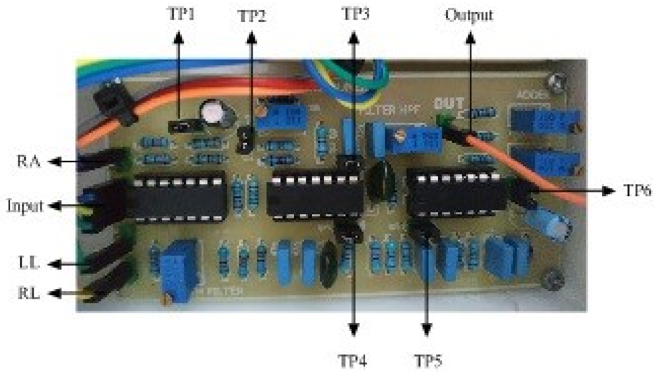

Fig. 15. Instrument ECG Design

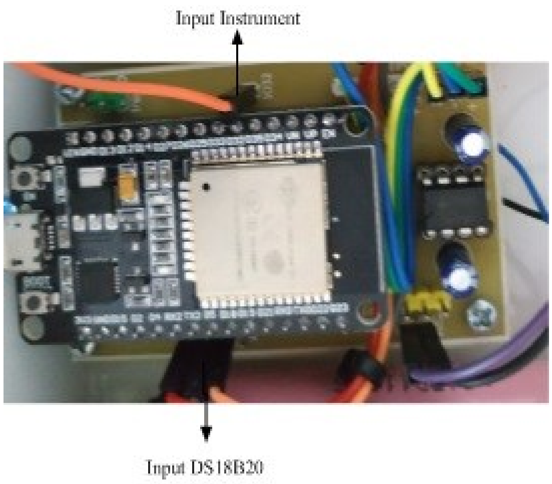

Fig. 16. ESP32 Design

1) Program for Arduino

2.1) Thingspeak initialization program

```
// Use this file to store all of the private credentials
// and connection details

#define SECRET_SSID "Miracle- "// replace MySSID
with your WiFi network name
#define SECRET_PASS "operator" // replace MyPassword
with your WiFi password

#define SECRET_CH_ID 632347    // replace 0000000
with your channel number
#define SECRET_WRITE_APIKEY
"O5WECCXIUNTZM201"   // replace XYZ with your
channel write API Key
```

On secret.h used to perform some of the settings of the WiFi channel number and write APIKEY to thingspeak account to connect with the channel to be used to enter the WiFi connection is used.

2.2) BPM readings program

```
void loop() {
//======== Autoreferensi ============
 //bacasuhu++;
 sinyal=analogRead(32);
 float tegangan = (sinyal / 4095 * 5);

 //=========REFERENSI BPM========
  if (ref <= tegangan) {
   ref = tegangan;
 }
 else {
   ref = ref;
   hold = (ref * 0.8);

   //======MONOSTABIL BPM======
if ((tegangan <= hold) && (logika_safety == 0))
    {
     waktu_safety = waktu_safety + 1;
     if (waktu_safety == 500)
     {
      waktu_safety = 0;
      logika_safety = 1;
      bpm = 0;
     }
    }
     if ((tegangan <= hold) && (logika_safety == 1)) {
      ref = 0;
      logika_safety = 0;
     }
     if (tegangan > hold) {
      waktu_safety = 0;
     }
```

```
   //======KETIKA TERDETEKSI PULSA ECG
NAIK=====
   if ((tegangan > hold) && (logika_detak == 0)) {
     logika_detak = 1;
   }

   //====KETIKA TERDETEKSI PULSA ECG
TURUN====
   if ((tegangan < hold) && (logika_detak == 1)) {
     detak++;
     digitalWrite(LED,HIGH);
     delay(5);
     digitalWrite(LED,LOW);
     delay(5);
     logika_detak = 0;
     if (detak == 1)
     {
       waktu = millis();
     }
     else if (detak == 5)
     { detak = 0;
       waktuBPM = millis() - waktu;
       bpm = 240000 / waktuBPM;
         sensor.requestTemperatures();
         temp = sensor.getTempCByIndex(0);
          }
}
}
```

Program arduino serves to calculate the BPM value of the ECG signal and turn on the LED as an indicator for measuring output rate and sensor DS18B20.

2.3) Thingspeak delivery program

```
 // Connect or reconnect to WiFi

   if(WiFi.status() != WL_CONNECTED)
   {
     Serial.print("Attempting to connect to SSID: ");
     Serial.println(SECRET_SSID);
     while(WiFi.status() != WL_CONNECTED)
     {
       WiFi.begin(ssid, pass);  // Connect to WPA/WPA2
 network. Change this line if using open or WEP network
       Serial.print(".");
       delay(5000);
     }
     Serial.println("\nConnected.");
   }
 //==== Waktu Upload Thingspeak ==========
   waktu2=millis()-waktusekarang2;
   if(waktu2>15000)
  {
   // set the fields with the values
   ThingSpeak.setField(1, temp);
   ThingSpeak.setField(2, bpm);
```

```
  // write to the ThingSpeak channel
  int x = ThingSpeak.writeFields(myChannelNumber,
myWriteAPIKey);
 if(x == 200)
  {
    Serial.println("Channel update successful.");
  }
  else
  {
    Serial.println("Problem updating channel. HTTP error
code " + String(x));
  }
   waktusekarang2=millis();
  }
}
```

Program arduino serves to adjust the data transmission to thingspeak.

2) Measurement results

TABEL.1 THE ERROR OF MEASUREMENT FOR BPM PARAMETER BETWEEN THE DESIGN AND THE CALIBRATOR.

Setting BPM	Error
30	1.3%
60	0.7%
120	0.2%
180	0.2%
240	0.2%

TABLE 2: THE ERROR OF MEASUREMENT FOR BPM PARAMETER BETWEEN THE DESIGN AND STANDARD UNIT (PULSE OXYMETRI).

Subject	Error
1	0.3%
2	0.0%
3	0.3%
4	0.6%
5	0.5%

TABLE 3 THE ERROR OF MEASUREMENT FOR TEPERATURE PARAMETER BETWEEN THE DESIGN AND STANDARD UNIT (THERMOMETER).

Subject	Error
30	0.6%
60	0.2%
120	0.3%
180	0.2%
240	0.1%

IV. Discussion

Based on the measurements by comparing errors between design and tools BPM Oximetry (with input from the simulator ECG) showed the greatest error value is 1.3% and it is in the BPM value measurement 30. From the results of temperature measurements of the respondents showed the greatest error value is 0, 6%. While the BPM value Measurement results of the respondents showed the greatest error value is 0.6%. This is because of the effect of the patient's condition and position of the patient on the temperature sensors and electrodes.

V. Conclusion

Based on the results of the discussion and goals can be concluded appliance module can work. However, there are unresolved issues such as the value of a great error when there is the movement of the patient and there is also a problem of delay that relies heavily on the Internet network used.

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