WIRELESS PATIENT MONITORING SYSTEM

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by

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Dissertation submitted in partial fulfilment of
the requirements for the
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CERTIFICATION OF APPROVAL

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in partial fulfilment of the requirement for the
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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2010

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

SOEUNG SOCHEATRA

ABSTRACT

This report is about building a wireless patient monitoring system which is used to read the pulse rate of a patient without disturbing or hurting him or her physically. All the readings are sent to a computer and saved for the purpose of monitoring the pulse rate. The system will keep reading the pulse rate of each patient once every minute. As the numbers of patients nowadays keep increasing rapidly, hospitals are facing problem on nursing the patients. Every often nurses have to reach patients to check the pulse rate, blood pressure, and body temperature. This work needs more man powers when the numbers of patients keep increasing. In order to assist the work and to improve the monitoring system in hospitals, the idea of wireless patients monitoring system is raised up. For this project only the pulse rate is taken into consideration in order to build a reliable system. This system can help nurses to monitor the patients' pulse rate more easily and without disturbing the patients directly. The normal pulse rate for a healthy adult is in the rank of 60 to 80 beats per minute. When the heart beat is below 50 beats per minute or higher than 100 beats per minute, it is considered as a dangerous stage for a patient and this can cause death. This system is used to read the pulse rate of a patient and the data will be sent wirelessly to a receiver terminal which is the monitoring computer. When there is any significant pulse rate which shows the patient is in the dangerous situation, an alarm will alert the nurse, then the nurse can reach and take any necessary action in order to help the patient in time.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Patient monitoring system is a system consists of devices that measure, display and record human physiological characteristics such as blood pressure, heart beat, and body temperature.

Wireless patient monitoring system is an updated version of patient monitoring system evolution from wire base to wireless base. This system measures human physiological characteristics and send the record wirelessly to a terminal such as cell phone or monitoring computer.

Nowadays, hospitals use electronic monitoring equipments to monitor the status of the patients. Heart rate monitor is used to read the pulse rate of a patient. This kind of electronic device can improve the monitoring system in a hospital. When the electronic tools get accurate readings from patient, nurses can take immediate action to reach any particular patient on time.

Even though hospitals are equipped with the electronic tool to monitor patients, they still need a lot of man powers to nurse the patients. A nurse has to check every patient at least every two hours in order to get the reading such as body temperature, blood pressure, and pulse rate. Since the number of patients keeps increasing from day to day, hospitals need a lot of nurses to take care of patients.

In conclusion, job in monitoring patients is not an easy task when there are quite numbers of patients keep increasing all the time while the numbers of nurses do not. So a new improved system should be introduced to hospitals in order to ease the workload in nursing. With the use of this system, the person in charge of nursing can perform the tasks much better and more efficiently.

1.2 Problem Statement

Monitoring patient is not an easy job when it comes to a large number of patients and at the same time the demand of nurses will increase too. In order to assist the workload of the nurse and to monitor the large number of patients, this project introduces a system to control patients' status wirelessly. The system is used to read the pulse rate from each patient and the reading is sent wirelessly to the monitoring computer. This can help to inform nurses which patient is in need for attention.

Comfort is one of the main needs in monitoring patients in hospitals. Many manufacturers try to produce the comfortable equipment in order to provide a comfortable service to consumers. Some systems require patient to wear a strap around the chest and wear a receiver around the wrist and have to bring along a mobile phone all the time. Using this system a patient has to wear a chest strap transmitter and wear a wrist based receiver or bring along a mobile phone with them, which this can result in discomfort to a patient. What is more, many large scale monitoring systems require moving patient to the machine for scanning and recording purpose. So this can lead to the discomfort to a patient.

Another point is when the system fails or malfunctions, there is no failure alarm to alert the nurses to take action manually or to alert the maintenance staffs to take the action in repairing and checking the system to determine what is wrong with it.

1.3 Objectives and Scopes of Study

The objectives of this project are:

- To build a working prototype to get the pulse rate reading from a patient.

- To be able to send data from the reading device wirelessly to the monitoring computer.
- To be able to display the data on the screen of computer using user friendly interface.
- To build a low cost prototype.
- To build a prototype with the failure alarm detection.

The scopes of study are:

- To understand the process of reading pulse rate and medical understanding behind.
- To understand what sensors should be used in the project and how to use or implement these sensors in the system.
- To have strong knowledge on wireless transferring, the transmitter and receiver system.
- To understand how to digest the data on the computer screen.
- To understand how to create a user friendly interface on computer screen.
- To understand and have knowledge on assembly language.

CHAPTER 2
LITERATURE REVIEW

2.1 Overview

With wireless patient monitoring system, hospitals can manage and monitor patients more effectively. It can help hospitals to provide more spaces available for patients. This project helps to build a patient monitoring system which does not disturb or do any harm to a patient. With this system nurses can monitor many patients at the same time without having to go to their bed one by one.

From the research patient monitoring system has been implemented in hospitals and clinics in different packages. There are multi function monitoring systems, and stand alone monitoring systems. In order to complete the project, the studying and understanding on the heart function, pulse rate, the existing systems, sensors, and wireless technology are being taken into consideration.

2.2 Heart Function

The heart is a muscular organ found in all vertebrates that is responsible for pumping blood throughout the blood vessels by repeated, rhythmic contractions. The term cardiac (as in cardiology) means "related to the heart".[1]

The heart is divided into two parts with four chambers. The right side of the heart is for collecting the de-oxygenated blood in the right atrium from the body via superior and inferior vena cava and pumping it via the right ventricle into the lungs to drop off the carbon dioxide and to pick up the oxygen.

The left side of the heart is to collect the oxygenated blood from the lungs into left atrium. From the left atrium the blood moves to the left ventricle which pumps it out to the body via the aorta [1].

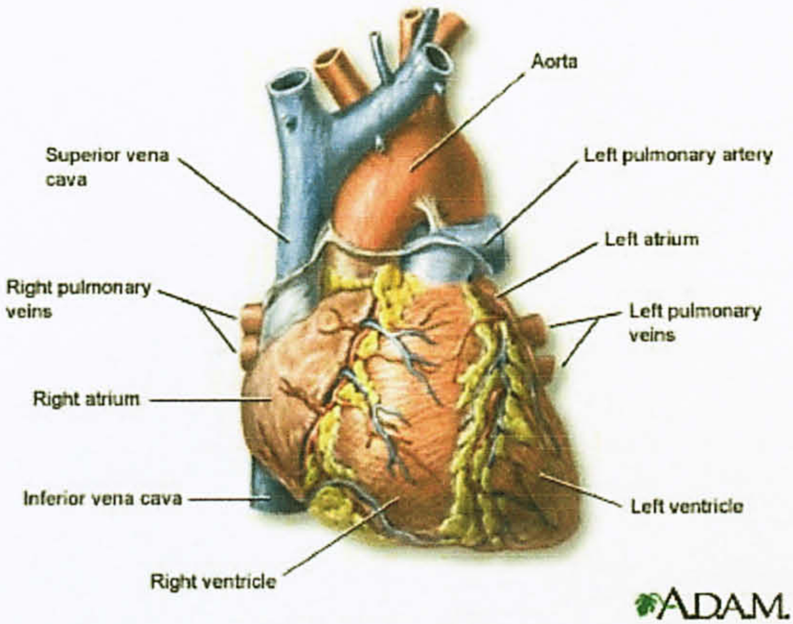

Figure 1: Heart front view [2]

2.3 Pulse Rate

Pulse is the arterial palpation of heartbeat. The pulse rate can also be measured by measuring the heart beats directly.

Table 1 shows the normal heart beat ranges regarding to ages. A normal adult's pulse rate, while resting, ranges in between 60 to 100 beats per minute. Generally infant has higher pulse rate compare to adult which infant's pulse rate can reach up to 110 beats per minute which is close to an adult pulse rate during strenuous exercise. The maximum pulse rate is:

Predicted maximum pulse rate = 220 - Age [3]

Table 1: Normal heart beat range [4]

Age	Heart beat per minute
Babies to age 1	100-160
Children ages 1 to 10	60-140
Children older 11 to 17	60-100
Adult	60-100
Well-conditioned athletes	40-60

The older a person is, the less pulse rate a person has. If the pulse rate is below 50 beats per minute, a person might have symptoms like fatigue, fainting, dizziness, weakness, chest discomfort, palpitation or shortness of breath.

When the heart beats rapidly, the heart will pump less efficiently and provide less blood flow to the rest of the body, including the heart itself. The increased in pulse rate leads to increased work and oxygen demand for heart and can cause the heart attack. Table 2 shows the heart beat disorder symptoms for adults.

Table 2: Heart beat disorder symptoms for adults [5]

Heart beat per minute	The possible affecting
Below 60 bpm or slow and weak heart pulse	• Dizziness, lightheadedness • Fainting • Shortness of breath • Hypothyroidism • Peripheral arterial disease • Heart failure • A blood clot in arm or leg
60 bpm to 100 bpm	Normal condition
Above 100 bpm or fast heart pulse	• Anemia • Fever • Heart disease • Hyperthyroidism • Asthma • Stress • Shortness of breath • Chest discomfort • Dizziness or lightheadedness • Change in vision • Fainting or feeling faint

2.4 Infra Red Sensor (IR)

IR stands for Infrared Radiation which is the portion of the electromagnetic spectrum, has a wavelength of 0.75 μm to 1000 μm. It is lying between visible light and microwave light. Table 3 shows the subdivisions of the infrared.

Table 3: Subdivisions of the Infrared [6]

Designation	Limits, Microns (μm)
Near infrared	0.75 to 3
Middle infrared	3 to 6
Far infrared	6 to 15
Extreme infrared (Ultra-far infrared)	15 to 100

Infrared has been applied in many areas:

- Military applications of infrared: its applications are on search systems, track systems, weapon guidance, navigation and flight control systems, ranging systems, measurement of flux, target and background signatures, miscellaneous, reconnaissance, applications of image converter tubes, infrared photography, terrestrial communications, infrared countermeasures, command guidance.
- Industrial applications of infrared: the applications are; search systems, measurement of temperature, position sensing, miscellaneous, nondestructive test and inspection, intrusion detection.
- Scientific applications of infrared: search and track systems, navigation and flight control systems, measurement of flux, world weather watch, remote sensing of the earth and its atmosphere, remote sensing of astronomical bodies, instrumentation and miscellaneous application, earth resource surveys, meteorological applications, lunar and planetary studies, reflectance properties of materials, space communications.
- Medical applications of infrared: search, track, ranging applications, obstacle detection (passive and active), measurement of temperature, diagnostic assistance, applications of image converter tubes. [6]

2.5 Pulse Oximeter

One of the applications is Pulse Oximeter which is a medical device that indirectly measures the oxygen saturation of a patient's blood. This technology provides the information how to get the reading from the patient's finger blood flowing by using the infrared light and sensor to detect the oxygen level in blood.

The LEDs emit the light of two wavelengths of 650 nm and 805 nm. These lights are absorbed by the haemoglobin by amount which differs depending on whether it is saturated or desaturated with oxygen. The processor can compute the proportion of haemoglobin which is oxygenated by calculating the absorption at the two wavelengths. The oximeter is dependant on a pulsatile flow. It produces a graph of the quality of flow. The computer within the oximeter is capable of distinguishing pulsatile flow from other more static signals (such as tissue or venous signals) to display only the arterial flow. Figure 4 shows a block diagram of a pulse oximeter which is created by Texas Instrument [7].

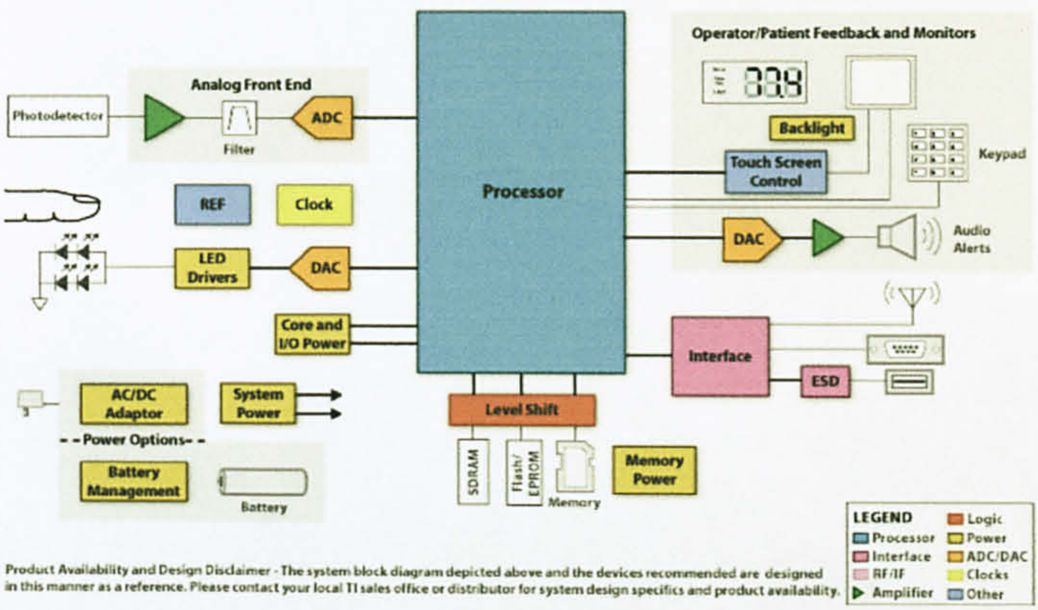

Figure 2: Pulse oximeter block diagram [7]

The above block diagram is showing the Pulse oximeter which is used to measure arterial blood oxygen saturation by sensing absorption properties of deoxygenated and oxygenated hemoglobin using various wavelengths of light. A basic meter is comprised of a sensing probe attached to a patient's earlobe, toe, finger, or other body locations, and data acquisition system for the calculation and display of oxygen saturation level, heart rate, and blood flow [7].

2.6 Types of Heart Beat Monitoring Systems

A heart rate monitor is a personal monitoring device that measures and records heart rate in real time. The record is kept for later study. One product of heart rate monitoring systems consists of chest strap transmitter and wrist receiver or mobile phone [8]. When the signal of the heart beat is detected a radio signal is transmitted. Then receiver is used to determine the incoming heart beat. The signal can be a radio pulse from Bluetooth or low power radio link.

Figure 3: Heart rate monitors [8]

In order to sufficiently monitor the patients, hospitals have to be equipped with modern and full multifunction systems. One of the systems is electrocardiography (ECG) where it is a transthoracic (through the thoracic cavity or across the chest wall) interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes. It is used to analyze the strength of a patient's heart function. Electrodes on different sides of the heart measure the activity of different parts of the heart muscle. 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.[9]

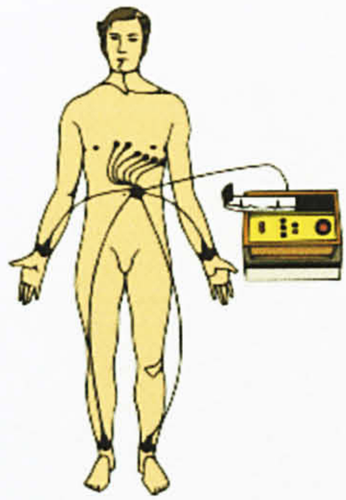

Figure 4: Patient connected to the 10 electrodes necessary for a 12-lead ECG [9]

CHAPTER 3
METHODOLOGY

3.1 Prototype Overview

The project of wireless patient monitoring system is to build a working prototype to get the pulse rate or heart rate from a patient without disturbing or hurting the patient. Figure 5 shows the block diagram of the system.

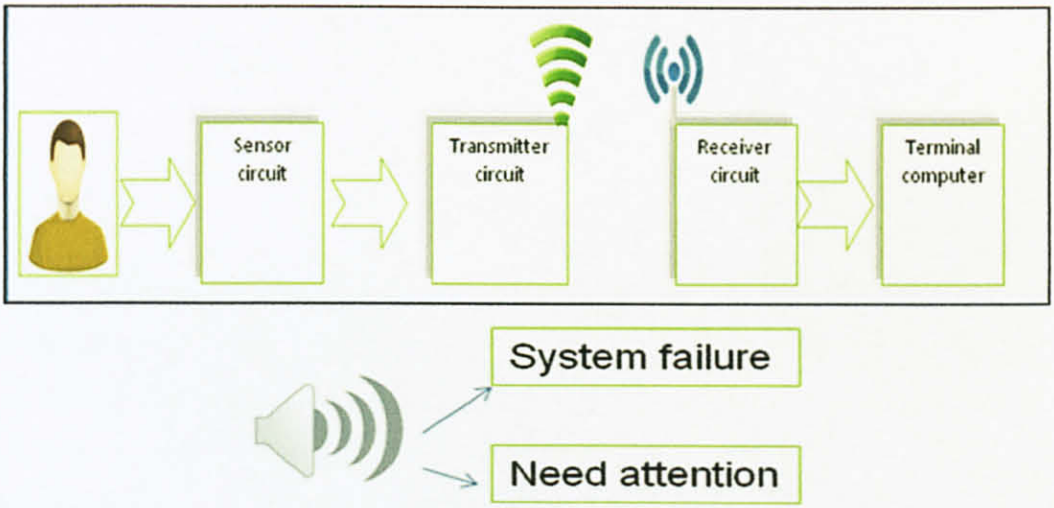

Figure 5: System block diagram

This block is proposed to find the way to help reducing the workload in nursing patients in hospital. At first the pulse rate is detected by the sensor from a patient. The sensor produces an analogue signal which is fed in the Schmitt Trigger to generate the digital pulse. This digital pulse is the input to input port of microcontroller. Microcontroller plays an important role to count the digital pulse and to transmit the counting result to transmitter.

At the receiver terminal, the receiver circuit is designed to receive digital data updated from a patient. Finally, the digital signal is retrieved and sent to a monitoring computer to store or keep patients' heart beat records for future analysis. At the computer terminal, if any patient has a significant sign of attention, the system will alarm and alert the nurses for attention.

In case of the system malfunctions or no power supplies to the system, the alarm will also be triggered. This is to call for immediate action to perform maintenance in the system or to tell the nurses that the system temporary fail and so manually nursing is needed.

From the block of prototype there are two main parts; transmitter part and receiver part. Transmitter part consists of IR sensor, Schmitt Trigger, Microcontroller and transmitter module. For receiver part consists of RF receiver, Microcontroller, and terminal computer.

3.2 Procedure Identification

Job in wireless monitoring patient is focusing on the reading of data, pulse rate, which is transferred wirelessly to the monitoring computer system. So the idea of how the data transferred wirelessly has come to the main point of the project. Figure 6 shows the flow chart of the project:

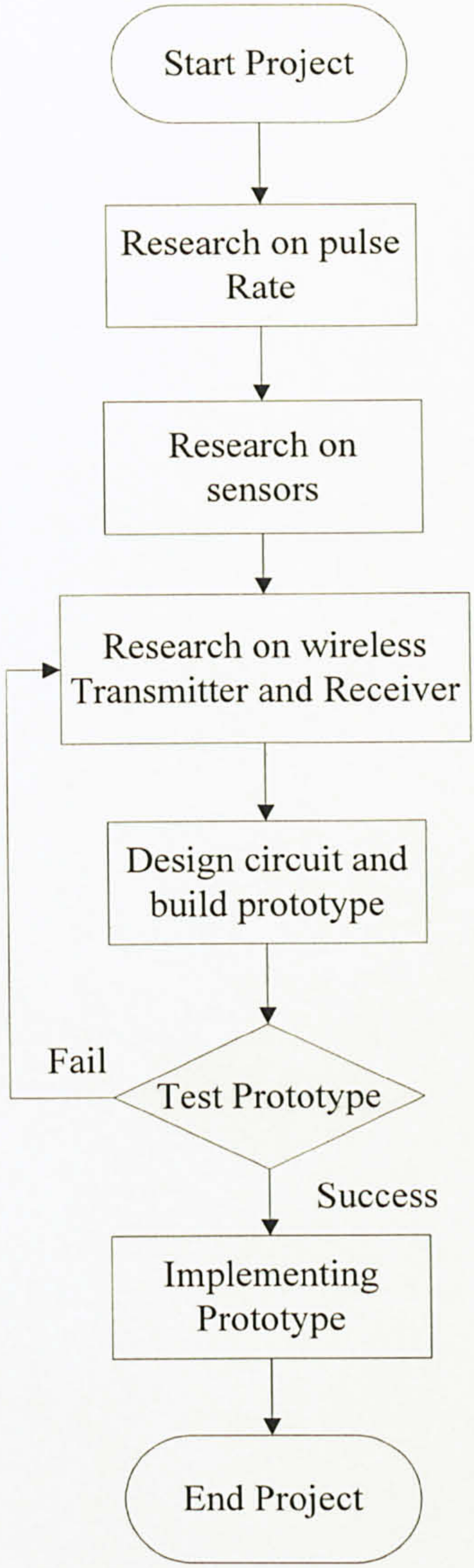

Figure 6: Flow chart of the project

3.3 Research on pulse rate

In order to start doing the project, the knowledge on the pulse rate of a normal person and how the heart functions should be clearly understood. This can provide useful idea and knowledge on the project.

3.4 Research on sensors

Electronic part is more important in collecting data from the patients. Sensors will be used in the monitoring system. They play important roles in core circuit of transmitter and getting data reading from each patient.

In the block of sensor circuit, there are two main components needed; one is the infrared LED to emit a light through the finger and two is a light sensor detector. The high intensity type LED and light sensor are needed to detect a small change in blood density flowing through a finger. A finger is placed between LED and light sensor (photodiode). The skin will be illuminated with the visible light by LED using transmitted and reflected light. The very small changes in reflectivity caused by the varying blood content of human tissue are almost invisible. There are noises occur during the detection of the invisible light. The preprocessing of raw signal has to be done in order to reduce the noises. The output is the filtered signal which is used for the next stage to transfer.

3.5 Research on wireless transmitter and receiver

There are many ways in sending the data wirelessly. The research on wireless technology must be done in order to accomplish the project. Understanding on how the transmitter and receiver work is really useful in designing circuit and choosing the right wireless device to transmit the data.

3.5.1 Transmitter

The digital outputs from microcontroller are fed into the transmitter module which is from Escol Company. TX9902B module is a RF transmitter module with encoder PT-2262 on board. This transmitter needs 4 digital inputs. These 4 inputs are encoded and sent to oscillator to be read ready to transmit. Appendix II provides the datasheet of the transmitter module.

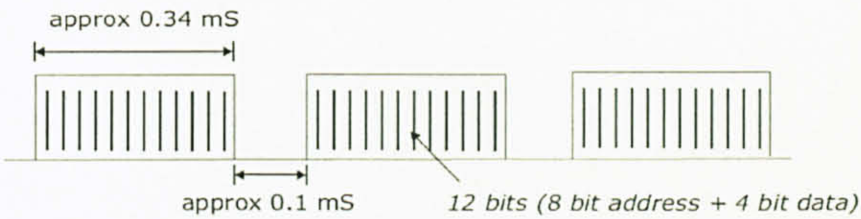

Figure 7: Encoder's output wave form

3.5.2 Receiver

RX9926 is a pair to the transmitter which is used to receive the digital signals. This module has decoder PT-2272 on board. When it receives the signal from transmitter, it decodes the signal to 4-bits digital signals. For more detail please refer to its data sheet in Appendix III.

3.6 Design Circuit and System

3.6.1 Heart Beat Circuit

Figure 8 shows the heart beat sensor circuit using IR emitter and IR phototransistor to detect the heart beat.

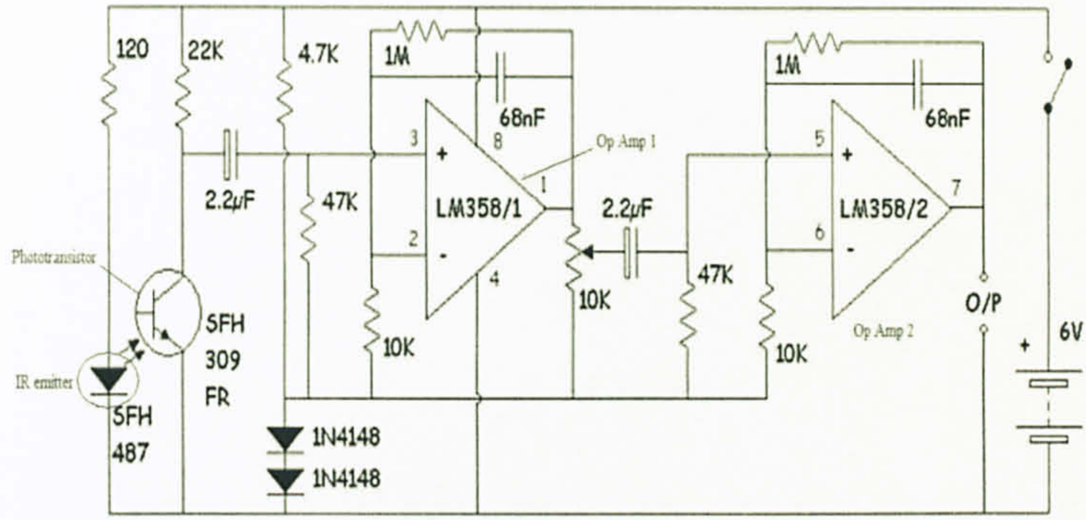

Figure 8: Heart beat sensor circuit

Patient finger is placed in between the LED emitter and phototransistor. The LED emitter produces an invisible infrared which is detected by the phototransistor. The intensity of the infrared light is varying during the pumping of the heart. Even a slightly changes in the density of blood, the detector, phototransistor can sense the changing in light density and produces various voltage values. Operational amplifier (Op Amp) is used to compare the voltage levels and to produce the output signal which is the heart beat detection. Figure 9 shows the output signal from Op Amp 2.

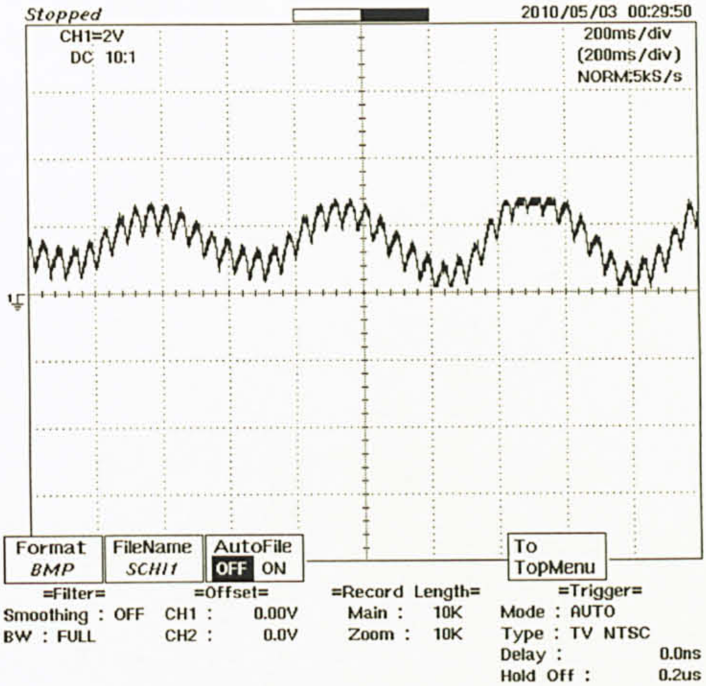

Figure 9: Op Amp 2 output signal

3.6.2 Operational Amplifier

Operational amplifier refers to a large family of general-purpose and special-purpose units having the distinctive feature. Op-amps provide high gain amplification of the difference between two input voltages. There are two input voltages v_p and v_n and one output v_{out}. The resulting voltage across the input terminals is the difference voltage $v_d = v_p - v_n$. The difference voltage is the entirely controls the output voltage.[10]

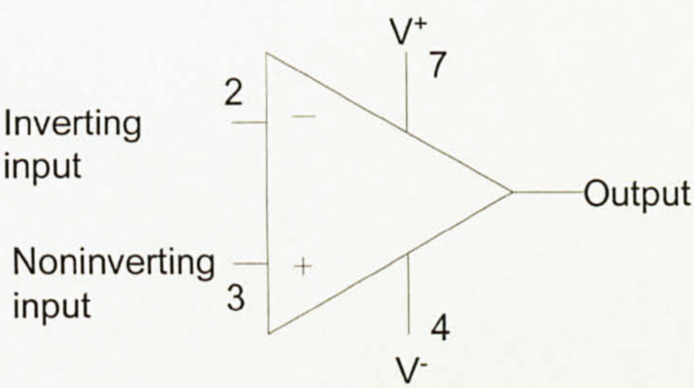

Figure 10: Operational amplifier

- Inverting Amplifier

This operational amplifier amplifies the input signal to produce the negative output signal using the following formula:

$$E_0 = - (R_0/R_i) * Ei$$

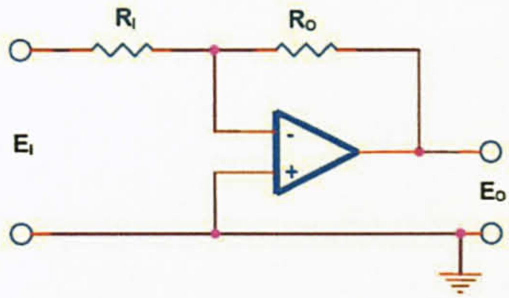

Figure 11a: Inverting Amplifier

- Non-Inverting Amplifier

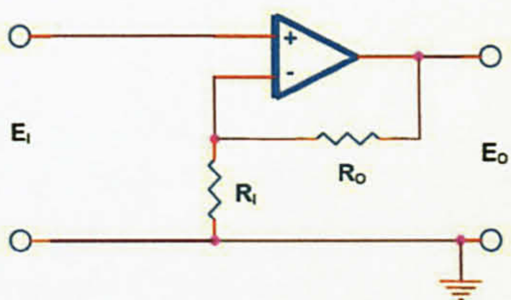

Figure 11b : Non-Inverting Amplifier

This mode of operational amplifier produces a positive output voltage by the following formula:

$$E_0 = (1+R_0/R_i)*E_I$$

3.7 Schmitt Trigger

A Schmitt trigger is a special type of IC that is used to transform slowly changing waveforms into sharply defined, jitter-free output signals. The Schmitt Trigger is used to reduce noise which is not a good wave form. In order to produce a sharply nice pulse, the analog signal is fed into the Schmitt trigger 7414. It introduces the Hysteresis which means that the switching threshold on a positive-going input signal is at a higher level than the switching threshold on a negative-going input signal. This is useful for devices that have to ignore small amounts of jitter or electrical noise, on input signals. Any signals above the positive threshold voltage, the Schmitt trigger will produce a low pulse. When any signals are below the positive threshold, it will produce a high pulse. [11]. Figure 12 shows the Schmitt Trigger ideal operation.

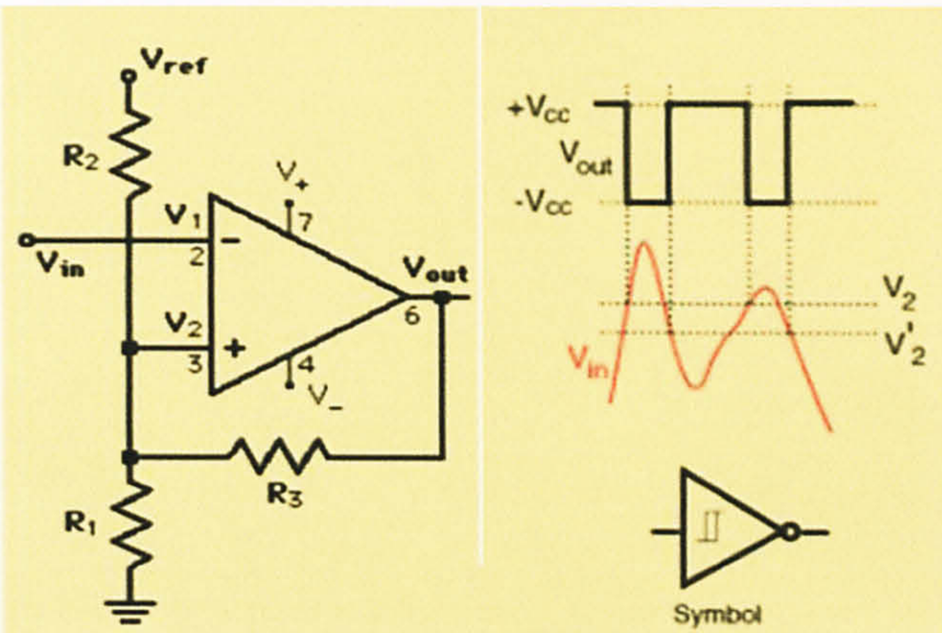

Figure 12: Ideal Smchitt Trigger [10]

3.8 Microcontroller

Microcontroller is used to count the pulse from the Schmitt Trigger in 1 second delay. The following is the extracting coding to program the counter. Figure 13 shows the delay calculation.

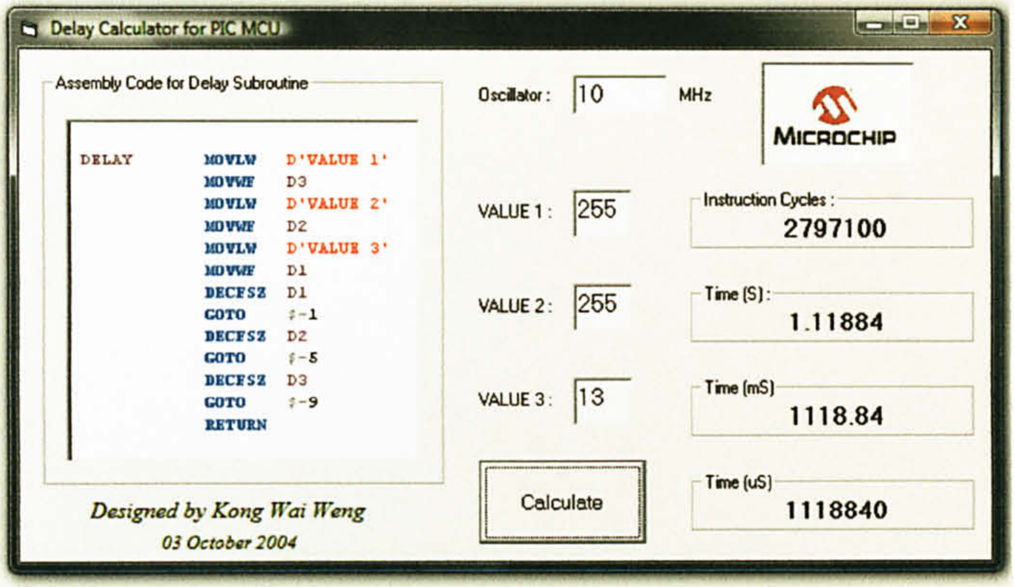

Figure 13: Delay calculation for PIC MCU

```
PROCESSOR 18F452
#include        "p18f452.inc"
config          WDT=OFF, OSC=HS
    ORG         0x00
    goto        main
    ORG         0x04
    goto        main
    D1          equ     0x20
    D2          equ     0x21
    D3          equ     0x22
main

    BSF         TRISC,RC0   ;Pin C0 is an input pulse
    CLRF        TRISB       ;PortB to be output

    MOVLW       0x02        ;Timer 1,16bits, ext clk,no prescale
    MOVWF       T1CON
    MOVLW       0x00
    MOVWF       TMR1L
    MOVWF       TMR1H
    BCF         PIR1,TMR1IF
    BSF         T1CON, TMR1ON      ; Start timer1
    CALL        Delay
```

```
    BCF         T1CON, TMR1ON     ; Off timer1
    MOVFF       TMR1L,PORTB

Delay
    MOVLW       D'255'
    MOVWF       D3
    MOVLW       D'255'
    MOVWF       D2
Second
    MOVLW       D'13'
    MOVWF       D1
First
    DECFSZ      D1,1
    GOTO        First
    DECFSZ      D2,1
    GOTO        Second
    DECFSZ      D3,1
    GOTO        Delay
    Return
    END
```

3.9 Interface with Monitoring Computer

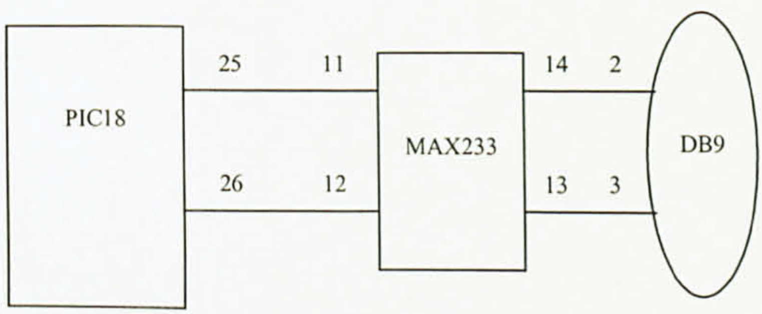

Figure 14: Serial communication interface

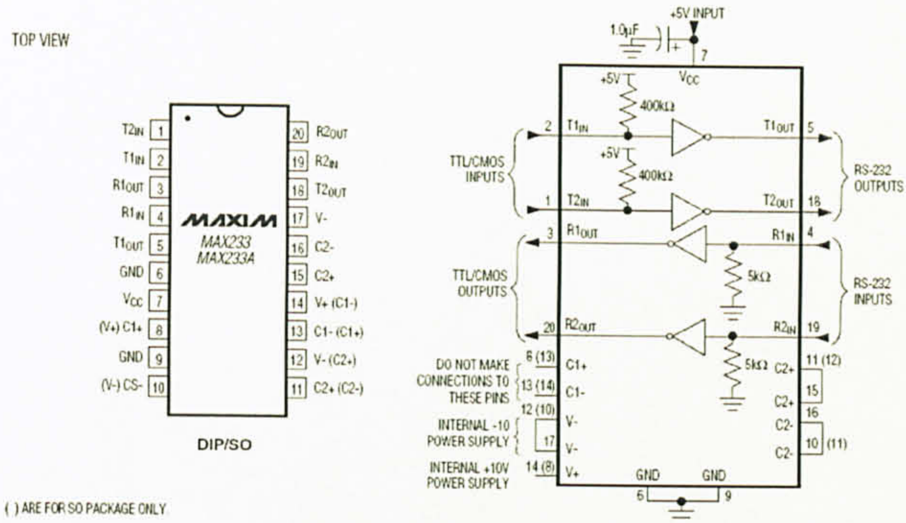

Figure 15: MAX 233

If the prototype passes the testing stage, the next stage will be interfacing the prototype with monitoring computer using knowledge on hyperterminal. This terminal allows microcontroller to communicate directly to computer.

The following is the extracting code for microcontroller to communicate with the host computer using serial port. The data from the reading is shown on the hyperterminal screen on computer.

```
;***Serial port
PROCESSOR    18F458
#include          "p18f458.inc"
config            WDT=OFF, OSC=HS
org               0x00
goto              main
org               0x04
goto              main
main
MOVLW       0xFF
MOVWF       PORTB
MOVLW       0x24
MOVWF       TXSTA           ;enable transmitter
                             choose high baud
MOVLW       0x0F            ;9600bps
```

```
MOVWF       SPBRG
BSF         RCSTA,SPEN  ;enable the serial
                        port itself
BCF         TRISC,TX    ;make TX pin an output

next        MOVLW       high(message)
            MOVWF       TBLPTRH
            MOVLW       low(message)
            MOVWF       TBLPTRL
Read        TBLRD*+
            MOVF        TABLAT,W
            CALL        trans

Pulse       MOVF        PORTB,W
            CALL        trans

trans       BTFSS       PIR1,TXIF
            BRA         trans
            MOVWF       TXREG
            RETURN

message     DB    "Avg Heart Beat per 5 seconds is : ",0
            END
```

3.10 Hyperterminal

The result will be displayed on the computer screen by this window. Hyperterminal is a freeware application you can use in order to connect your computer to other remote systems. Within HyperTerminal's user interface, you will find menus, buttons, icons, and messages. All these elements and controls work together so as to provide convenience for the user, especially for accessing the necessary features and performing various tasks.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Heart Beat Detector Circuit Analysis

From figure 8, the heart beat detector produces the output voltage in the range from 800 mV to 2.6 V. This output voltages are higher than Schmitt Trigger's the minimum threshold voltage of 800 mV. So Schmitt Trigger will not produce a correct result. In order to overcome this problem, a voltage divider has to be used to drop down the IR output voltage. Figure 16 shows the heart beat sensor circuit diagram with a voltage divider part at the output.

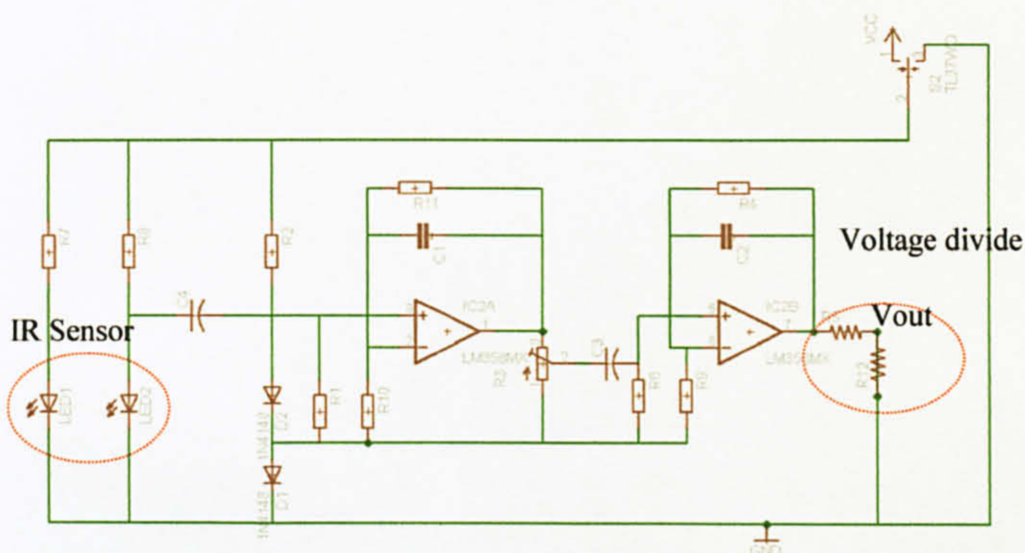

Figure 16: Heart beat Sensor schematic

4.2 Schmitt Trigger Output

Schmitt Trigger has the positive threshold voltage of 1.5 V and the negative threshold voltage of 0.8 V. Any signal in between the negative and positive threshold voltages will remain in the same state. The output signal only changes state when the input signal higher than the positive threshold voltage or lower than the negative threshold voltage. Figure 18 shows the Schmitt Trigger's output. The amplified heart beat detector signal is fed into the Schmitt Trigger. When the voltage level is higher than the positive threshold voltage, Schmitt Trigger starts to convert the signal to logic 0 of 0 V. When the voltage drops below the negative threshold voltage, Schmitt Trigger will convert the signal to logic 1 of 3.60 V.

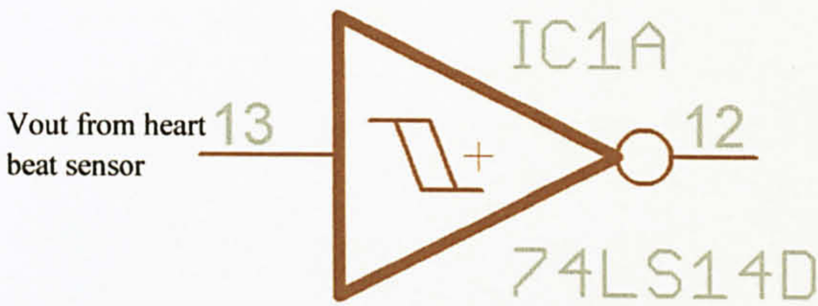

Figure 17: Schmitt Trigger schematic

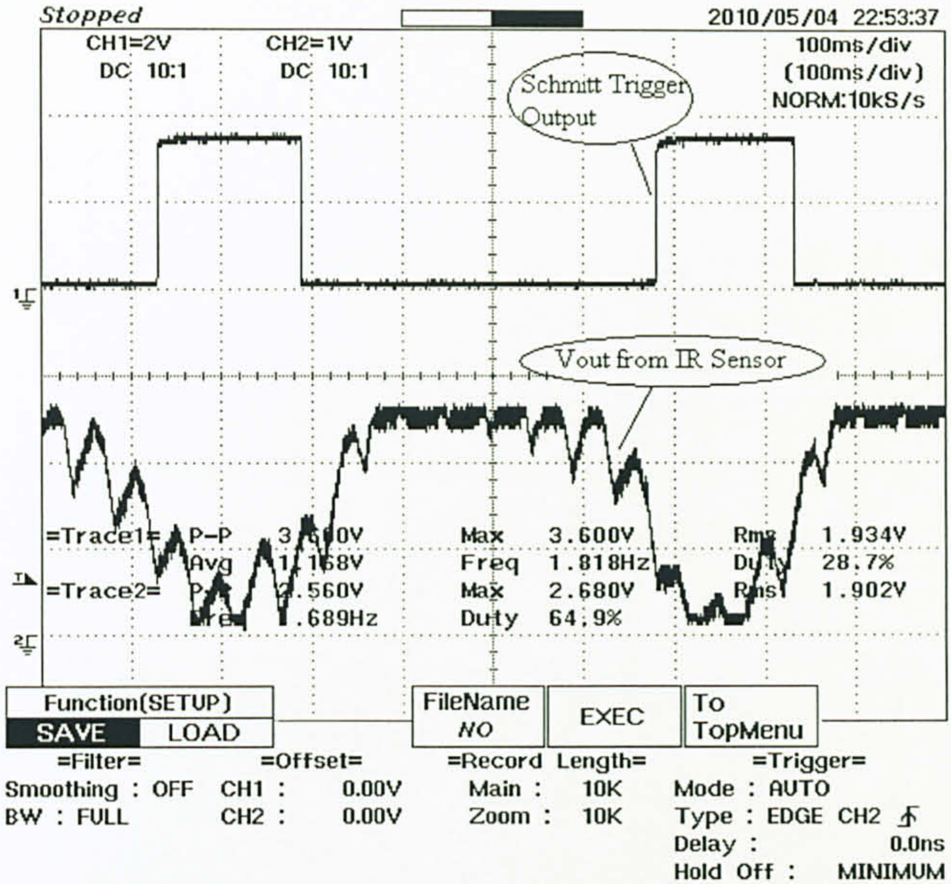

Figure 18: Schmitt Trigger's output voltage level

4.3 Relay Circuit

A relay is an **electrically operated switch**. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in figure 19.

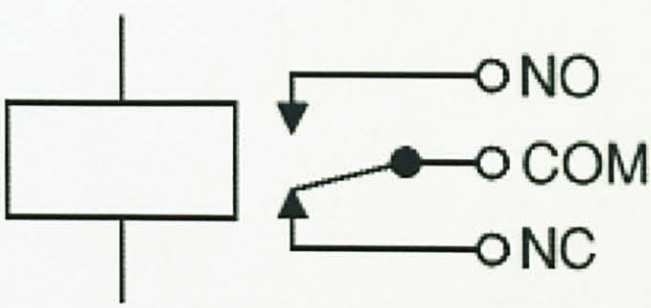

Figure 19: Relay Circuit

This relay circuit is used to give the alarm when the system runs out of batteries.

4.3 Transmitter, Receiver and Microcontroller

The digital pulse from Schmitt Trigger is fed into microcontroller which is already programmed to be a counter. The result of counting is sent to port B. This counting result is then connected to transmitter module. The outputs from port B are fed into the transmitter from D0 to D3. These digital inputs are encoded by PT-2262 encoder. In figure 20, LEDs light up to prove the signals have been transmitted at the transmitter and received at receiver terminals.

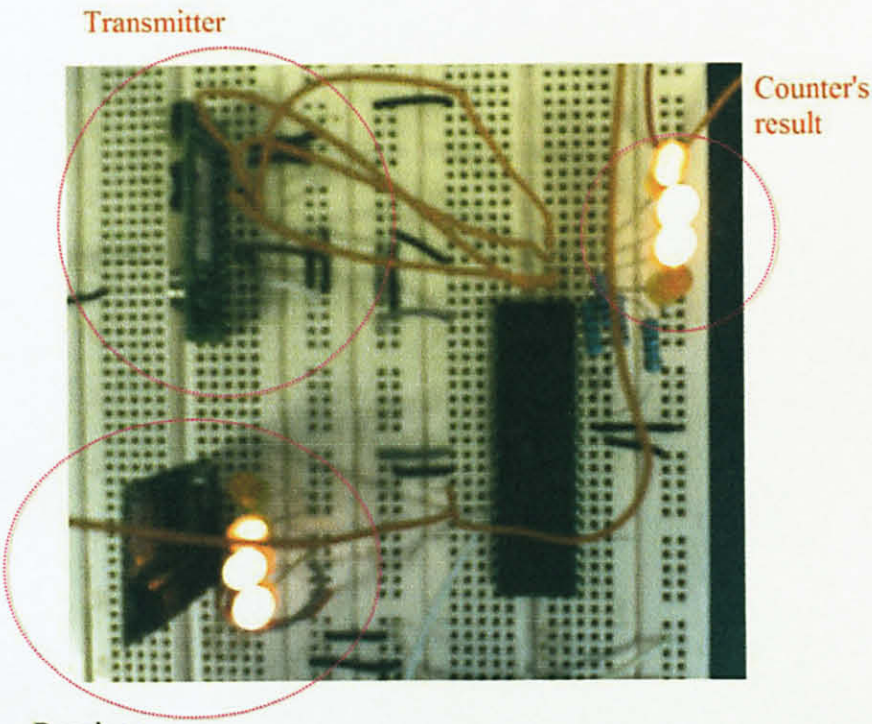

Figure 20: Transmitter and Receiver demo

4.4 Overall Schematic

4.4.1 Transmitter part

Figure 21a shows the schematic drawing for heart beat sensor, Schmitt Trigger, buzzer, microcontroller, and transmitter. Figure 21b shows the PCB drawing from schematic in figure 21a.

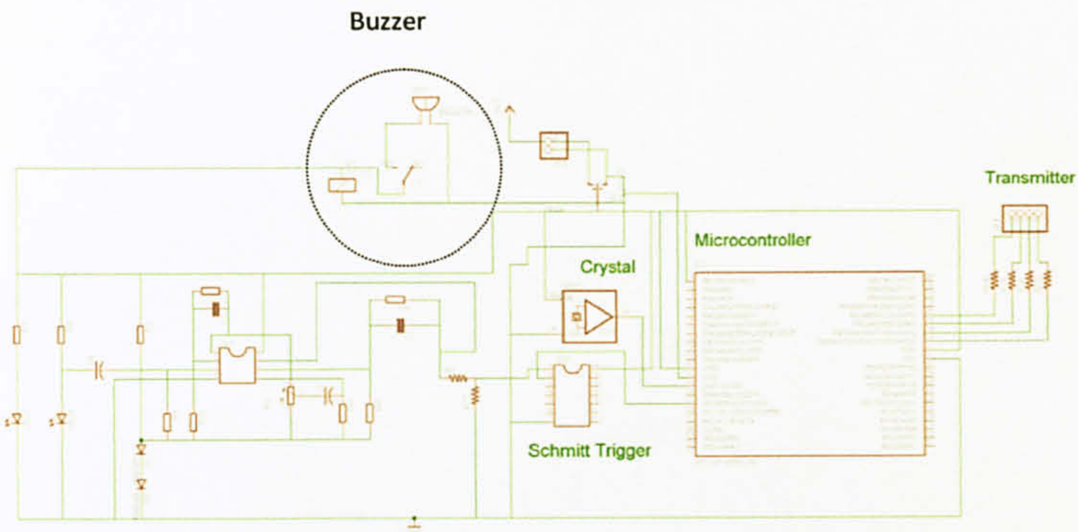

Figure 21a: Schematic diagram of transmitter part

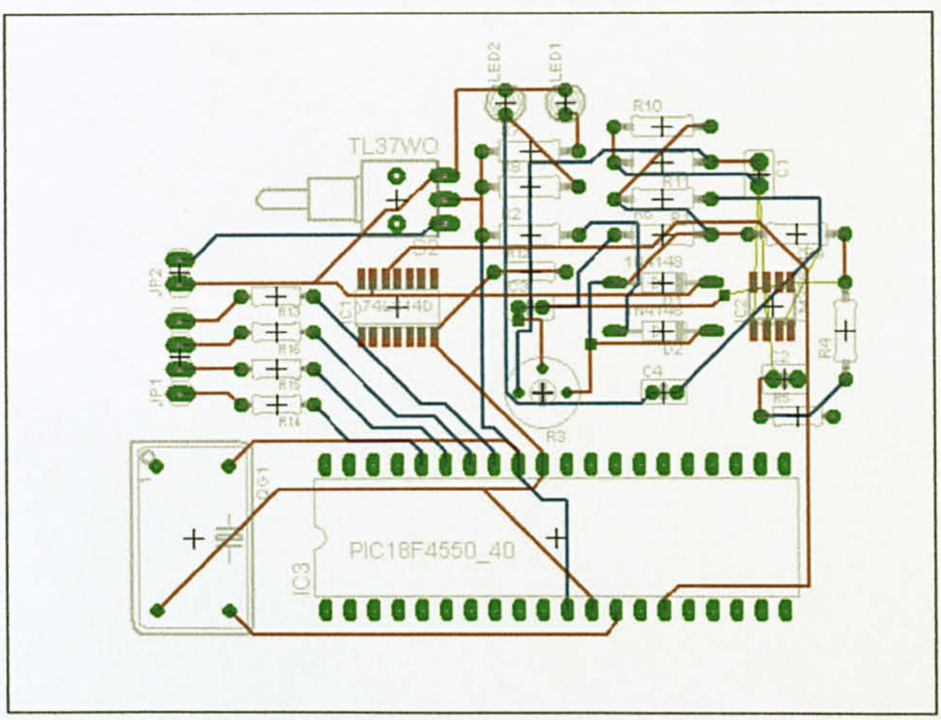

Figure 21b: PCB drawing for transmitter part

4.4.2 Receiver part

Figure 22a show the schematic for the receiver part which consists of transmitter, microcontroller and buzzer. Figure 22b shows the PCB drawing for the receiver part.

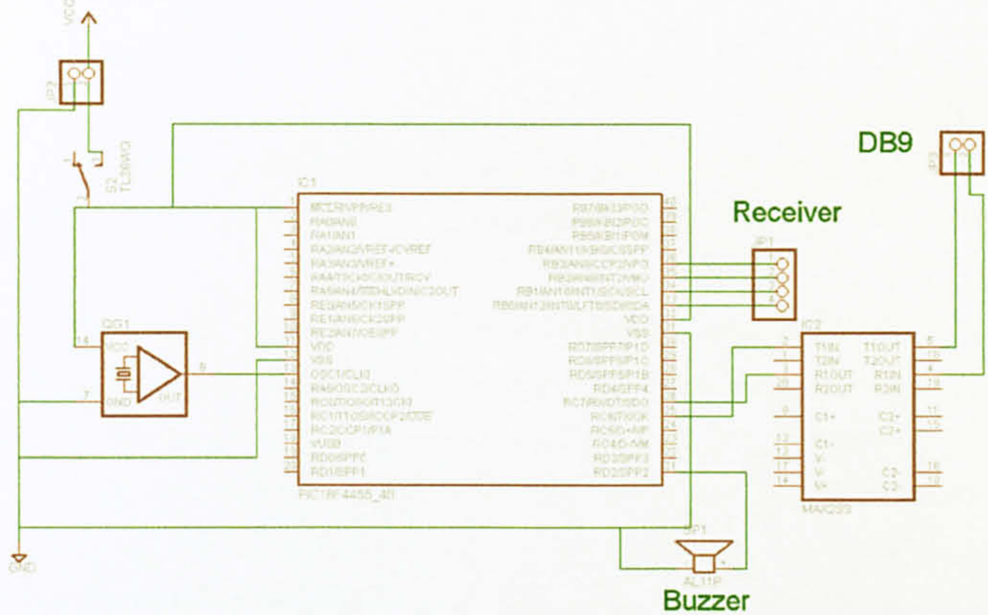

Figure 22a: Receiver part schematic

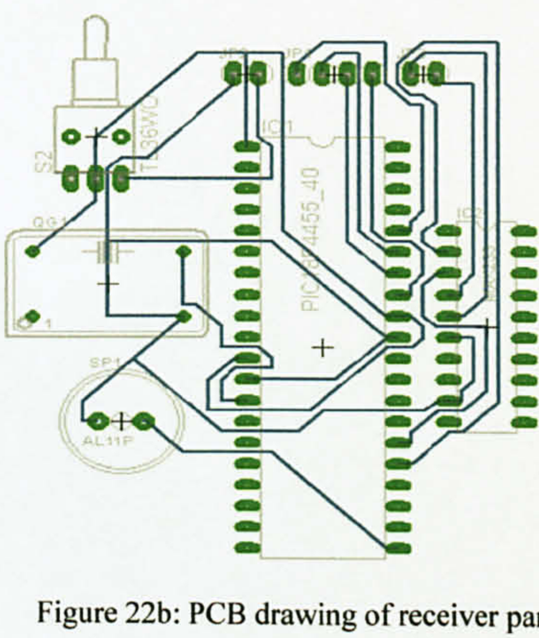

Figure 22b: PCB drawing of receiver part

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In conclusion to this project, it can help nurses to monitor patients' status effectively; it can save the time and manage the patients' need well.

The system consists of data reading module, transmitter circuit, receiver circuit, terminal monitoring computer, and alarm. The main component in the project is the Heart beat detector circuit which produces various voltage values. These voltage values are compared by the OP AM to produce the analog output. Then the analogue output is fed into operational amplifier to reach the high voltage. This high voltage becomes an input of Schmitt Trigger. Microcontroller counts pulses obtained from Schmitt Trigger and send the output to the transmitter. At the terminal, the receiver accepts the signal then passes to microcontroller to display on the screen.

4.2 Recommendations

The wireless technology is being used in this project. All the data are transferred wirelessly to the main computer. For future improvement, the author should choose any transmitter which can send the data faster. There are noises due to the movement of the finger, blood speed, patient's physical. So the noise reduction should be recommended. Finally, better user interface should be recommended. Better user interface will help nurses be able to monitor the patients more efficiently.

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APPENDIX

APPENDIX I

Final year project I (FYPI) schedule

No.	Detail/ Week	1 22.Jun	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic														
	Submission of proposal form														
	Meeting with Supervisor														
2	Project reseach														
	Study on pulse rate														
	Research on Sensors														
	Transceiver														
	Outline the prototype														
3	Virtual prototype														
	Buy components														
	Testing heart beat sensor														

Final year project II (FYPII) schedule

No.	Detail and Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Design and test Circuit														
	Construct heart beat circuit														
	Test heart beat detector														
	Construct RF transmitter and receiver														
	Test transceiver														
	Build prototype														
	Test prototype														
	Interface to computer														

APPENDIX II

TX9902B

RF Transmitter Module With Encoder

(SAW resonator stabilized) (DC 3 ~ 12V)

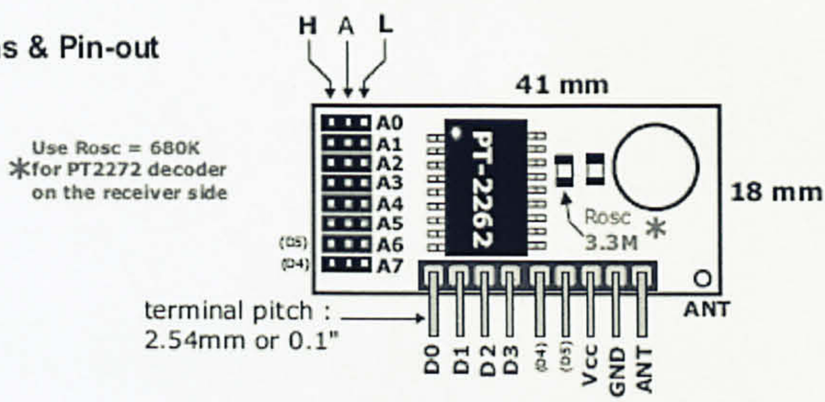
Application

1) Industrial remote control, remote monitoring & sensing
2) Wireless security alarm or low baud rates digital signal transmission receiver
3) Remote control for household electrical appliances and robotic projects.

Technical Specifications

Operating voltage	3 ~ 12V DC
Operating current	max: < 5mA(12V), < 2mA(3V)
Oscillator	SAW filter stablilized
Modulation	OOK, ASK
Frequency	**315 MHz or 433.92 MHz**
Frequency tolerance	± 150 KHz (max)
Transmission (RF) power	50mW (at 315 MHz & 12V)
Data transmission rate	<= 10K bps
On board Encoder IC	**PT2262** or compatible chips (SC2262, CS5211, etc)
Antenna length	**24 cm** (315MHz), **18 cm** (433.92 MHz)

Dimensions & Pin-out



IMPORTANT NOTES

1) **Antenna :** Use any soft/hard wire with the specified length. If a telescopic antenna is used, be sure that it is fully extended. Length of antenna is important and frequency dependent (refer to the specs section above for the correct length)

2) If the transmitter module is housed in a metal casing, an external antenna should be used. For best result, use 50 Ω coaxial cable for connecting the antenna to the module.

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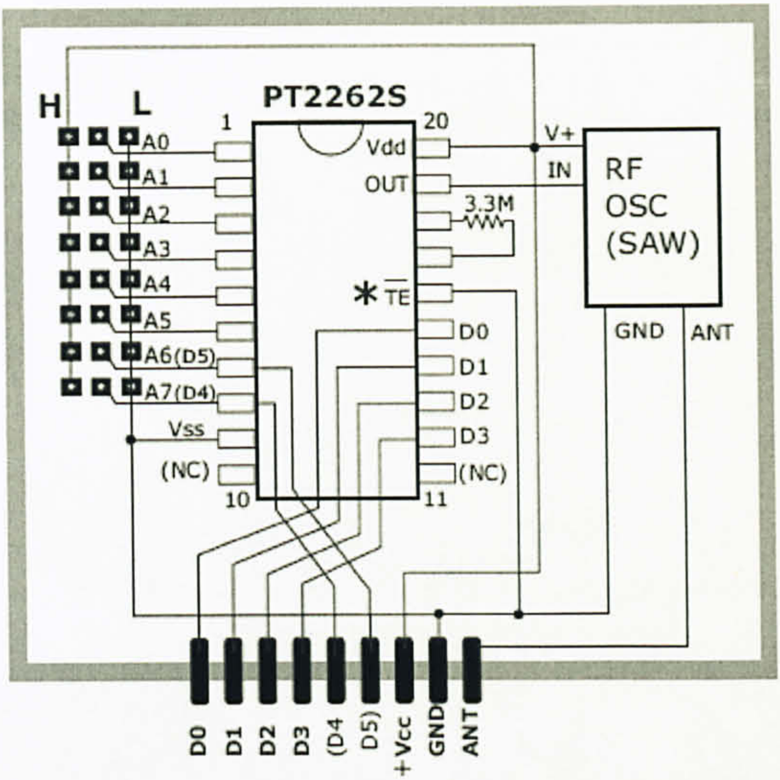
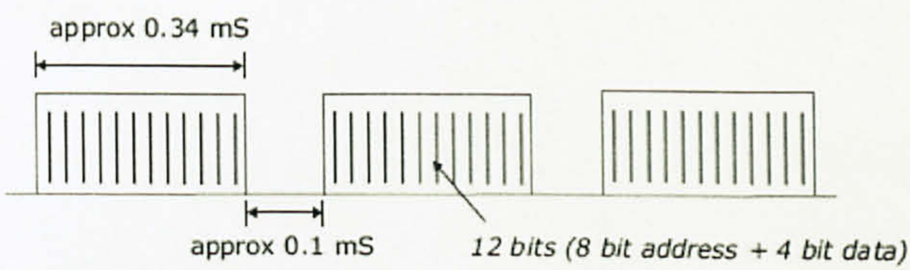
Simplified Block diagram



* NOTE : TE pin is permanently tied to GND. The transmitter is in the continuous transmission mode.

Waveform at PT2262 output pin

(please refer to PT2262 datasheet for more info on signal format & timing)



APPENDIX III

RX9926

RF Receiver Module with Decoder

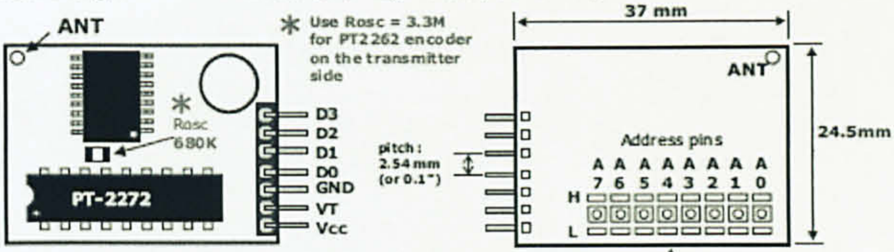
- Superheterodyne
- SAW resonator based design
- High sensitivity

Application

1) Low baud rates digital signal link
2) Industrial remote control, remote monitoring & sensing
3) Wireless security alarm receiver and remote control for household electrical appliances.

Technical Specifications

Operating voltage	5.0 VDC ± 0.5V
Operating current	<= 5 mA (Vs=5.0 V DC)
Receiver config.	Superheterodyne
Modulation	OOK, ASK
RF Frequency	315 MHz or 433.92 MHz
Channel width	2MHz (315MHz @ 3 dBm rolloff)
Sensitivity	> -100 dBm (50)
Data transmission rate	< 9.6 Kbps (315MHz, -95 dBm)
On board decoder IC	**PT-2272-L4** or compatible chip **(8-bit trinary address, 4-bit binary data)**
Output	TTL compatible
Antenna length	24 cm (315MHz), 18 cm (433.92 MHz)



Each address pin can assume one of the 3 possible logic states.
i.e. : logic high (H), logic low (L) or floating (no connection)
The module is supplied with all the address pins open.

IMPORTANT NOTES

1) **Antenna :** Use any soft/hard wire with the specified length. If a telescopic antenna is used, be sure that it is fully extended. Length of antenna is important and frequency dependent (refer to the specs above for the correct length)

2) Supply voltage should be stable & with low ripple.

3) Note that output waveform may become distorted if the transmitter is too close to the receiver (~ a few cm). This is inherent to superheterodyne receivers and is considered as normal

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