Design and Implementation Monitoring System for The Effects of Prolonged Sitting

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A B S T R A C T S

Workers spent more than two-thirds of their working hours sitting behind their desk. Almost all of them never put attention to good sitting position and caused health problems for themselves such as increasing the risk of hemorrhoids, heart disease, diabetes, obesity, joints damage, muscles and posture. The workers are not aware into account how long they had been sitting. Thus, one way to avoid health problems caused by long-term sitting is using a device which monitors body temperature, heart and muscle. In this study, the prototype is designed and implemented to monitor how long the worker had sit in their chair and the effect to their body. This system detected the temperature on the chair using temperature sensor, sensor ECG to heart detection placed on the finger and the sensor EMG to detect muscle is placed on the hand muscles. The information from the sensors are sent and saved to the database server and displayed through the website. The test results indicate that body weight and gender affect the speed of rise of body temperature which is measured on the seat cushions. Functional testing using the web interface successfully performed in displaying the results to the web interface sensor readings in real time and displays the results of the previous sensor readings.

K E Y W O R D S

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1. INTRODUCTION

The habit of employees who work in offices is to spend more than two-thirds of their working hours sitting at their desks [1], and they pay less attention to good body position when working. This routine can continuously cause health problems for him. Sitting for too long can increase the risk of hemorrhoids, heart disease, diabetes, obesity, as well as damage joints, muscles and body posture [2]–[4] This research also shows that breaking up sitting for two minutes every 20 minutes can improve glucose and insulin responses after eating, thereby reducing the risk of diabetes and heart disease [5]. However, sometimes employees do not realize and do not take into account how long they have been sitting. Therefore, a device is needed that can provide warnings about the length of time someone has been sitting in their chair, so that office workers in particular can avoid the risk of health problems caused by sitting too long.

Apart from that, this tool can also provide information to companies about the health conditions of their employees, especially for those who spend more than two-thirds of their working hours sitting at their desks to avoid the risk of diseases such as hemorrhoids, heart and muscle diseases. This monitoring system must fulfill several basic requirements in the form of data accuracy, effectiveness and sustainability. Accurate data is of course based on the results of sensor readings on the object being measured, and effectiveness means that monitoring can be carried out anywhere and at any time outside the location of the object, while continuous means that data that is measured continuously can be stored so that it can help monitoring implementers in making decisions [6] , [7].

Several studies have been conducted related to real time monitoring for health. Hongxu, et al monitored apnea patients, apnea is a chronic sleep disorder, using EEG sensors and ECG sensors, before being sent to the microcontroller the signal was strengthened by an amplifier circuit. The signal from the sensor is converted into digital data and then entered into a database to analyze the relationship between EEG and ECG in apnea sufferers [8]. Al Rasyid et al. developing WSN-based mobile Electromyogram (EMG) monitoring using the e-health sensors platform. The sensor reading results will be displayed on the mobile application. Patients can see the percentage of muscle tension in real time. Additionally patients can view their previous EMG data [9]. Saputro, et al use MPX5100DP & DS18B20 sensors to monitor patient body temperature and blood pressure, the sensor reading results are then stored in the server database. Patients and doctors can see monitoring results on the website application [10].

In this research, a risk warning tool for prolonged sitting was developed. This tool works based on the temperature detected on the seat cushion that has been designed, the heart detection sensor (ECG) is placed on the finger and the muscle detection sensor (EMG) is placed on the hand muscles, the information is then sent to a

database. server and displayed via the website. So the results of these sensor readings can be determined and analyzed by doctors and experts as input for companies in positioning their employees.

2. RESEARCH METHODOLOGY

In this section will discuss the design tools, implementation of the system and how the system works base on the outline of the system design. The explanation of the hardware also explains in this section, which consists of several parts to process the data including the design and manufacturing information systems.

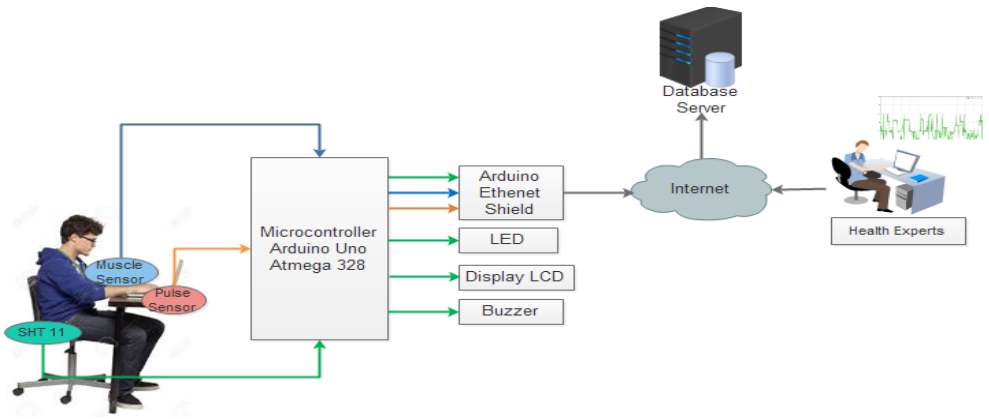

FIG 1.. Scheme of monitoring system design

Figure 1 can be explained, devices of warning system of risk long-term sitting is working based on the temperature detected in the seat cushion. To detect the temperature, the tool is equipped with temperature sensors SHT11 which is placed at the bottom seat cushion, sensors of the heart detection (ECG) were placed on the finger and the sensor detecting muscle (EMG) is placed on the hand muscle. Microcontroller arduino Atmega328 control the whole system work. The microcontroller informs the value of the temperature of the pillow with LED indicators and display on the LCD. LED and buzzer use as a warning indicator if the worker has been sitting too long. Table 1 shows the reference of warning devices of risk long-term sitting.

TABLE 1. Reference of warning devices of risk long-term sitting

Temperature (^{O}C)	Led Indicator	LCD Display (^{O}C)	Buzzer
<36	Green	Value of temperature detection	Off
36 – 37	Yellow		Off
>37	Red		On

Table 1 can be explained that the temperature sensor detects a temperature less than 36 °C, then the LED indicator will show a green color and the buzzer off, then the temperature sensor reading will continue to run and when the temperature sensor detects a temperature between 36 ºC to 37 ºC , the LED indicator will showing yellow and buzzer still off , and when the temperature sensor detects a temperature greater than 37 °C , the LED indicator will show red and the buzzer on and workers will be advised to stand on temporarily until the LED shows green again. The LCD will display the temperature detected by the temperature sensor SHT11. Information from microcontroller (temperature, heart rate and muscle) are also sent to the database server using an Ethernet shield and displayed using the mobile application website shaped to allow a user to monitor.

Hardware Design

Hardware design consists of design tools and circuit. A tool will be placed on a chair and desk office workers. Sensor SHT11 position on the pillow shown in Figure 2.

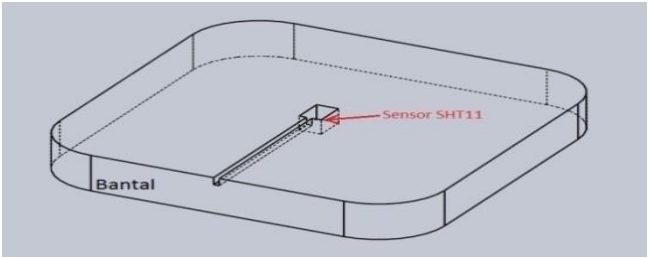

FIG 2. Sensor SHT11 position on the pillow

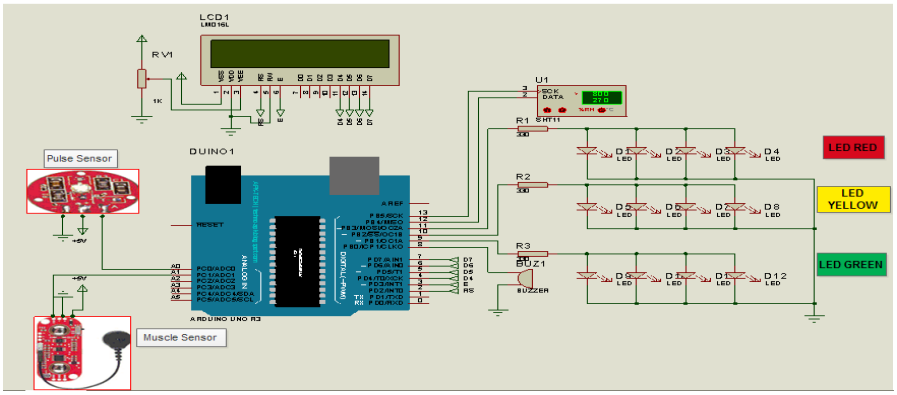

FIG 3. Electronics circuit monitoring system for effect of long-term sitting

Figure 3 contain of an electronic circuit monitoring system for effects of long-term sitting, arduino microcontroller, sensor and circuit LCD, LED, and buzzer. Microcontroller functions to manage and control the result of SHT11 sensor reading , pulse sensor and muscle sensor connected to the pin D11, A0 and A1. The results of the sensor signal processing in the microcontroller ATmega328 is displayed on the LED circuit which connected to the pin D11, D10, D9, lcd circuit and buzzer pin D8.

Information System Design

Microcontroller communication with the server using the PHP programming language to sent and stored a database uses Mysql. This application is displayed via a web browser using PHP software, Ajax and Java script. Figure 4 shows the layout of the database and the remote monitor interface for health professionals. Health professionals can edit the details of the patient, add new records and view the status of health (real time measurement of the heart rate and muscle tension) employees

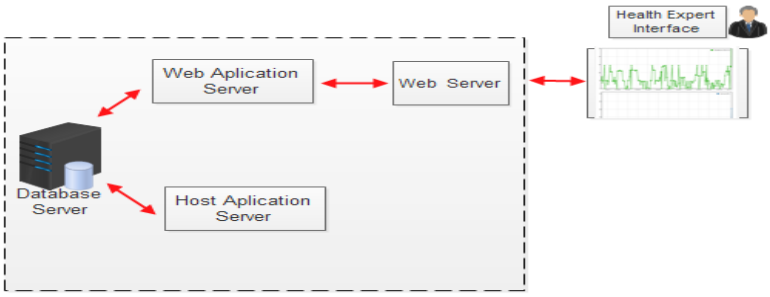

FIG 4. Layout to Monitor Database

3. RESULTS AND DISCUSSION

Overall testing system aims to find out that the whole system is working as desired. Systems designed have been tested to six employees at Politeknik Negeri Padang. Figure 5 is a view of the warning device test overall risk of long-tem sitting. Tests carried out in two stages. The first phase of testing was conducted to determine whether the risk of long-term sitting warning device works according to the predetermined temperature. The second phase of testing is the monitoring database, if all sensor readings have been stored to database in real time. With web applications can access the patient's medical experts as well as all measurements are done remotely.

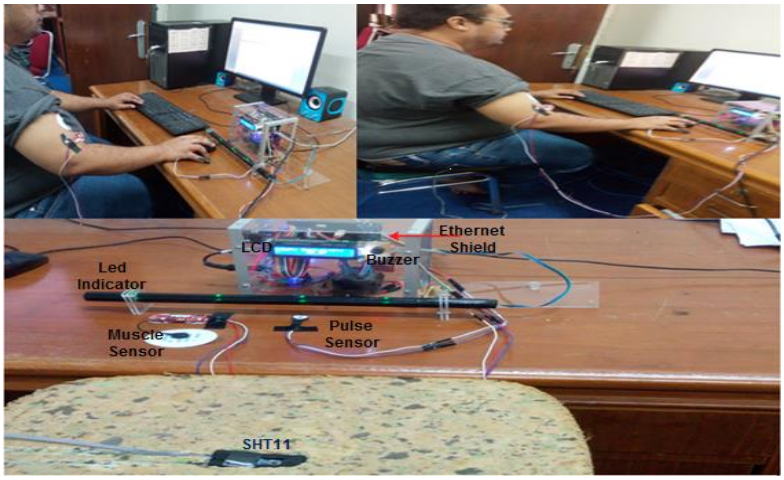

FIG 5. The testing of the monitoring system

A. Testing of Prolonged Sitting Risk Warning Tools

Tests conducted to determine the worker's body temperature rise measured on the bearing seat by long-term sitting while they work. Temperature measurement of cushion is carried out per half hour. Temperature measurement of cushion is done in three stages. The first phase is cushion temperature measurements at two places that have different room temperatures, but with the same weight of people. The second phase of measurements performed on two people with different weight but in the constant room temperature. The third stage is to compare the body temperature by long-term sitting male with female.

TABLE 2. Experiment of warning system for effect of long-term sittingbase on room temperature

Room Temperature 30^{O}C				Room Temperature 27 ^{O}C			
Minutes	**Temperature (^{O}C)**	**Led Indicator**	**Buzzer**	**Minutes**	**Temperature (^{O}C)**	**Led Indicator**	**Buzzer**
1	31.12	Green	Off	1	28.96	Green	Off
30	34.61	Green	Off	30	34.51	Green	Off
60	35.21	Green	Off	60	35.56	Green	Off
90	35.72	Green	Off	90	36.21	Yellow	Off
120	36.12	Yellow	Off	120	36.53	Yellow	Off
150	36.57	Yellow	Off	150	36.88	Yellow	Off
180	36.91	Yellow	Off	172	37.03	Red	On
195	37.02	Red	On	180	37.05	Red	On

Based on the measurement results in Table 2, it can be seen the temperature of the room greatly affect the temperature of the pillow at the beginning of the measurement. In the early minutes of the measurement sensor detects temperature SHT11 cushion approaching room temperature. Further measurements were performed at two people with different weight but in the same room and room temperature remained 27 °C. Measurements were performed twice with the first weight 70 KG and the second weight 110 KG. The test results can be seen in table 3.

TABLE 3. Experiment of warning system for effect of long-term sitting base on weight

Weight 70Kg				Weight 110Kg			
Minutes	**Temperature (^{O}C)**	**Led Indicator**	**Buzzer**	**Minutes**	**Temperature (^{O}C)**	**Led Indicator**	**Buzzer**
1	28.96	Green	Off	1	28.01	Green	Off
30	34.51	Green	Off	30	32.52	Green	Off
60	35.56	Green	Off	60	34.58	Green	Off
90	36.21	Yellow	Off	90	35.86	Green	Off
120	36.53	Yellow	Off	120	36.36	Yellow	Off
150	36.88	Yellow	Off	150	36.98	Yellow	Off
172	37.03	Red	On	155	37.02	Red	On
180	37.05	Red	On	165	37.08	Red	On

Based on the monitoring body temperature of two people who have different body weight is 70 KG and 110 KG , it is known that body weight affects the speed of rise of body temperature measured on the pillow. In the first weighing 70 KG reaches body temperature above 37 ºC in 172 minutes, while the second person weighing 110 KG reaches body temperature above 37 ºC in minutes to 155 minutes. This indicates the greater weight; the faster temperature body measured on the pillow reaches temperatures of over 37 ° C. Temperature greater than 37 °C are categorized exceeding above normal human body temperature. In the third stage, compare the body temperature measurement by long-term sitting male with female. The measurement results can be seen in table 4.

TABLE 4. Experiment of warning system for effect of long-term sitting base on different sex

Man				Woman			
Minute	**Temperature (ºC)**			**Minute**	**Temperature (ºC)**		
	Rizky (58 KG)	**Jaka (59 KG)**	**Hanafi (58 KG)**		**Nela (61 KG)**	**Ani (62 KG)**	**Citra (62 KG)**
1	29.04	29.52	29.22	1	29.75	30.12	30.07
30	33.90	33.38	33.51	30	34.38	34.55	34.10
60	34.88	34.76	34.79	60	35.11	35.21	35.05

Based on measurements according to gender differences, it was carried out on 6 people, namely 3 men and 3 women who had almost the same body weight, namely ranging from 58 KG to 62 KG, with an average body weight of 60 KG. It is known from the measurement results in table 4 that men sitting for one hour measured an average body temperature of 34.81 oC, while women sitting for one hour measured an average body temperature of 35.12 oC. This shows that women's body temperature rises faster than men's body temperature.

B. Functional Testing Using a Web Interface

Testing of this system was carried out by testing the functionality of the web-based heart rate and muscle temperature monitoring system. The web interface test results can be shown in table 5 and the web interface display showing all sensor readings can be seen in figure 6.

TABLE 5. System web interface test results

No	*Parameter*	Yes	NO
1	Connection to database	√	
2	Displays sensor reading results on the web interface in real time	√	
3	Displays the results of previous sensor readings	√	

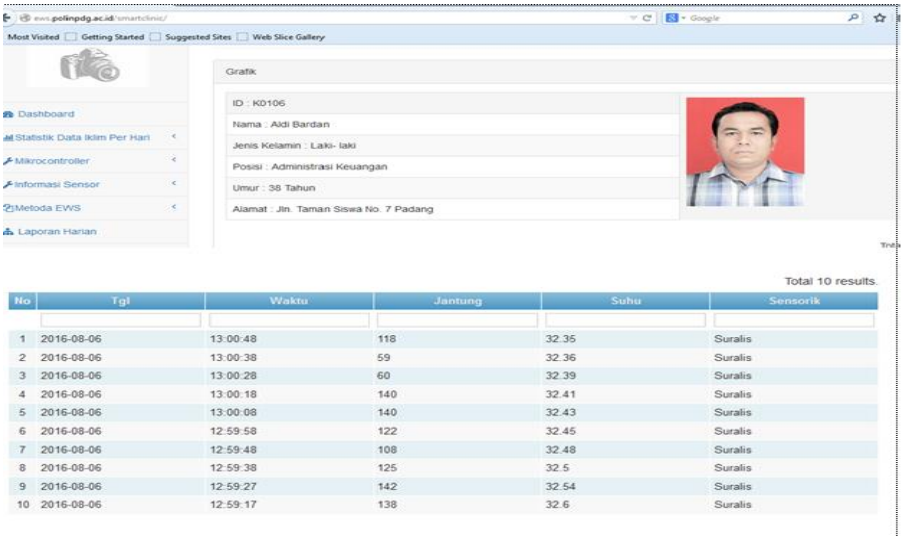

FIG 6. Web interface display

To measure the delay from the Arduino to the server computer, an RTC (Real time Clock) circuit is needed, so that it can be compared with the server clock. The test results are in the following table.

TABLE 6. Testing time from sender to server

No	RTC (hh:mm:ss)	Server (hh:mm:ss)	Delay (ss)
1	10:24:35	10:25:41	66
2	10:24:42	10:25:46	64
3	10:24:45	10:25:49	64
4	10:24:44	10:25:47	63
5	10:24:47	10:25:50	63
6	10:24:49	10:25:52	63
7	10:24:51	10:25:54	63
8	10:24:53	10:25:56	63
9	10:24:55	10:25:58	63
10	10:24:57	10:26:00	63
		Rata-rata Delay	63,5

Based on Table 6 of 10 test results, 10 data from the time from Arduino to server averaged 63.5 seconds or 1 minute 3 seconds. The test results show that the system is able to transmit monitoring data reliably

4. CONCLUSIONS

This research presents the design of a tool and system for monitoring the effects of prolonged sitting with temperature parameters. The design includes hardware and software to process monitoring data and send it to the monitoring server. The design of the tool developed was tested on employees at the Padang State Polytechnic to determine the function of the tool and monitoring system. Based on the results of testing the tool, it is known that people who weigh approximately 70 KG need 172 minutes to pass a temperature of 37 oC, and people who weigh approximately 110 KG need 155 minutes to pass a temperature of 37 oC. Women's body temperature is faster. increased by 0.31 oC compared to men's body temperature based on sitting time. The bargraph as an indicator will be active in green when the body temperature is less than 36 oC, the yellow bargraph will be active when the body temperature is between 36 oC to 37 oC, and the red bargraph is active when the temperature body is greater than 37 oC. The buzzer is an active indicator when the body temperature has entered a dangerous condition, namely when the temperature is above 37 oC. The monitoring system can work well displaying measurement results data in real time via a web browser. The client node device can read and process sensor output data and send monitoring data to the internet with an average delivery delay time of 63.5 seconds.

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