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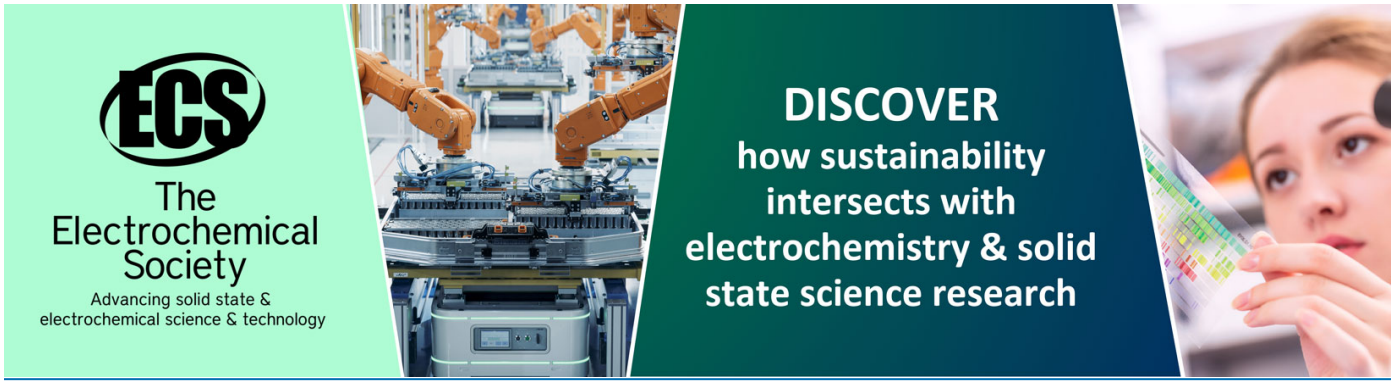

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Design a system of measurement of heart rate, oxygen saturation in blood and body temperature with non-invasive method

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Abstract. Heart disease is the number one cause of death in the world. The heart functions to pump blood flowing through the veins or arteries to all parts of the body. In the blood contains many levels of molecules or constituents, such as oxygen in blood HbO_2 (oxyhemoglobin). This study aims to design a system used to measure changes in voltage fluctuations to the transducer (photoplethysmography), oxygen saturation and changes in body heat. From the test result got error value at measurement of SpO_2 equal to 0.89% and for measurement of BPM (heart rate) equal to 3.095%, difference or difference measurement of body temperature sensor got error value equal to 0.78%.

1. Introduction

The human body consists of various vital organs that are interconnected and have a unique and complex function. The heart as a vital organ that serves to provide oxygen throughout the body and cleanse the body of the metabolism (carbon dioxide). Heart disease is the number one cause of death in the world, so the need for early detection of this disease. The pulse can be measured at any point on the body where the vibrations in the arteries are sent to the surface frequently when it is pressed against a structure that lies beneath such a bone [1].

Pulse oximetry is a non-invasive method for measuring the percentage rate of hemoglobin saturation. This method uses the different wavelengths of red light (660 nm) and infrared light (940 nm) captured by the detection sensors after passing through the veins and capillaries at the tip of the index finger [2]. Pulse oximetry serves to manage long-term patients with oxygen therapy and to identify patients with congenital heart disease. Pulse oximetry has a high accuracy for detecting congenital heart disease in newborns [3].

Photoplethysmography is an optical technique of detecting cardiovascular pulse waves (heart) from the fingertips. By exploiting optical sensor reflection then warming the area around the skin, this is evidenced by the increasing beats component of photoplethysmography [4]. The design of monitoring of integrated signal monitoring system on a platform of system on chip (SoC) and wireless technology in hospital with monitored parameter is ECG and body temperature then processed using microcontroller. Results from data processing are sent to the web server using wireless communications [5].

Detection of beat pressure (pulse) is an integration of most analytical techniques for arterial blood pressure (ABP), intracranial pressure (ICP) and pulse oximetry signals (SpO2). Pulse detection is used

to estimate heart rate in ABP signals, to classify ICP morphology and to estimate blood pressure using pulse oximeter wave [6]. Therefore, medical record media of heartbeat, oxygen saturation in blood and body temperature are computationally computed and study of observation approach of health condition of body without any surgery or physical or non-invasive, and is expected to prevent human death due to abnormalities heart early because of the less than optimal medical record and responsive.

2. Materials and methods

This section explains the materials and methods used in this research.

2.1 Materials

Heart rate sensor and oxygen saturation in blood, body temperature sensor, Arduino Board Due, MULTISIM® software, and BASCOM® SIMULATOR software.

2.2 Method

The selection of sensor types used for the measurement of heart rate parameters, oxygen saturation and body temperature with the measuring unit of each monitoring parameters placed on the fingers, then by analyzing the work characteristics and suitability of each component supporting the idea of design obtained the initial design is steady and optimal both in terms of mechanical, electronic and ergonomic. The block diagram of the proposed method is shown in figure 1 and the design of the pulse oximetry sensor is shown in figure 2.

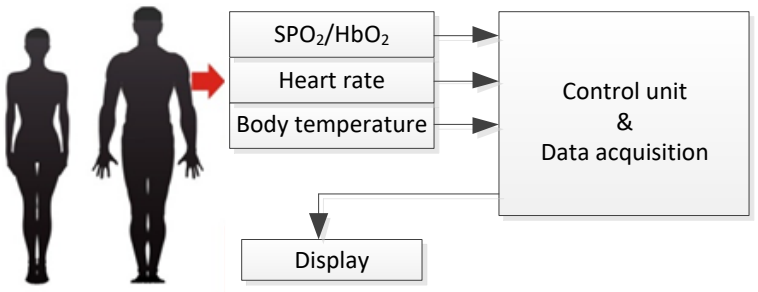

Figure 1. Block diagram of the proposed method.

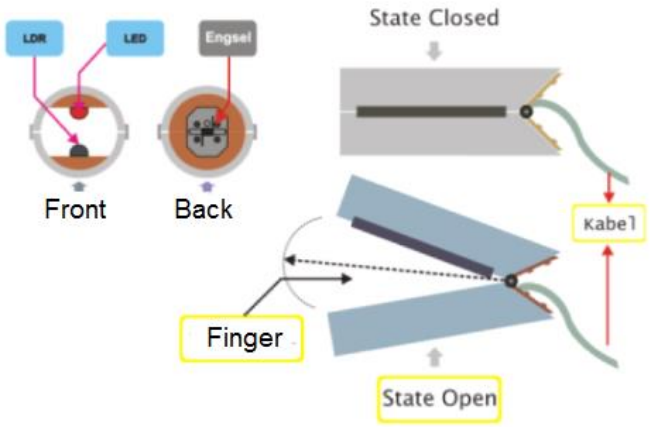

Figure 2. Design of pulse oximetry sensor.

3. Results and discussions

The system is a form of heart rate detection application by sensing the change in blood volume in the finger arteries as the heart pumps blood. It consists of an infrared LED that transmits an IR signal through the subject's fingertip, from the part reflected by the blood cells. The reflected signal is detected by the photo diode sensor. The change in blood volume with the heart rate at the output of the photodiode is not too large to be detected directly by the microcontroller.

Therefore, two stages of high gain and active low pass filter are required, the design uses two operational amplifiers (Op-Amp) to filter and amplify the signal at the appropriate voltage level so that the analog signal can perform computation by the microcontroller. Table 1 shows the results of SPO_2 testing of ten respondents with an average error of 0.89%. Table 2 shows the test results from BPM (heart rate) to ten respondents with an average error of 3.095%.

Table 1. Results of SPO_2 testing.

No	Respondent	R			SPO_2
		Led	IR	Difference	%
1	Respondent 1	2.0	2.0	1.0	85.0
2	Respondent 2	1.0	2.0	0.5	97.5
3	Respondent 3	1.8	2.0	0.9	87.5
4	Respondent 4	1.8	1.8	1.0	85.0
5	Respondent 5	1.4	2.0	0.7	92.5
6	Respondent 6	1.0	1.0	1.0	85.0
7	Respondent 7	2.0	2.0	1.0	85.0
8	Respondent 8	1.4	1.4	1.0	85.0
9	Respondent 9	1.4	2.0	0.7	92.5
10	Respondent 10	1.0	2.0	0.5	97.5

Table 2. Heart rate test results.

No.	*Heart Rate* (bpm)	ECG BIOPAC (bpm)	*Error* (%)
1	74	73.35	0.886
2	68	67.80	0.295
3	78	75.00	4.000
4	82	77.00	6.494
5	70	72.90	3.978
6	64	69.40	7.781
7	86	83.00	3.614
8	80	81.00	1.235
9	78	77.00	1.299
10	74	75.00	1.333

Table 3 shows the value of human body temperature test results against ten respondents with an average error of 0.78% The results of the measurement of heart rate parameters, oxygen saturation in blood and body temperature are represented in units of measured values displayed on 16x2 LCD. The measurement value is fluctuating, because the measurement uses non-invasive method (without surgery).

Table 3. Body temperature test results.

No	Respondent	Body Temperature (°C)		*Error* (%)
		Digital Thermometer	Measuring Instrument	
1	Respondent 1	37.0	37.12	0.32
2	Respondent 2	36.5	36.76	0.71
3	Respondent 3	36.6	36.71	0.30
4	Respondent 4	36.3	36.76	1.26
5	Respondent 5	35.6	36.14	1.51
6	Respondent 6	36.6	37.02	1.14
7	Respondent 7	36.7	36.92	0.59
8	Respondent 8	36.8	37.12	0.86
9	Respondent 9	36.9	36.98	0.22
10	Respondent 10	36.7	37.04	0.92

4. Summary

The system created in this study has been able to work in accordance with the planning, which can measure heart rate, oxygen saturation in blood and body temperature. From the test results can be concluded that the difference or different pulse oximetry sensor measurement obtained error value on measurement of SPO_2 of 0.89% and for the measurement of BPM (heart rate) of 3.095%. Differences or differences in body temperature sensor measurement obtained error value of 0.78%. Difference or difference between measurable and measured measurements caused by several errors, including finger shape output error for sensor readings. The sensor response time is average when the tool is turned on for approximately 20 seconds.

Acknowledgments

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