SISTEM PAPARAN KESIHATAN MENGGUNAKAN BORLAND C++ BUILDER

SARJANA MUDA KEJURUTERAAN (KEJURUTERAAN ELEKTRONIK)

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4 Mac 2005

Abstract

This project is implemented to develop a user-friendly health indicator system. The system is a graphical user interface (GUI) built using the Borland C++ Builder software. The system is to assist physicians and other medical personnel to monitor a patient's vital signs namely the patient's blood pressure, body temperature, oxygen level concentration in blood and heart beat rate by just glimpsing at one screen instead of having to scrutinize four separate equipments in order to get readings. In general, the system is made up of three main modules which includes; a search module, real-time monitoring module and recovery module. The search module encompasses a box to key in the patient's name or ID and a search button to locate the patient's file. The real-time monitoring module shows the current measurements of the health parameters on the screen. Each parameter has an alarm that will flicker should any abnormalities occur. In practical, this system should be hooked up to hardwares that interpret signals acquired from the patient and measurements are stored in a source file. Thus, this system is also implemented to retrieve the measurements from the source file and present it on the screen in numerical and graphical form.

Abstrak

Projek ini diimplementasi untuk membangunkan sebuah sistem paparan kesihatan yang mesra pengguna. Sistem ini merupakan sebuah antaramuka pengguna grafikal (GUI) yang dibina menggunakan perisian Borland C++ Builder. Paparan ini menunjukkan empat parameter kesihatan pada satu skrin iaitu tekanan darah pesakit, suhu badan, tahap oksigen dalam darah dan kadar degupan jantung yang membantu pakar kesihatan untuk menjimatkan masa di mana mereka hanya perlu merujuk kepada satu skrin sahaja untuk memperolehi bacaan keempat-empat parameter ini tanpa merujuk kepada empat peralatan berbeza untuk memperoleh bacaan yang sama. Secara amnya, sistem ini mempunyai tiga modul utama iaitu modul pencarian, modul paparan masa nyata dan modul kebolehpulihan data. Modul pencarian merangkumi sebuah kotak edit untuk memasukkan nama pesakit atau ID pesakit dan sebuah butang “Search”. Paparan masa nyata akan menunjukkan bacaan parameter kesihatan pesakit yang terkini pada skrin. Setiap parameter mempunyai sebuah penggera masing-masing yang akan bernyala dan berbunyi sekiranya terdapat bacaan yang tidak normal. Secara praktik, sistem ini harus dipasang kepada perkakasan yang boleh membaca isyarat dari pesakit dan menyimpan bacaan tersebut dalam satu fail sumber. Sistem ini juga diimplementasi untuk mendapatkan bacaan tersebut dari fail sumber dan memaparkannya pada skrin dalam bentuk nombor dan graf.

Acknowledgements

I would like to thank some people who made this project a success. First, I would like to express my utmost gratitude towards my supervisor, Dr. Harsa Amylia Mat Sakim for being so patient and helpful throughout the whole journey in completing this project. Another person who motivated me during this whole ordeal is my academic advisor, En. Basir Saibon. Despite being discouraged at a few occasions due to my incompetent proficiency in programming language, he had faith in me and made me believe I can move mountains with hard work and dedication.

Thank you also to my fellow course mates for the advices given, especially the tips given in programming. Not forgetting my best friends Thanis and Bernadette for their constructive criticism which spurred me to move ahead when things looked bleak. I learnt the real meaning of hope with the encouragement they have showered unto me.

Last but not least, million thanks to my family for cheering me on even though we were miles apart. Their love and support kept me going and I am eternally indebted to them.

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Chapter 1

INTRODUCTION

1.1 Introduction

Health indicators play an integral role in the medical world today. The necessity of these health indicators is significant when monitoring a person's vital signs of life. As mankind becomes more advanced in technology, health indicators become more complex and more accurate due to the discovery of new applications in the engineering field. The applications created assisted physicians and other medical personnel in their diagnosis and save precious time when examining patients.

1.2 Objectives

The development of this health indicator system is as an instrument to present four health parameters, namely the patient's blood pressure, oxygen concentration level in blood, body temperature and heart beat rate on one screen. Instead of having to scrutinize four different equipments to get the measurements, medical personnel can just refer to one screen for all readings. In the practical case, this system should be hooked up to a signal processing unit that will interpret signals from the measuring instruments connected to patients. The signal processing unit will store these information in its memory and the indicator system will acquire the readings from the memory and display it on the screen. In this project however, the indicator system will read the data from a source file and display it on the screen.

1.3 Scope of Study

There are many types of health indicators present today as the medical world progresses in parallel with technology. In this project, focus is given to four health parameters, namely heart beat rate, body temperature, oxygen concentration level in blood and blood pressure because these four health parameters play the most distinctive role in determining one's health.

1.4 Project Implementation

To realize this project, several steps have been taken (Figure 1.1). Firstly, a thorough understanding of the Health Indicator System and the four health parameters that make up the system was given focus. This is important to ensure that no difficulties will be encountered due to misinterpretation in the course of the project implementation. The important concepts regarding the project were delved into via the Internet and biomedical engineering books. The research is important to produce the literature review that meets the objectives and requirements of the project.

The supervisor and friends who happen to be in the medical line are important sources to clarify all doubts and difficulties encountered in understanding the project. Understanding of the subject is further enhanced by reading past reports.

The next step which proved to be most challenging aspect in this project is learning to use the Borland C++ Builder version 5.0 software. The system is developed in stages according to the planning chart constructed to ensure that the project runs smoothly and systematically. The development of the systems ends when all the four parameters can be summoned from the database and shown on the screen as specified by the objective.

After the development stage of the system, the effectiveness of the system to perform is tested by checking to see if the parameters conform to the specifications. The system is then improved should the system fail to execute properly. Finally, the functional system will be updated so that it will be more user-friendly.

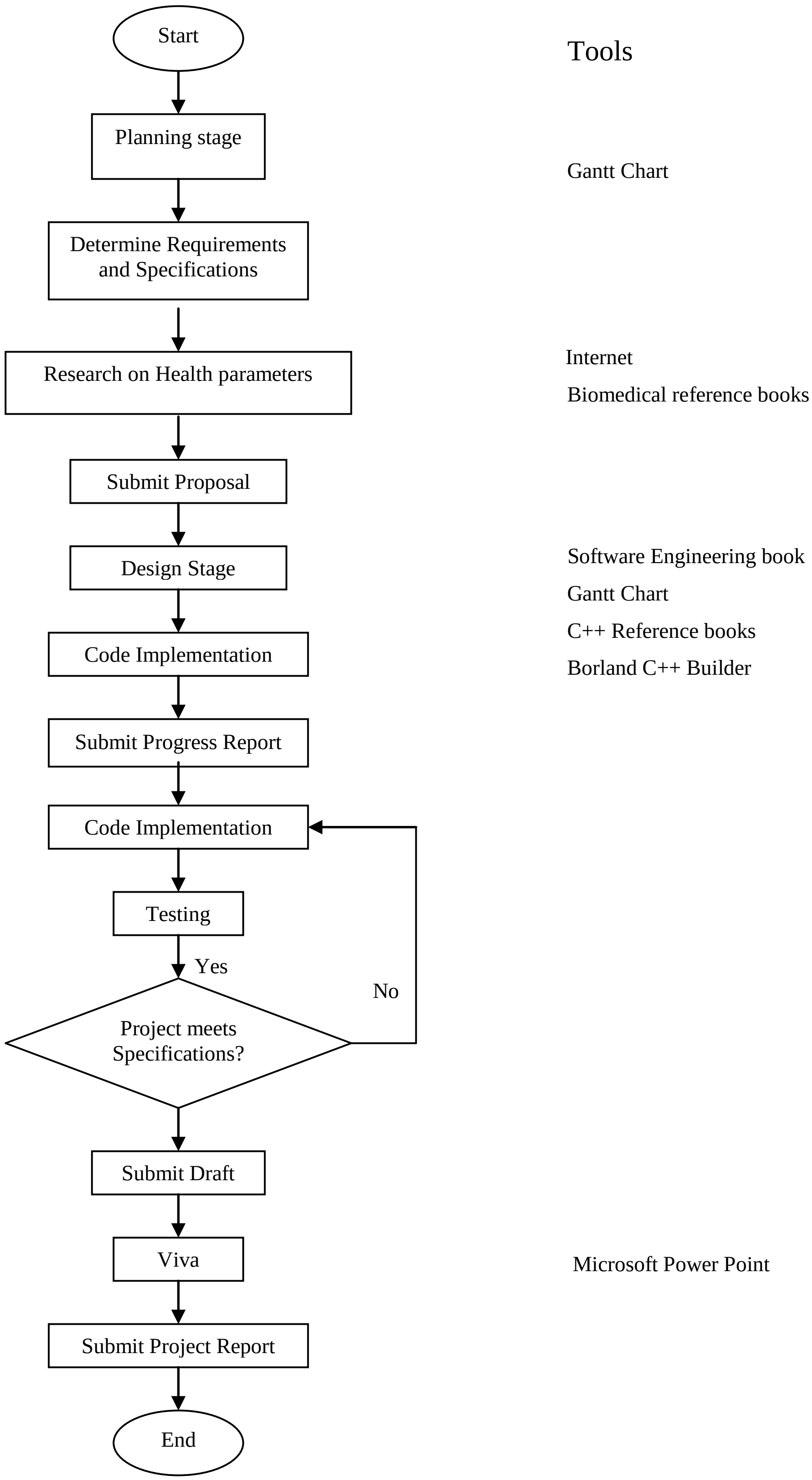

Figure 1.1: Flowchart of Project Implementation

1.5 Report Guide

Chapter 1 presents the introduction and explains about the whole project in brief. Chapter 1 explains the objectives of the project's implementation and the scope of study done. The flow of the project is given in this chapter and is presented in the form of a flowchart. A brief guide on the report is also given in this chapter.

Chapter 2 gives the facts on the health indicator system and the parameters that are displayed on the screen. It explains about the history behind the creation of these life-saving instruments and details about the parameters itself, namely the heart beat rate, body temperature, oxygen concentration in blood and blood pressure. Besides that, chapter 2 presents the symptoms that appear when the optimum level of performance is not met.

Chapter 3 discusses the implementation of the Health Indicator System using the Borland C++ Builder. It explains the components used in building the system such as the frames, buttons, calendar, timer and etcetera. The data structure used in the development of the system and the flow of the system are described in chapter 3.

Chapter 4 presents the results achieved at the end of the project. Since this is a programming project, an analysis of the result will not be done as results in the creation of the GUI is very palpable whereby the results displayed on the screen mirror the success of the project.

Chapter 5 is the conclusion of the report. Basically, this chapter discusses the results achieved in this project as well as the shortcomings of the project and suggestions to improve the project.

Please note that the words "readings" and "measurements" are used interchangeably in this project and it has similar meanings in this context.

Chapter 2

LITERATURE REVIEW: HEALTH INDICATOR SYSTEM

2.1 Introduction

In this rapid era of progress, it is crucial to be more aware and concerned about health issues. Health indicator is a good way to ensure sustainable development in our country, as well as keeping track of the environmental issues, social equality, basic infrastructures such as water and electricity supply as well as transportation. Unsustainable development degrades Mother Nature and the spread of hazardous diseases is a consequence of this. Therefore the age old proverb, “prevention is better than cure” could not be more appropriate. One way to keep track of our health is to constantly monitor a few health parameters that play vital roles in determining one’s well-being.

2.2 Measurement Instruments

Electronics play an important role in the development of measuring instrumentations used today. History of the use of electronics in building instrumentations dated back to the early 1900s. The method of monitoring for the parameters is non-invasive except for blood pressure monitoring. Non-invasive method of measurements is carried out with sensors/probes attached to the outside of the patient’s body. An advantage of non-invasive method is that the patient will not feel uncomfortable when measurement is taken. However, invasive types (where sensors/ transducers are inserted in the veins/arteries etc.) like those in intensive care unit (ICU) are most likely to give more accurate measurements and enable doctors to act fast and giving immediate treatment or drugs into the veins/arteries.

The biomedical engineering field marries two important disciplines: medicine and engineering. Biomedical engineering is aimed at keeping people healthy and helping to cure them when they are ill. The four instruments used to measure their respective parameters are described below;

2.2.1 Electrocardiograph

In 1903, the electrocardiograph (ECG) was invented by the Dutch physiologist Willem Einthoven. The original machine used a wire suspended between the poles of a magnet. Motion of the wire due to body currents between the two arms, generated by the heart was measured by a recording light reflected off a mirror supported by a wire. Enhancement of the ECG trailed as electronic amplifiers were developed. In the 1940s, readings of ECG traces on paper chart recorders were launched.

2.2.2 Thermometer

To measure one's body temperature, a thermometer is normally used. In 1603, the Italian scientist Galileo introduced the idea of height of liquid (water was used) sucked into a closed glass tube by partial vacuum varied with the temperature. Santorio Santonia, a Slavic physician constructed a similar device in 1625, which was used to measure the temperature of the human body. The Dutch instrument maker Gabriel D. Fahrenheit introduced the modern thermometer by substituting the water contained in the glass tube with mercury thus improving the thermometer's accuracy.

2.2.3 Pulse Oximeter

A pulse oximeter is used to measure the oxygen concentration level in blood. M. Cremer in 1906 introduced the pH electrode for quantifying the acid/base content of biological solutions. Its invention led to the creation of measurement method of oxygen concentration level in blood

2.2.4 Blood Pressure Catheter

In 1970, blood pressure was measured with an instrument with a balloon-tipped catheter. The method of measuring this parameter became more advanced when ultrasonic principles were developed during the World War II.

2.3 Parameters

As mentioned, the four health parameters that are displayed on the screen are the heart beat rate, body temperature, oxygen concentration in blood and blood pressure. In order to understand what the system has to display, it is important to first understand the basic concepts of the parameters. The details of the parameters are as below;

2.3.1 Heart Beat Rate

Heartbeat is the rhythmic contraction and expansion of the arteries with each beat of the heart. An electrocardiogram (ECG) is the display of a patient’s heart beat in a wave form. A few electrodes are attached to specific points on the patient’s chest/body and the electrical signals picked up is displayed on the ECG monitor. The electrical signals is produced by heart muscle (nodes) and sent to different part of the heart to simulate contraction/relaxation (which causes pumping action). The wave form will show different phases of the heart beat (normal/abnormal/absence of heart beat. An ECG waveform has labels P, Q, R, S and T which denotes distinctive features. The horizontal axis correlates the length of each electrical event with its duration in time. The vertical axis on the monitor strip measures the amplitude (electrical voltage).

The P-wave (Figure 2.1) is a resulting voltage wave during diastole, when the heart is at rest. At that moment, all the cells are polarized so that the potential inside each cell is negative with respect to the outside. The imbalance results in an ionic current, I and creates the P-wave. The P-R interval signifies the time it takes an impulse to travel from the atria through the AV node, bundle of His, and bundle branches to the Purkinje's fibers.

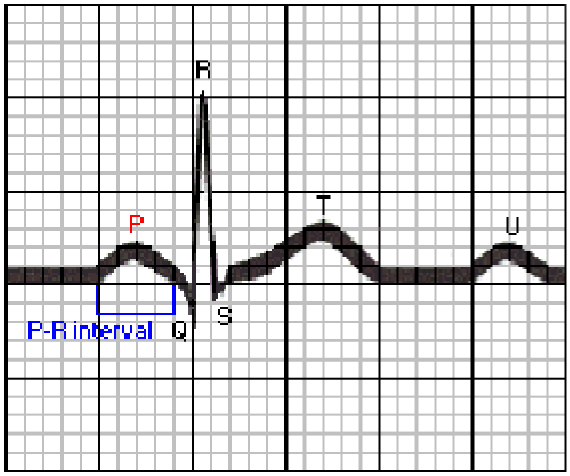

Figure 2.1: P-Wave in an ECG waveform

The R-wave (Figure 2.2) on the QRS complex arises from depolarization of the ventricles. The magnitude of the R-wave within this complex is approximately 1mV. However, the normal values of amplitude vary with age and gender.

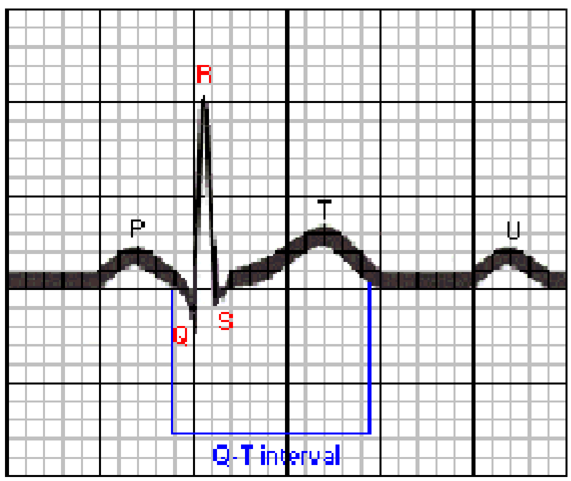

Figure 2.2: R-wave in an ECG waveform

The T-wave (Figure 2.3) represents the repolarization of the ventricles. On rare occasions, a U-wave can be seen following the T-wave. The U-wave reflects the repolarization of the His-Purkinje's fibers. It is a second-order effect and is of little diagnostic significance.

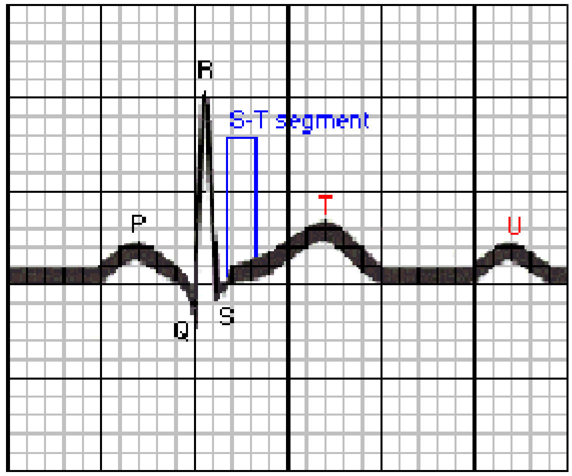

Figure 2.3: T-wave in an ECG waveform

Table 2.1: Typical durations of different segments in ECG waveform

Features	**Duration (ms)**
QRS complex	70-120
R-R segment	600-1000
P-R segment	150-200
S-T segment	320

Typical durations of different segments in an ECG waveform (horizontal axis) are listed in Table 2.1. By observing the ECG's pattern, abnormalities can be detected. A static horizontal line shows the absence of heart beat, indicating that the patient is dead. Dense pattern of the ECG shows critical condition whereby the patient's heart is beating rapidly.

2.3.2 Temperature

Body temperature (normally 98.6ºF or 37ºC in humans) is also measured using an electrode (sensor) attached to a patient's body, normally under the axilla. Since humans are warm-blooded mammals, the body will always attempt to keep internal temperature constant. Human life is only compatible with a constricted array of temperature, as seen in Table2.2:

Table 2.2: Range of temperature with its symptoms to the human body

Temperature (°C)	Symptoms
28	Muscle failure
30	Loss of body temperature control
33	Loss of consciousness
37	Normal
42	Central nervous system breakdown
44	Death

2.3.3 Oxygen Concentration in Blood

Oxygen concentration in the blood or often called pO2 can be monitored using a pulse oxymeter. The monitoring is done by securing an infrared transducer behind the ear lobe of the patient. Oxygen in the blood is carried by hemoglobin in the red blood cell. The concentration is expressed in percentage. The normal percentage of oxygen concentration is more than 90%.

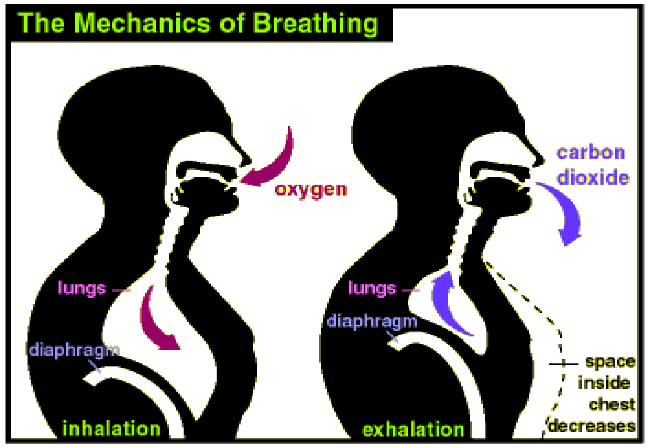

Figure 2.4: The Mechanics of Breathing

The respiratory system's primary function is to obtain oxygen (O_2) for use by body's cells and expel carbon dioxide that cells produce (Figure 2.4). Oxygen is transported in blood via 2 ways:

- Bound to hemoglobin (98.5% of all oxygen in the blood)
- Dissolved in the plasma (1.5%)

Oxygen concentration level in blood (pO_2) is also known as hemoglobin saturation. It can be defined as the extent to which the hemoglobin in blood is combined with O_2. The amount of oxygen carried by blood is primarily upon the concentration of the inhaled air. This is shown by the graph in Figure 2.5.

The normal range of values for hemoglobin saturation in blood is from 95% to 98%. Effective measures should be taken by medical personnel if a patient's hemoglobin saturation is from the range of 90% to 94% as these values are considered quite hazardous to one's health.

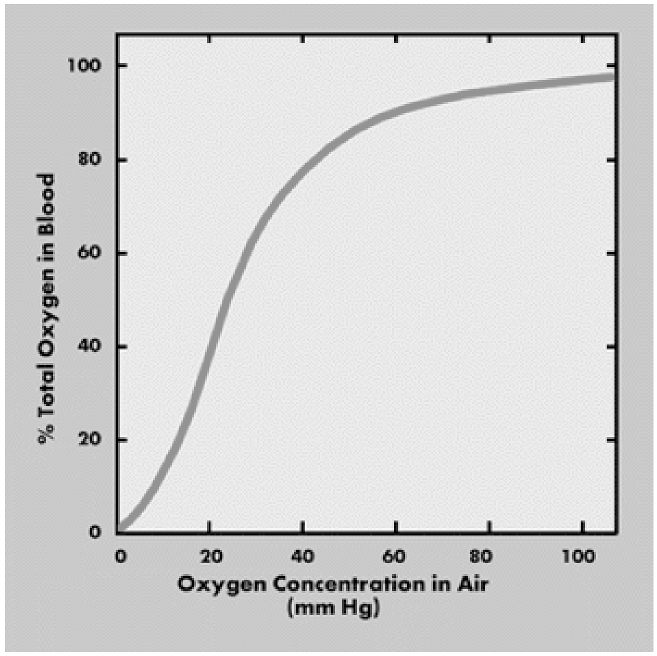

Figure 2.5: The relationship between oxygen levels and hemoglobin saturation is indicated by the oxygen-hemoglobin dissociation (saturation) curve

2.3.4 Blood Pressure

Blood pressure is measured over the arm using transducer(s) inserted into the blood vessels (both veins/artery). Pressure is displayed as a form of inverted V wave on the monitor. This measurement is carried out from time to time at selected intervals.

The pressure of the circulating blood against the walls of the blood vessels; results from the systole of the left ventricle of the heart; sometimes measured for a quick evaluation of a person's health; 'adult blood pressure is considered normal at 120/80 where the first number is the systolic pressure (the blood pressure as measured by a sphygmomanometer during the contraction of the left ventricle of the heart) and the second is the diastolic pressure (the blood pressure as measure by a sphygmomanometer after the contraction of the heart while the chambers of the heart refill with blood). Blood pressure display indicates the rise and fall in pressure in the blood vessels as a result of heart pumping. Table 2.3 shows the different categories for blood pressure levels in adults.

Table 2.3: Categories for Blood Pressure Levels in Adults*
(In mmHg, millimeters of mercury)

Category	Systolic (Top number)	Diastolic (Bottom number)
Normal	Less than 120	Less than 80
Pre-hypertension	120-139	80-89
Low blood pressure	Less than 90	Less than 60
High Blood Pressure	**Systolic**	**Diastolic**
Stage 1	140-159	90-99
Stage 2	160 or higher	100 or higher

* For adults 18years and older who:

- Are not on medication for high blood pressure
- Are not having a short-term serious illness
- Do not have other conditions such as diabetes or kidney diseases

2.4 Borland C++ Builder Software Version 5.0

The interface of the system is built using a very powerful software, the Borland C++ Builder Version 5.0. The C++ programming language is the standard programming language used in many corporations and governments around the globe. The Borland C++ Builder differs from the C++ programming language because the latter does not offer object-oriented programming (OOP). With C++ Builder, drag-and-drop techniques are used to create rapid application development. Builder C++ works from creating instances of control classes. In this project, the Win32 GUI (graphical user interface) program is created.

2.5 Summary

In this chapter, important concepts were introduced and explained in detail. At the end of this chapter, we can understand the four main health parameters that play important roles in determining our health. The optimum standard in our human body's heart beat rate, body temperature, oxygen concentration level in blood and blood pressure were also discussed in this chapter.

Chapter 3

IMPLEMENTATION OF THE HEALTH INDICATOR SYSTEM

3.1 Introduction

There are two phases in developing the Health Indicator System using the Borland C++ Builder software. The first phase involves the drag and drop function. The user can just click on the component button needed from the Component Palette and then click it to the form where the user wants it to appear. The second phase poses more challenge because it requires quite an in-depth understanding of the C++ programming language.

The Health Indicator System is a Graphical User Interface to display the four health parameters on the computer screen. Ultimately, there are other instruments needed to acquire and interpret signals to a form understood by men before it can be displayed on the screen. These instruments include transducer and sensor which are attached to the patients either in the invasive or non-invasive manner, the signal processing equipment and the data storage and data print out equipment.

3.2 The Man-Instrument System

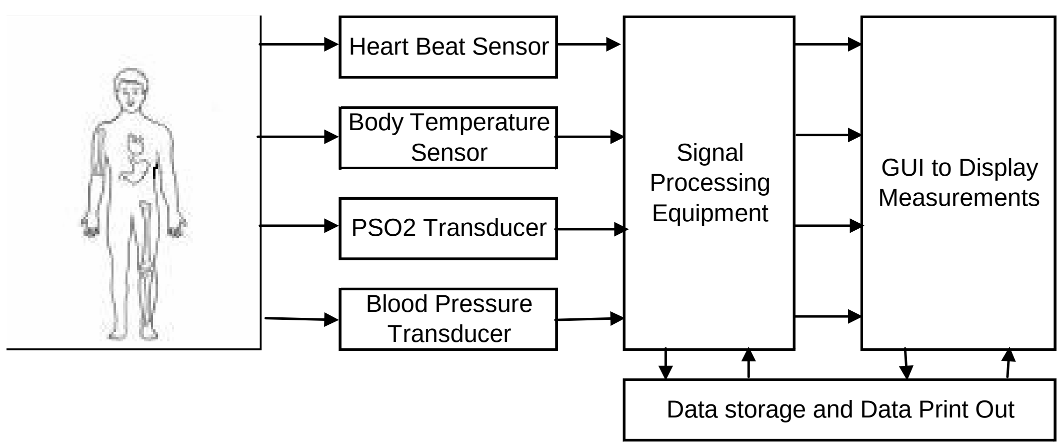

Figure 3.1: Block diagram of the man-instrument system

The block diagram of the man-instrument system is shown in Figure 3.1. The overall system which includes both the human organism and the instrumentation required for measurements of the parameters is called a man-instrument system. The system components are given as follows:

3.2.1 The subject

The subject is the human being on whom the measurements are made.

3.2.2 The Transducer/Sensor

Transducer is an electrical device that converts one form of energy into another. In the man- instrument system, each transducer is used to produce an electrical signal that is an analog of the phenomenon being measured. The transducer measures the variables in the body and its output is always an electrical signal. Sensor is a device that receives a signal or stimulus and responds to it in a distinctive manner. In this context, it performs the exact same function as the transducer.

3.2.3 Signal Processing Equipment

Signal processing is the processing, amplification and interpretation of signals. A signal-processing equipment is the instrument used to manipulate the signals. In essence, the purpose of the signal-conditioning equipment is to process the signals from the transducers and sensors in order to satisfy the functions of the system and to prepare signals suitable for operating the display or storage equipment that follows.

3.2.4 Display Equipment

The electrical output of the signal-processing equipment must be converted into a form that can be perceived and conveyed in a meaningful way. The input to the display device is the modified electrical signal from the signal-processing equipment. Its output is in the form of visual and audible information. This project will develop the interface to display measurements. It will enable the user to interact with the system.

3.2.5 Data Storage and Data Print Out Equipment

It is important to store the measurements for later use or to transfer it from one location to another. In certain cases, medical personnel might need to print out the readings to assist them in their medical diagnosis and further analysis; hence the data print out equipment is an optional equipment.

3.3 Components of the Graphical User Interface (GUI)

3.3.1 Specifications for the GUI

The program consists of two subcomponents in the system. The first subcomponent is the Patient Database Manager which writes data into file and the second is the main interface; the Health Indicator System which reads data from the file.

The Patient's Database function is to input information as listed in the "Patient's Details" group box. The details entered by the user will be saved into the database. This database is linked to the Health Indicator System and will appear when the correct identification number (ID) or patient's name is entered. The second interface, the Health Indicator System is to display the real-time measurements of the body temperature, oxygen concentration level in blood and blood pressure in numerical form so that it is easy for the medical personnel to get data on these three parameters immediately. Besides that, the indicator system presents the heart beat rate in an ECG wave form. Readings from the past are stored in a database and can be attained by using the calendar by clicking on the respective date. There are three (3) alarms on the GUI representing body temperature, oxygen concentration level in blood and blood pressure. The alarm for the ECG graph is indicated in the panel. If any abnormality is detected in any of the parameters, the alarm will beep and flicker. A "Silence Alarm" checkbox is also available. It is used to disengage the beeping sound emitted by the alarm.

3.3.2 Flow of the System

There are many components involved in building this project, but first, it is vital to understand the flow of the system in order to fully understand the function of each component. The flow chart of the program is given in Appendix A and Appendix B where two scenarios could occur. The flow charts of the Patient Database Manager and Health Indicator System are presented in Figure 3.2 and Figure 3.3 respectively.

3.3.2.1 Patient's Database Manager

The patient's database manager is used to key in the patient's details; patient's ID, name, age, identity card number (NRIC), date admitted to the ward, blood type, allergies and medical history. After typing in the details, the user can select the "Add" button to add the new patient into the list on the list box on the right of the screen. To save the details and to exit from the application, press the "Save and Close" button. The details will be saved into a library linked to the Health Indicator System.

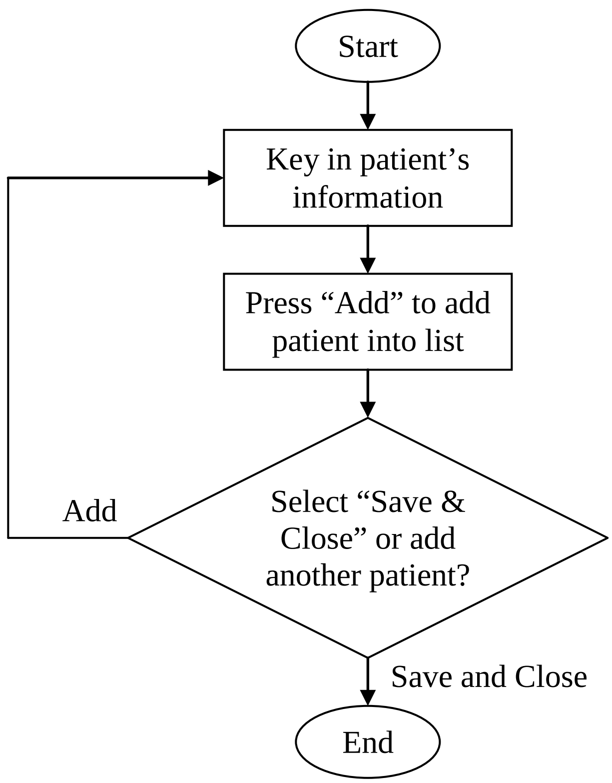

Figure 3.2: Flow Chart of Patient Database Manager