BLUETOOTH BASED HEALTH MONITORING DEVICE

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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BLUETOOTH BASED HEALTH MONITORING DEVICE

TAN KIEN LEONG

This report submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunications Electronics) With Honours

Faculty of Electronics and Computer Engineering

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FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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I hereby, declared this report entitle "BLUETOOTH BASED HEALTH MONITORING DEVICE" is the results of my own research except as cited in the references

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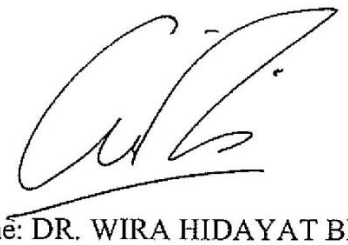
Signature: 

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DEDICATION

Special dedication to my beloved parents,

Tan Sea Eng & Ooi Hor Tiew

To my supervisor

Dr Wira Hidayat Bin Mohd Saad

My friends and my fellow lecturers

Thank you for all your care, support and believe in me

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ABSTRACT

Health monitoring device is a device that able to monitor vital body‟s sign. The developments in sensor technology and wireless communication technology have made health monitoring device to become portable and wearable. However, adding more sensors into health monitoring device will increase its weight and size. This will cause an uncomfortable feeling to user if user needs to use it for a long period of time. Besides that, a device interface needs to be created on the computer to process and display the data sent by health monitoring device. Thus, the main objective for this project is to design the portable devices using BLUNO microcontroller with pulse rate sensor and thermistor. The device graphical user interface (GUI) is designed on the Windows 8 platform. The developed health monitoring device is tested on five persons to verify its functionality. Overall, the developed health monitoring device able to measured the heart rate and body temperature and then send data to Windows Apps through Bluetooth Low Energy 4.0.

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ABSTRAK

Alat pemantau kesihatan merupakan alat yang dapat memantau tanda penting pada badan. Perkembangan dalam teknologi alat pengesan dan teknologi komunikasi tanpa wayar membolehkan alat pemantau kesihatan menjadi mudah alih dan boleh digunakan. Walaubagaimanapun, penambahan alat pengesan akan mengakibatkan berat dan saiz alat pemantau kesihatan semakin meningkat. Ini akan menyebabkan rasa tidak selesa kepada pengguna sekiranya pengguna perlu menggunakannya untuk tempoh masa yang panjang. Selain itu, penyambungan peralatan perlu diwujudkan di komputer untuk memproses dan memaparkan data yang dihantar daripada alat pemantau kesihatan. Oleh itu, objektif utama projek ini adalah untuk mereka bentuk alat mudah alih yang menggunakan peranti kawalan mikro BLUNNO dengan alat pengesan kadar nadi dan termistor. Peralatan „Graphical User Interface (GUI)" direka melalui platform Windows 8. Alat pemantau kesihatan ini telah diuji kepada lima orang untuk mengesahkan keadaan fungsinya. Secara keseluruhan, alat pemantau kesihatan ini dapat membaca kadar nadi dan suhu badan dan kemudian menghantar data tersebut ke Windows Apps melalui Bluetooth Low Energy 4.0.

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TABLE OF CONTENTS

CHAPTER	CONTENT	PAGES
	TITLE	**i**
	REPORT STATUS VERIFICATION FORM	**ii**
	DECLARATION	**iii**
	APPROVAL	**iv**
	DEDICATION	**v**
	ACKNOWLEDGMENT	**vi**
	ABSTRACT	**vii**
	ABSTRAK	**viii**
	TABLE OF CONTENTS	**ix**
	LIST OF FIGURES	**xii**
	LIST OF TABLES	**xiv**
	LIST OF ABBREVIATIONS	**xv**
	LIST OF APPENDICES	**xvi**
I	**INTRODUCTIONS**	
	1.1 INTRODUCTION	1
	1.2 PROJECT OBJECTIVES	2
	1.3 PROBLEM STATEMENT	2
	1.4 SCOPE OF WORK	3
	1.5 CHAPTER REVIEW	3

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II LITERATURE REVIEW

2.1 HEART RATE 4
2.2 HUMAN BODY TEMPERATURE 6
2.2.1 SPECIFIC TEMPERATURE CONCEPTS 7
2.3 HEART RATE SENSOR 7
2.4 THERMISTOR 8
2.5 BLUNO MICROCONTROLLER 9
2.5.1 SPECIFICATION 10
2.6 BLUETOOTH 11
2.6.1 CLASSICAL BLUETOOTH 11
2.6.2 BLUETOOTH LOW ENERGY 11
2.7 RELATED RESEARCH 14

III METHODOLOGY

3.1 METHODOLOGY 19
3.2 DESIGNING ALGORITHM FOR HEART RATE SENSOR 21
3.3 DESIGNING ALGORITHM FOR BODY TEMPERATURE SENSOR 26
3.4 PROCEDURES TO ESTABLISH CONNECTION BETWEEN BLUNO AND PC 29
3.5 DESIGNING ALGORITHM FOR BLUNO TO READ DATA FROM SENSORS AND SEND DATA TO PC 32
3.6 DESIGNING ALGORITHM FOR DATA TRANSFER BETWEEN WINDOWS APPS AND BLUNO 35
3.7 PROCEDURES TO DISPLAY IMAGE ON WINDOWS APPS 39
3.8 HARDWARE FABRICATION 41

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IV	**RESULT & DISCUSSION**	
	4.1 HARDWARE & SOFTWARE LAYOUT	43
	4.2 WINDOWS APPS DATA VERIFICATION BY USING SERIAL MONITOR IN ARDUINO IDE	47
	4.3 HEART RATE & BODY TEMPERATURE VALUES FOR FIVE PERSONS	48
V	**CONCLUSION**	
	5.1 CONCLUSION	50
	5.2 SUSTAINABLE DEVELOPMENT	51
	5.3 COMMERCIALIZATION	51
	5.4 FUTURE WORK	51
	REFERENCE	52
	APPENDICES	55

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LIST OF FIGURE

Figure 2.1: PPG waveform 5

Figure 2.2: Autonomic physiological mechanisms 6

Figure 2.3: LED and photo-detector diode position for transmission and reflectance mode photoplethysmography (PPG) 8

Figure 2.4: Different kind of thermistor 9

Figure 2.5: Pinout of Bluno board 10

Figure 2.6: Bluetooth low energy protocol stack 13

Figure 2.7: Block diagram of button system 14

Figure 2.8: Block diagram of sensor interface 15

Figure 2.9: Block diagram of Low Cost Patient Monitoring Device 16

Figure 2.10: Block diagram of Medicare System 17

Figure 2.11: Block diagram of PIC microcontroller-based RF wireless ECG monitoring system 17

Figure 3.1: Project workflow 21

Figure 3.2: Flow chart for designing algorithm for heart rate sensor 22

Figure 3.3: Circuit connection for heart rate sensor 23

Figure 3.4: Flow chart for designing algorithm for body temperature sensor 27

Figure 3.5: Schematic diagram for body temperature sensor circuit 27

Figure 3.6: Bluno version 1.6 29

Figure 3.7: Flow chart for update BLE firmware on Bluno 31

Figure 3.8: Layout of DFRobot blunoFWDownloader 31

Figure 3.9: Status of Bluno on PC 32

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Figure 3.10: Flow chart for designing algorithm for Bluno 33
Figure 3.11: Flow chart for data transfer between Windows Apps and Bluno 35
Figure 3.12: Data binding technique 39
Figure 3.13: Image control 40
Figure 3.14: Steps to import image 40
Figure 3.15: List of images stored in Assets folder 41
Figure 3.16: Select image file to be displayed on screen 41
Figure 3.17: Body temperature sensor circuit in Proteus layout 42
Figure 4.1: Health monitoring device 44
Figure 4.2: Windows Apps for health monitoring device 44
Figure 4.3: Detect Bluno board 45
Figure 4.4: Bluno is connected with Windows Apps 45
Figure 4.5: Hold the sensors 46
Figure 4.6: Body temperature sensor 46
Figure 4.7: Heart rate sensor 47
Figure 4.8: Comparison of data displayed on Windows Apps and serial monitor 47

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LIST OF TABLES

Table 2.1: Specifications of heart rate sensor 8

Table 2.2: Comparison between classic Bluetooth & Bluetooth Low Energy 13

Table 4.1: Measured heart rate (BPM) for five persons 48

Table 4.2: Measured body temperature (degree Celsius) for five persons 48

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LIST OF ABBREVIATIONS

ECG	**-**	**Electrocardiogram**
ADC	**-**	**Analog to Digital Conversion**
BLE	**-**	**Bluetooth Low Energy**
BPM	**-**	**Beat Per Minute**

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LIST OF APPENDICES

APPENDIX	TITLE	PAGES
A	**Coding For BLUNO**	55
B	**Coding For Heart Rate Sensor**	57
C	**Coding For Body Temperature Sensor**	60
D	**Publication**	64

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CHAPTER I

INTRODUCTION

1.1 Introduction

In the last decade, portable health monitoring devices have increased a lot of interest from the medical industry and the research community as it is gaining interest by the enormous research and development works [1], [3]. Due to development in sensor technology and wireless communication systems, it provides opportunities for researchers to innovate health monitoring systems which can improve quality of life for individuals [3].

Nowadays, people are more aware of their health condition and thus there is a rising need for redevelopment in health managing system [2]. For health monitoring,

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one would accepted and used only if the monitoring system is tiny and lightweight, as this would not cause any inconvenience for the users and their daily activities [3-4]. Various types of prototypes and commercial products which are able to measure several types of body‟s vital-sign have been introduced to cater this demand. Decrease in power consumption, device dimension, and production cost, make it potential for integrating them into clothing or small apparel items which intent to providing real-time feedback information about one‟s health condition [1], [3]. These feedback information will be sent to the user himself or to a medical center through WiFi, Bluetooth or etc. so that user is being warned of potential health threatening circumstances [1].

1.2 **Problem statement**

A portable health monitoring device contains few sensors to monitor human body‟s vital sign. Combining various sensors into a device will increase the weight and dimension of that device. This will cause an uncomfortable feeling to the user due to its bulky size. A device interface needs to be created on computer to process and display the data sent by health monitoring device.

1.3 **Objective of project**

The aim of this study is to develop the portable Bluetooth based device to logging the data from several different sensors for health monitoring related application. In order to achieve this, some of the objectives need to be accomplished.

1. To design the portable devices using BLUNO microcontroller with pulse rate sensor and thermistor.
2. To create the device graphical user interface (GUI) on the Windows 8 platform.
3. To develop an algorithm that reads data from various sensors.

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1.4 Scope of project

A working prototype and device interface program will be produced at the end of this project. The health monitoring device consists of pulse sensor, body temperature sensor, and BLUNO microcontroller will be used. The device interface program will displays the heart rate (measured in beats per minute) and body temperature (measured in degree Celsius). In this study, the device interface program only been tested on Windows 8 or Window 8.1 operating platform, others operating platform like Windows phone and tablet are not tested.

1.5 Chapter Review

Chapter 1 describes the general overview of this project. This chapter presents the problem statement, objectives, scope of project and review of all chapters of this thesis. Chapter 2 discusses the previous work and sensors that been used in this project. The Bluetooth technology is also discussed in this chapter.

Chapter 3 presents the methodology to design algorithms for sensors and Bluno. The procedures to create a Windows Apps is also included. Chapter 4 describes the result obtained and a basic demonstration on how to use the developed health monitoring device. Chapter 5 presents the conclusion of this project.

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CHAPTER II

LITERATURE REVIEW

In this chapter, it describes the findings of a literature review of the project. Overall, it covers related research for health monitoring device. This chapter starts with the basic concept of heart rate and body temperature. Basic understanding on heart rate and body temperature is essential to control on how the bio-sensors measured data from the human body. Next, the basic operation of pulse rate sensor and thermistor will be discussed. Lastly, a few past related studies are presented at the end of this chapter.

2.1 Heart Rate

Sino-atrial node (SAN) consists of the primary pacemaker cells that produces the spontaneous electrical activity that controls the heartbeat. The electrical impulses are generated by a cluster of cells that are located in the upper part of the wall of the heart‟s right atrium. The electrical waveform generated by this instantaneous electrical activity is propagated through the atria, then follow by the cardiac conduction system, viz., atrioventricular node (AVN), Bundle of His, Bundle

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branches, and Purkinje fibre network, to the rest of the heart. This process known as the cardiac cycle will repeat itself throughout the life of an organism with a high level of efficiency [17].

There is a pulse wave propagated along all arteries to every appendage of capillary tissue when the heart circulates blood through the human body. The pulse wave travels faster than the speed of the blood circulates in the human body. Figure 2.1 shows the PPG waveform. When there is a pulse exists, the signal will rise rapidly and then falls back down to normal point when the pulse had gone. Usually the signal settles down to background noise although sometimes the dichroic notch is more noticeable than others before the next pulse wave. The heart rate is measured by calculating the duration between each peak since it is a repeating and predictable pulse wave. Any recognizable part of the pulse wave can be chosen as a reference point and usually peak of the pulse wave is chosen. Different researchers have their own definitions to define a pulse signal that exists. Some of them claim the signal exists when the signal rises to 25% or 50% of the amplitude, and some say it occurs when the gradient is steepest during the upward rise event [18].

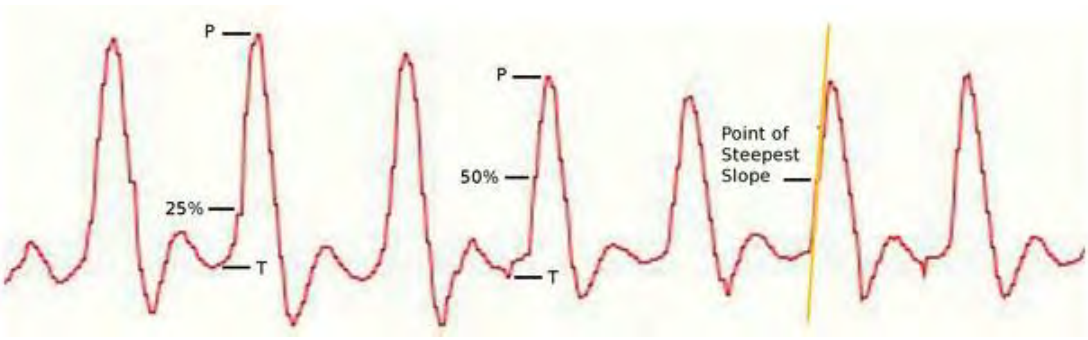

Figure 2.1: PPG waveform [18].

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2.2 Human Body Temperature

Normothermia or euthermia is the scientific term for normal human body temperature. It is a concept that the measurement is taken on different location of the human body and degree of activity of the person. Different parts of the human body will show different temperature value and thus there is no single number that represents a normal temperature for all people under all conditions. Skin temperature measurements are slightly lower than oral measurements, and oral measurement is fairly lower than rectal measurements [20]. The ability to detect and adjust body temperature is a key feature for human to survive. Physiological damages and fatality will occur when there is a differences of ± 3.5°C from the resting temperature of 37°C. There are few intrinsic factors that affect human body temperature, for example: ovulation, circadian rhythm, age, exercise, and thyroid hormones [22]. Figure 2.2 shows the flow chart for autonomic physiological mechanisms.

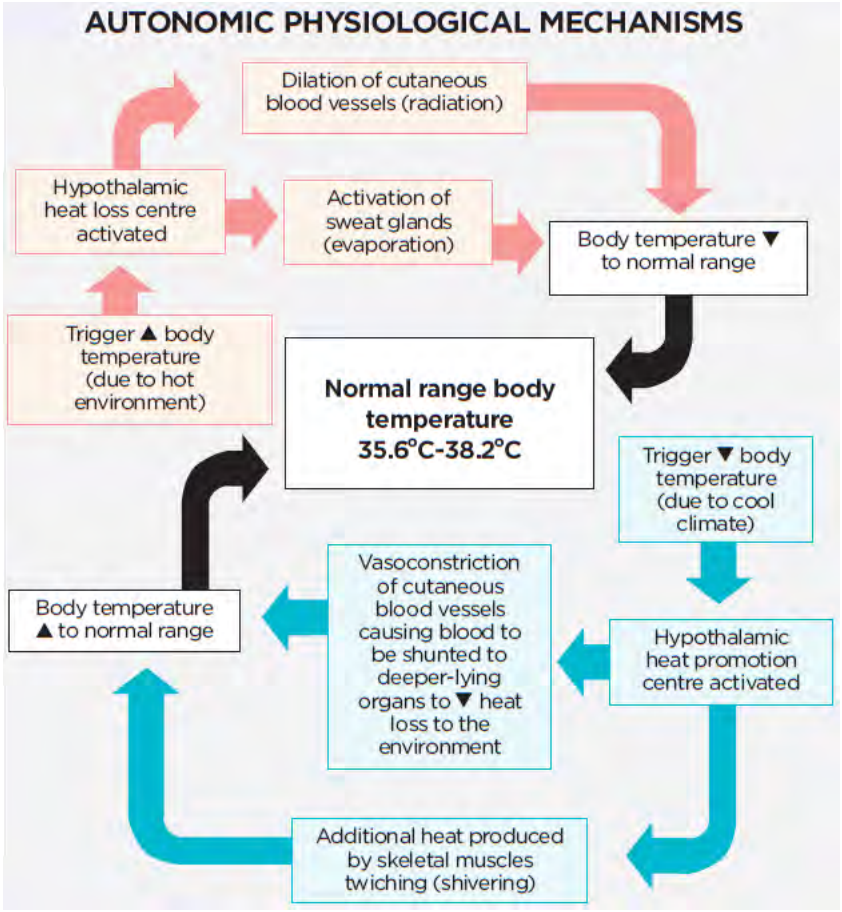

Figure 2.2: Autonomic physiological mechanisms [22].

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2.2.1 **Specific temperature concepts**

Hypothermia is a condition where the human body temperature decreases until to a point below that needed for bodily function and normal metabolism. This happened due to the human body over exposure to cold water or air for a long period of time. Symptoms will occur when the body temperature decreases by 1°C to 2 °C below normal temperature [20].

Fever is an increase in temperature more than 38°C and is a normal response to infectious disease, inflammation or drug treatment [22]. Afebrile or apyrexic, meaning "without fever" is a condition where an organism at optimum temperature. If the temperature is increased, but the reference point is not increased, then the consequence is hyperthermia [20].

Hyperthermia happens when a human body cannot dissipate heat that overproduces or absorbs. It is normally due to exposure to high surrounding temperatures for a long period of time. The heat-regulating mechanisms of the human body finally become unable to handle effectively with the heat, thus causing the human body temperature to rise out of control [20].

2.3 **Heart Rate Sensor**

The heart rate sensor used in this project is operated based on a well-studied technique for measuring cardiac activity known as Photoplethysmography (PPG). PPG used optical technique to measure changes in the blood volume of a part of the body. An LED is placed at the center of the heart rate sensor, emits light of a certain wavelength into finger, toe or ear to measure the heartbeat during the blood flow. A photo-detector diode placed near to the LED to measures the amount of light intensity reflected back from human body and thus produced the corresponding electrical current. When the light passed through the body skin and enters the underlying tissue, some portion of light is reflected, scattered and absorbed. Blood absorbs light more easily than surrounding tissue, therefore less light will be detected by photo-detector diode if there is more blood in that region. For every heartbeat,

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