REMOTE MONITORING OF VITAL SIGNS

By

SYAZANA BINTI HASAN NAWAWI

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Universiti Teknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

Dr. Afza Shafie

(Project Supervisor)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

December 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.

SYAZANA BINTI HASAN NAWAWI

ABSTRACT

In this project, our goal is to design a wireless sensor system, which can monitor user's vital signs and notifies medical personnel. . During health emergencies, there is little tolerance for system errors and poor usability designs. Clinical and technological efforts are being directed to focus on post surgery concerns to enhance the safety of the patients during this vulnerable period. This system will consist of a monitoring device, data transmission and the monitoring station. The proposed device will be asked to measure the blood pressure of the patients. Data will be transmitted using Hyperterminal and RS 232 into PC and the development the GUI will be based on LABVIEW. This system shall facilitate communication between patients and medical professionals from distant locations.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Recovery is a process and may take some time before patient feels completely healed. Patients who have an operation may develop a complication. All surgeries have the risk of reaction to drugs and anesthesia, airway obstruction, and the development of bleeding or infection after the operation. These risks are usually small but certain surgeries may have an increased risk of complications occurring. Hence, most of the time, these patients are subject to constant monitoring.

In this project, a system is developed to assist in monitoring the vital sign of patients which require constant monitoring both for routine assessment and continuous monitoring. Through continuous monitoring, medical staff able to pick up critical changes in the data earlier than normal, manual monitoring. In this system, the vital signs of the patient will be measured and transmit to a monitoring station. The propose system will allow for remote monitoring of the data. It will consist of a monitoring device and transmission of these data to a monitoring station. These data will be stored in hospital database. Any medical personnel will able to access patient's data at anytime required. Figure 1 shown is the diagram for proposed remote monitoring of vital signs project.

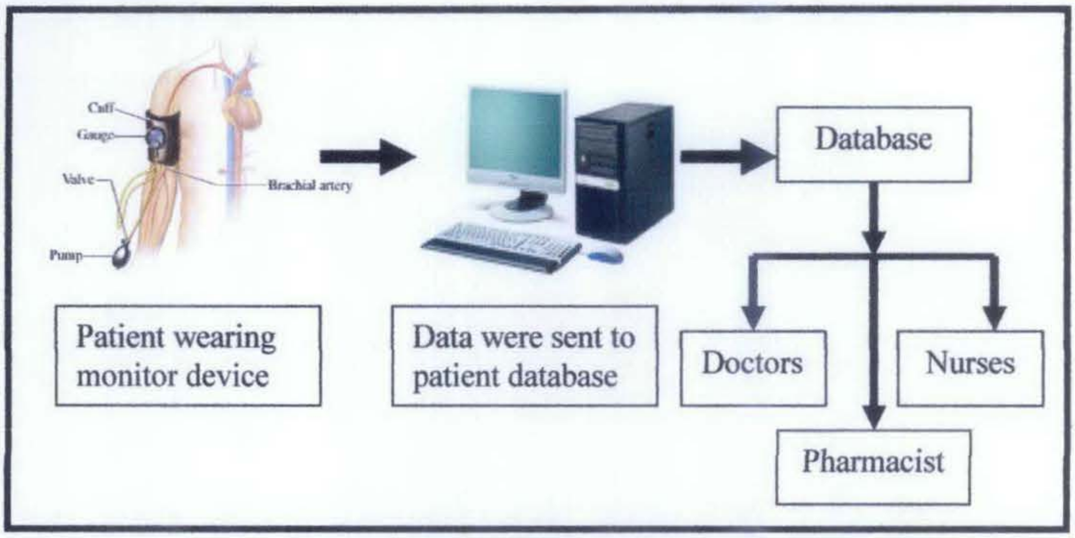

Figure 1. Remote Monitoring Vital Signs System Overview

1.2 Problem statement

During post surgery where it involves many victims, it is important to keep track of the vital signs of the victims. This is critical for patients who are surely injured and needed monitoring of the vital signs. Furthermore during unexpected disaster which involves large number of patients, a lot of medical personnel are required to assist in one time. This situation may give rise to lack of manpower since most of the staff will be involved in the rescue operations. In addition, hospitals in rural areas often do not have enough personnel to carry out this continuous monitoring. Currently, doctors monitor their patients' conditions through reading the patients records at he ward. This system will enable them to monitor the patients even if they are not at the wards.

1.3 Objective

The main objective of the project is to develop a system that is able to:

i) Remotely controlled to read the blood pressure and pulse

ii) Transmit the real time data to a monitoring station

iii) Display the data on the GUI

1.4 Scope of Study

Vital signs are indicators that reflect the physiological condition of the vital organs like heart, brain or lounges. They express in an immediate way of functionality changes that happen in the body. Vital signs, traditionally consists of blood pressure, temperature, and pulse rate. Scope of the study will focus on:

(i)Blood pressure and pulse measurement device will be attached to a remote control ON/OFF circuit.

(ii)LCD output serial bus will be connected to RS 232 port to send data into PC.

(iii)LabVIEW, or Laboratory Virtual Instrumentation Engineering Workbench will be used as graphical user interface (GUI) for monitoring purpose.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

A wireless sensor system that can monitor users' vital signs have been developed by [1] . This system is able to notify the relatives and medical personnel of the patients' location during life threatening situations. This system consist wireless sensor networks, RFID and Vital Sign Monitoring technology. Besides this, [2] has developed developed a real-time patient monitoring system that integrates vital sign sensors, location sensors, ad-hoc networking, electronic patient records and web portal technology to allow remote monitoring of patient status. This system has proven useful in special cases such as mass casualty disaster scene, where is is able to ease medical personnel to give priority to victims that needs urgent medical attention. A wireless Health Care system for vital sign monitoring has been designed by [3]. The system consists of a smart fabric that is worn and interpreted with computing techniques, smart sensors, portable device and telecommunication, together with local intelligence and decision support system. This system is suitable for patients during rehabilitation or while working in extreme stressful environment situation. Most of the remote monitoring system uses LABVIEW as the GUI [4, 5]

2.2 What are Vital Signs?

Vital signs are measurements of the body's most basic functions. The four main vital signs routinely monitored by medical professionals and healthcare providers include the following:

- body temperature
- pulse rate
- respiration rate (rate of breathing)
- Blood pressure

Vital signs are useful in detecting or monitoring medical problems. Vital signs can be measured in a medical setting, at the site of a medical emergency [4]

2.3 Current Monitoring Assessment

A thorough, properly sequenced rapid assessment is essential to identifying a patient's needs and providing proper emergency care. To assess a patient, the medical staff must gather, evaluate, and record key information including the patient's vital signs, injuries, and symptoms and the conditions leading to the illness or injury. They must learn the history of what happened before and since the accident or medical problem occurred and learn the patient's past medical history and overall health status [5]. Assessment is a process which must be taught in steps in order to establish good assessment habits and a systematic approach in order to avoid missing important injuries or illnesses. Many aspects of the patient assessment may be done simultaneously.

2.3.1 Pulse Rate Measurement

A useful tool to measure pulse rate is a portable pulse oximeter (See Figure 2 Pulse Oximeter). A pulse oximeter is a small, hand-held medical device that measures the oxygen saturation of a patient's blood as well a patient's heart rate. As opposed to measuring oxygen saturation through an invasive procedure such as a blood sample, a pulse oximeter is used as a painless and non-invasive medical instrument [7]. Because of their ease of use, speed, and cost effectiveness, pulse oximeters are the preferred medical device in all healthcare settings as well as for home diagnostics for accurately measuring pulse rate.

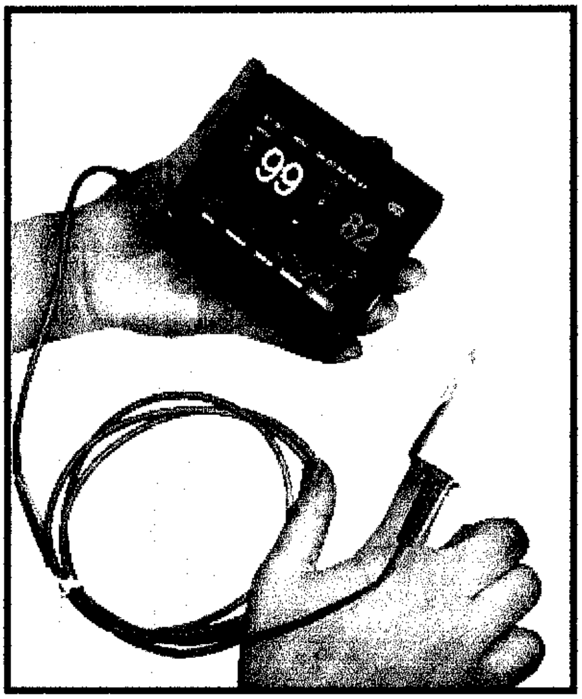

Figure 2.Pulse Oximeter.[8]

2.3.2 Temperature Reading

Thermometers are used to measure temperature. There are many types of thermometers used for various purposes. Clinical thermometers are basically used to record the temperature of human body.

Clinical thermometers are classified as:

- Mercury or Digital thermometers
- Fever Strip
- Instant Thermometers

Mercury Thermometers: They are used under the child's arm or mouth. Plastic digital thermometers, which beep when they're ready, are easier to use and read than traditional thin glass thermometers [9]. They're also less fragile. Some also bend to mould into the shape of underarm. Digital thermometer is shown at Figure 3 and Thin Glass thermometer is at Figure 4.If the nurse takes the temperature in patient's mouth or ear, the normal temperature is between 36° and 36.8° C (97.7° to 99.1°F).


Figure 3.Digital Thermometer [9]

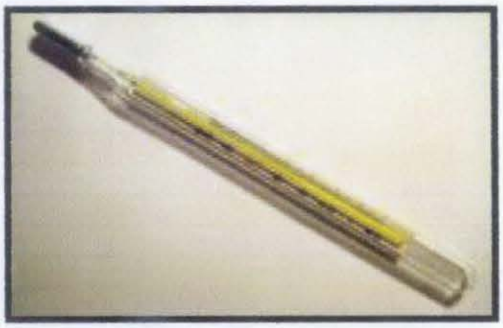
Figure 4.Thin Glass Thermometer [9]

2.3.3 Blood Pressure Measurement

The blood pressure is the pressure of the blood within the arteries. It is produced primarily by the contraction of the heart muscle. Its measurement is recorded by two numbers. The first (systolic pressure) is measured after the heart contracts and is highest. The second (diastolic pressure) is measured before the heart contracts and lowest. A blood pressure cuff is used to measure the pressure.A sphygmomanometer cuff is wrapped around the subject's upper arm, just above the elbow and a stethoscope is placed on the hollow of the elbow, over the brachial artery as shown Figure 5 .

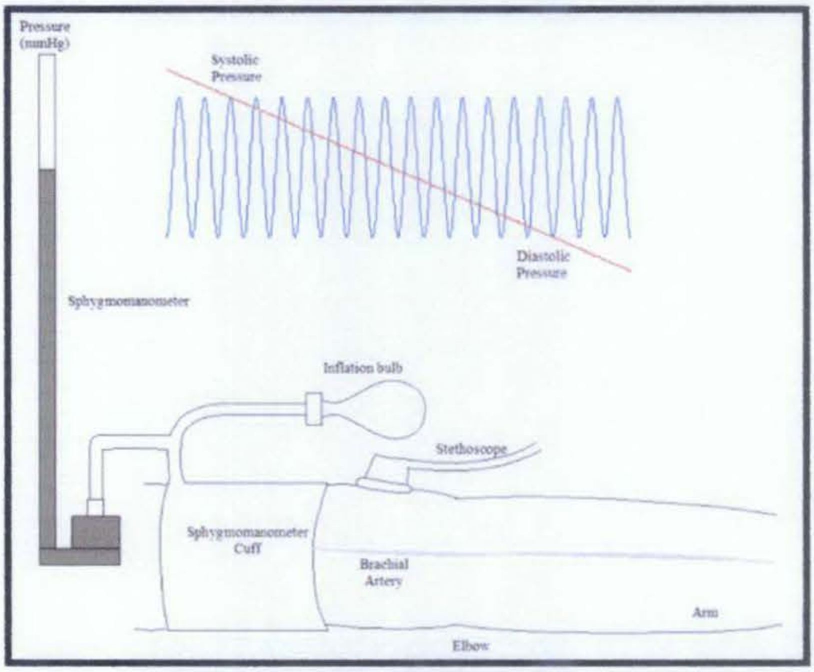

Figure 5.Sphygomanometer [10]

The cuff is 'pumped- up' to a pressure of 180mmHg, compressing the brachial artery hence causing the artery to collapse once the systolic pressure (the maximum pressure exerted by the blood against the wall of the brachial artery when the heart beats) has been exceeded. At the point where the pressure of the cuff is greater then the systolic pressure, the artery has collapsed thus, there is no flow of blood through the brachial artery.

2.3.4 Blood Pressure Air Pump Working Principle

The cuff pumped-up operation is closely related to air pump working principle. See Figure 6 for the operation diagram. This ball check valve type diaphragm pump is powered by compressed air and is a 1:1 ratio design. The inner side of one diaphragm chamber is alternately pressurized while simultaneously exhausting the other inner chamber. This causes the diaphragms, which are connected by a common shaft secured by leather cup to the centers of the diaphragms, to move in a reciprocating action. (As one diaphragm performs a discharge stroke the piston is pulled to perform the suction stroke in the opposite chamber.) Air pressure is applied over the entire inner surface of the diaphragm while air is discharged from the left side of the diaphragm. The diaphragm operates in a balanced condition during the discharge stroke.

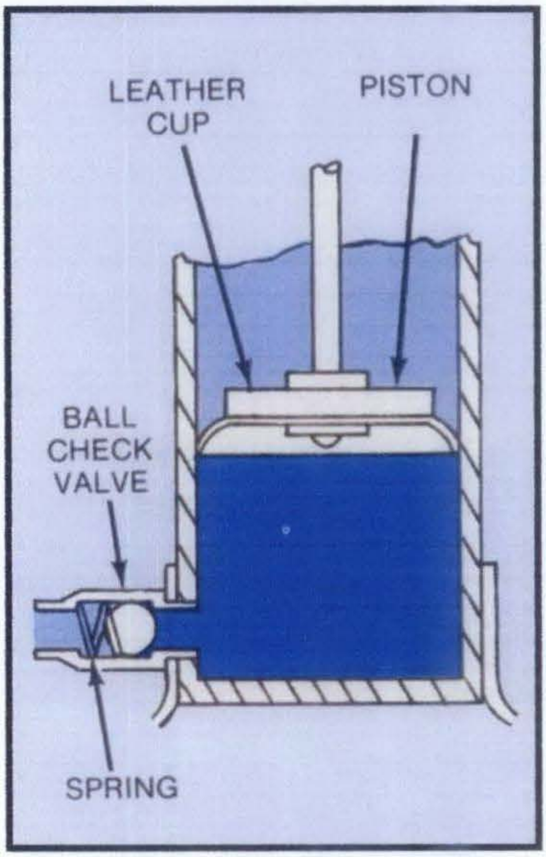

Figure 6 Air pump working principle

2.3.5 The Korotkoff sounds

The valve on the pump is loosened slowly to allow the pressure of the sphygmomanometer cuff to decrease. Once the systolic pressure is reached (approximately 120mmHg in the 'normal' case), the brachial artery opens causing volatile blood flow, which cause vibrations against the artery walls. These noises are called Korotkoff sounds (named after their discoverer) and can be heard through a stethoscope as the pressure exerted onto the brachial artery falls. The blood flow through the brachial artery increases steadily, until the pressure of the sphygmomanometer cuff falls below the diastolic pressure (the pressure between successive heart beats, the low pressure), approximately 80mmHg. This is the point where the blood flow through the artery is laminar.[10]

The Korotkoff sounds are the sounds heard through the stethoscope as the pressure cuff deflates. The sounds are first heard when the cuff pressure equals the systolic pressure, and cease to be heard once the cuff has deflated past the diastolic pressure. It is generally accepted that there are five phases of Korotkoff sounds. Each phase is characterized by the volume and quality of sound heard. In the Figure 7 below, the systolic and diastolic pressures are 120mmHg and 80mmHg respectively.

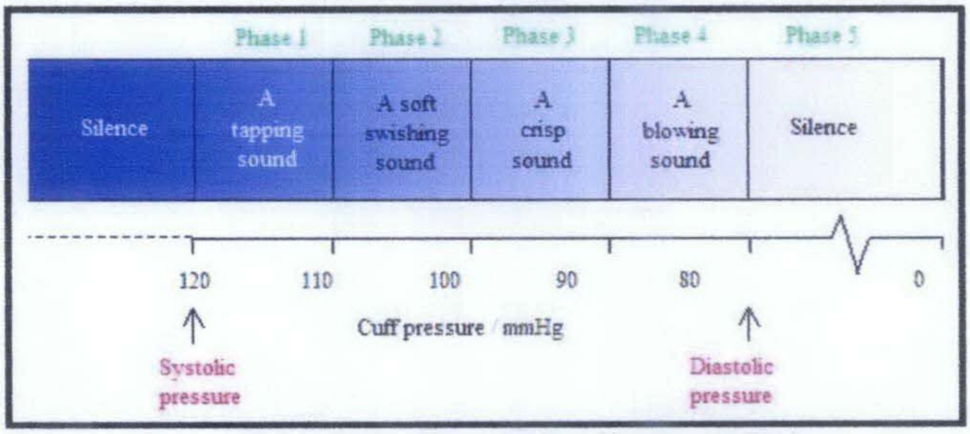

Figure 7.Systolic and Diastolic pressure[10]

Phase1

With the pressure cuff inflated to beyond the systolic pressure, the artery is completely occluded and no blood can flow through it. At the point where cuff pressure equals the systolic pressure, a sharp tapping sound is heard. We recall that the blood pressure oscillates between systolic and diastolic pressure. At systolic, the pressure is great enough to force the artery walls open and for blood to spurt through. As the pressure dips to diastolic, however, the artery Walls bang shut again [10].

Phase2

This phase is characterized by a swishing sound, caused by the swirling currents in the blood as the flow through the artery increases. Sometimes, if the cuff is deflated too slowly, the sounds vanish temporarily. This happens when the blood vessels beneath the cuff become congested, and is often a sign of hypertension. The congestion eventually clears, and sounds resume. The intervening period is called the auscultatory gap.[10]

Phase3

In this phase, there is a resumption of crisp tapping sounds, similar to those heard in phase 1. At this stage, the increased flow of blood is pounding again.

Phase4

At this point, there is an abrupt muffling of sound. The blood flow is becoming less turbulent. Some medical practitioners choose to record this point as the diastolic pressure.[10]

Phase5

This is the point at which sounds cease to be heard all together. The blood flow has returned to normal and is now laminar. The pressure cuff is deflated entirely and removed.[10]

2.4 Remote control ON/ OFF circuit

2.4.1 Radio Frequency Identification

Radio-frequency identification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.

Radio-frequency identification comprises interrogators (also known as readers), and tags (also known as labels).

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal.

There are generally three types of RFID tags: active RFID tags, which contain a battery and can transmit signals autonomously, passive RFID tags, which have no battery and require an external source to provoke signal transmission, and battery assisted passive (BAP) RFID tags, which require an external source to wake up but have significant higher forward link capability providing greater range.[11]

2.4.2 Zigbee module

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking.[12]

The current list of application profiles either published or in the works are:

- Home Automation
- ZigBee Smart Energy 1.0/2.0
- Commercial Building Automation
- Telecommunication Applications
- Personal, Home, and Hospital Care
- Toys

There are three different types of ZigBee devices:

- *ZigBee coordinator (ZC)*: The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It is able to store information about the network, including acting as the Trust Centre & repository for security keys. [12]
- *ZigBee Router (ZR)*: As well as running an application function, a router can act as an intermediate router, passing on data from other devices. [12]
- *ZigBee End Device (ZED)*: Contains just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep

significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC. [12]

2.4.3 Bluetooth module

Bluetooth is a proprietary open wireless technology standard for exchanging data over short distances (using short length radio waves) from fixed and mobile devices, creating personal area networks (PANs) with high levels of security.

Bluetooth is a standard communications protocol primarily designed for low power consumption, with a short range (power-class-dependent: 100 m, 10 m and 1 m, but ranges vary in practice; see table 1 below) based on low-cost transceiver microchips in each device. Because the devices use a radio (broadcast) communications system, they do not have to be in line of sight of each other.[13]

Table 1 Power Class Dependant.

Class	Maximum Permitted Power		Range (approximate)
	mW	dBm	
Class 1	100	20	100 meters
Class 2	2.5	4	10 meters
Class 3	1	0	1 meters

2.4.4 Infrared

Infrared (IR) light is electromagnetic radiation with a wavelength between 0.7 and 300 micrometers, which equates to a frequency range between approximately 1 and 430 THz.IR wavelengths are longer than that of visible light, but shorter than that of terahertz radiation microwaves. Bright sunlight provides an irradiance of just over 1 kilowatt per square meter at sea level. Of this energy, 527 watts is infrared radiation, 445 watts is visible light, and 32 watts is ultraviolet radiation.

A commonly used sub-division scheme is:

- Near-infrared (NIR, IR-A DIN): 0.75-1.4 μm in wavelength, defined by the water absorption, and commonly used in fiber optic telecommunication because of low attenuation losses in the SiO_2 glass (silica) medium. Image intensifiers are sensitive to this area of the spectrum. Examples include night vision devices such as night vision goggles.
- Short-wavelength infrared (SWIR, IR-B DIN): 1.4-3 μm, water absorption increases significantly at 1,450 nm. The 1,530 to 1,560 nm range is the dominant spectral region for long-distance telecommunications.
- Mid-wavelength infrared (MWIR, IR-C DIN) also called intermediate infrared (IIR): 3-8 μm. In guided missile technology the 3-5 μm portion of this band is the atmospheric window in which the homing heads of passive IR 'heat seeking' missiles are designed to work, homing on to the IR signature of the target aircraft, typically the jet engine exhaust plume.
- Long-wavelength infrared (LWIR, IR-C DIN): 8–15 μm. This is the "thermal imaging" region, in which sensors can obtain a completely passive picture of the outside world based on thermal emissions only and requiring no external light or thermal source such as the sun, moon or infrared illuminator. Forward-looking infrared (FLIR) systems use this area of the spectrum.
- Far infrared (FIR): 15 - 1,000 μm

2.5 Microcontroller

As an automated extension of blood pressure detector, measurement must made while the arm cuff inflated "up-ramp" and deflated "down-ramp".

However, the up-ramp system becomes a bit more complicated because pressure measurements are made while the cuff is inflated. This requires the microcontroller in the device to extract the pressure pulses from a "noisy" pressure system because the motor is constantly changing the pressure in the system as the cuff inflates. The circuit to remove noise is shown Figure 8 below.

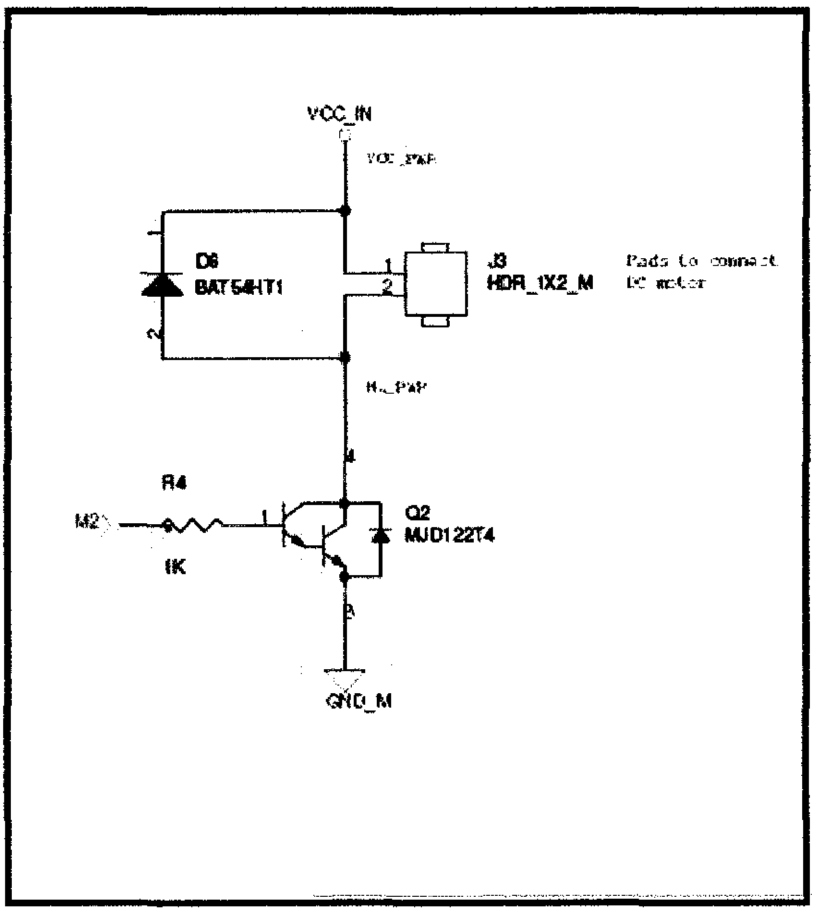

Figure 8: Inflatable pads to connect with motor

Also, the up-ramp motor control is usually more complex than in a down-ramp system, where motor control can be as simple as turning on a motor driven pump and letting it run without further control until it reaches the required pressure.

In a down-ramp system some patients feel uncomfortable as the cuff pressure reaches its preset value and then slowly ramps down to get diastolic pressure. Up-ramp systems minimize this discomfort because the cuff pressure is immediately released after determining the patient's systolic pressure (or after a preset maximum pressure).[14]

2.5.1 Bit Microcontroller

With built-in peripherals and low power consumption might be sufficient for a simple down-ramp blood-pressure monitor with an automated cuff inflation, push button user interface and data logging. The capabilities of an eight-bit-processing core are typically outpaced by implementing an up-ramp system with more features on the same printed circuit board with additional data processing and algorithm requirements to filter the pulse from the noisy inflating pump. This could implement numerous options for blood-pressure monitor on a single printed circuit board, and provides for collecting data, as shown Figure 9 below.

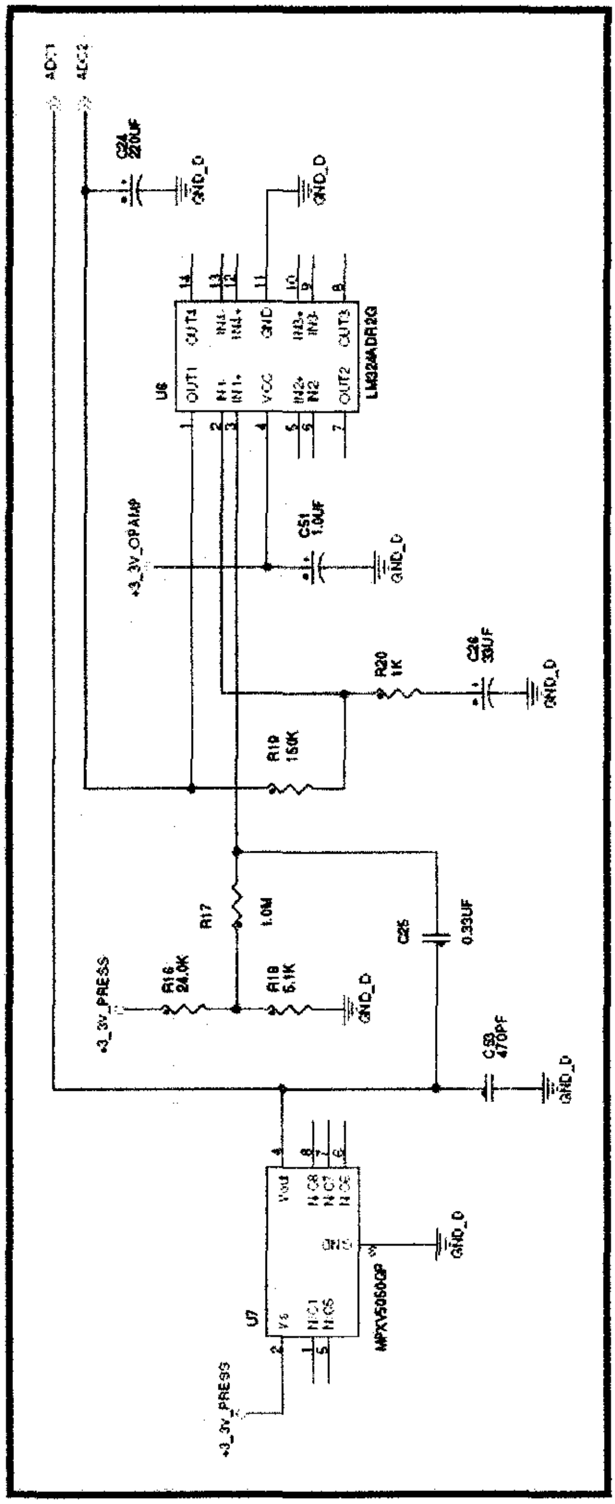

Figure 9 . Blood Pressure Sensor

2.6 LabVIEW Software

Labview is a graphical programming system that is designed for data acquisition, data analysis, and instrument control. LabVIEW programs are called *virtual instruments (VIs)* because the appearance and operation imitate actual instruments.The code in LabVIEW is written graphically using a programming principle known as data flow. Each block in the diagram represents a function that will execute once data has arrived on each ot its inputs. Outputs of a block are connected via wires to the inputs of other blocks or they are connected to control and indicators symbol, which correspond to graphical items on the GUI called the front panel as shown Figure 10 .[15]

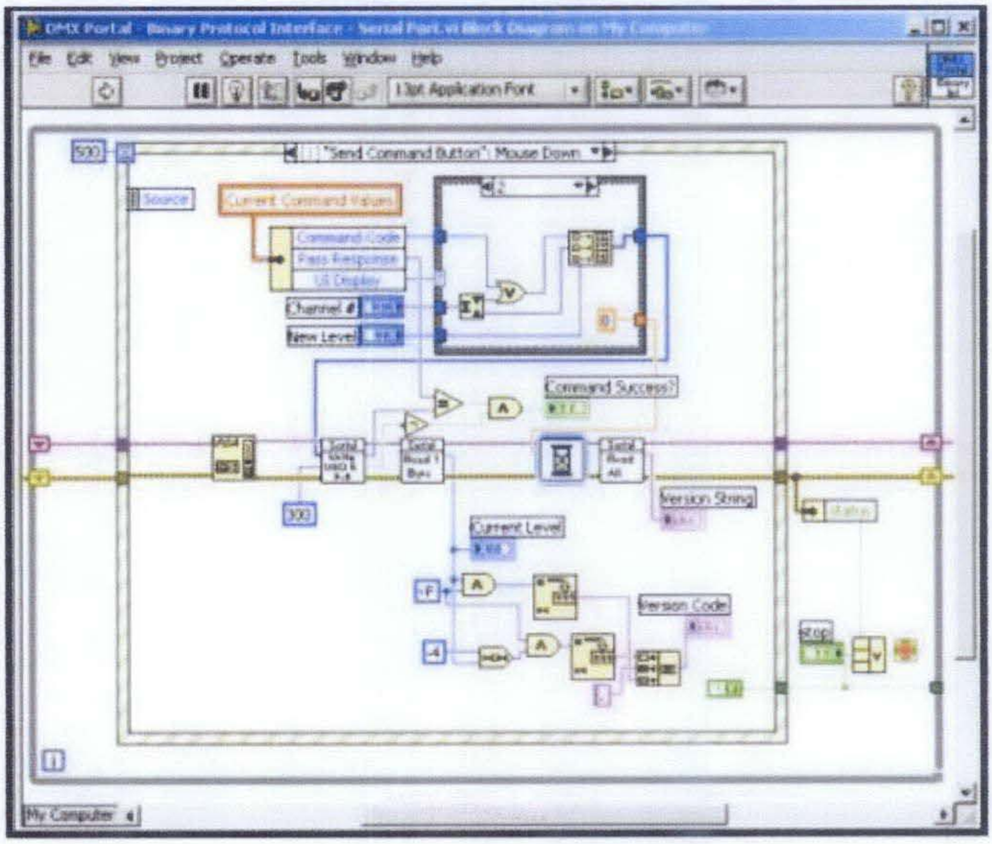

Figure 10.The Front Panel [15]

VIs may be used directly by the user or as a subroutine (called subVI's) of a higher program which enables a modular programming approach. The user interface is called the *front panel*, because it simulates the front panel of a physical instrument. The front panel can contain knobs, push buttons, graphs, and other controls and indicators. The controls can be adjusted using a mouse and keyboard, and the changes indicated on the computer screen. The block diagram shows the internal components of the program. The controls and indicators are connected to other operators and program structures. Each program structure has a different symbol and each data type (eg. integer, double-float etc) has a different color as shown Figure 11[15].

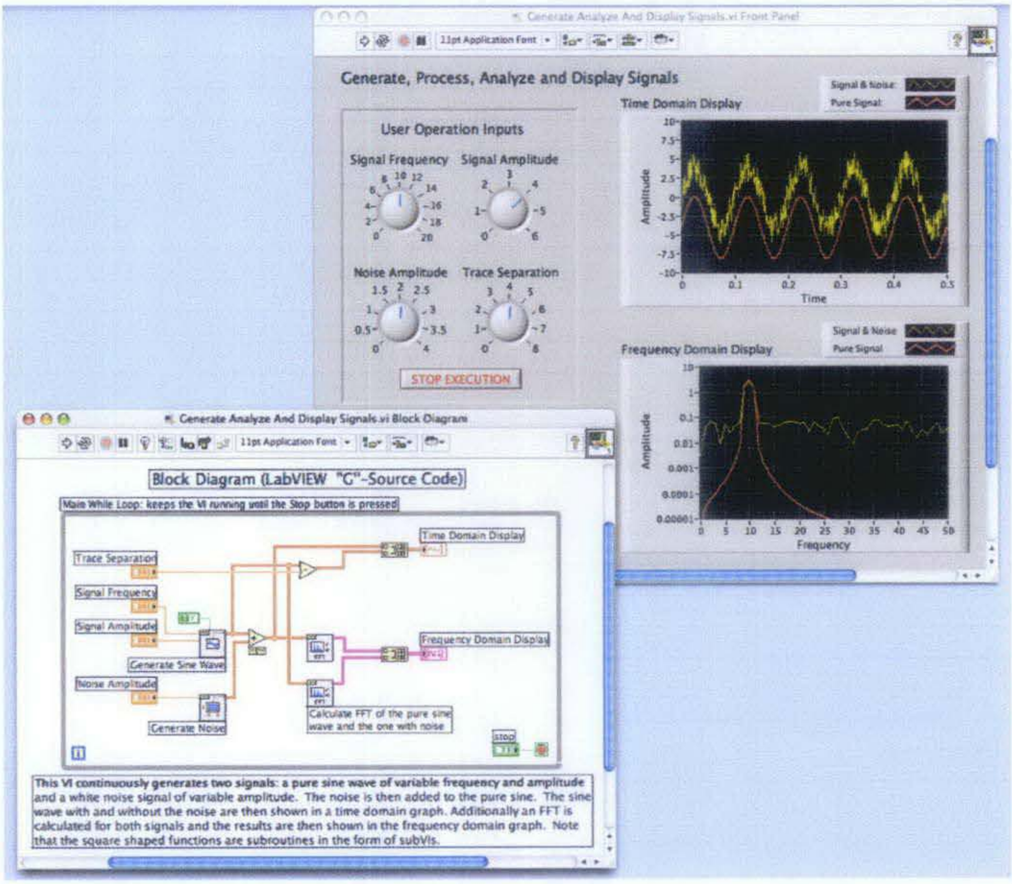

Figure 11.Modular programming [15]

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

Step 1. Define problem – Identify the usage of a vital signs monitoring device.

Step 2. Research – Thorough research is conducted to generate alternatives and solution(s) to the problems discussed. Summarize all finding in literature review which will include the solution to detect the vital signs.

Step 3. Identification hardware required – Refer to literature review for basic components needed and control equipment (microcontroller) needed. This process includes identifying the specification that meets the requirement for the project.

Step 4. Development of internal circuit – Build the internal circuit of the prototype.

Step 5. Programmed the transmitter and receiver module to communicate and transmit appropriate signal. Also, the microcontroller is program using the control program.

Step 6. Test and run the control program – The sequence of the operation is also checked.

Step 7. Build the prototype – Include the necessary modification on the hardware, the control equipment and the system.

Step 8. Integration between the internal circuit and system – The integration between the internal circuit and system must be programmed to handle signals from sensors, to trigger an alarm, and to interface with the computer to handle the general administrative actions.

Step. 9 Test and run the monitoring system - The system must meet the specification required to trigger an alarm when it detect emergency situation.

Step 10. Modification – If necessary, modification has to be made to achieve building a working prototype.

3.2 Procedure Flowchart

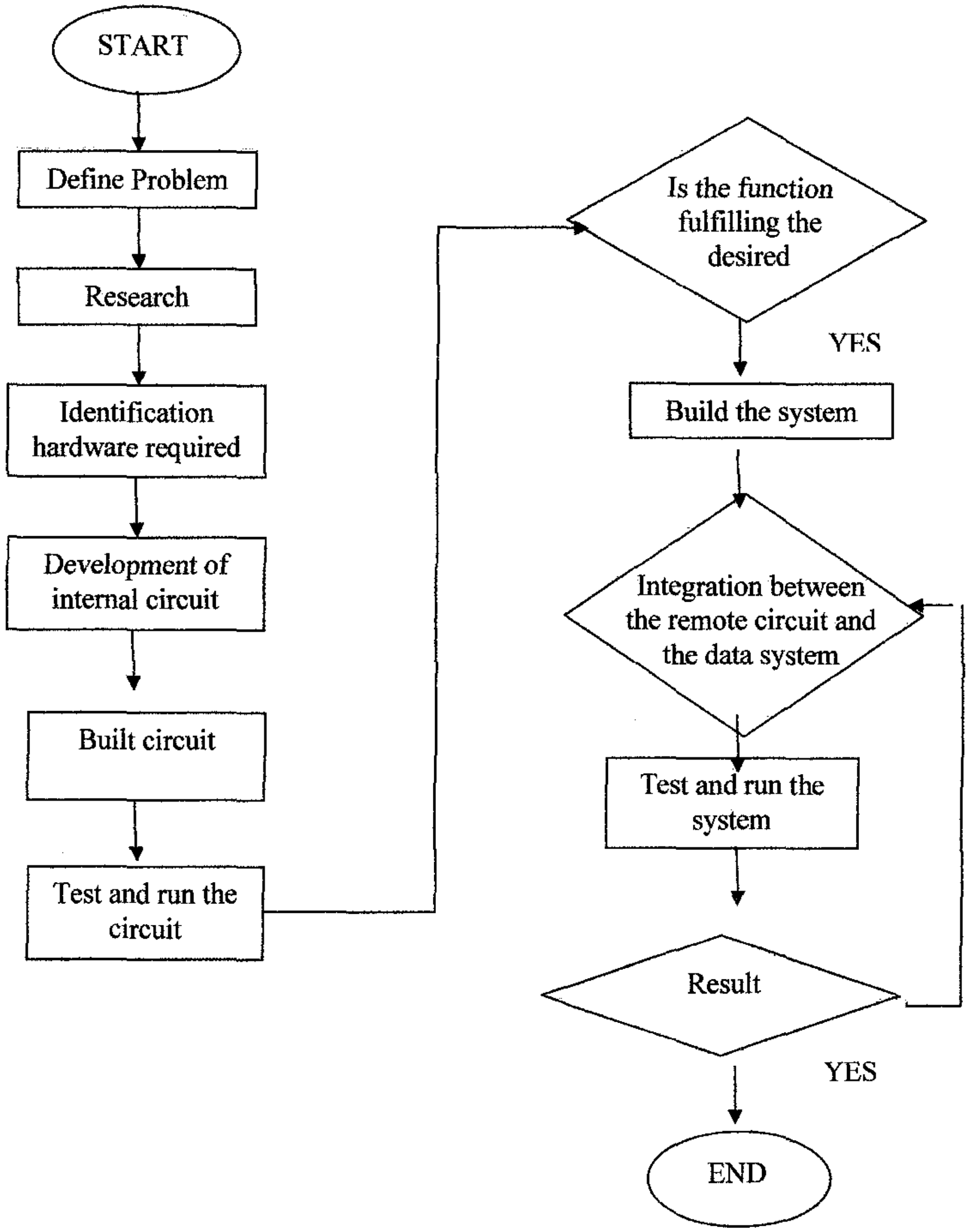

Figure 12: Flowchart designing and building the vital signs monitoring system

3.3 Tools and Equipment

Hardware	Software
1. Remote ON/ OFF IR circuit : R1 3k3 R2 1k R3 22k R4 220k R5 1M R6 3k3 B1 12 V D1 1N4148 D2 1N4003 Q1 B109 LED1 IC1 IC2 4049 IC3 CA555 IC4 SN74HCT74 IC5 LM7805 Relay 12 Volt C1 100u C2 22u C3 100n C4 2u2	1. Hyperterminal -To detect data on PC. 2. LabVIEW -To display data in GUI

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Wireless Infrared On/Off Switch

Operation to trigger blood pressure device uses Infrared remote circuit which can be used within 100m (possible scale for demonstration.). The sender is usually a LED diode made from material that emits photons in the IR range (see Figure 13). The receiver is usually a PIN diode or a transistor. The design allows the IR photons to illuminate the reverse junction area in the diode or the base in the transistor.

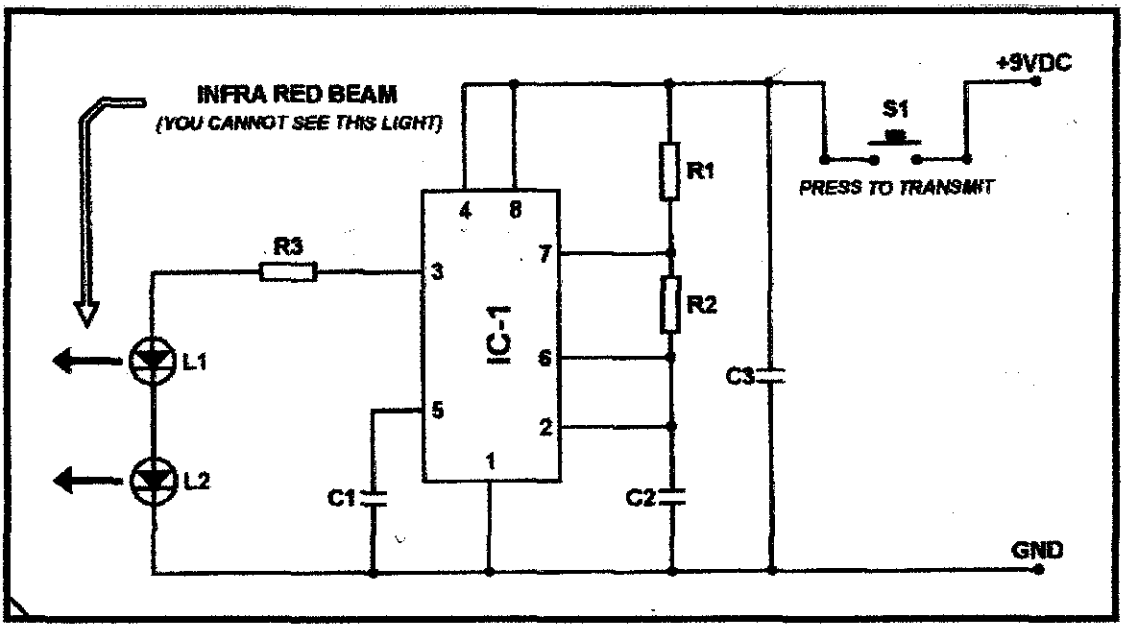

Figure 13 Infrared Sender circuit diagram

For the receiver, the transistor with the usual BJT circuit (see Figure 14) and the photocurrent flows out the collector through a resistor which makes a voltage. For the diode receiver, reverse bias it through a resistor and the photo current flows through the resistor which makes a voltage. Trigger relay coil and caused to make a closed circuit between pin 2 and 5.

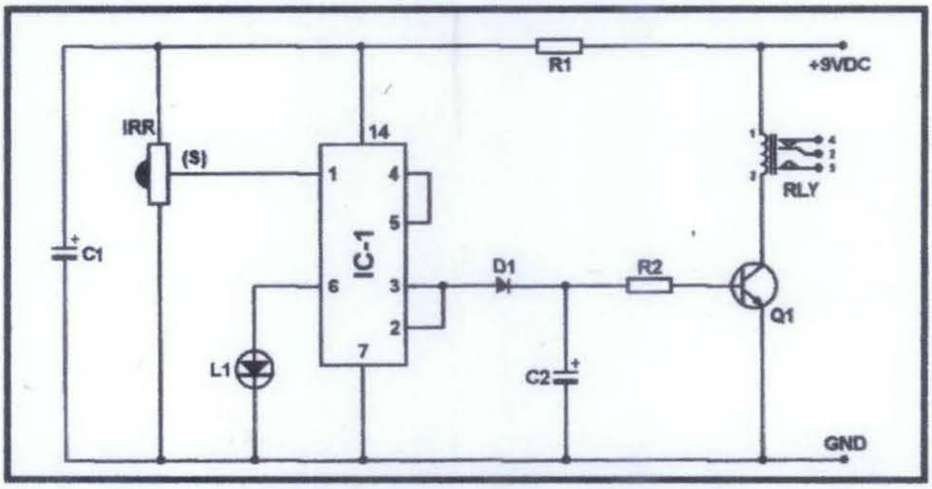

Figure 14 Infrared Receiver circuit diagram.

For the first experiment, Figure 15 shows both IR sender and receiver on the same breadboard, which only separates 5cm away. However, to prove there is connectivity between sender and receiver, output for this experiment is by observing LED lights ON.

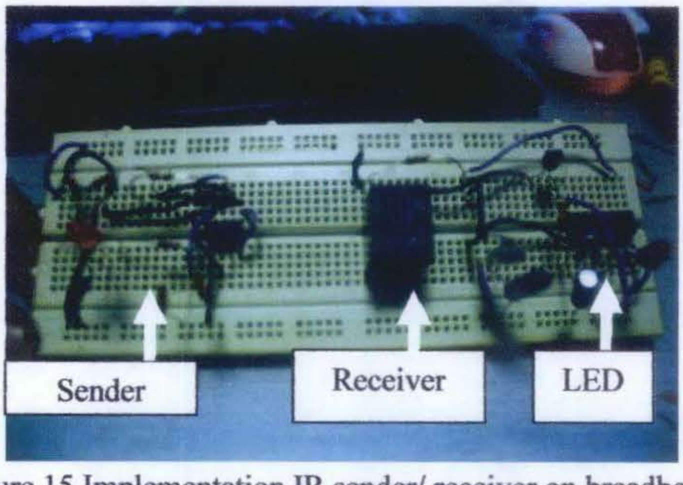

Figure 15 Implementation IR sender/ receiver on breadboard

After the circuit is proven to have connectivity, components are mounted on circuit board for proper installment, just like Figure 16.

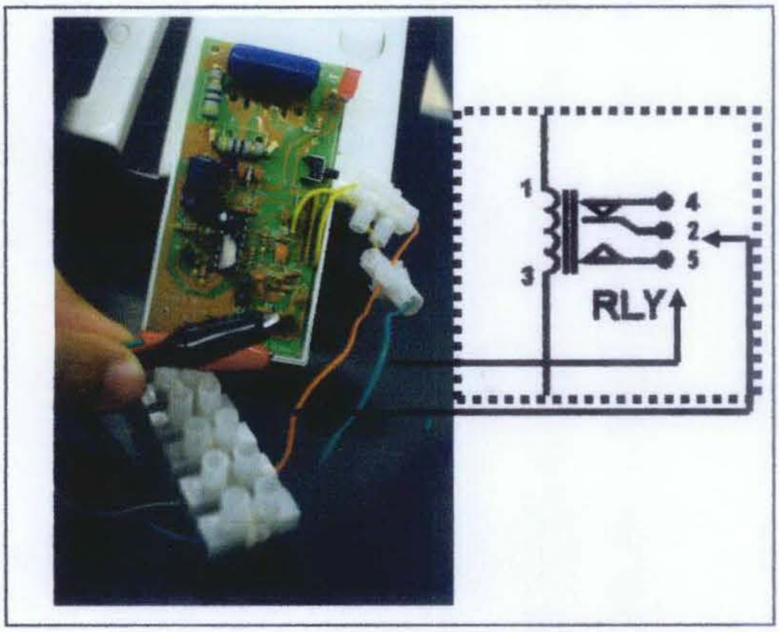

Figure 16 IR receiver circuit.

Two open-circuit wires from pin 2 and 5 were pulled out to connect with blood pressure push button device, as Figure 17. During circuit testing, 9 volt battery could not supply power for the whole operation. Modification on connecting circuit to 2 pin power supply, as shown in Figure 18 below.

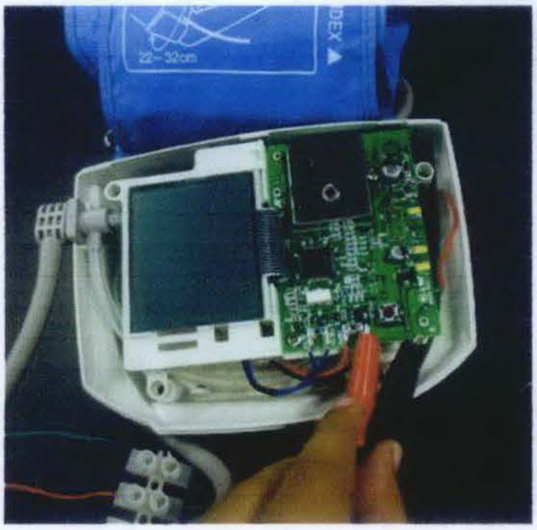

Figure17. Two open circuit wires

Figure18. IR receiver circuit modified

Operation in Figure 19 below shows a working IR remote control to trigger ON the measuring device from cuff inflates to deflates back until data is analysed.

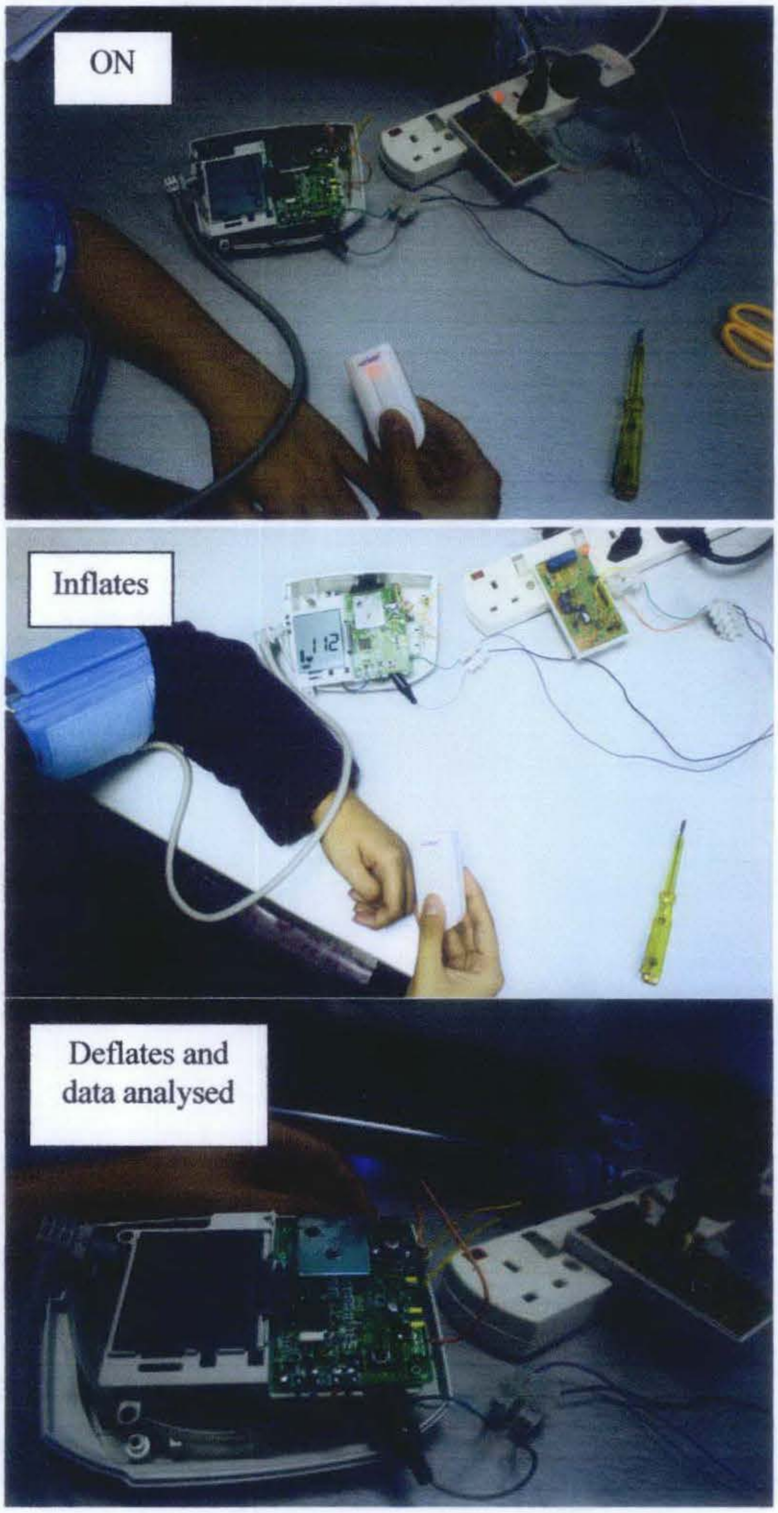

Figure 19 IR remote circuit operation.

4.2 Data send to PC through LCD output

The method tested in this project are :

4.2.1 LCD output to RS 232

Here is the brief explanation on methods to send data from measurement device through serial bus LCD output and RS 232 port. Shown in Figure 20.

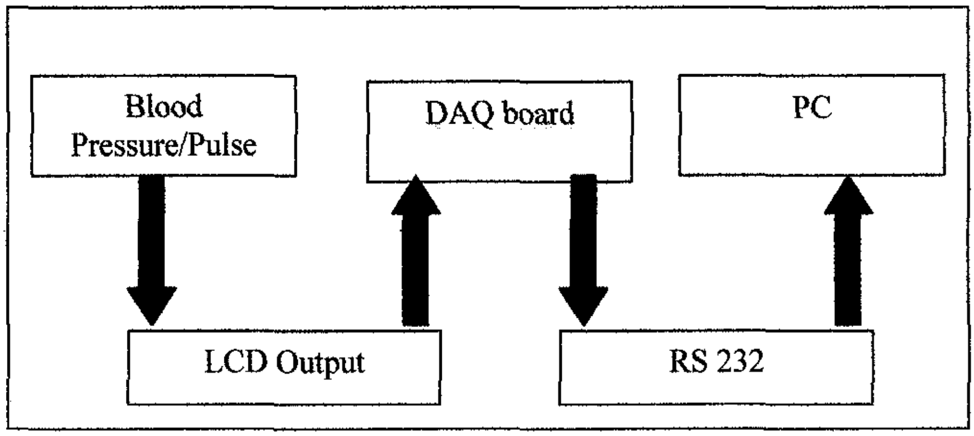

Figure 20. Graphical explanation on sending data method.

Assigning LCD output to DAQ board, I/O port in DAQ need to be label incoming inputs and able to send into PC through RS 232. Reading process may take some time, but this serial bus is a one-way connection, which held no triggering signal from PC to receive data. It is a real time reading and continuously receives data whenever IR remote ON to trigger measuring device.

Figure 21 shows DAQ board and RS 232 made links from blood pressure device to PC.

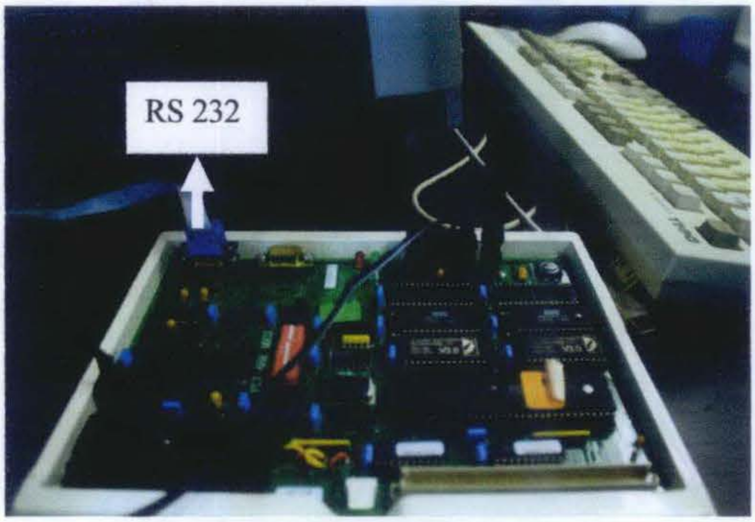

Figure 21 DAQ board and RS 232

4.2.2 LCD output to USB cable

In USB terminology, endpoints are the points where data enters or leaves the device. An endpoint has a direction of data flow, either input (from device to host) or output (from host to device). It may help to think of these directions as being relative to the host. Input goes to the host; output comes from the host. The following diagram illustrates the two endpoints.

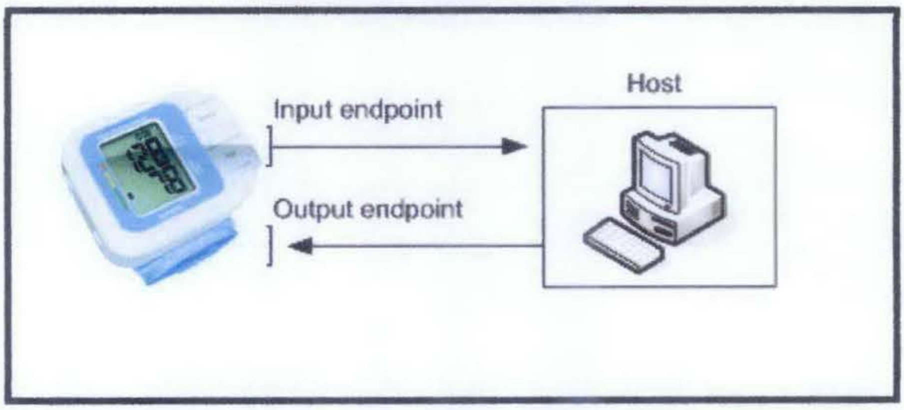

Figure 22. Example block diagram USB endpoints

Figure 23 shows LCD output should connected to the digital input PIC 18f4550 microcontroller.

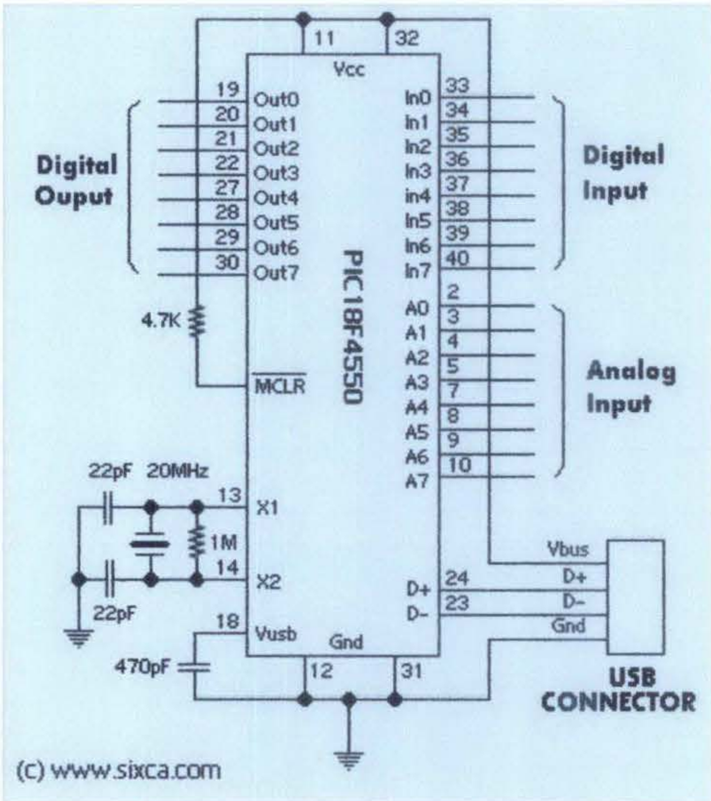

Figure 23. Block diagram PIC 18f4550

. Technically, the address appointed at LCD output to display data should links into Digital Input of PIC 18f4550, so that the microcontroller could retrieved data and send to PC for monitoring purpose

Circuit for sending data through USB cable has been developed and figure below explains job flow between device and PC.

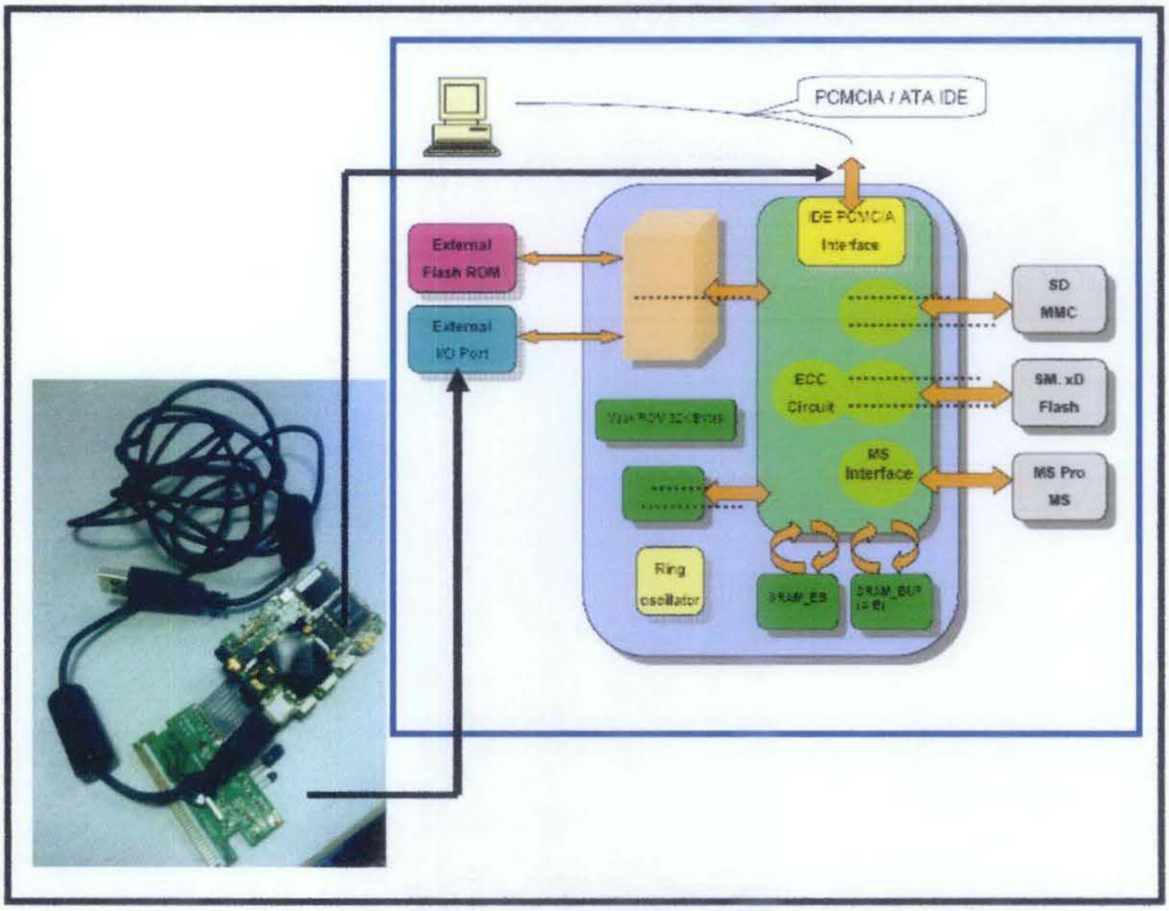

Figure 24. Device and PC connection

4.3 LabVIEW Implementation

For the data acquisition system Figure 22, the program/software use is Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW). LabVIEW is a platform and development environment for a visual programming language from National Instruments. The graphical language is named "G". LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft Windows, various flavors of UNIX, Linux, and Mac OS.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

Remote Monitoring System is a system, which encompasses collection of information, method of transfer from the blood pressure measuring device, analysis and control of the On/ Off remote and display of the received information. Function of this system is to integrate functions like monitoring, safety, remote controls and management information that may be used for nursing care. The system gives many advantages and benefits for the user as the system helps for systematic time management in simultaneously data collection and storage, increases efficiency as less manpower, time and energy used. It also gives flexibility to the user to manage the vital sign data of more than 1 patient. For the data acquisition system, the program/software use is Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW).

Recommendation for the system includes two-way communication where button ON can be triggered through PC only. Plus, adding more measurement patient's data such as temperature or oxygen saturation in patient's blood to be able to display through PC monitor. Also the data can be transmitted wirelessly to the PC, as shown in Figure 23.

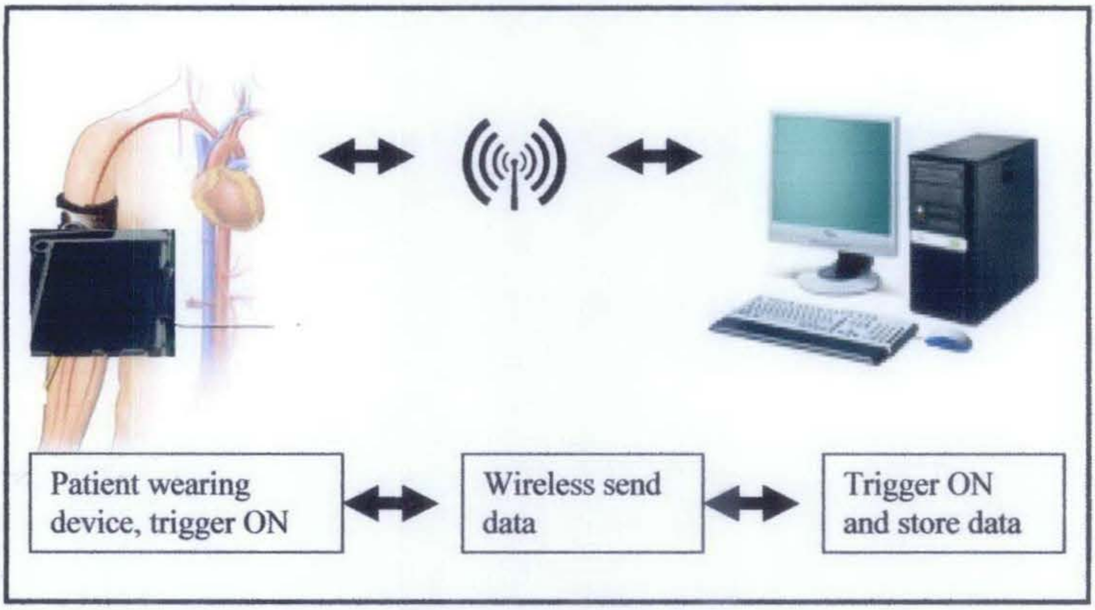

Figure 25 Recommendation for next development.

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APPENDIXES

APPENDIX A

Gantt Chart for FYP I Semester Jan 2010

No	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Selection of Project Topic								Mid-semester break							
2	Preliminary Research Work															
3	Submission of Preliminary Report															
4	Project Work; Research on Color Analysis, Image Processing and Oil Palm fruit characteristic															
5	Submission of Progress Report															
6	Seminar															
7	Project Work Continue; Build Coding System and Simulation															
8	Submission of Interim Report Final Draft															
9	Oral Presentation															

Suggested milestone

Process

APPENDIX B

Gantt Chart for FYP II Semester July 2010

No	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Project Work Continue								Mid-semester break							
2	Submission of Progress Report 1															
3	Project Work Continue															
4	Submission of Progress Report 2															
5	Seminar (compulsory)															
6	Project Work Continue															
7	Poster Exhibition															
8	Submission of Dissertation (soft bound)															
9	Oral Presentation															
10	Submission of Project Dissertation (hard bound)															

Suggested milestone

Process