Monitoring System of Heart Rate, Temperature and Infusion in Patients Based on Microcontroller (Arduino Uno)

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Abstract. A patient who is hospitalized generally gets health monitoring including 3 parameters including heart rate, body temperature and level of intravenous fluid usage. These three parameters are used as an indication of the patient's significant health development. Body temperature is needed because in addition to being an indicator of a person's health, it also has little to do with heart performance, namely the more the body temperature moves away from normal body conditions, then it affects how fast or slow the heart pumps blood. Throughout the body. To solve this problem, the researchers intend to create a three-parameter monitoring system, namely heart rate, body temperature and intravenous drips for patients. This monitoring system is also designed to provide a sound warning indicator in case of abnormal conditions in the monitored parameters. From the test results, it can be concluded that the device can display indicators of patient health development with 3 parameters, namely heart rate, body temperature and the level of infusion usage.

1. Introduction

The development of technology and science has now progressed rapidly, one of which is the development of technology in the biomedical field. However, the patient health monitoring system in hospitals or polyclinics in general is still carried out in a conventional way[1]. The nurse or doctor comes to the patient room to check the patient's health progress. This will not be a problem for hospitals or polyclinics in urban areas with adequate numbers of nurses and doctors[2]. However, for hospitals or polyclinics in rural areas with small numbers of medical personnel and limited facilities, this is a problem, because nurses and doctors have to go the extra mile from one room to another in monitoring patient health[3]. If the number of patients is large and the number of medical personnel is inadequate, this monitoring process will take a lot of time and can endanger patients who need priority direct treatment from doctors and nurses[4].
A patient who is hospitalized generally gets health monitoring including 3 parameters including heart rate, body temperature and level of intravenous fluid usage. These three parameters are used as an indication of the patient's significant health development[5]. Body temperature is needed because in addition to being an indicator of a person's health, it also has little to do with heart performance, namely the more the body temperature moves away from normal body conditions, then it affects how fast or slow the heart pumps blood[6]. Intravenous drip monitoring device is needed because of the important function of the infusion as a metabolic aid fluid, because the delay in infusion replacement and if there is a disturbance in the infusion fluid droplets can be a fatal risk that can even cause death for patients with certain conditions[7].

Therefore we need a method that can assist nurses and doctors in monitoring the development of patient health to determine which patient priorities should be given special treatment. The method that can be applied is microcontroller based patient telemonitoring. The telemonitoring method is one part of the existing telemedicine method. with telemonitoring, the process of monitoring the patient's health is carried out remotely without having to visit the patient's place[8].

2. Methodology

In this study, the authors used the Prototype Model research method. In the Prototype model, the process of creating a system that is made will be structured[9]. How many stages must be passed in the making, namely gathering needs, designing and evaluating. If the final stage states that the system that has been created is not perfect or still has flaws, the system will be re-evaluated and will go through the process from the beginning[10].

The processes in this prototyping model are:

a. Collection of needs
In this process, the researcher collects the needs in the form of data on the problems that exist in controlling the lights at this time, in the form of interviews with sources, and direct observation. After that the researcher formulates the problem that occurs to get a solution to the existing problem to get an idea of what tools are needed to solve the problem. Collection of needs is also carried out in making tools including any components that are needed.

b. Design
This process is the stage of designing a tool to solve the problem in creating a Monitoring System for Heart Rate, Temperature and Infusion for Patients at Puskesmas Tenayan Raya. The design includes how the tools work, tool workflows, and coding design and designing a series of tools that will be built up to making tools in the form of prototyping.

c. Evaluation
After the process of designing a tool in the form of a prototype has been carried out, the next stage is evaluation of the Heart Rate, Temperature and Infusion Monitoring System for Patients. Includes these tools that have worked well or not and are able to be a solution or not, to make or repair the Monitoring System.

3. Result and Discussion

Design of a Heart Rate Sensor Circuit
In designing a heart rate sensor, a sensor that is able to detect heart rate through blood circulation is needed by utilizing light and optical sensors, the sensor used is a pulsesensor or heart rate monitoring, this sensor is placed on the fingertip which will produce a heart rate in the blood circulation as input input. Analog data sent through the 2 pulsesensor legs are then connected to the Arduino A0 pin for further processing by the ATMega328 microcontroller.
Designing Body Temperature Sensor Circuit

In designing this body temperature sensor using DS18B20 components can be defined as an electronic component that functions to change changes in temperature received in changes in electrical quantities. The DS18B20 temperature sensor can convert temperature changes into voltage changes at the output. The DS18B20 temperature sensor requires a DC voltage source of +5 volts and a DC current consumption of 60 µA in operation, this sensor is installed on parts of the body such as the armpit or wrist. This component has 3 legs connected to the Arduino ATMega238, leg 1 as vcc, leg 2 connected to PIN A2, foot 3 as ground.

Design of Infusion Drop Level Sensor Circuit

In the design of the infusion drop level sensor circuit, in the first stage, monitoring the infusion drop level uses a photodiode component as a light receiver reflected by an infrared LED, as well as additional infusion sensor amplifiers including using a tripotentiometer to adjust sensitivity and using ICLM324 as a stabilizer to keep it 0-5 volts. Following the additional LED as an indicator, for the position of the series to be placed in the infusion chamber, each drop produced by the infusion flask will pass through the 44 infusion chambers that have been installed in the circuit, whether there is light or not will produce analog data and the calculation results will be sent and processed on the PIN - 11 arduino uno.
Heart Rate Testing

A pulsesensor is a medical device used to monitor heart rate non-invasively. The heart pulse signal that exits the photoplethysmograph is an analog fluctuation in voltage. Fingertip Pulse Sensor characteristics as raw signal amplification from previous versions of Pulse Sensors, and normalizes the pulse wave around $V/2$ (midpoint in voltage). Sensor pulses respond to relative changes in light intensity. If the amount of light on the sensor remains constant, the signal value will be fixed at or close to 512 (the midpoint of the ADC range). The more light the signal goes up. Lack of light, on the contrary. The light from the green LED that is reflected back to the sensor will change with each heart rate that is read.

Based on the results of pulsesensor testing in Figures above, the fact is that each heart of the human body does not have the same stress because many factors influence it, both normal and unhealthy body conditions so that in each graph experiment and bpm results will always change, the results Pulsesensor testing with the i2C LCD user interface can be seen in the table below:

| Testing | BPM calculation results | Result |
|---------|-------------------------|--------|
| 1       | 105                     | Normal |
| 2       | 101                     | Normal |
| 3       | 105                     | Normal |
| 4       | 102                     | Normal |

Testing the DS18B20 temperature sensor

Characteristics of the DS18B20 temperature sensor with waterproof capability equipped with a 6mm diameter stainless steel tube with 30mm cable length 100cm containing a temperature sensor. The DS18B20 provides 9 to 12-bit (configurable) data. Because each DS18B20 sensor has a unique silicon
serial number, multiple DS18B20 sensors can be installed on one bus. This allows temperature readings from multiple places. It takes an additional component a 4.7k resistor, which is needed as a pullup from the vcc data when using the sensor.

The DS18B20 sensor specifications use a temperature range: -55 to 125 °C (-67 °F to +257 ° F). The 9 to 12 bit resolution is selected using the 1-Wire interface — requiring only one digital pin for the unique 64 bit ID communication used on the chip. ± 0.5 °C Accuracy from -10 °C to +85 °C. Used with 3.0V to 5.5V electricity / data. The test results of the DS18B20 temperature sensor using the Nextion LCD as the user interface are in the image below.

![Testing the DS18B20 temperature sensor on the LCD](image)

**Figure 5.** Testing the DS18B20 temperature sensor on the LCD

**Infusion Drip Sensor testing**

![Infusion Drop Sensor Testing](image)

**Figure 6.** Infusion Drop Sensor Testing

Based on the test of the infusion drop sensor from the image above using a photodiode as a light receiver that is reflected by an infrared LED, this test utilizes analog data input generated by the photodiode from the results of receiving or not light from the infrared LED by calculating each refraction of the infusion liquid droplets, test data in the table below.

| Table 2. Drip test results on the i2C LCD |
|-----------------------------------------|
| **Testing** | **Drops** | **Result** |
| 1           | 1         | Success    |
| 2           | 2         | Success    |
| 3           | 3         | Success    |
| 4           | 4         | Success    |
4. Conclusion

Based on the results of the system design and the results of testing and analysis that have been carried out from the three parameters using a heart rate sensor, temperature and infusion drop level displayed on the i2C LCD user interface, several conclusions can be drawn, namely the device can display indicators of patient health development with 3 parameters, namely heart rate, body temperature and infusion level. A monitoring system equipped with a sound indicator warning in case of abnormal conditions in one of its parameters. The monitoring device cannot display patient data history on the i2C LCD user interface. From a reference source and doing this i2C LCD experiment, it has a disadvantage, namely that it cannot display and send decimal value data (the value of the decimal number) as in the temperature setting image display. There is a way to manipulate value data by changing it to text or string, but this can only manipulate data on the display without computational mathematical calculations.

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