ADAPTATION OF ECG MACHINE FOR REAL TIME ECG CAPTURE MONITORING

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor Degree of Electronic Engineering (Industrial Electronic)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
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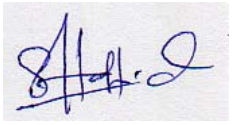
Signature : 

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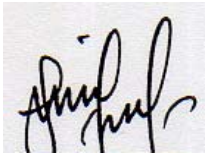
Signature : 

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To my parents, family members and friends;

My all times beloved.

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ABSTRACT

Electrocardiogram (ECG) is a major source for doctors who need the information to diagnose patient's health condition and pathology. The electrocardiograph (ECG) is one of the medical equipment that investigates any heart disease or any cardiac abnormalities. Each portion of the ECG waveform can obtain the patients status prediction whether there are in good condition or not. ECG signal are usually small (approximate 1mv) and carry lot of noise (which are commonly influenced by 50 Hz power supply, by changing of skin electrode contact resistor).This project is to design, analysis and developed a system that can capture a real time ECG signal from patient and can turn the signal or data to pc. To measure the ECG signal, firstly an amplifier and a driven right leg circuit are used to reduce a part of 50 Hz common noise. ECG signals after the instrumentation amplifier will be filtered by a low pass filter to eliminate high frequency noise components, and then filtered by high pass filter to remove the base line drift. The instrumentation amplifier is designed using IC AD620 of Analog Devices Corp.

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ABSTRAK

Electrocardiogram (ECG) adalah sumber utama kepada doktor untuk mendapatkan maklumat bagi mendiagnosis patologi dan keadaan kesihatan pesakit. Electrocardiograph (ECG) adalah salah satu alatan perubatan yang digunakan untuk menyelidik apa sahaja jenis penyakit jantung dan keabnormalan kardium jantung. Setiap bahagian pada isyarat gelombang ECG boleh mengenalpasti ramalan status pesakit samada mereka di dalam keadaan yang baik atau tidak. Isyarat ECG biasanya kecil (lebih kurang 1mV) dan memberi banyak gangguan (kebiasaanya dipengaruhi oleh bekalan kuasa 50Hz, oleh pertukaran sentuhan rintangan elektrod). Projek ini adalah untuk merekabentuk, analisis dan membangunkan sistem yang dapat memaparkan masa sebenar isyarat ECG dari pesakit dan terus memaparkan isyarat atau data ke komputer. Untuk menyukat isyarat ECG, pertama sekali penguat dan litar pemacu kaki kanan digunakan untuk mengurangkan gangguan 50Hz. Isyarat ECG selepas penguat instrumentasi akan di tapis oleh frekuensi potong rendah untuk menyingkirkan gangguan komponen frekuensi tinggi dan seterusya di tapis oleh frekuensi potong tinggi untuk menyingkirkan aliran arus pada garis tapak. Penguat instrumentasi direkabentuk menggunakan IC AD620 dari Analog Device Corp.

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LIST OF ABBREVIATIONS

ECG/EKG	-	Electrocardiograph
DC	-	Direct current
RA	-	Right arm
RL	-	Right leg
LA	-	Left arm
LL	-	Left length
mV	-	mili-volt
SA	-	Sinoatrial
AV	-	Atrial Ventrical
dB	-	decibel
Op amp	-	Operational Amplifier
AD	-	Analog Device
CMRR	-	Common mode rejection ratio

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CHAPTER I

INTRODUCTION

1.1 Introduction

Nowadays, the volume of ECG recorded in hospital is increasing because there are so many heart diseases that attack each person in this world. The electrocardiograph (ECG) is one of the medical equipment that can measure the heart rate and produce data from patient heart into a signal in piece of paper. It is not systematic and efficient because the result maybe lost, damage and difficult to save and send to exchanging patients clinical information between health care facility.

The main objective of this project is to analysis and developed a system that can capture a real time ECG signal from patient and can turn the signal or data to pc. The signal form will be displayed on monitor and also printed with a normal printer. It also make easier to receive and transfer data. This project is a step towards the complete fusion of healthcare, the internet and the home. This project aims to improve quality of live people in terms of time saving, cost reduction and medical service quality.

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An electrocardiogram (ECG) is a recording of the electricity on the body surface generated by the heart. ECG measurement information is collected by skin electrodes placed at designated locations on the body. ECG signals are usually small and they may be corrupted by various kinds of noise: power line interference, electrode contact noise, motion artifacts. So the measurement of ECG signal is a difficult task.

The ECG signals captured by the electrodes are amplified by using the instrumentation amplifier. ECG signals after the instrumentation amplifier may still be affected by noise. Therefore, the next step is to apply a low pass filter for eliminating high frequency noise parts. A high pass filter is used to get rid of DC (direct current) noise components. To reject common noise voltage, an operational amplifier deriving common mode voltage is used to invert the common mode signal and drive it back into the patient through the right leg (Usually called, driven right leg circuit) with the aim of canceling interference.

1.2 Objectives

The objectives of the project consist of:

1. To design a bio-instrumentation amplifier that can amplify an ECG signal.
2. To analysis and developed a system that can capture a real time ECG signal from patient and can turn the signal or data to pc.
3. To analyze type of signal ECG.

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1.3 Problem statements

Nowadays, the volume of ECG recorded in hospital is increasing. Most of ECG machine (output waveform) is display on paper ECG and the result cannot save and filing because it can lost and damage. So, it make difficult for doctor to check the result again and patient don't know about their heart related diseases result. So, it is not systematic and efficient because the result maybe lost, damage and difficult to save and send to patient if patient at home. It also will be very helpful to exchanging patient's clinical information between healthcare facilities. This project needs knowledge of amplifier and filter theories to design well balanced circuit. This system is already used. But the system has complicated functions and very high cost. Example: bedside monitor.

1.4 Scopes of Work

1. Adaptation of ECG block diagram.
2. Focus on hardware only for capture monitoring to amplifier ECG signal. The hardware development includes bio-instrumentation amplifier and filter circuits.
3. Focus on lead I, II and III only.
4. Three electrodes (RA, LL and RL) as input from the patient's skin. The function of ECG electrode is to convert the ionic potential produced at the surface of body by the bio-electric activity within it, to electronic potentials that can be processed by the ECG machine.

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1.5 Project Methodology

1) Study about electrocardiography and related physiology

Electrocardiograph is the study of the electrical activity evident on the surface of the body which is a by product of the heart. The heart made up of muscle fibers, which continuously respond to electrical and pneumatic signals. A recording of such activity is called electrocardiogram and is produced electrocardiograph.

2) Analysis and research of ECG block diagram.

Study about ECG amplifier design stage, design decisions are made about the differential gain and the frequency response of the circuit. Each variable is identified by carefully choosing resistor and capacitor values.

- Breadboard testing.
- Component.

3) Design the project circuit on the PCB.

This project consists of three phases. Firstly, study about the ECG amplifier design stage. In the ECG amplifier design stages, values for capacitors and resistors are chosen so that have the proper gain and frequency response. These include the resistor in the amplification stages as well as the resistors and capacitors in the filtering stages. ECG amplifier consist an instrumentation amplifier, operational amplifier and a bandpass filter.

The second phases are make analysis for ECG circuit, and software simulation for the output circuit using the MultiSim Software and getting the component to make the testing on the bread board and the output circuit. After all components are already the project component were constructed on the bread board to test the project

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functionality before proceed on the PCB. If the projects are success on the bread board, then go through to proceed on the PCB circuit.

Thirdly, design the project circuit on the PCB using Proteus 6.9 Software. Then all the components were constructing on the PCB circuit. The complete constructing circuit project must be tested to verify the performance of the system in real time. If the functionality is succeeding, then the finishing will be doing.

1.5.1 Hardware Design

For hardware part involved ECG amplifier and bio-potential electrodes.

1.5.1.1 Bio-potential Electrodes

On the market, it is possible to find several types of electrodes: limb electrodes, floating electrodes, disposable electrodes and pasteless electrodes. In this project, the disposable electrode was used because it provide good contact with the skin and produces minimal noise generated by movement. The gel electrode also used, it is a conductive substance that enhances the signal transfer between the electrodes contacts and the body surface. The placement of electrodes at the correct positions is very important as different positions on the body could give different signal strength. Placement of electrodes on the body is based on Einthovens Triangle.

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1.5.1.2 Bio-instrumentation amplifier design

Normal ECG signal present very low amplitude and low frequencies with high common noise voltage. On the other hand, the ECG electrode present very high output impedance. Noise common voltage is high. These characteristics impose that the amplifier must also have very high input impedance, low bias current, low offset voltage and high CMRR (>60dB). The Analog Device AD620 instrumentation that meets those specifications.

The bio-instrumentation amplifier is composed of two stages. The first is instrumentation amplifier (IA). The next stage is the bandpass amplifier. In instrumentation amplifier stage, the Analog Device AD620 instrumentation and operational amplifier was used.

The op amp used in the right-leg common-mode feedback circuit is the OP97, a low power, high precision operational amplifier with extremely high common-mode rejection (114 dB minimum). This circuit applies an inverted version of the common-mode interference to the subject's right leg, with the aim of canceling the interference. The other op amp is LM741, it used to provide gain of 125.

1.6 Thesis Outline

This thesis represent by five chapters. The following is the outline of adaptation of ECG machine for real time ECG capture monitoring in chapter by chapter.

Chapter I: This chapter will focus on brief introduction of the project carried. The important overview or description including the problem statement, project objectives and project scopes are well emphasized in this part.

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Chapter II: This chapter will be based on the literature review of the project. It is mainly focused on the electrocardiography and related physiology. It also defined the details of the characteristics and application of bio-instrumentation amplifier design.

Chapter III: This chapter will explain on the concepts, theories and principles used in order to complete the project. This part consists of the methodology and also the information on research and experiment carried during the project development.

Chapter IV: This chapter mainly focused on the result and analysis done using the device. All testing and verification result are attached with the aid of figure, table and statistic related to the project.

Chapter V: This chapter is a complimentary of previous four chapters. It describes on the overall project, discussion and suggestion for the project. All matters arise including the problems and unachieved objectives will be described clearly in this part.

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