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Design of Health Monitoring System Based on Internet of Things (IoT): ESP8266 and BLYNK

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Abstract

Health monitoring is important for living creatures. There are many things that are important factors in the health of living creatures, especially humans, including heart rate, body temperature and oxygen saturation. IoT technology is very helpful in the development of health technology so that it becomes possible to monitor patient health in real time and patient emergency information can be accessed easily. This research also aims to design an Android-based heart rate monitoring system using ESP8266 as a microcontroller. The sensor used is Max30102. The research method used is applied research, with experimental research methods. The research stages carried out were literature study, software design, hardware design, system testing, and analysis. The results of the research are the design of a patient health monitoring tool with three measured indicators, namely the patient's heart rate, body temperature and oxygen levels. The system can monitor in real time based on Internet of Things and can be accessed by Android and iOS. From the study results, it was found that the Android-based health monitoring system has an accuracy rate of 97.63% and it can be said that the system can be used for patient measurements. With details, 96.71% is the accuracy level for measuring heart rate, 96.45% accuracy level for measuring oxygen levels in the patient's body, and 99.75% accuracy level for measuring patient temperature.

I. INTRODUCTION

Health monitoring is important for living creatures. There are many things that are important factors in the health of living creatures, especially humans, including heart rate, body temperature and oxygen saturation.

Vital signs of human health can be determined from body temperature, heart rate, breathing and blood pressure [1]. Body temperature is the most important of the three vital signs, body temperature is the difference between the amount of heat produced by body processes and the amount of heat lost to the external environment with a normal value range of 36.5°C-37.5°C [2].

Apart from that, monitoring the health of sick people is very important, to detect abnormalities and control their health development. One of the diseases that is dangerous and has a high risk of causing death for humans is arrhythmia or disturbances in heart rhythm [3]. Heart rate beats per minute (BPM) is a parameter that shows heart health, and can be determined by calculating the heart rate frequency. Normal human heart rate ranges from 60-100 beats per minute [4] [5] [6].

Several studies related to making heart rate monitoring devices have been carried out, such as those carried out by M. Aldi et al, namely making a health monitoring system prototype with real-time Internet of Things (IoT) based temperature, heart rate and oxygen saturation indicators, with the result that the device achieved an accuracy of 98 .78% when measuring oxygen saturation and heart rate was 95.12 while body temperature reached 99.07% [7]. The difference in the study carried out by M. Aldi et al is the temperature sensor used by the DS18B20 sensor and the microcontroller system used by Arduino and ESP.

The next study was conducted by Muthmainnah, et al. Aiming to test the accuracy of the MAX30102 sensor in measuring heart rate and human body temperature, the results of measurements with the MAX3012 sensor have a standard deviation for heart rate measurements of 1.19, with an accuracy rate compared to the oximeter, which is 97%. while the standard deviation in temperature measurements is 0.07. The average accuracy level of the sensor when compared to a thermometer is 99% [8]. Research by Muthmainnah et al. Created a prototype of a non-invasive heart rate measuring device using the IoT-based photoplethysmograph method [9]. IoT technology

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is very helpful in the development of health technology. IoT technology can make real-time patient health monitoring possible and can help handle patient emergencies easily [10] [11].

Based on the background above, the problem to be raised in this study is how anyone can monitor their pulse anytime and anywhere in real time using the internet via smartphone. This research also aims to design an Android-based heart rate monitoring system using ESP8266 as a microcontroller [12].

II. METHODS

Fig. 1 Research flow diagram

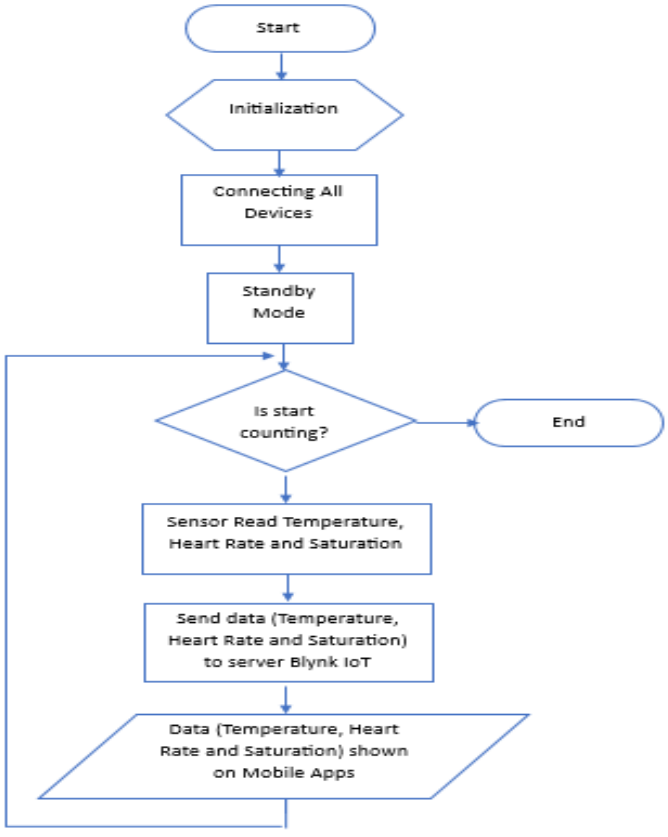

Fig. 2 Flowchart for the system

The research carried out includes applied research, with experimental research methods [13]. Figure 1 shows the research flow diagram. The research stages carried out were literature study, software design, hardware design, system testing, and analysis [14] [15]. Software design begins by simulating the system that will be created in the Proteus program and synchronizing it with the program that has been created on the Arduino IDE. designing this software aims to organize the program with the device to be used. Hardware design is carried out by configuring the device according to the wiring diagram in Figure 3. Hardware design aims to create a system so that tests can be carried out on samples. Furthermore, data collection and data analysis is an activity to test whether the system is stable and in accordance with standard measuring instruments that apply on the market, so that later the system will be used by patients and has the same functional value as existing measuring instruments but has advantages because the system can provide real time data, which is very necessary for hospital staff in monitoring emergency patients.

Figure 2 shows the flowchart of the health monitoring system that was built. The health monitoring system was created using a max30102 sensor with Arduino Uno and using ESP8266 as a microcontroller. The system wiring diagram is shown in Figure 3, which illustrates the composition of the devices used WeMos D1 Mini Board ESP8266 and Max30102 sensors

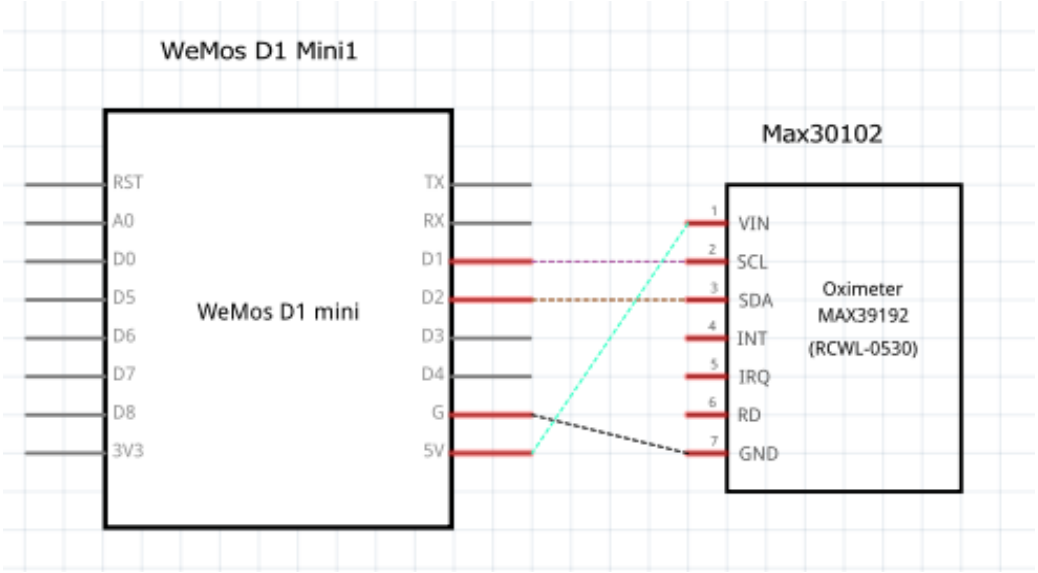

Fig. 3 Wiring Diagram for the system

III. RESULTS AND DISCUSSION

Figure 4 shows the initial appearance of the system created in the Android application. This display shows that before the system works, there are 3 information menus in accordance with the objectives of this research, namely calculating heart rate, oxygen saturation level and body temperature.

Figure 5 shows the interface of the health monitoring system on the user's Android. The data displayed is heart rate data, oxygen levels and body temperature. There is a STOP button to end the measurement process and reset the measurement. At this stage, trials of the system being built are carried out on several samples. The test was carried out on 3 people as samples with varying ages, the test results were compared with standard measuring instruments. Table 1 shows data on heart rate measurements from three samples.

TABLE 1
HEART RATE MEASUREMENT RESULTS DATA

Patient's age	Max30102	Oximeter	Dissimilarity	Error	Accuracy
19 years old	90.8	89.2	3.6	3.24	96.76
25 years old	83	82	4.6	3.768	96.232
22 years old	85	88.2	3.2	2.856	97.144
		Average		3.288	96.712

TABLE 2
DATA FROM OXYGEN LEVEL (SPO2) MEASUREMENTS

Patient's age	Max30102	Oximeter	Dissimilarity	Error	Accuracy
19 years old	97	97.4	2.4	2.332	97.668
25 years old	95	96.2	3.6	3.458	96.542
22 years old	94.4	97	5	4.85	95.15
		Average		3.546667	96.45333

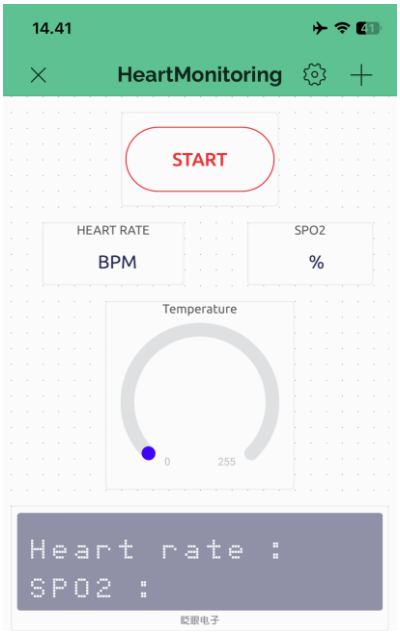

Fig. 4 Application display before operation

From table 1 it can be concluded that the accuracy of the health monitoring system created is 96.71%, so that the system built can be used by patients to measure heart rate. From table 2 it can be concluded that the accuracy of the health monitoring system created to measure oxygen levels is 96.45%, so that the system built can be used by patients.

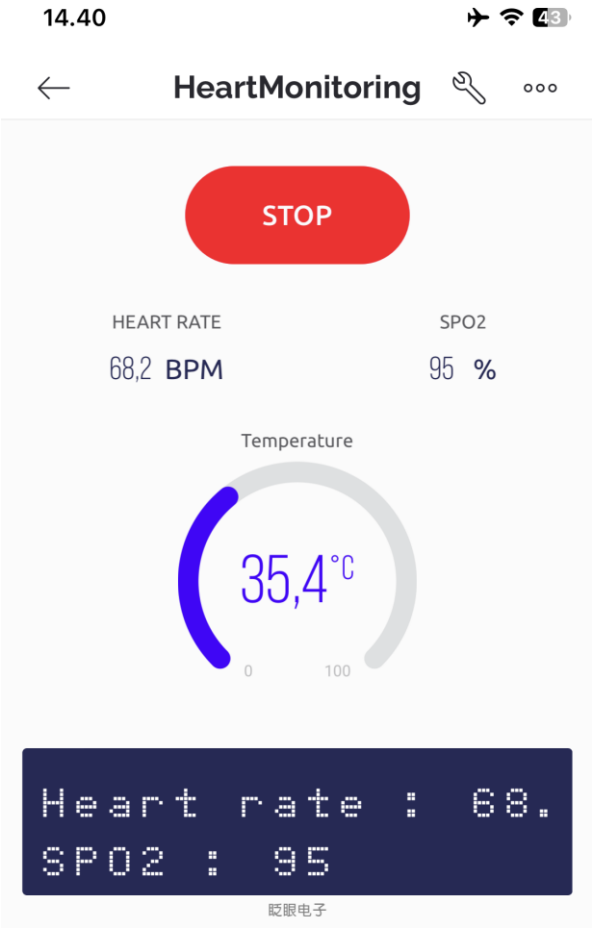

Fig. 5 Display of the health monitoring system interface on the Android system

Table 2 shows data on the results of measuring oxygen saturation values from patients. The normal SpO2 condition value is between 95% to 100% and the abnormal condition value is <95%[16]. From the test results it can be concluded that the patient has a normal oxygen saturation condition. The measurement results were compared with oxygen saturation measuring devices available on the market, and the system built had an average accuracy level of 96.45% with an error rate of 3.5%, this shows that the system built can be used to measure oxygen saturation levels in patients.

From table 3 it can be concluded that the accuracy of the health monitoring system created to measure human body temperature is 99.75%, so that the system built can be used by patients. Overall, the Android-based health monitoring system has an accuracy rate of 97.63% and it can be said that the system can be used for patient measurements.

TABLE 3
DATA FROM PATIENT BODY TEMPERATURE MEASUREMENTS

Patient's age	Max30102	Temperature (ºC)	Dissimilarity	Error	Accuracy
19 years old	35.16	35.44	0.48	0.17	99.83
25 years old	35.62	36.26	0.64	0.2321	99.7679
22 years old	33.04	34.1	1.06	0.36214	99.63786
Average				0.254747	99.74525

IV. CONCLUSIONS

In this study, an internet of things (IoT) based health monitoring system has been built using ESP8266 as a microcontroller and BLYNK as an IoT system. The results of the research are the design of a patient health monitoring tool with three measured indicators, namely the patient's heart rate, body temperature and oxygen levels. The system can monitor in real time based on IoT and can be accessed by Android and iOS. The sensor used is Max30102. From the study results, it was found that the Android-based health monitoring system has an accuracy rate of 97.63% and it can be said that the system can be used for patient measurements. With details, 96.71% is the accuracy level for measuring heart rate, 96.45% accuracy level for measuring oxygen levels in the patient's body, and 99.75% accuracy level for measuring patient temperature.

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