



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

REMOTE HEART RATE MONITORING SYSTEM

This report submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

by

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DECLARATION

I hereby, declared this report entitled “Remote Heart Rate Monitoring System” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology Telecommunications with Honours . The member of the supervisory is as follow:

.....
(Dr. Abdul Kadir)

ABSTRACT

A Remote Heart Rate Monitoring System was designed to monitor the heart rate of the patient. Recently, technology has a great impact on our life. As people concern about health, further improvement in medical field is required. Many studies have been done across the world to monitor health condition in the easiest way. As complicated and expensive devices becoming a burden to the user to monitor the heart, researchers kept finding methods to replace the usage of the devices and monitoring the heart beat anytime and everywhere with easy problem. This research designed and implemented of a new remote heart rate monitoring system by using Radio Frequency, Arduino and GSM Module. This system consists of three main parts which are heart rate controller, heart rate mediator and receiver. The heart beat is detected using Pulse Sensor Amped by measures subtle changes in light from expansion of the capillary blood vessels to sense the heartbeat. Then, it will transmit pulse data to the Arduino Nano for processing. After that, the signal is sent to the RF transmitter and receiver. Then, Arduino Uno is used as the brain of the entire system same as microcontroller where it will compare the threshold value with the heart beat rate in the Pulse Sensor Amped. If the heart rate is normal then the patient health condition is good. If the patient heart rate is more than threshold value, it is considered as abnormal. The user will get an alert message if heart rate is abnormal by using the GSM network.

ABSTRAK

Alat Pengawal denyut jantung adalah alat direka untuk mengawal jantung pesakit. Pada zaman ini, teknologi memberi kesan kepada kita terutamanya dalam bidang perubatan. Banyak kajian telah dilakukan di seluruh dunia untuk memantau keadaan kesihatan dengan cara yang paling mudah. Sebagai sebuah alat yang rumit dan mahal, menjadi satu beban kepada pengguna untuk memantau jantung mereka. Penyelidik sentiasa mencari cara untuk menggantikan penggunaan alat-alat seperti itu dan melakukan pemantauan jantung di mana-mana, pada bila-bila masa dengan cara yang mudah. Kajian ini membentangkan reka bentuk dan pembangunan baru alat pemantauan kadar jantung kawalan jauh menggunakan kawalan mikro dan penghantaran tanpa wayar dan menunjukkan bacaan tepat kadar jantung menggunakan teknologi penghantaran. Reka bentuk penyelidikan dan melaksanakan sistem pemantauan kadar jantung jauh baru menggunakan Frekuensi Radio, Arduino dan GSM Modul. Sistem ini terdiri daripada tiga bahagian utama iaitu pengawal kadar jantung, kadar denyutan jantung pengantara dan penerima. Denyutan jantung dikesan menggunakan alat pengesan denyutan. Alat pengesan denyutan mengesan perubahan jantung dalam cahaya dari pengembangan saluran darah kapilari untuk mengesan denyutan jantung. Kemudian, ia akan menghantar data nadi kepada Arduino Nano untuk diproses. Selepas itu, isyarat yang dihantar kepada pemancar RF dan penerima. Kemudian, Arduino Uno digunakan sebagai keseluruhan sistem yang sama dengan pengawal mikro di mana ia akan membandingkan nilai ambang dengan kadar denyutan jantung di alat pengesan jantung tu. Jika kadar jantung adalah normal maka keadaan kesihatan pesakit adalah baik. Jika kadar jantung pesakit adalah lebih daripada nilai ambang, ia dianggap sebagai tidak normal.

DEDICATIONS

*Dedicated in thankful appreciation
for support, encouragement and understanding
to family members, supervisor, lecturer and friends*

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LIST OF SYMBOLS AND ABBREVIATIONS

ECG	=	Electrocardiogram
GSM	=	Global, System Mobile Communication
GPRS	=	General Packet Radio Service
GND	=	Ground
IR	=	Infrared
RF	=	Radio Frequency
SMS	=	Short Messaging Service
V	=	Voltage
LED	=	Light Emitter Diode

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter introduced project background, problem statement, objectives as well as the scope of this project. Then, the project's significant which outlines benefits could be derived from the outcome of this project.

1.1 Background

The heart is one of the most important organs in the entire human body. The main function is to pump oxygen rich blood to the muscles and carry cell waste products and 100 beats per minute(BPM) depending on the person's physical condition and age. According to the National Health and Morbidity Survey 2011 statistics, Coronary Heart Disease is the no.1 killer in Malaysia which is accounting for 25.4% of the total mortality. The number of individuals suffering from high cholesterol or hypercholesterolemia and the chief risk factor for cardiovascular disease rose from 20.7 per cent in 2006 to 35.1 per cent last year. Besides that, 10 million Malaysians have high cholesterol (NHMS, 2011).

In this fast pace world, it is difficult for people to be constantly available to take care of the patients who are suffering from coronary heart disease. It is because the cardiac patients need to be monitored continuously by the doctors to verify their heart rate. This would be difficult for the doctors to be present besides their patient all the

time. Hence, it is important that the doctor and family members will have a handy device that can always monitor their patients when they are not around.

Other than that, it is one of the major improvements in the global health care program because of its advanced technology. This project enable the user to monitor the patient to get proper treatment that will help to prevent sudden heart attack. It is due to GSM network that used to operate from any distances to any point of control that is done with the help of local network support where it can get communicated to any part of the world which the network of the local system is applicable.

1.2 Problem Statement

In real world application, it has many systems that provide a continuous health monitoring services in the market. However, it is difficult for people nowadays to be constantly available for their near ones who might need them while they are suffering from heart problem. Therefore, remote heart rate monitoring system is important nowadays. It enables the medical experts or patient's family member to monitor the patient's heart rate. Besides, the patient will get proper help that to prevent sudden heart attack. It is due to the concept of using Radio Frequency that can travel through larger distances and to minimize size and functionality in the computerized element of the project. Furthermore, GSM network concept was applied in this project to send an alert message to the user.

1.3 Objectives

The objectives of this project:

- a) To study a heart rate monitoring system using GSM Technology.
- b) To design the remote heart rate monitoring system with a feature of sending SMS to doctor and patient's relative in event of emergency.

1.4 Scope of Project

Basically, this project had hardware and software development in order to accomplish one complete system. This project is divided into three main parts:

i) Heart Rate Control

It involved Pulse Sensor Amped, Arduino Nano and transmitter that involved in this project.

ii) Heart Rate Mediator

It included receiver, Arduino Uno and GSM Module that involved in this project

iii) Receiver

It involved mobile phone to receive the message.

1.5 Project Significant

The heart is important system in human health. If the heart is failure, the person will died. Therefore, remote heart rate monitoring system project is beneficial to medical doctors or patient's family for monitor the heart beat rate condition of patient. This project will increase the user alertness to monitor the heart beat rate condition of patient.

Thus, doctor can monitor and diagnose the patient's condition continuously and could suggest earlier precaution for the patients themselves. This will absolutely alert the family members to quickly attend the patient by receiving the alert message.

GSM is a wireless connection that is used to connect with the Arduino Uno and Arduino Nano as the brain of the entire system same like other microcontroller. Due to RF module, this will make the user to communicate for longer distances. Hence, it can be done to monitor consistently the heartbeat health level at any time.

1.6 Summary of Chapter 1

The first chapter about the introduction to the project which includes research background, problem statement, objective of the project, scope of study and project significant.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter was being discussed on the components that involved in this project in details. This explanation will be focused on the related field of remote heart rate monitoring in order to design and develop heart rate monitoring system. Besides that, it was being included with the explanation on the recent research on the technology and emphasizes the use of GSM nowadays. All the related research papers, websites, journals also were involved in this chapter.

This study aims at the device of monitoring of patients with good stability, wearable and low power consumption. This system is necessary to the users when they need to monitor the patient's heart beat rate is normal or abnormal based at any time. Besides that, this project can monitor the patient and utilize the Radio frequency (RF) module for a free transmission of data or signal collected by the heart sensor placed through patient's finger. The radio frequency module makes this project different from previous project. This system illustrates the advantages of Arduino IDE software and powerful GSM Network by using Short Messaging Service (SMS).

2.1 Past Related Research

There are various ways of heart rate measurement systems have been developed and many researchers has put and effort on enhancement developing heart rate measurement devices. Most of these studies use different types of sensors. Here are several of the previous studies which is related to this project.

2.1.1 Heart Disease Monitoring System using Web and Smartphone

In this paper, a real-time heart disease monitoring system is introduced. The system extracts the ECG signal from the patient, sends it through the Internet and stores it into a hospital server. The system also processes the ECG using MATLAB to alerts the doctor and hospital staff by sending email and SMS message if any abnormality is detected. The system implements an application based on Android platform to provide online information about the patient status such as the patient's heart beat rate, ECG, and patient history (Al-Omary, et al, 2014).

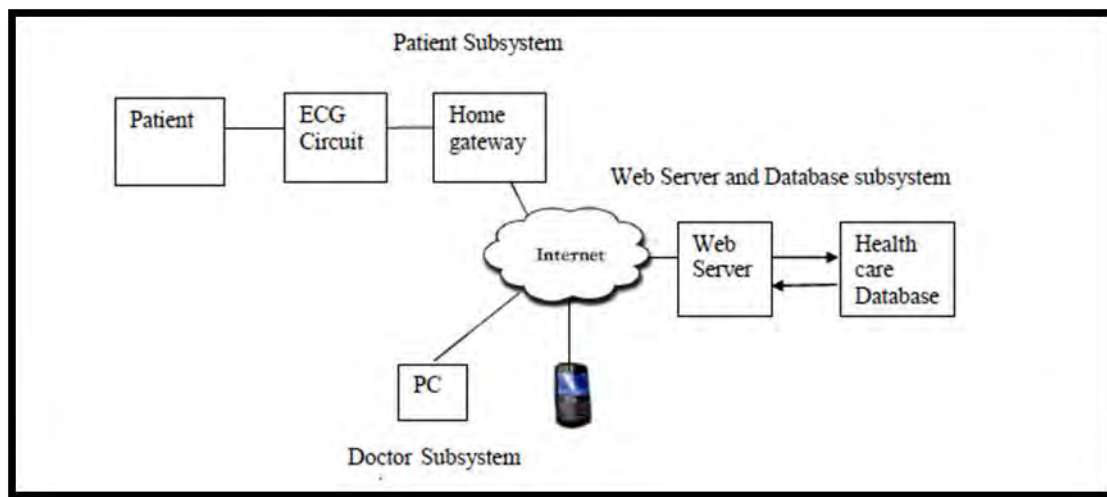


Figure 2.1: Remote ECG System Architecture (Al-Omary, et al, 2014).

The system starts with electronic circuit that acquires the ECG signal from the patient and sends it to a PC or laptop that serve as a home gateway. The home gateway sends to patient ECG through the internet to a hospital server. The hospital server publishes the ECG and makes it available to the hospital staffs that monitor the patient status. The monitoring can be done by authorized person through the hospital web using PC or smart phone using Android based application.

The system processes the ECG signal using MATLAB to detect any abnormality. The system can automatically alert medical service providers through Short Message Service (SMS) and Multimedia Message Service (MMS) when medical assistance is deemed

crucial for the user band on the MATLAB analysis result. This is the situation when the system detects any abnormality. The test on determining ECG signal had been conducted. Figure 2.2 shows the result that obtain in this project.

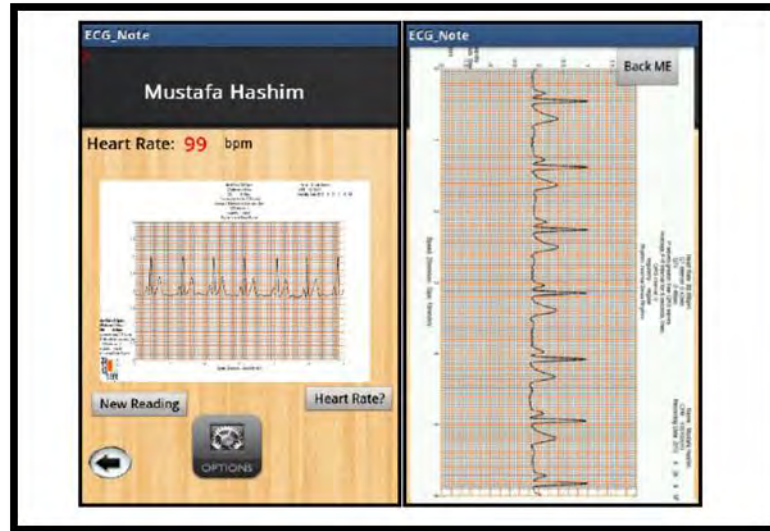


Figure 2.2: Result of patient's ECG in smartphone (Al-Omary, et al, 2014).

As a conclusion, this system is enable doctors to remotely follow-up the status of their patient using their smart-phone by analyzed the patient's live ECG system in real-time electrical activity of the heart rate.

2.1.2 Heartbeat Monitoring Alert via SMS

This project is about the heart rate can be detected using photoplethysmograph (PPG) technique that consists of a matched infrared emitter and photodiode which transmits changes in infrared reflectance resulting from varying blood flow. The signal is processed using PIC16F87 microcontroller to determine the heart rate per minute. The input value is converted into binary coded decimal number to be displayed at 7-segment. The interfacing between PIC circuits to GSM modem is established by using Hyper Terminal. Then, it sends SMS alert to the mobile phone of medical experts or patient's family members via SMS. Thus, doctor can monitor and diagnose the patient's condition continuously and could suggest earlier precaution for the patients themselves.

This will alert the family members to quickly attend the patient. Figure 2.4 shows the result that obtain in this project (Jubadi and Sahak, 2009)

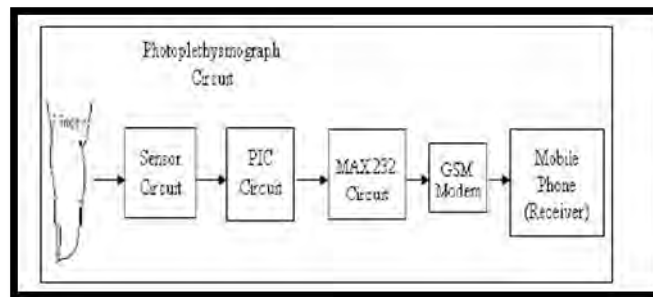


Figure 2.3: Block Diagram of System (Jubadi and Sahak, 2009).

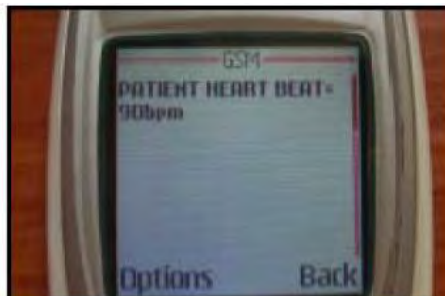


Figure 2.4: Alert message appears on mobile phone screen (Jubadi and Sahak, 2009).

As a conclusion, this project is initiated to alert the family member about patient's heartbeat via SMS through the communication between Hyper Terminal and GSM is established. Besides that, this project is to monitor patient's heartbeat rate using PPG technique by detecting blood volume changes in the microvascular bed of tissues.

2.1.3 Remote Patient's Health Monitoring by Using Zigbee Protocol

This project has indicated the system to the message from the base station of homecare embedded system. The data can be transmitted through wireless transmission using Zigbee module and sent to caretaker of the patients or doctor. It used LM35 as temperature sensor whose output voltages linearly proportional to the Celcius temperature. It also used heart beat sensor to monitor the flow blood through finger and

transmitted to LDR. The signal is amplified, inverted and filtered in the circuit (Chopade and Nitti, 2014).

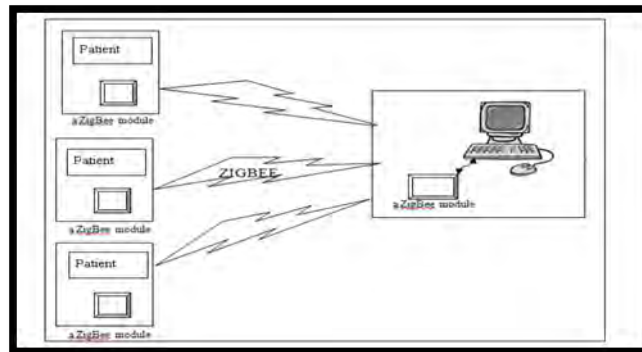


Figure 2.5: Remote monitoring system using Zigbee module (Chopade and Nitti, 2014).

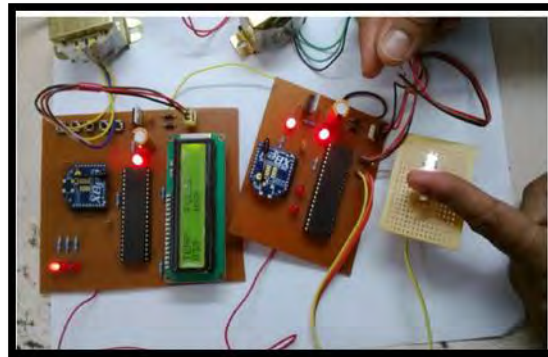


Figure 2.6: Patients heart rate and temperature reading (Chopade and Nitti, 2014).

As a conclusion, it is necessary to monitor the heart beat rate and body temperature of patients. As the focus of this, the hardware design and implementation of a Zigbee based wireless sensor network in this project.

2.1.4 Electrocardiogram (ECG) Monitoring System using Bluetooth

This paper is about ECG. Generally ECG analog signals from the sensors are converted into a binary bit sequence by using the analog-to-digital converter. Digital bits are stored in the microcontroller cushion before shipment. Signal processing circuit, act as intermediate nodes between ECG sensor circuit and a PC. The ECG data is sent to the display device via a Bluetooth link (Md. Amin, et al, 2010).

There has 3 electrodes are used to detect the ECG signal. Signal obtained represent an Einthoven bipolar lead. By convention, potential difference between right arm (RA) and left arm (LA) are measured, where positive electrode attached on the LA and on RA the negative electrode stick. Meanwhile electrodes on right leg (RA) function as reference electrode for recording.

Data from the Bluetooth module will send to the USB dongle has been installed on the computer. Communication between Bluetooth module and USB dongle connected to using the assembly languages and Bluetooth protocol in which digital signals can be processed through layers of wireless networking application. Finally, Visual Basic program displays the signal from the connection device.

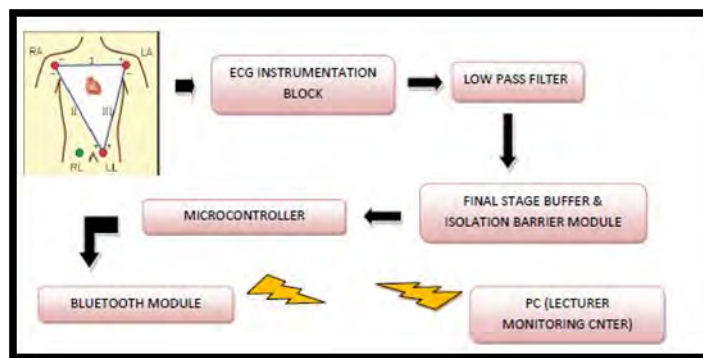


Figure 2.7: Block Diagram of System (Amin, et al, 2010).

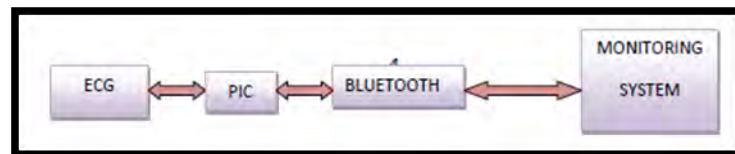


Figure 2.8: Overall system (Amin, et al, 2010).

2.1.5 Remote Health Monitoring of Elderly using GSM

In this paper, the project uses sensors to detect certain body parameters which is heart rate, oxygen level and temperature. These health parameters are then communicated to a doctor or a hospital or a medical server. If the measured body parameters exceed the normal values for a human being then immediate medical attention can be given to the patient (Manjushree, et al, 2010).