BIOMEDICAL SIGNAL GENERATOR

CHUN WEY TONG

This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering and Computer Engineering with Honors

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2009

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Biomedical Signal Generator

Sesi Pengajian : 2008/2009

Saya CHUN WEY TONG
(HURUF BESAR)

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐ **SULIT*** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **TERHAD*** (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐ **TIDAK TERHAD**

Disahkan oleh:

________________________ (TANDATANGAN PENULIS)

________________________ (COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: 1178, Lorong Malinja,
Jalan Sungai Nibong,
36000 Teluk Intan,
Perak Darul Ridzuan.

Tarikh: ………………………..

Tarikh: ………………………..

“I hereby declare that this report is the result of my own work except for quotes as cited in the references.”

Signature	: ....
Author	: ....
Date	: ....

“I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering and Computer Engineering with Honors.”

Signature : …………………………………………..

Supervisor’s Name : …………………………………………..

Date : …………………………………………..

To my beloved mom and dad

ACKNOWLEDGEMENT

First and foremost, I would like to convey my deepest appreciation to my supervisor Cik Noor Shahida Binti Mohd Kasim for her patience, concern, invaluable guidance and also encouragement throughout the preparation of this thesis.

Besides that, I would like to dedicated my deepest thank to my beloved parents and family members for their tolerance, financial and moral support while completing my tertiary education here. Thanks to all the lecturers, friends, fellow course mate for their pleasure opinion and encouragement.

Last but not least, my thanks to the librarians and the technician of Universiti Teknikal Malaysia Melaka for their helping hand in providing invaluable resources.

ABSTRACT

In general, biomedical signals such as electrocardiogram (ECG) and heart sound signal play an extremely important role for doctors and other medical practitioners to forecast and determine a patient's well-being and condition. Although biomedical signals are very important to predict patient's condition but it is so hard to get the signals from human body for study and analysis purpose. Therefore, as a solution, a biomedical signal generator was developed in this final year project.

The objectives of this project are to build or construct a biomedical signal generator to read the signal data such as ECG and heart sound signals by using PIC as the simulator or processor. In this project, a SD/MMC was use as the external memory for the signal generator to store the signals data in text file. Besides that, a PIC18F452A was used as the processor to process or read the biomedical signals data from the external memory that is MMC. While for the output of the signal generator, it was observed on the LCD or on the PC using Hyper Terminal Interfacing.

ABSTRAK

Secara amnya, isyarat bio-perubatan seperti isyarat jantung dan isyarat denyutan jantung memainkan peranan yang penting bagi doktor ataupun mana-mana staf perubatan untuk mengenal pasti dan meramalkan keadaan dan kesihatan pesakit. Walaupun isyarat bio-perubatan adalah sangat penting untuk meramalkan kesihatan pesakit, tetapi ia adalah susah untuk mendapatkan isyarat-isyarat terus daripada badan manusia untuk tujuan pembelajaran dan analisasi. Oleh itu, untuk menyelesaikan masalah ini, satu "*Biomedical signal generator*" telah dibina dalam projek sajana muda.

Objektif projek sajana muda ini adalah untuk membina "*Biomedical signal generator*" untuk membaca data isyarat bio-perubatan seperti isyarat jantung dan isyarat bunyi jantung dengan mengunakan "*PIC*" sebagai "*processor*". Di dalam projek sajana muda ini, "*SD/MMC*" akan digunakan sebagai media penyimpan luar untuk menyimpan data isyarat dalam bentuk "*text file*". Selain itu, PIC18F452 akan digunakan sebagai "*processor*" untuk membaca data isyarat bio-perubatan. Untuk *output*, LCD atau PC ("HyperTerminal") akan digunakan untuk mempaparkan data isyarat bo-perubatan tersebut.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

LIST OF ABBREVIATIONS

ECG/EKG	-	Electrodiagram
EEG	-	Electroencephalography
PIC	-	Peripheral Interface Controller
PSM	-	Project Sajana Muda
SD	-	Secured Digital
USART	-	Universal Synchronous Asynchronous Receiver Transmitter
DSP	-	Digital Signal Processing
ADC	-	Analog to Digital Convertor
DAC	-	Digital to Analog Convertor
RAM	-	Random Access Memory
I/O	-	Input or Output
ISR	-	Interrupt Service Routine
CPU	-	Central Processing Unit
ICSP	-	In Circuit Serial Programming
LVP	-	Low Voltage Programming
IDE	-	Integrated Development Environment
ANSI	-	American National Standards Institute
DRM	-	Digital rights management
MMC	-	Multi-Media Card
SPI	-	Serial Peripheral Interface
VB	-	Microsoft Visual Basic
CS	-	Chip Select
LCD	-	Liquid Crystal Display

CHAPTER 1

INTRODUCTION

1.1 Background Study

Biomedical signal is or biopotential is an electric quantity (voltage or current or field strength), caused by chemical reactions of charged ions. Another use of the term lies in describing the transfer of information between and within cells, as in signal transduction. Example for biomedical signal is electrocardiogram, heart sound signal, lung sound signal, etc.

Biomedical signals such as electrocardiogram (ECG) indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle. It is the best way to measure and diagnose abnormal rhythms of the heart, particularly abnormal rhythms caused by damage to the conductive tissue that carries electrical signals, or abnormal rhythms caused by levels of dissolved salts (electrolytes), such as potassium, that are too high or low. In myocardial infarction (MI), the ECG can identify damaged heart muscle.

Nowadays, biomedical signals such as ECGs are easily recorded at the bedside using portable machines. Electrodes are placed in specified positions on the patient's bare skin, and a simultaneous recording from all the leads is processed via a computer and the resultant ECG printed out on standard paper.

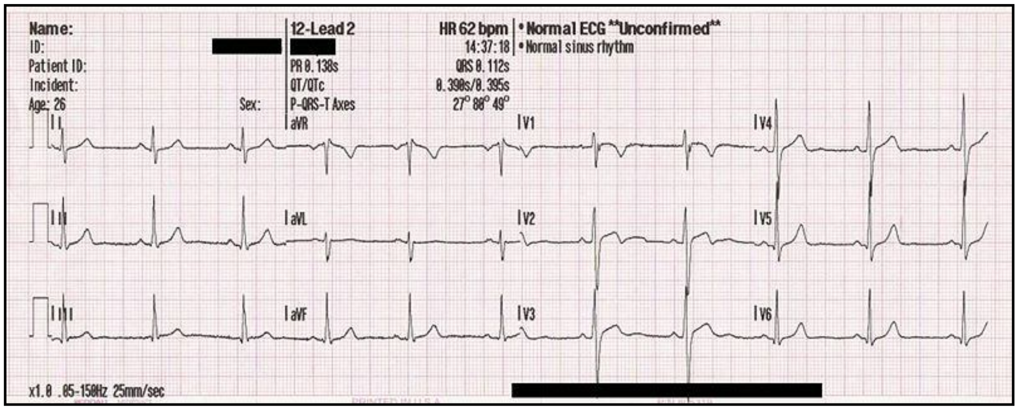

Figure 1.1 Example of 12 Lead ECG of a 26 year old male [1]

Since the biomedical signal are very important to predict patient's condition, therefore, a biomedical signal generator which can store data and regenerate the signal similar with human signal for monitoring purpose was develop in this project.

1.2 Objectives

The objectives of the project are:

(I) To construct the signal generator using PIC (PIC was used as a simulator or processor)

(II) To read the signal data from MMC

(III) To display the signal data read from MMC at LCD

1.3 Problem Statement

In real life, it is hard to get a desired biomedical signal straight from a human body for a study and analysis purpose. As a solution to make the study and analysis easier, a signal like ECG, EEG, heart sound signal, lung sound signal etc was generated.

Besides that, the signal generator was constructing for calibration purpose. These are because the ECG machine needs to calibrate every half year and for safety purpose, signal generator was use to replace human signal for calibration.

1.4 Scope

- A PIC18F452 will be used as a platform or simulator to read the biomedical signal data from MMC.
- The biomedical signal data was saved in external memory like SD/MMC memory card in a text file format.
- The project will concentrate on generating ECG and the heart sound signal first. For the further improvement, EEG signal and lung sound signal can be added into this signal generator.
- The data will be display on the LCD or on the PC using Hyper Terminal.

1.5 Project Methodology

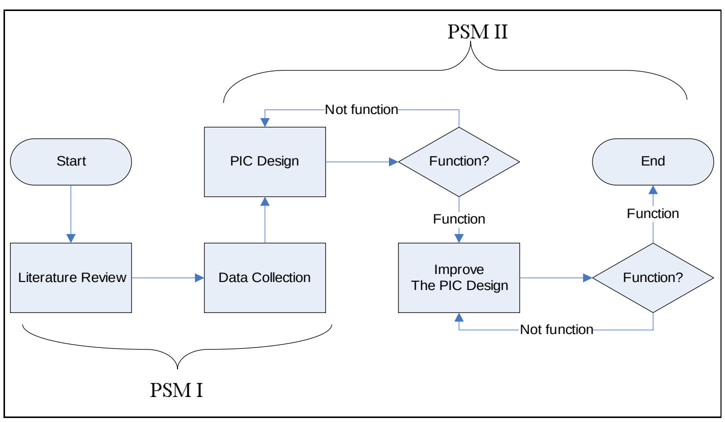

Figure 1.2 Methodology of Final Year Project

The sequences of the step to complete the project are illustrated in flowchart shows in Figure 1.2. Basically, this final year project are divided into two sections that is PSM I and PSM II. For PSM I, research, literature review and data collections was done. Besides that, experimental design will be planned and the design will be used to build the signal generator in PSM II. While in the PSM II, signal generator was designed and built.

1.6 Thesis Overview

Chapter 1: Introduction of the final year project. This chapter introduces the purpose of the signal generator and why I choose this project. Besides that, this chapter also includes objective, problem statement, scope, methodology of the project, and thesis overview.

Chapter 2: Literature review. This chapter mentioned the literature review that had been done before the project is started. This chapter includes background study, theory, research and data collections.

Chapter 3: Microcontroller. This chapter was mentioned functions, embedded system of the PIC18F452, the programming language use to develop the program and the compiler use to compile the program.

Chapter 4: Methodology. This chapter mentioned about method and approach used to do the project. Besides that, this chapter also mentioned method use to analyze the data, factors considered when choosing the method, advantages and disadvantages of the method.

Chapter 5: Results and Discussion. This chapter mentions about the results of the project and discussion of the projects.

Chapter 6: Conclusion and Future Development. This chapter mentioned about the finding of the project, data conclusion and suggestion to the project's future improvement.

CHAPTER 2

LITERATURE REVIEW

2.1 Biomedical Signals

There are many types of biomedical signals such like electrocardiogram (ECG), heart sound signals, electroencephalography (EEG), lung sound signals and etc.

2.1.1 Electrocardiogram (ECG)

An electrocardiogram is a recording of the electrical activity of the heart over time produced by an electrocardiograph, usually in a noninvasive recording via skin electrodes. [1]

Sympathetic electrical impulses in the heart originate in the senatorial node and travel through the heart muscle where they impart electrical initiation of systole or contraction of the heart. An ECG displays the voltage between pairs of these electrodes, and the muscle activity that they measure, from different directions, also understood as vectors. This display indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle. It is the best way to measure and diagnose abnormal rhythms of the heart, particularly abnormal rhythms caused by damage to the conductive tissue that carries electrical signals, or abnormal rhythms caused by levels of dissolved salts (electrolytes), such as potassium, that are too high or low.

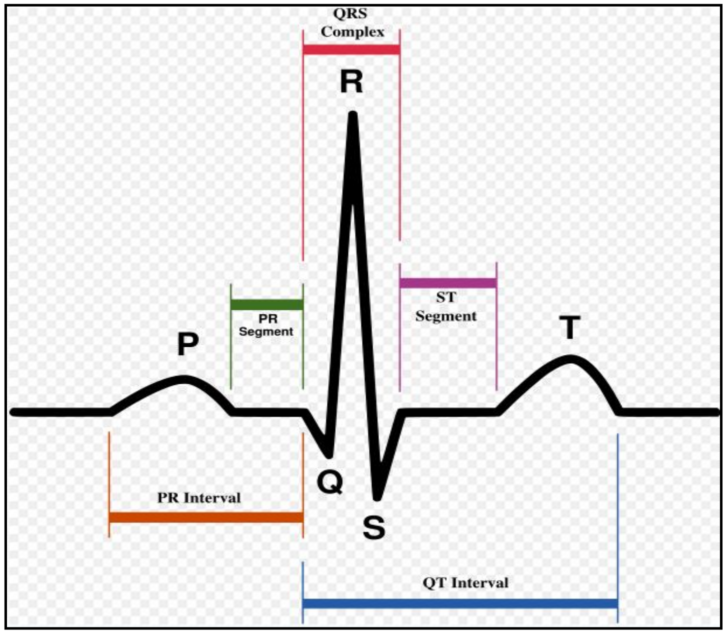

Figure 2.1 Schematic Representation of Normal ECG [1]

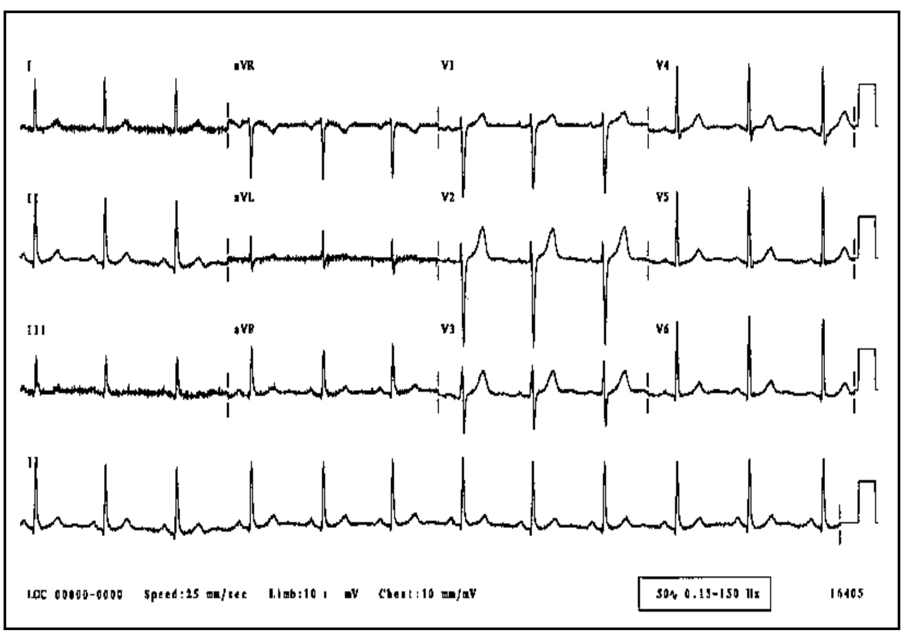

Figure 2.2 A Normal Adult 12-Lead ECG [2]

2.1.2 Heart Sound Signals

The heart sounds are the noises or sound that generated by the beating heart and the resultant flow of blood through it. This is also called a heartbeat. In cardiac auscultation, an examiner uses a stethoscope to listen for these sounds, which provide important information about the condition of the heart. [3]

There are two major sounds heard in the normal heart sound like "lub dub". The "lub" is the first heart sound, commonly termed S1, and is caused by turbulence caused by the closure of mitral and tricuspid valves at the start of systole. The second sound, "dub" or S2, is caused by the closure of aortic and pulmonic valves, marking the end of systole. Thus the time period elapsing between the first heart sound and second sound defines systole (ventricular ejection) and the time between the second sound and the following first sound defines diastole (ventricular filling).[4]

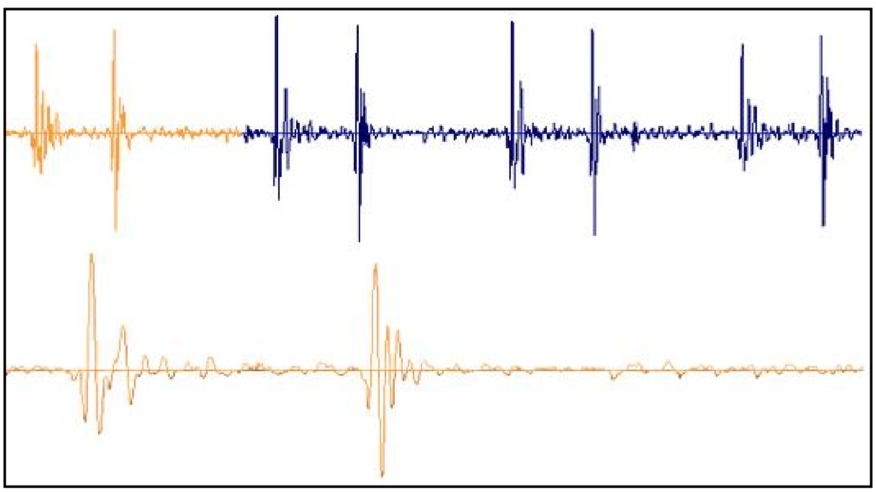

Figure 2.3 A Heart Sound Signal for a Normal Heartbeat

2.1.3 Electroencephalography (EEG)

Electroencephalography (EEG) is the measurement of electrical activity produced by the brain as recorded from electrodes placed on the scalp. EEG signals are amplified and digitalized for later processing. The data measured by the scalp EEG are used for clinical and research purposes. [5]

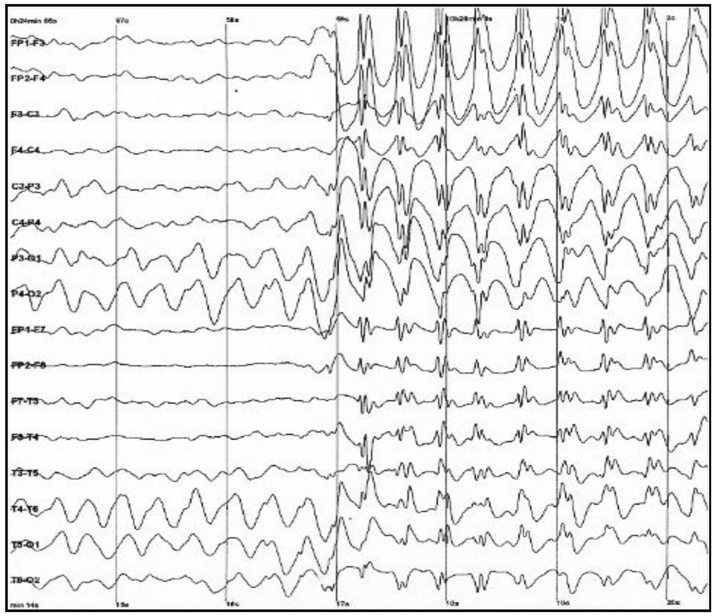

Figure 2.4 Epileptic Spike and Wave Discharges Monitored with EEG [5]

2.2 Microcontroller [6]

Microcontroller is a functional computer system on a single chip or it also known as an integrated circuit was build where all the component of the microcomputer system was combined together. Microcontrollers include an integrated CPU, memory (a small amount of RAM, program memory, or both) and peripherals capable of input and output.

In addition to the usual arithmetic and logic elements of a general purpose microprocessor, the microcontroller integrates additional elements such as read-write memory for data storage, read-only memory for program storage, Flash memory for permanent data storage, peripherals, and input/output interfaces.

At clock speeds of as little as 32 KHz, microcontrollers often operate at very low speed compared to microprocessors, but this is adequate for typical applications. They consume relatively little power and will generally have the ability to retain functionality while waiting for an event such as a button press or interrupt. Power consumption while sleeping may be just nanowatts, making them ideal for low power and long lasting battery applications.

2.2.1 Embedded Design

The majority of computer systems in use today are embedded in other machinery, such as automobiles, telephones, appliances, and peripherals for computer systems. These are called embedded systems where an embedded system is a special-purpose computer system designed to perform one or a few dedicated functions often with real-time computing constraints. Some embedded systems are very sophisticated; many have minimal requirements for memory and program length, with no operating system, and low software complexity. Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a personal computer, and may lack human interaction devices of any kind. For example: embedded systems for microcontroller are interrupt and program.

Interrupts

Microcontroller has provided a real time response to events in the embedded system that is interrupt. When certain events occur during main program is running, an interrupt system can signal the processor to suspend processing the current program and begin an interrupt service routine (ISR). The ISR will perform any processing required before returning to the original instruction sequence. The interrupt are device dependent and often include events such as an internal timer overflow, data receive on a communication link and etc.

Program

Microcontroller program must fit in the available on-chip program memory, since it would be costly to provide a system with external memory. Compilers are use and assembly languages are used to turn high-level language programs into a compact machine code for storage in the microcontroller's memory.

Microcontrollers were originally programmed only in assembly language, but various high-level programming languages are now also in common use to target microcontroller. These languages are either designed especially for the purpose, or version of general purpose such as the C programming language.