DEVELOPMENT HEART RATE MONITORING SYSTEM USING ZIGBEE

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Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
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Dedicated to my beloved family especially my parents and friends. Last but not least to my supervisor and all lecturers who guide and support me to finish this thesis.

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ABSTRACT

Nowadays, have a few systems that provide a continuous health monitoring service for people or patient. Where, the device is a large and cannot suitable bring at anywhere. A portable wireless technology heart rate monitor is a personal monitoring device which allows a subject to measure heart rate value in real or record heart rate for analysis at any time and any place. Advancement in wireless technology nowadays has allowed the creation of various remote control systems, one of which is the famous Heart Rate monitor concept. This project is to implement an Electrocardiogram (ECG) and Digital Heart Rate counter using ZigBee (Xbee) wireless protocol and portable unit. The main challenges include amplifying the desired weak signal in the presence of noise from other muscles and electrical sources. The device is most useful if it is portable and it can be monitored from distant location. This requires a battery to be able to power all of the necessary components as well as the power output of the battery to be regulated. Implementation of the heart monitor involves low cost amplifier and filter components coupled with a microcontroller unit and LCD screen to display the output. Results were successful for the amplifier filter stage of the implementation with an ECG successfully detected and recorded but the calculation and display of the actual rate. Generally, the project software application together with its Graphical User Interface (GUI) was developed using Microsoft Visual Studio in VB language for the computer platform. The microcontroller, PIC16F877A located on the main circuit board was programmed in C language using MPLAB IDE software and debugged together with the circuit design using Proteus 7 ISIS. The final prototype of the system was built to demonstrate the proposed functionality of the system. The limitation of this project only detects the value of normal and abnormal condition. It cannot detect the diseases and what the category of diseases.

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ABSTRAK

Kini, terdapat beberapa system yang menyediakan perkhidmatan pemantauan kesihatan yang berterusan untuk orang ramai atau pesakit. Peranti yang besar dan tidak sesuai dibawa kemana sahaja. Teknologi mudah alih tanpa wayar adalah alat pemantauan peribadi kadar jantung yang membolehkan subjek untuk mengukur kadar jantung nilai dalam kadar jantung sebenar atau rekod untuk analisis pada bila-bila masa dan mana-mana tempat. Kemajuan dalam teknologi tanpa wayar kini telah membolehkan penciptaan pelbagai sistem kawalan jauh, salah satu yang merupakan kadar jantung terkenal adalah konsep pemantauan. Projek ini adalah untuk melaksanakan Elektrokardiogram (ECG) dan Kadar Jantung Digital kaunter menggunakan ZigBee (Xbee) dan unit mudah alih. Cabaran utama termasuk menguatkan isyarat yang diingini lemah dalam kehadiran hingar daripada otot lain dan sumber elektrik. Peranti ini adalah yang paling berguna jika ia adalah mudah alih dan ia boleh menjadi alat pemantau dari lokasi jauh. Ini memerlukan bateri untuk dapat kuasa semua komponen yang diperlukan serta keluaran kuasa bateri dikawal. Pelaksanaan memantau jantung melibatkan penguat kos rendah dan komponen penapis ditambah dengan unit mikropengawal dan skrin LCD untuk memaparkan keluaran. Keputusan telah berjaya untuk peringkat penguat penapis pelaksanaan dengan ECG berjaya dikesan dan direkodkan tetapi pengiraan akan dipaparkan kadar sebenar.Secara umumnya, permohonan projek perisian bersama-sama dengan Antara Muka Pengguna grafik telah dibangunkan menggunakan Microsoft Visual Studio dalam bahasa VB untuk platform komputer. Mikropengawal PIC16F877A terletak di papan litar utama telah diprogramkan dalam bahasa C menggunakan perisian MPLAB IDE dan debugged bersama-sama dengan reka bentuk litar menggunakan Proteus 7 ISIS. Prototaip akhir sistem dibina untuk menunjukkan fungsi yang dicadangkan sistem. Had projek ini hanya mengesan nilai keadaan normal dan tidak normal. Ia tidak dapat mengesan penyakit dan apa kategori penyakit.

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LIST OF ABBREVIATIONS

ECG	-	Electrocardiogram
SA	-	Sinoatrial
AV	-	Atrioventricular
PIC	-	Peripheral Interface Controller
LCD	-	Liquid Crystal Display
IEEE	-	Institute for Electrical and Electronics Engineers
RF	-	Radio Frequency
MAC	-	Medium Access Control
LoWPANs	-	Low Power Wireless Personal Area Network
DSP	-	Digital Signal Processors
RISC	-	Reduces Instruction Set Computer
A/D	-	Analog-to-Digital
SPI™)	-	Serial Peripheral Interface
I²C™)	-	Inter-Integrated Circuit
USART	-	Universal Asynchronous Receiver Transmitter
CPU	-	Central Processing Unit
CU	-	Control Unit
CRT	-	Cathode Ray Tube
I/O	-	Input and output
GUI	-	Graphical User Interface
RAD	-	Rapid Application Design
PCB	-	Printed Circuit Board
UV	-	Ultra-Violet
LDR	-	Light Dependent Resistor

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VB	-	Visual Basic
ISIS	-	ISIS schematic capture
LED	-	Light Emitting Diode
RAM	-	Random Access Memory
ROM	-	Read Only Memory
EPROM	-	Erasable programmable read only memory
EEPROM	-	Electrically erasable programmable read only memory

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CHAPTER I

INTRODUCTION

1.1 Overview

This chapter will cover the introduction of the project where involve of the project background, objective of project, problem statement and scope of project.

1.2 Project Background

The electrocardiogram (ECG) is a recording of the electrical activity of the heart. Each heartbeat is initiated by the excitation (depolarization) and recovery (polarization) phase of this electrical activity. An ECG recording, or trace, shows the various phases of the electrical activity above or below a baseline. The ECG records the activity of the sinoatrial (SA) node to the atrioventricular (AV) node, then into the ventricular bundles, and finally out to the ventricles.

The heart contract as the electrical impulse travels through the heart's conduction system. Each contraction is one heartbeat, and the atria contract before the ventricles. The process of blood flow is such that the blood empties into the ventricle before the ventricles contract. The heart rate is the number of heart per minute. A heart beat monitor is a device used to measure the heart rate. This device

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helps to detect heart malfunctions such as a tachycardia, bradycardia, or other diseases. By detecting the voltage created by the beating of the heart, its rate can be easily observed and used for a number of health purposes. In general, the monitoring occurs by studying chart data or computing beats per minute [1].

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 such as potassium that are too high or low. ECG is 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 result ECG printed out on standard paper.

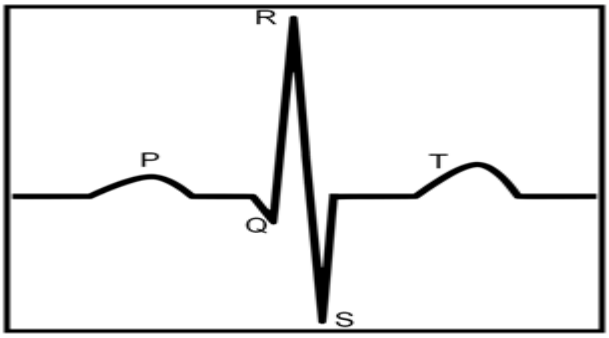

Figure 1.1: Typical heart rate signal

An electrocardiogram (ECG) is a graphical trace of the voltage produced by the heart. There are 5 identifiable features in an ECG trace corresponds to different polarization stages that makes up a heartbeat. These deflections are denoted by the letters P, Q, R, S and T. By detecting the R peaks and measuring the time between them the heart rate can be calculated and then displayed. Measuring the heart rate using an electrical circuit can be done much quicker and more accurately [1].

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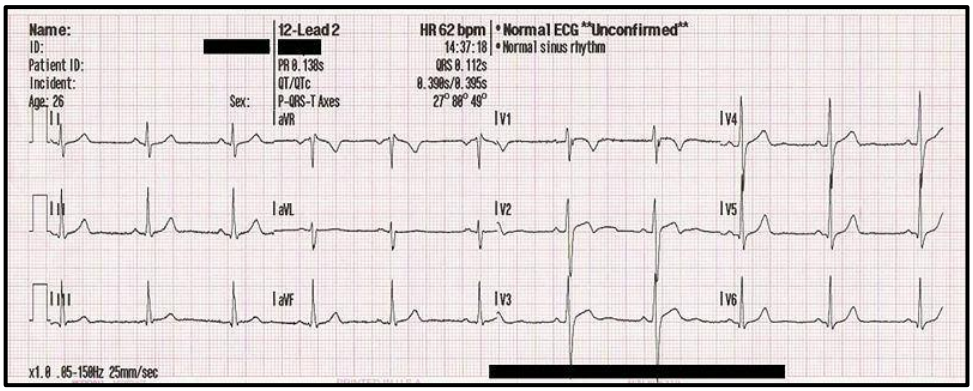

Figure 1.2: Example of 12 Lead ECG

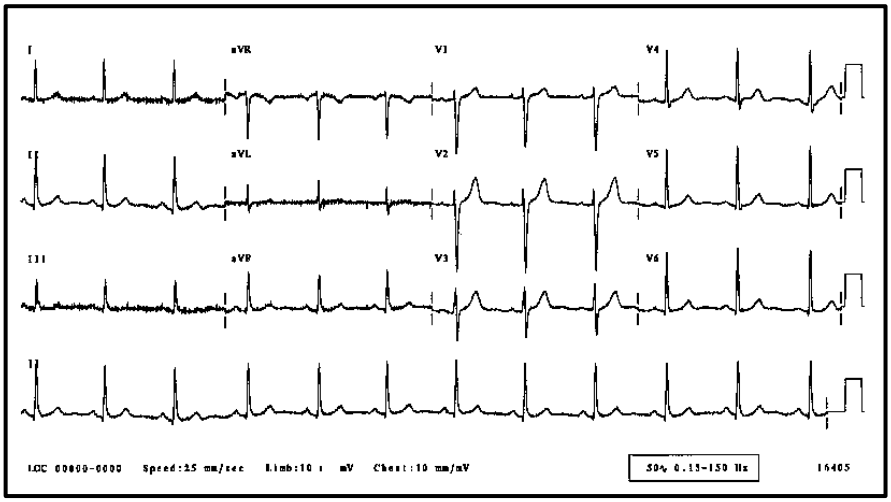

Figure 1.3: A normal heart rate

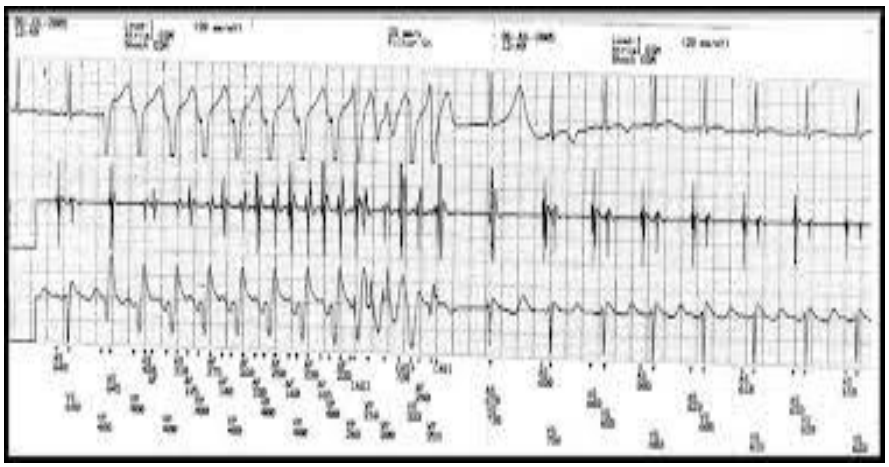

Figure 1.4: An abnormal heart rate

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1.3 Problem Statement

In real world applications, have a few systems that provide a continuous health monitoring service for people or patient. Where, the device is a large and cannot suitable to bring at anywhere so, the device is most useful if it is portable. The device of heart rate monitor is a new way to solve this problem by implements an ECG and Digital Heart Rate counter using ZigBee wireless protocol and portable. The challenge of this project is how far the data will transfer using ZigBee. It is because the ZigBee is wireless protocol device and accurate. If have any interruption such as blockage and noise, the transfer data might be lost. Another major challenge using ZigBee is, if the data transfer simultaneously from various heart rate monitor it might have congested and effect the real time measurement of the heart rate of patient.

1.4 Objectives of Project

The main objective of this project is to monitor the heartbeat. Besides that, there have other objectives which are related each other as shown as below:

a) Implement a portable heart rate monitoring system.
b) The project is proposed to design and build the device that can measure the human heart rate.
c) The project is proposed to assist the people for monitor their healthy by referring their normal heart rate.

1.5 Scope of the Project

This project focuses on into two parts, which are hardware and software development. In this project, it involves 2 parts in order to accomplish one complete system in monitoring system. For hardware development, it has two boards collectively from a ZigBee module network, one of which is transmitter and receiver circuit. After that, selecting of suitable heart rate sensor and types of PIC that want to

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be used and also study the literature of ZigBee wireless networking. Besides that, for software development and interfacing identify the suitable programming and its implementation into PIC microcontroller and ZigBee module. It also includes designing the system, built the hardware for the system connection between ZigBee modules using proper software to program the microcontroller PIC 16F877A and LCD interfaces for user purposes.

1.6 Significant of this Project

The main project's objective is to monitor the human heart beat. By monitor the heartbeat, the health's level can be easy identify or determine. It can be done by measure the normal heart rate and make it as reference. The heart rate will be measured consistently in order to check the health's level. Therefore, the benefits or contributions for this project are;

a) The heart in the important system in the human body. If the heart is failure, the person will dead. Therefore, by monitoring the heart rate, any change in the heart can be detected and the precaution step can be taken in order to make sure the heart beat is back to normal.

b) The device's operation is simple and easy to handle. Therefore, the people can measure their heart rate and monitor their health by themselves without guidance from the skilled people.

c) The designed device is portable and cost is not too expensive. Therefore, the people can buy it and can do the monitor process at home. Besides that, the people also can make the monitor process at any time that they want. It is very useful and suitable to the people whose are busy with their routine.

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1.7 Thesis outline

As a requirement in thesis format, it include by five chapters. In chapter I, it focuses on brief introduction of project carried. The important things in this chapter are the problem statement, project objectives and project scopes are well emphasized in this part.

Chapter II normally is focused for literature review that covers related theory and previous works regarding this project are explained in this chapter. It discuss on the Wireless Network, ZigBee protocol module, microcontroller and software development.

Chapter III consists of project methodology. It also includes information on research and experiment carried during the project development. It will explain on the concepts, theories and principles used in order to complete the project. In this chapter, the functional of each component which used has been explained clearly.

Chapter IV consists of results and analysis. It explains and focused for component description from the project. This chapter described the hardware and software system development. It also included the discussion of this project.

Chapter V consists of conclusion and recommendation for this project. It will explain for this chapter it includes the conclusion, the witness and also the future improvement that can be made in future.

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