Internet of Things-Based Monitoring System of Patients Using W1209 Digital Thermostat and Pulse Sensor

by Warju Warju

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ABSTRACT

Some diseases are transmitted through doplets or touch and contact with patients. Transmission can also occur with objects that are often touched by patients. This contact is impossible to avoid for medical personnel who care for patients, therefore the effort made is to minimize contact with patients but still control and monitor the patient's condition. This paper proposes monitoring system of body temperature and patient heart rate using the Internet of Things (IoT). The developed system is expected to be able to develop e-healt technology and assist medical staff in monitoring patient conditions. The research stage is system design, design implementation, and system testing. The design of this research is temperature sensor and heart rate connected with arduino then connected with ESP 8266. The measurement results from these sensors will be sent to the server via the internet. Medical staff can access body temperature data and heart rate of patients sent by sensors by accessing the server via laptob or gadged, with this proposed system, medical personnel can minimize physical contact with patients but still monitor the patient's condition.

Keywords: *IoT, pulse sensor, temperature, beat, rate*

1. INTRODUCTION

The background of this papaer is that some diseases are transmitted through doplets, touch and contact with patients. In addition, transmission can also occur with objects that are frequently touched by the patient. This contact may not be avoided for medical personnel who treat patients, because of that, the efforts made are to minimize contact with the patient but still control and monitor the patient's condition. One of the efforts made is by using technology to monitor the patient's condition. Every now and then the nurse or medical personnel must measure the temperature and heart rate of the patient. To measure temperature, medical personnel usually use a thermometer, either a digital or manual body thermometer, or a thermometer that uses infrared which is fired at the patient's forehead. To measure the heart rate, medical personnel visiting the patient to have their heart rate measured. However the method above, there is still contact between the patient and medical personnel. It is feared that it will pose a risk to the health of medical personnel. This paper proposes the development of an Internet of Things (IoT) based measuring device for measuring body temperature and heart rate for patients. It is hoped that temperature and heart rate sensors will be attached to the patient so that medical personnel can monitor the patient's temperature and pulse via the Internet via IoT (remote). This will minimize contact between patients and medical personnel, but medical personnel are still monitoring the patient's condition well at all times.

Coronaviruses are a group of viruses covered with RNA that is not fragmented, single-stranded, and positive-sense RNA genomes. In 2019, the Centers for Disease Control and Prevention (CDC) began monitoring the new coronavirus outbreak, SARS-CoV-2, which causes the respiratory disease now known as COVID-19. The results of the identification of this virus began in Wuhan, China [1]. Transmission by means of a person can get the infection through close contact with someone who has symptoms of the virus including coughing and sneezing. Generally, the corona virus is spread by zoonotic droplets in the air [2]. This high level of transmissibility increases our awareness of patient contact, including limiting the cough from the sufferer. The level of transmission that is vulnerable is medical personnel. They must be in direct contact in caring for and monitoring patient health. Because it is necessary to think about a mechanism so that contact with patients is minimized but still monitor the patient's condition. Some of the things that the results can monitor are the patient's temperature and heart rate. Usually medical personnel regularly monitor the patient's temperature and heart rate by visiting the patient every unit of time.

Several studies have examined the measurement of body temperature using IoT, including using the LM 35 as a sensor and a heart rate sensor with a Bluetooth connection [3,4]. Several studies have also used IoT in sending data. The sensor is attached to the patient's body and the medical personnel will monitor the patient's condition by accessing the measurement results via the internet [5-11]. This research is still being tested on a laboratory scale and there has been no detailed trial of how the variable variations of this tool are applied.

Based on a literature review, one of the solutions offered is to use the Internet of Things (IoT) when measuring temperature and heart rate. The sensor is attached to the patient's body and with each unit of time the medical personnel can monitor the patient's temperature and heart rate without contact with the patient. This research will be conducted using the W1209 Digital Thermostat and Pulse Sensor sensor, then analyzed how the response is. In addition, tests were carried out in detail with variations in the variables and the size of their measurements.

2. METHOD

The stages of this research are system design, design implementation, unit trials, system 1 trials, system improvements based on trial 1, system testing 2, and results analysis. The early stage of the research is system design, where the output of this system is expected to be in the form of hardware design, software, integrated systems, and IoT. The design of this system is illustrated in Figure 1. The design of this study is that the temperature and heart rate sensors are connected to Arduino and then connected to the ESP 8266. The measurement results of these sensors will be sent to a server via the internet. Users will be able to access the data sent by sensors by accessing the server via their laptob or gadged, with this proposed system it is hoped that medical personnel will minimize contact with patients but still monitor the patient's condition.

Figure 1. Design of the system

The output of the design implementation is expected to have a system that is ready to be tested. This system consists of parts or units. To ensure that each unit is working properly, a unit trial process is required. After testing per unit, it is necessary to test all integrated units, starting from hardware, software, servers, and IoT. The test output of this system is the test results and a list of improvements that must be made. This repair list is followed up by improvements process. This repaired system will be tested again, and expected that this test can produce better results that are acceptable to the user.

Hardware design by identifying all requirements up to system design. This design requires pulse sensor in order to measure the number of heartbeats in minutes or BPM (Beats Per Minutes), and the temperature sensor used is W1209 Digital Thermostat Temperature Control. Meanwhile, to support IoT used WEMOS D1 mini. The design is illustrated in Figure 1.

The harware design is illustrated in Figure 2. The pulse heart sensor is connected to data pins A0, VCC 3V3, and ground. While the thermostat is connected to pin D5 VCC 3V3, and ground. Data will be sent to the server via the internet. WEMOS D1 mini is equipped with a WIFI module so that direct data can be sent via the internet.

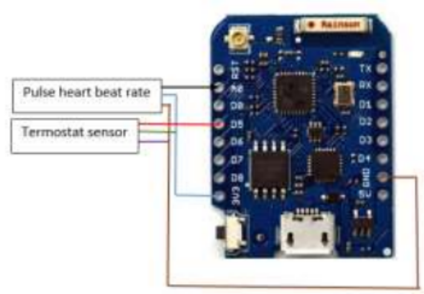

Figure 2. Hardware of system

3. Result and Discussion

Testing process for hardware, software, and IoT in order to identify the performance and role of each unit, whether it is in accordance with the design. The trial was carried out by 5 experiments, duration of each experiment is 90 second. The first experiment results are shown in Figure 3. The blue points are the data generated by the system, while the red points are the data generated by the reference BPM meter. In experiment 1, the results were still unstable.

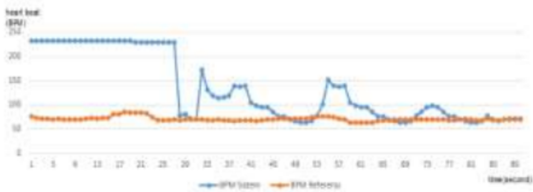

Figure 3. Result of the first experiment for BPM testing process

The second experiment shows the results shown in Figure 4. The blue points are the data generated by the system, while the red dots are the data generated by the reference BPM meter. In the second experiment, better and stable results were obtained, the results obtained tended to be lower than the results of measuring the reference BPM.

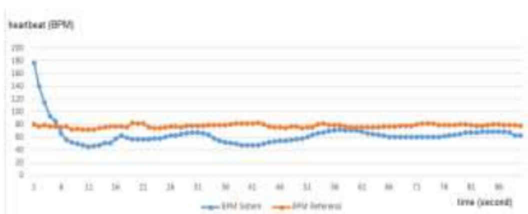

Figure 4. Result of the second experiment for BPM testing process

The third experiment results in data as shown in Figure 5. In the third experiment, it was found that it was almost the same as in the second experiment. The results obtained tend to be lower than the results of measuring the reference BPM.

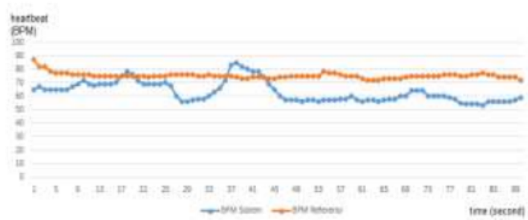

Figure 5. Result of the third experiment for BPM testing process

The fourth experiment produces data as shown in Figure 6. In the fourth experiment, the results were stable when the data reached 63, but after that, the data was less stable.

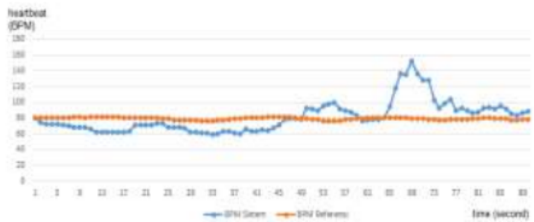

Figure 6. Result of the fourth experiment for BPM testing process

The fifth experiment produces data as shown in Figure 7. In the fifth experiment, the results were more stable but the value was below the reference BPM measurement.

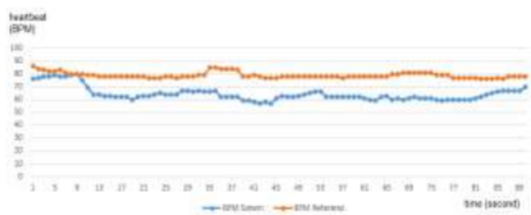

Figure 7. Result of the fifth experiment for BPM testing process

The result of the difference between the BPM value generated by the system and the BPM measurement using a reference is illustrated in Figure 8. In the first experiment, a large difference was still obtained, the result that was close to the reference value was experiment 5.

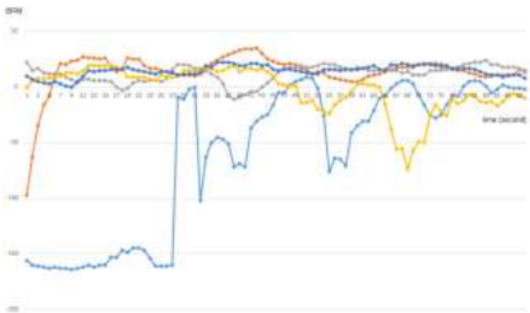

Figure 8. The difference between BPM value of system and the reference BPM in each experiment

The results of the experiment between BPM using the proposed system and measurement results using a reference BPM meter are different. Both measurements use the Photoplethysmograph (PPG) principle.

Photoplethysmograph (PPG) is an optical sensor-based measurement technique that is able to detect microvascular changes in blood volume in skin tissue. The PPG sensor monitors changes in light intensity. through light reflection passing through the network. Changes in light intensity caused by fluctuations in blood in the tissues provide information regarding the cardiovascular system.

Figure 9. Optical sensor-based measurement technique

Figure 9 shows two PPG sensor models where the first image shows the light emitted from the LED received by the Photo Diode (PD) positioned opposite. While the second image the light emitted by the LED spreads through the tissue on the human finger and the PD captures the light reflection that spreads through the network.

Differences in measurement results in experiments 1 to 5 can also be caused by differences in measurement methods. For the proposed system using the second principle, namely the light emitted by the LED spreads through the network on the human finger and the PD captures the light reflection that spreads through the network. Meanwhile, the reference BPM measurement uses the first principle, namely the light emitted from the LED is received by the Photo Diode (PD) which is placed opposite.

The results of temperature measurement are shown in Figures 10 to 15. At the blue point is the temperature generated by the system, while the red point is the data generated by the reference temperature. The temperature generated by the built system takes time to stabilize at 45 seconds in the first experiment. This also happened in experiments 2 to 5, but the results obtained tended to be stable.

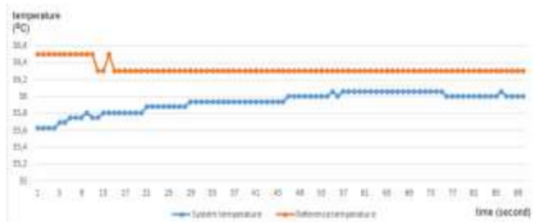

Figure 10. Result of the first experiment for temperature testing process

The results obtained in experiment 1 were improved and refined in the second experiment. In the first experiment the resulting data is still below the reference value. At this stage, what is improved is that the system is recalibrated so that better data is obtained.

The results in experiments 2 and 3 are depicted in Figures 11 and 12. In this graph, it can be seen that the results after the calibration process are better and have approached the reference temperature. In this graph, it can be seen that getting to a stable point takes about 40 seconds.

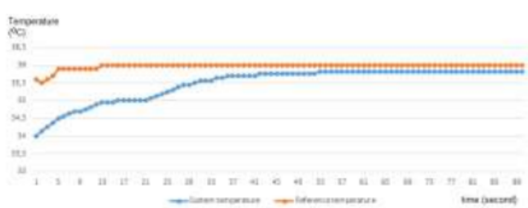

Figure 11. Result of the second experiment for temperature testing process

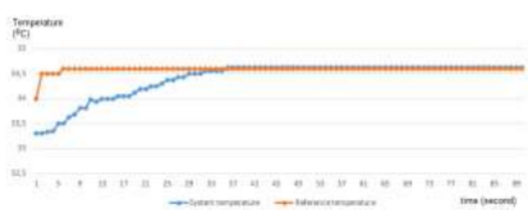

Figure 12. Result of the thirth experiment for temperature testing process

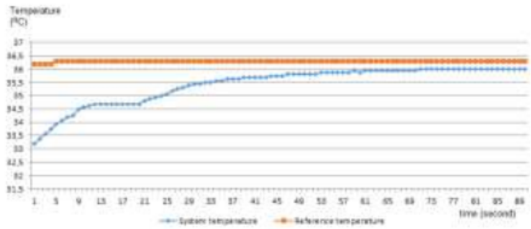

Figure 13. Result of the fourth experiment for temperature testing process

The fourth and fifth experiments we perform calibrate and derive the numbers in our coding, this has an effect on the resulting temperature. The resulting temperature returns below the reference temperature. This shows that the best temperature settings in this system are the settings used in the second and third experiments.

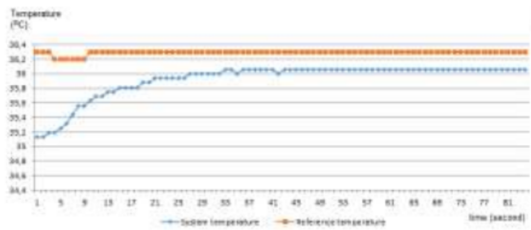

Figure 14. Result of the fifth experiment for temperature testing process

The difference between the data with the system temperature meter and the reference temperature meter in experiments 1 to 5 is illustrated in Figure 15. Figure 15 shows that it is better if the measurement is carried out for 1 minute, because the data will be stable at 35 seconds.

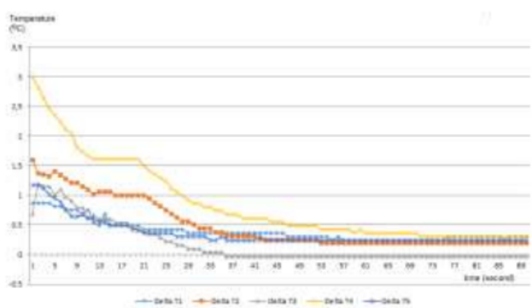

Figure 15. Result difference of experiment for temperature testing process

The first experiment still had a greater difference in measurement results from the second, third, fourth, and fifth experiments. The results of the first experiment were followed up by recalibrating in order to get better results for the next experiment. This is evident from the difference shown in the graph in Figure 15. The calibration process is very important in this system so that results are close to or even the same as the calibrator.

The advantage of this system is that users can access data for two or three patients at once in one information system, so that this system can increase the efficiency of time and energy required by the user.

4. CONCLUSION

The system is running well and the system is well integrated. The IoT system is already running and data can be sent by the device and can also be accessed by the user. The accuracy of the data still needs to be improved because there is still a difference between the data generated by the system and the data generated by the reference measuring instrument. The resulting data is also caused by noise and changing user positions.

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REFERENCES

[1]Subhash Unhale, A review on Corona Virus (COVID-19), International Journal of Pharmaceutical and Life Sciences, 2020.

[2]Dharmendra Kumar, Corona Virus: A Review of COVID-19, Eurasian Journal of Medicine and Oncology, 2020.

[3]Naddeo, A Real-time m-Health Monitoring System: An Integrated Solution Combining the Use of Several Wearable Sensors and Mobile Devices, Science and Technology Publications, 2017.

[4]Sachchidanand, Real Time Patient Health Monitoring and Alarming Wireless Sensor Network, International Journal of Engineering Science and Computing, 2016.

[5]Patil, Design and Implementation of Wireless Patient Health Monitoring System, International Journal of Engineering Research & Technology (IJERT), 2013.

[6]Udara, Healt Monitoring System Using IoT, International Journal of Engineering and Manufacturing Science., Volume 8, Number 1 (2018) pp. 177-182.

[7]Madhumathi, Healttcare Monitoring System Using Body Sensor Network, International Conference On Engineering Innovations And Solutions, 2016.

[8]Pawar, Home Based Health Monitoring System Using Smartphone, International Journal of Electrical, Electronics and Data Communication, Volume-2, Issue-2, Feb.-2014.

[9]Priyanka, IOT Based Health Monitoring System Using Blynk App, International Journal of Engineering and Advanced Technology (IJEAT), 2019.

[10]Ibrahim, IOT Patient Health Monitoring System, Journal of Engineering Research and Application, Vol. 8, Issue 1, (Part -III) January 2018, pp.77-80.

[11]Rani, Iot Patient Health Monitoring System, Indian Journal of Public Health Research & Development, October-December 2017, Vol.8, No. 4

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