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Smart-band BPM and Temperature Based on Android Using Wi-Fi Communication

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ABSTRACT Patient monitoring is an important part of the health care system, both in the hospital and at home. Monitoring is very necessary if there are symptoms of a disease in a patient. How to monitor the patient's condition can be seen from the BPM value and the patient's temperature. The purpose of this study is to design a device on the patient's wrist that can monitor the patient's BPM and body temperature in real time and is not affected by distance. The contribution of this research is a system that can provide indicators of bradycardia-tachycardia for measuring BPM and hyperthermia-hypothermia for measuring temperature. A practical and efficient BPM and temperature monitoring tool for use with real-time monitoring, has the form of a bracelet and provides notifications on cellphones and emails when the patient's condition is not normal. The design of this tool uses SEN0203 as a BPM sensor, and MLX90614 as a temperature sensor. The data will be processed and displayed on the ESP32TTGO and the data will be sent to the blynk on the cellphone using the ESP32TTGO as a wifi module. BPM has the smallest error 0.1% and the largest 1.09% while the temperature has the smallest error 0.19% and the largest 1.63%. The results of this study can be developed on a patient monitor to increase the efficiency of the remote monitoring system.

INDEX TERMS Smartband, Heart Attack, Temperature, SEN0203, MLX90614

I. INTRODUCTION

Patient monitoring is an important part of today's health care system, both in the hospital and at home.[1] Monitoring tool serves to monitor a person's health condition. Monitoring is very necessary if there are symptoms of a disease that must be taken quickly so that the patient's condition does not worsen.[2]

Monitoring and measuring body temperature is very important to know the patient's condition. One way to monitor the patient's condition can be seen from the BPM value and the patient's temperature. [3]A healthy body is able to maintain a constant body temperature despite changing environmental conditions.[4] Body temperature is associated with a number of human heart beats, a slight change in body temperature can significantly affect the performance of the heart because the further the patient's normal temperature affects how fast the patient's heart pumps blood throughout the body.[5]

Heart rate beats per minute (BPM) is a parameter to indicate the condition of the heart, and one way to find out the condition of a person's heart is by knowing the frequency of the heart rate. In addition to notifications, monitoring is needed that is not adrift by distance so that monitoring can be carried out anywhere and anytime with remote monitoring, the doctor or nurse does not have to monitor the patient directly using only the doctor's or nurse's cellphone to see the BPM value and temperature of the patient.[5]

Research in (2020) a monitoring tool in the form of a bracelet was also developed by Gde Bagus Marten Giri Pramana from the Surabaya Health Polytechnic's Electrical Engineering with the title Smartband Design Equipped with BPM and Temperature Monitoring with an Android Display.[6] The device in the form of a bracelet with an OLED display that displays the BPM and Temperature values from the patient is equipped with sending notifications on the blynk application and an email that has been determined if the patient's condition is not normal.[7] It's just that this tool still has shortcomings in sensors and data retrieval. Where this tool still uses the Ds18b20 temperature sensor which results from this sensor are still affected by the temperature of the tool around the sensor, and also BPM data collection on this tool is still done on the fingers, so this tool still requires a connection to be placed on the fingers to retrieve BPM data.

To improve some of the weaknesses that exist from previous research, the author plans to create a tool called Smartband Monitoring BPM and Temperature on the Wrist Display Android.[9] The device in the form of a bracelet with an LCD display from the ESP32 TTGO T-Display which will display the BPM value and temperature of this patient will use the BPM sensor SEN0203 which the sensor will take BPM data on the wrist.[10] And will also use a non-contact infrared temperature sensor MLX90614, so that the temperature obtained by the sensor is pure body temperature which will not be affected by the heat around the sensor.[11]

Based on the description of the literature study that has been described, there are several things that need to be improved from previous research. Therefore, in this study, smartband monitoring of heart rate and body temperature on the wrist appears android by using the screen feature on the ESP32TTGO which is equipped with a wifi connection to a mobile device with the aim of making it easier to monitor patients who will not be constrained by distance.[12] The results of heart rate and body temperature checks will be displayed in real time on the ESP32TTGO screen and on the blynk application. and also features in-app storage blynk for further analysis purposes. In this case the author intends to make a Smartband BPM and Temperature Monitoring Delivered on Android Phone via Wifi Communication.

II. MATERIALS AND METHODS

A. EXPERIMENTAL SETUP

The experiment was conducted on 10 male and female respondents with each respondent taking 10 times BPM and temperature data collection. The BPM parameter uses pulse oximetry as a comparison, while the temperature parameter uses a thermogun as a comparison.

1) MATERIAL AND TOOL

This study uses the SEN0203 sensor as a BPM sensor on the wrist, and the MLX90614 sensor as a non-contact temperature sensor. The voltage source used is a 3.7v Lithium Battery. The microcontroller, display, and wifi module used have become one in the ESP32TTGO T-Display. For the comparison tool, Oximeter is used as a comparison of BPM data, and Thermogun as a comparison of body temperature data.

2) EXPERIMENT

In this study, after the tool was completed, to ensure the BPM and temperature values were the same as the values for the oximeter and thermogun comparison tools. Measurement of BPM and temperature values is done by pairing the smartband module on the respondent's wrist, then watching for 10 seconds and 10 times per respondent to see the BPM value and stable temperature on the patient's body.

B. THE DIAGRAM BLOCK

The patient will be paired with a bracelet that already has an SEN0203 sensor that reads BPM data from the patient's wrist and there is also an MLX90614 sensor that will read the patient's body temperature data. The data reading obtained from the SEN0203 sensor and the MLX90614 sensor will be processed by the ESP32 TTGO T-Display microcontroller and will be displayed on the LCD from the one on the ESP32 TTGO T-Display, then sent to the Blynk application on the Android device. If the patient is in an abnormal condition, the Blynk application will provide a notification on the Android device at once to the specified email. These steps can be viewed according to **FIGURE 1.**

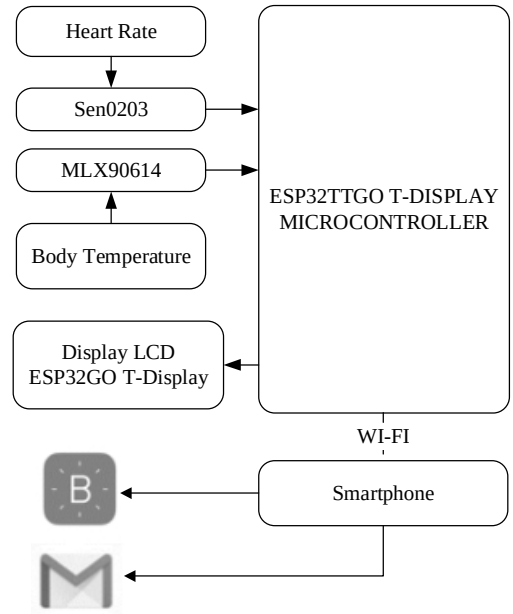

FIGURE 1. Diagram Block

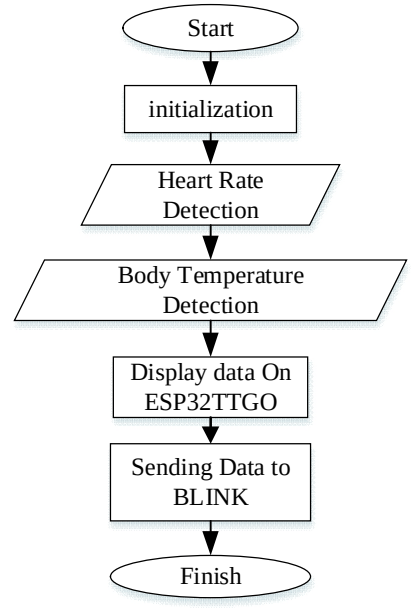

FIGURE 2. The Flowchart of the Microcontroller

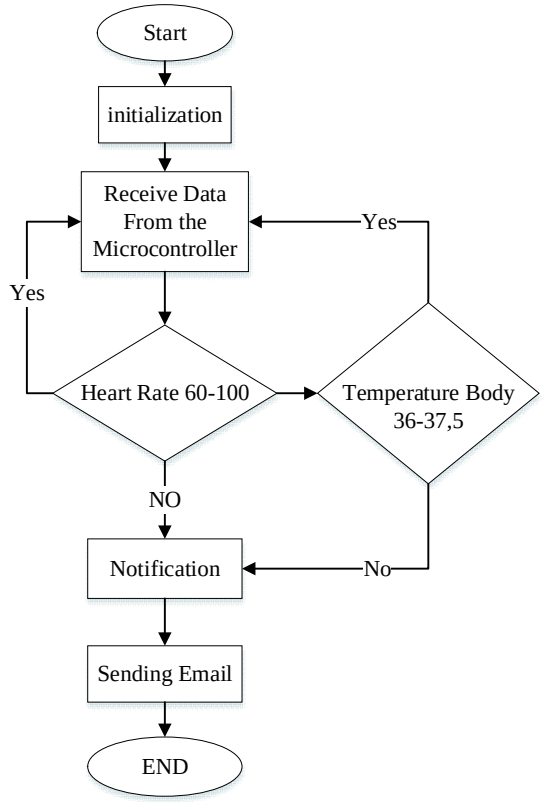

FIGURE 3. **The Flowchart of Android**

C. THE FLOWCHART

FIGURE 2 In the microcontroller program flow diagram after the start button is pressed, the initialization process will occur, and the sensors of each parameter will work. The SEN0203 sensor will work to detect the heart rate on the patient's wrist. . The method of measuring heart rate in wrist blood vessels in this system uses the reflection method, where infrared as a light source is paired parallel to a photodiode as a light sensor. The signal or change received by the photodiode is the reflection of light from the infrared. Photodiode converts the amount of light intensity received into an electric current. The size of the light received is based on the reflection of light from the infrared emitted into the veins on the wrist and the ESP32 TTGO T-Display as a microcontroller will process the data which then calculates the heart rate value (BPM). The non-contact sensor MLX90614 will work to detect body temperature by converting the temperature scale into a digital quantity and the ESP32 TTGO T-Display as a microcontroller will process the data which will then calculate the body temperature value. After the value of the two parameters has been taken, the value will be displayed in the form of a number on the LCD located on the ESP32 TTGO T-Display and at the same time will be sent to the blynk application via the ESP32 TTGO T-Display using wifi.

FIGURE 3 In the flow chart of the blynk program, after the device is turned on, data retrieval of BPM and patient's body temperature occurs. BPM and temperature data are obtained from sensors that have been processed by the ESP32 TTGO T-Display microcontroller which simultaneously sends data to the blynk application with a wifi connection. When the patient is in an abnormal condition or the patient's BPM value is less than 60 and more than 100 and also the patient's temperature is less than 36°C and more than 37.5°C then the blynk application on android will provide notifications while sending data to the email that has been determined. If the patient is in normal condition, the device will monitor the patient continuously until it is finished.

1) SENSOR BPM AND TEMPERATURE

FIGURE 4. **Sensor BPM and Temperature**

FIGURE 4 is a BPM and temperature sensor that functions to detect BPM and body temperature of the patient's condition, the output of these two sensors will be connected to the ESP32TTGO which will process it and send it to blynk with the help of wi-fi

III. RESULT

FIGURE 5 is the front-view image of the final task tool titled "Smartband BPM and Temperature Monitoring Delivered on Android Phone via Wifi Communication"

FIGURE 5. **Design Module**

1) DESIGN MODULE

As in **FIGURE 5**, in this study, the authors make a smartband monitoring tool that can monitor BPM and patient temperature at a distance that does not depend on distance. Wifi module and LCD display on smartband using ESP32TTGO microcontroller. In this smartband there is a blynk application that is directly connected in real time with the smartband, and there is also a notification in the email that has been determined if the BPM condition and the patient's temperature are not normal.

2) THE LISTING PROGRAM FOR ARDUINO

Pseudocode: 1. Sensor reading program SEN0203

```
1.  #ifndef _heartbeat_
2.. #define _heartbeat_
3.  VOID detak(){
4.  beat=digitalRead(heartPin);
5.  currentMillis5=millis();
6.  currentMillis6=millis();
7.  IF(currentMillis6-delay6>=20){
8.  delay6=currentMillis6;
9.  IF(beat!=last_beat){
10. flag++;
11  IF(bpm==0){
12. Serial.println("Waiting for valid data");}
13. ELSE{
14. Serial.print("nilai BPM adalah    : ");
15. Serial.println(bpm);}}
16. ELSE{}
17. delay(20);
18. last_beat=beat;}
19. IF(currentMillis5-delay5>=10000){
20. delay5=currentMillis5;
21. bpm=((flag/2)*6);
22. flag=0;}
23. Blynk.virtualWrite(V0,bpm);}
24. #endif  _heartbeat_
```

Pseudocode: 2. Sensor reading program MLX90614

```
1.  #ifndef _temperature_
2.  #define _temperature_
3.  VOID suhu(int j){//default j=500ms
4.  currentMillis2 = millis();
5.  IF(currentMillis2-delay2>=j){
6.  real_temp=mlx.readObjectTempC();
7.  Blynk.virtualWrite(V1,real_temp);}}
8.  #endif  _temperature_
```

Pseudocode: 3. Display program ESP32TTGO T-Display

```
1.  const char* auth=
2.  "Ioe3iB-X2ezL7iqc6Dd-5hAmZ67FZc18";
3.  const char* ssid = "smartband";
4.  const char* password = "smartband123";
5.  VOID setup() {
6.  Serial.begin(115200);
7.  tft.init();
8.  mlx.begin();
9.  pinMode(ADC_PIN,INPUT);
10. pinMode(ADC_EN, OUTPUT);
11. intro();
12. wifi_connection();
13. Blynk.begin(auth,ssid,password);
14. Blynk.virtualWrite(V0, BPM);
15. Blynk.virtualWrite(V1, temp);
16. VOID loop() {
17. Blynk.run();}
```

3) GRAPH ERROR FROM DATA DISPLAYED ON SEN0203 AND MLX90614

Smartband BPM and Temperature Monitoring Delivered on Android Phones via Wifi Communication displayed via blynk in the form of BPM, temperature, storage, and email in realtime. wifi will send data readings of BPM measurement results and body temperature and then the data retrieval can be stored in Microsoft Excel form (**FIGURE 6**).

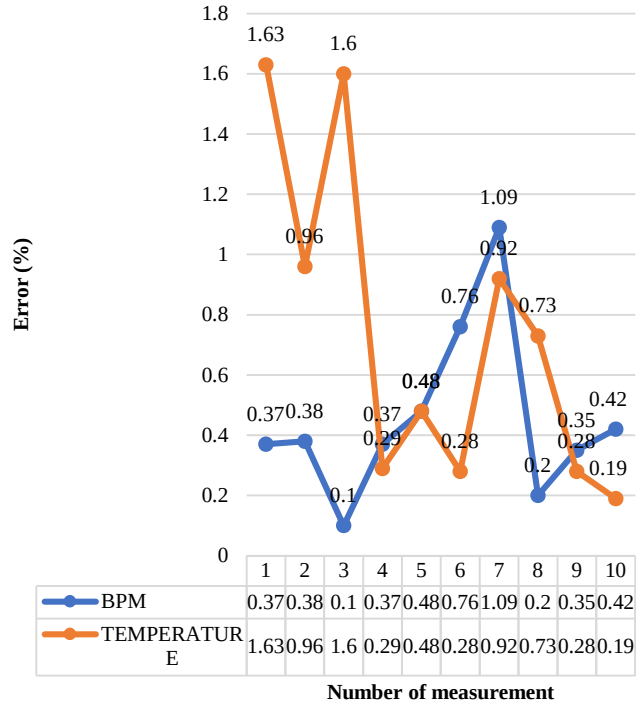

FIGURE 6. Graph error from data displayed on SEN0203 and MLX90614

On the measurement of BPM and body temperature, measurements are made on the patient's hand. Measurements were carried out to 10 respondents consisting of men and women, and were repeated 10 times. measurement results are shown by **TABLE 1.**

TABLE 1
ERROR TEST BPM AND TEMPERATURE

Respondent	*Error* (%)	
	BPM	Temperature
1	0,37	1,63
2	0,38	0,96
3	0,10	1,60
4	0,37	0,29
5	0,48	0,48
6	0,76	0,28
7	1,09	0,92
8	0,20	0,73
9	0,35	0,28
10	0,42	0,19
Total error	0,452	0,736

In this measurement, testing is carried out using an oximeter as a BPM comparison tool, and using a thermogun as a temperature comparison tool. measurement results are shown by table **TABLE 2.**

TABLE 2
AVERAGE BPM AND TEMPERATURE

Respondent	Average ± SD (Deviation Standart)	
	Difference BPM	Difference Temperature
1	0,3± SD	0,592± SD
2	0,3± SD	0,35± SD
3	0,1± SD	0,584± SD
4	0,3± SD	0,106± SD
5	0,4± SD	0,176± SD
6	0,7± SD	0,1± SD
7	0,9± SD	0,332± SD
8	0,2± SD	0,265± SD
9	0,3± SD	0,102± SD
10	0,3± SD	0,07± SD

IV. DISCUSSION

In previous research, Marten developed a Smartband Design Equipped with BPM and Temperature Monitoring with Android Display. This smartband is also equipped with storage in the blynk application, but in this smartband the BPM value is still taken on the fingers, not on the wrist like smartbands in general. In this study, the series of modules used consisted of the ESP32TTGO mainboard module, the MLX90614 temperature sensor and the SEN0203 BPM temperature sensor. From the temperature sensor it is connected to the VCC on the ESP32TTGO, and for serial data communication it uses SDA and SCL on the ESP32TTGO. The BPM sensor gets the VCC from the ESP32TTGO, for data from the BPM sensor it is connected to the DAC ESP32 pin (26). While the ESP32TTGO itself gets a voltage from a 3.7v lithium battery and 220mah power. The module works according to the program that has been given. When the ON button is pressed or in a ready state, all circuits get voltage and are processed in the ESP32TTGO circuit.[13] The OLED display on the ESP32TTGO will initiate initialization, and the initial display appears, along with the SEN0203 sensor, and the MLX90614 sensor. The OLED screen will display the readings on the SEN0203 and MLX90614 sensors, while the ESP32TTGO will send the results of the blynk android application readings. If the tool detects an abnormal event between BPM and temperature, there will be a notification on the cellphone and send a warning to the specified blynk application and email.[14][15]

In the blynk application display there are BPM and temperature values that function to monitor BPM conditions and patient body temperature. There is also an email to set the destination of the email that will be sent notifications. Then there are reports that function to store data on BPM and patient body temperature. Then there are event settings. The eventor setting in the Blynk application functions to set the BPM threshold and temperature for email notifications and the Blynk application. To set the BPM and temperature treshold on the Blynk application, it is enough to connect the pin of the sensor that is used then the desired conditions and what activities are carried out when the Blynk application has met these conditions. When the BPM and temperature values are in accordance with the set threshold, the blynk application will send a notification to the specified email and blynk application.

Notifications on email and the blynk application on smartphones are signs to know that the patient's BPM and body temperature are not normal. Blynk will send notifications via email that has been addressed and through the blynk application on a smartphone if the patient's BPM condition is below 60 and above 100. For the temperature, Blynk will send a notification if the patient's temperature is below 36 and below 37.5.

The communication used by the microcontroller and the blynk application on the cellphone uses wifi communication. Wifi is used because it has the advantage of unlimited distance between the module and the cellphone. From ESP32TTGO sends BPM and Temperature data via wifi to the blynk application on the cellphone, then from blynk it will send notifications when the patient's condition is not normal via email and the blynk application itself. Before the blynk application works, the blynk application must be set first for the pins of the BPM sensor and the temperature sensor. When the BPM sensor pin and temperature sensor are correct, the blynk application will work when ESP32TTGO sends data from the BPM sensor and temperature sensor.

BPM and temperature measurements have been carried out to 10 male and female respondents 10 times. The smallest error was obtained at BPM, namely 0.1% in the 3rd respondent and the largest error was 1.09% in the 7th respondent. For temperature measurements, the smallest error was 0.19% in the 10th respondent and the largest error was 1.63 at 1st respondent. In the BPM module the error occurs due to movement of the patient's wrist which makes sensor readings inaccurate. While in the temperature module, the error occurs due to the difference in temperature on the surface of the skin on the wrist that is exposed to the temperature on the surface of the skin covered by the smartband.

Based on the results of this study, there are some limitations experienced and can be some factors that can be more considered. This module that has been made has several shortcomings, namely the size of the module is still large, then the BPM value and temperature are not stable if there is movement in the patient's wrist. Then the PPG signal graph is not yet equipped and the shape of the module that is made is still large. Then the module will not work when there is no internet connection available on the module, and the last is the limitation of sending email notifications to this module. It is limited to 100 emails per day.

V. CONCLUSION

The purpose of this research is the author wants to make a BPM Smartband and a Temperature Monitoring tool that is delivered to an Android Phone via Wifi Communication. the purpose of this study After carrying out the process of making and studying literature, testing modules and collecting data, the authors can conclude as follows. The SEN0203 sensor can be used to determine the value of he human heart rate on the wrist. Blynk will display the same BPM and temperature values on the ESP32TTGO display in realtime. Blynk will send a notification via email that has been addressed and on the blynk application if the patient's BPM and body temperature are not normal. Using wifi communication using the ESP32TTGO microcontroller. Wifi is used because it has the advantage of unlimited distance between the module and the cellphone. The smallest error value of the BPM module is 0.1% and the largest error is 1.09%. For the temperature sensor the smallest error value is 0.19% and the largest error is 1.60%

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Attachment :

- *Listing Program* https://drive.google.com/file/d/1ZnVILExE3MYJzZanbUn4Ohj7KYkx7Px3/view?usp=drivesdk
- Schematic + board https://drive.google.com/file/d/1_dvWlVcSGFJU5fV_lUJgJOQQT6DGvTNg/view?usp=drivesdk