Abstract

The pulse-coupled neuron, which is significantly different from the conventional artificial neuron, is a result of recent research conducted on the visual cortex of cats and monkeys. Pulse-coupled neural networks (PCNNs) are modeled to capture the essence of recent understanding of image interpretation processes in biological neural systems. Study indicates that the PCNN is capable of image smoothing, image segmentation and feature extraction. The PCNN reduces noise in digital images better than traditional smoothing techniques. As an image segmented the PCNN performs well even when the intensity varies significantly within regions, and adjacent regions have overlapping intensity ranges.

ACKNOWLEDGEMENT

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INTRODUCTION

CHAPTER 1: INTRODUCTION

1.1 Project Overview

Magnetic Resonance Imaging proved to provide high quality medical images. Examples of medical image used especially for brain. The advantage of Magnetic Resonance Imaging is that the spatial resolution is high and provides detailed images. Magnetic Resonance Images are used to detect or track tumours such as in brain.

Segmentation is an important step in many applications especially in those that deal with medical images. When Magnetic Resonance image is segmented, it is very important that the segmentation to give the output as accurate as possible. Segmentation can be categorized into traditional and intelligent methods. Traditional methods including thresholding, classifiers, clustering, region growing, and edge-based segmentation. Newer methods such as such as artificial neural networks, markov random field, and energy-based methods perform intelligent segmentation. Traditional methods are not accurate enough for sophisticated approach. Intelligent methods offer the accuracy needed for sophisticated treatment.

Pulsed-coupled Neural Network (PCNN) is different from other neural networks. It does not have multiple layers like the other neural networks. The implementation and testing of the PCNN showed their effectiveness when applied to a variety of images. Best of all, there is no training involved prior to or during testing. The operation and maintenance of PCNN is straightforward. The future of PCNN will undoubtedly bring a wealth of opportunities and challenges alike.

1.2 Brief History of MRI and PCNN

1.2.1 Magnetic Resonance Image

Magnetic Resonance Imaging or MRI is an imaging technique that is used in medical to produce high quality images of the internal human body. MRI is based on the principles of Nuclear Magnetic Resonance or NMR, a technique used by scientists to obtain microscopic chemical and physical information about molecules. The technique was called Magnetic Resonance Imaging rather than Nuclear Magnetic Resonance Imaging because of the word nuclear. MRI started out as a Tomographic Imaging technique (produced an image of NMR signal in a thin slice through the human body).

Felix Bloch and Edward Purcell, were discovered the magnetic resonance phenomenon in 1946. In 1952, they were awarded the Nobel Prize. In the period between 1950 and 1970, NMR was developed and used for chemical and physical molecular analysis. In 1971, Raymond Damadian found the differences between the tissues nuclear magnetic relaxation times and tumours. Scientists were motivated by that to consider magnetic resonance for the detection of disease. Hounsfield introduced X-ray-based Computerized Tomography (CT) in 1973. This date is very important to the MRI timeline because it showed hospitals were willing to spend large amounts of money for medical imaging hardware. Paul Lauterbur first demonstrated magnetic resonance imaging on small test tube samples. He used a back projection technique similar to that used in CT. In 1975 Richard Ernst proposed magnetic resonance imaging using phase and frequency encoding, and the Fourier Transform. This technique is the basis of current MRI techniques

A few years later, in 1977, Raymond Damadian demonstrated MRI of the whole body. In this same year, Peter Mansfield developed the echo-planar imaging (EPI) technique. This technique will be developed in later years to produce images at video rates (30 ms / image). Edelstein and co-workers demonstrated imaging of the body using Ernst's technique in 1980. A single image could be acquired in approximately five minutes by this technique. By 1986, the imaging time was reduced to about five seconds, without sacrificing too much image quality.

In 1987, echo-planar imaging was used to perform real-time movie imaging of a single cardiac cycle. In this same year Charles Dumoulin was perfecting magnetic resonance angiography (MRA), which allowed imaging of flowing blood without the use of contrast agents. In 1991, Richard Ernst was rewarded for his achievements in pulsed Fourier Transform NMR and MRI with the Nobel Prize in Chemistry. In 1993 functional MRI (fMRI) was developed. This technique allows the mapping of the function of the various regions of the human brain. Six years earlier, many clinicians thought echo-planar imaging's primary applications were to be in real-time cardiac imaging. MRI is clearly a young, but growing science.

Diagnosing	Visualizing	Evaluating
• Diagnosing multiple sclerosis (MS) • Diagnosing tumours of the pituitary gland and brain • Diagnosing infections in the brain, spine or joints • Diagnosing tendonitis • Diagnosing strokes in their earliest stages	• Visualizing torn ligaments in the wrist, knee and ankle • Visualizing shoulder injuries	• Evaluating masses in the soft tissues of the body • Evaluating bone tumours, cysts and bulging or herniated discs in the spine

Table 1.1: Diagnosing, Visualizing, and Evaluating of MRI

1.2.2 Pulsed-Coupled Neural Network

Pulsed-Coupled Neural Network is designed on a model of cat's visual cortex. Its were introduced as a simple model for the cortical neurons in the visual of the cat's brain. Research on PCNN led the establishment of a general model for PCNN in the 80's and 90's. the models proved to be highly applicable in the field of image processing.

Pulse Coupled Neural Networks (PCNN), are image-processing tools that are used in extracting features, segments, and edges from a wide variety of images. The application of PCNN such as medical image segmentation, object isolation and target recognition. The PCNN was then used to segment several Magnetic Resonance Images (MRI). The results of the PCNN were then collected and used for evaluation of PCNN effectiveness.

The PCNN is unique from many of the neural network being used today. PCNN deviated from the fields of the basic math foundation. PCNN attempt to emulate the unique pulsing phenomenon that had been observed in the cortex. The structure and behaviour of PCNN are different from those of both traditional image processing engines and conventional neural networks. No training required for PCNN, there is no "learning" involved between successive iterations. The PCNN do not need to see any similar images prior to being used to process a new image.

The architecture of the PCNN is simpler than most other neural network implementations. PCNN do not have multiple layers such as input layer, hidden layer and output layer, which pass information to each other. PCNN only have one connected layer of neurons. This layer is 2-D and receives input directly from the original image. It uses to form the resulting pulse image. Each pixel passes its value to corresponding neuron and after processing produces a pixel in the pulse image. Image at the same location as the original pixel was on the original image. (http://www.dtic.mil/stinet/)

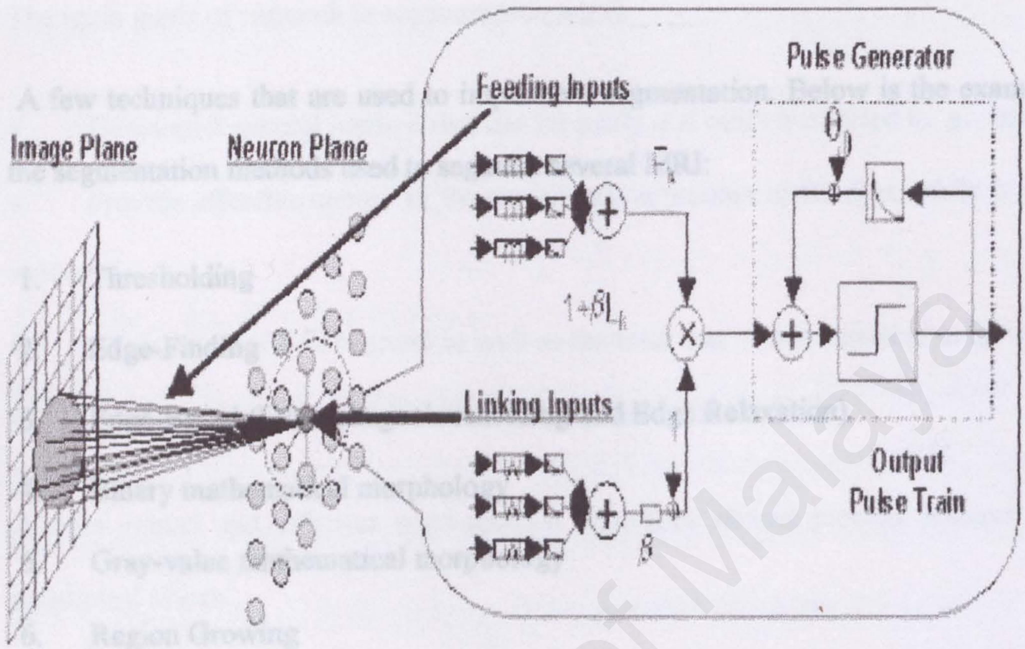

Figure 1.1 The Component of PCNN

1.3 Segmentation

Image segmentation is one of the most important steps to the analysis of processed image data. Its goal is to divide an image into parts that have a strong correlation with objects of the real world contained in the image. Two kinds of segmentation:

1. Complete Segmentation

   This results in set of disjoint regions uniquely corresponding with objects in the input image.

2. Cooperation with Higher Processing Levels

Use specific knowledge of the problem domain is necessary.

A few techniques that are used to implement segmentation. Below is the examples of the segmentation methods used to segment several MRI:

1. Thresholding
2. Edge-Finding
3. Edge-Based (Edge Image thresholding and Edge Relaxation)
4. Binary mathematical morphology
5. Gray-value mathematical morphology
6. Region Growing
7. Classifiers
8. Clustering
9. Markov Random Field
10. Artificial Neural Network

It is important to understand that:

- There is no universally applicable segmentation technique that will work for all images, and,
- No segmentation technique is perfect.

In this project, explanation about the techniques that are mentioned above only cover a several methods of segmentation.

1.4 Statement of Problem

The main goals of research in segmentation are to:

- Developed general method that can be easily and quickly applied to given data
- Provide effective control of the segmentation process to the user, while it is being executed
- Minimize user involvement as well as the total user's time required in the process.
- Assess and validate the results of the segmentation methods.

A truly robust and efficient segmentation algorithm should process features (i)-(iv) mentioned above.

1.5 Scope of Project

Scope is defined as a boundary of a project or what part of the business to be studies, analyzed, designed, constructed, implemented, and ultimately improved. Scope also defines those aspects of a system that are considered outside of the project.

Based on my project title, my scope of project is:

- To show how the system created allow users to input an image and how it processes the image using Pulsed-Coupled Neural Network (PCNN).
- To give a better view of the segmentation of MRI (Magnetic Resonance Image) with the use of PCNN.

- To evaluate the effectiveness of the PCNN by using several segmented MRI.

Magnetic Resonance Imaging segmentation using Pulsed-Coupled Neural Network two integrated modules- Administrator Module and User provide for the tracking and management process of all details in the system.

1.5.1 The Administrator Module

The administrator module provides separate access types of databases details to the administrators (like databases administrator) and the users (normally is the staff). The different are of course; only administrators are allowed to access administrative records, such as register and set-level security which is authorized to use the system providing them with username and password in order for them to mine the certain data from certain databases. The reason is to avoid the user from opening the objects that they are not allowed to enter. Only an administrator account can clear a password if a user forgets the password.

1.5.2 The User Module

The user module let users sign in the system by just keying in their username and password, which obtain from the administrators for security purposes. Therefore, the users only can grant the certain objects to mine using the method, which they are asked by their superior or decided by themselves which one is the better way to discover the useful patterns. Here, this project is emphasizing the Pulsed-Coupled Neural Network Analysis.

1.6 Objectives

Given our understanding of current system's scope, problems, and opportunities, we can now establish system improvement objectives. This task establishes the criteria against which any improvements to the system will be measured and identifies any other constraints that may limit flexibility in achieving those improvements. An objective is measured of success. It is something that we expect to achieve, if given sufficient resources.

My objectives for this project are consisting of the following:

- To understand what is Magnetic Resonance Image, meaning of the Segmentation & the use of PCNN.
- To apply one of the segmentation method to get a better image or choose the best segmentation methods that can produce clearer image.
- To apply the benefits of Pulse-Coupled Neural Network since it is unique if we were to compare with other neural networks.
- The method developed and presented uses a PCNN to both filter and segment medical resonance image.
- Using PCNN to segment the images to arrive at the final result.
- To access and validate the results of the segmentation method.

Objectives represent the first attempt to establish expectations for any new system. In addition to objectives, we must also to identify any known constraints. A constraint is something that will limit our flexibility in defining a solution to our objectives.

1.7 Project Schedule

A project schedule is carefully planned and arranged to implement time management and systematic working throughput the system development time frame. This is to ensure achievement of the outlined project objectives at the end of the project development period.

During the first part of the project development period, comprehensive systems study, and literature reviews have been carried out to gather as much information as possible for the planning of a good development strategy.

After the studies, a project proposal is prepared and viva sessions provide the opportunity for an extensive brain storming and critical analysis on the suggested project. After the system requirement analysis has been done, the system is designed. The subsequent individual development stages of the system are divided among the period during the second part of the project development period.

Project Schedule for Data Mining in Computer Auditing

No	Task Name	Duration	Start	Finish
1	Research on Thesis title	1 weeks	-	16/03/03
2	Literature Review	4 weeks	17/03/03	-
3	Requirement Analysis	3 weeks	23/03/03	-
4	System Design	6 weeks	23/03/03	-
5	System Development	15 weeks	-	16/08/03
6	System Testing	8 weeks	-	23/08/03
7	Documentation	33 weeks	15/03/03	30/08/03

1.8 Thesis Organization

This proposal contains the documentation on all the activities carried out throughout the period of system development. Details of pre-design studies and literature review, system analysis and design are included.

1.8.1 Chapter 1- Introduction

This chapter introduces the needs of the system development and overview of the project proposal. It includes sections on the introduction to the Magnetic resonance imaging Segmentation Using Pulsed-Coupled Neural Network, statement of problem, project scope, objectives, and development schedule.

1.8.2 Chapter 2- Literature Review

This is the literature review and existing system analysis chapter, which indicate research findings, summarization, analysis, and synthesis on the development of MRI segmentation using PCNN s, which are including details on several studied issues and field of interest and critical analysis, and features study on existing system. Besides that, the tools of choice also cover in this chapter.

1.8.3 Chapter 3- Methodology

Several development approaches are studied and the proposed the methodology, mechanism, approaches, fact-finding technique are explained and justified.

1.8.4 Chapter 4- System Analysis and design

Here, the details of functional and non-functional requirement are discussed and analyzed. This chapter described the planning, development, and management. System design, interface considerations, and business process flows are included. Additional reports are on system development environment and system development tools.

Summary of Chapter 1

In chapter 1, the overview of Magnetic Resonance Imaging Segmentation Using Pulsed-Coupled Neural Network had been discussed. Besides that, the brief history of Magnetic Resonance Imaging (1.2.1), and Pulsed-Coupled Neural Network (1.2.2), and Segmentation (1.3) and Statement of Problem (1.4) also had been touched, which are the key factor that triggered the development of this project or system. Other than that, Chapter 1 also outlined the scope of project (1.5). After that came to the objectives of the project (1.6). Finally yet importantly, we came across the project schedule (1.7). The project schedule overviewed the overall development process according to its schedule from the beginning research of the thesis to the implementation and operation. Finally, in organization of the thesis (1.8), all the activities throughout the project had been listed out.

References of Chapter 1

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3. *Segmentation.* Retrieved May 4, 2003 from World Wide Web: (http://www.math.pku.edu.cn/teachers/jiangm/courses/dip/html)

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2: LITERATURE REVIEW

2.1 Visualization in Medicine

Medical imaging today is contributing to accurate and quality medical treatment. Almost none of the more complicated cases in all medical disciplines are diagnosed without the assistance of medical imaging. Before the 20^{th} century, any disorders related to the internal anatomy could only be confirmed by making incisions on the patient's body. Because of development in medical imaging, non-invasive medical examinations for diseases affecting internal regions of the body, has become possible. These technologies have greatly increased knowledge of normal and diseased anatomy for medical research, becoming a critical and efficient component in diagnosis and treatment planning.

Contrast or dyes materials that is used in X-ray and CT work in the same way because both areas use x-rays (ionizing radiation). These agents work by blocking the X-ray photons from passing through the area where they are located. This results in differing levels of density on the X-ray or CT film. These dyes have no direct physiologic impact on the tissue in the body. The contrast used in MRI is fundamentally different.

Local magnetic field in the tissue being examined will alter when the MRI contrast works on them. Normal and abnormal tissue will respond to this alteration. These signals are transferred to the images, allowing us to visualize many different types of tissue abnormalities and disease processes better than we could without the contrast.

2.2 Digital Image Processing

The area of digital image processing revolution the field of medical imaging. It allowed high quality image to be produced, processed, stored, printed, or transferred, quickly and efficiently. Digital image processing has its roots in two principles applications; improving picture quality for human interpretation and machine perception of visual information. In medicine, the internal anatomy is imaged using various techniques and transmitted into the computer in the form of digital images. These digital images are further processed in order to display the result in the format required by the user. Computer vision, image processing and computer graphics are the field of computer science respondible for the development of imaging in medicine.

2.2.1 Computer Vision

Computer vision involves applications where visual information is examined and finally used directly by a computer, as in automated processing. Therefore, operation involves are for the purpose of understanding and constructing symbolic description of the image processes such as edge or line detection, segmentation, feature extraction and pattern classification are performed in computer vision.

2.2.2 Image Processing

Image processing involves application where image are examined and finally used directly by people. Therefore, processes involved are for improving the image to aid visual perception of a person. Typical processes of image processing are image restoration, enhancement, and compression.

Image restoration involves taking an image with some known or estimated degradation, and restoring it to its original appearance. Processes such as noise removal and geometric transforms are performed. Using knowledge of the human visual system's response, image enhancement aims to visually improve an image. Image sharpening and smoothing are a part of enhancement. Image compression is carried out to reduce the massive amount of data needed to represent an image. This is done by eliminating data that is visually unnecessary.

2.2.3 Computer graphic

Computer graphic involves the reproduction of visual data by generating or manipulating images for output. Computer graphic provides methods to synthesize image from numerical descriptions. These methods were originally developed for realistic displays of human defined objects, such as models from Computer-aided Design (CAD).

2.3 MRI Technology

MRI is an imaging technique based on the principles of NMR that was discovered in 1978. MRI was formerly known as NMR imaging. The change in name was brought about by negative connotations associated with the word nuclear in the late 1970's.

Today MRI has developed into one of the most powerful non-invasive technique in diagnostic clinical medicine and biomedical research. It produces high quality images of internal organs or tissue structures besides image of the anatomy, information on the physical chemical state of tissues, flow diffusion, and motion can also be obtained from MRI scan.

2.3.1 The Principles of MRI

The principles of the MRI machine are the magnet, radio frequency(RF) coils and the gradient coils. A patient is surrounded by powerful electromagnets that create a high intensity static magnetic field. These radio waves cause the nuclei of molecules to emit a signal are decoded using the Fourier Transform Algorithm.

Before MRI examination, patient has to remove their watch and jewellery. The MRI machine generates a strong magnetic field. It will attract any metallic objects. Patient with metallic implants also dangerous for MRI scan. The MRI examination room itself can be intimidating. A conventional MRI machine looks like a large cube, perhaps 2 metres high, with a tunnel, or bore, through the middle. Protruding from the bore is a bench. The patient lies down on this bench. Something called a surface coil is positioned around the area of interest, such as the head if patient having a brain scan. The patient is then moved into the bore and the examination begins. This can be uncomfortable about 3 percent of patients suffer claustrophobia. The examination has to be abandoned. The noise can be distressing a clicking sound, registering up to 90 decibels continues throughout the procedure. Patients can use earplugs or headphones help reduce any discomfort that this might cause. Vacuum technology is being developed to reduce the noise. The examination takes between 10 minutes and an hour. It depends on the type of examination being performed and the MRI system being used.

2.3.2 Magnetic fields and radio waves of MRI

2.3.2.1 Magnetic Fields

The machine generates a very strong magnetic field inside the bore. Hydrogen nuclei in the patient's body act like tiny magnets and aligns with the field. MRI operators can determine what type of tissue exists at a particular point inside the patient's body by altering the magnetic field and sending pulses of radio waves. For example, tumours can be distinguished from normal tissue. As the machine scans different points inside the body, it sends this information to a computer that generates a map of the different tissue types.

The strength of the magnetic field inside the MRI machine (0.5-2.0 tesla) is up to 20,000 times stronger than the Earth's magnetic field. Despite the strength of the field, it has no detrimental effects on the human body. Nevertheless, such a strong magnetic field can still be dangerous any loose, metallic object inside the MRI examination room will be attracted to the machine, often at high speed. All sorts of hospital equipment such as spectacles, watches and earrings have all ended up stuck to MRI machines by mistake. The danger is not limited to external metallic objects tiny metal fragments that may be lodged in a patient's eye can be 'sucked' out by the magnet, damaging the tissue and the patient's eyesight. Pacemakers and bionic ears may also be adversely affected. (http://electronics.howstuffworks.com/)

2.3.2.2 Radio Waves

The MRI machine applies an RF (radio frequency) pulse that is specific only to hydrogen. The system directs the pulse toward the area of the body we want to examine. The pulse causes the protons to absorb the energy required making them spin, or process, in a different direction. This is the resonance part of MRI. The RF pulse forces them to spin at a particular frequency, in a particular direction. The specific frequency of resonance is called the Larmour frequency and is calculated based on the particular tissue being imaged and the strength of the main magnetic field.

These RF pulses are usually applied through a coil. MRI machines have many different coils designed for different parts of the body. These coils usually conform to the contour of the body part being imaged, or at least reside very close to it during the exam. At approximately the same time, the three gradient magnets jump into the act. They are arranged in such a manner inside the main magnet that when they are turned on and off very rapidly in a specific manner, they alter the main magnetic field on a very local level. In MRI, speak of slices, think of a loaf of bread with slices as thin as a few millimetres the slices in MRI are that precise. MRI can easily slice any part of the body in any direction, giving a huge advantage over any other imaging modality. Patient does not have to move. The machine can get the image from a different directions and manipulate them with gradient magnets.

When the RF pulse is turned off, the hydrogen protons begin to slowly return to their natural alignment within the magnetic field and release their excess stored energy. When they do this, they give off a signal that the coil now picks up and sends to the computer system. What the system receives is mathematical data that is converted, with a Fourier transform, into a picture that we can put on film. That is the imaging part of MRI.(http://electronics.howstuffworks.com/).

2.3.3 The Relaxation Process

Relaxation is a very important process in MR imaging as it determines the type of signal obtained greatly affecting the type of image generated. When the RF pulse is terminated, the net magnetic vector (NMV) is once again influenced by the main magnetic field (B_0)

and tries to re-align with it along the longitudinal axis. Protons attempt to return from a state of non-equilibrium to a state of equilibrium. As the NMV gives up its absorbed RF energy while trying to return to B_0, the process of relaxation occurs. As relaxation is occurring, magnetization is recovering in the longitudinal plane while decaying in the transverse plane. Longitudinal and transverse magnetization occurs at simultaneously but is two completely different processes.

2.3.4 Patient Safety in MRI

MRI can be used as a primary diagnostic tool to provide a quick and accurate diagnosis for physician. MRI is a non-invasive procedure with no known side or after-effects. The procedure is painless and will not feel any sensations during the procedure. In fact, many patients find the procedure so relaxing; they fall asleep during the MRI exam.

MRI images are formed when signals, emitted by body tissue, are processed by software and turned into clinical images. These signals are generated using a safe magnetic field in combination with radio waves.

A typical procedure averages 30 minutes or longer depending on the type of information required by physician. Patient can help make the image quality of MRI the best it can be by simply relaxing and remaining as still as possible.

During exam, an MRI technologist will be with the patient. Intercom system is built into the system so they can make contact with technologist if the need arises.

Pregnant woman must notify physician prior to having the MRI exam. Prior to entering the scan room for exam, the patient will be asked to leave items that are not compatible with a magnetic field. Some of those items include:

- coins
- jewellery
- earrings
- watches
- glasses
- credit cards
- hearing aides
- keys
- hair pins
- other metal objects

The patient may also be asked to remove make-up and dentures and to wear a hospital gown to avoid magnetic interference from belt buckles and zippers.

Other items to consider are the presence of implants and similar items. Physicians and MRI technologists will check if the patient had any brain, ear, eye or other surgeries or any of the following:

- **pacemaker**
- **neuro-stimulator (tens-unit)**
- **metal implants**
- **Intrauterine device (IUD), etc.**
- **aneurysm clips**
- **surgical staples**
- **implanted drug infusion device**
- **foreign metal objects in the eye**
- **shrapnel or bullet wounds**

Advantages	Disadvantages
1. MRI systems do not use ionizing radiation is a comfort to many patients 2. MRI contrast materials have a very low incidence of side effects 3. ability to image in any plane 4. MRI system can create axial images as well as images in the sagitall plane 5. the patient do not require to move if we were compare with X-ray	1. People with pacemaker and too big cannot safely be scanned with MRI. 2. The machine makes amount of noise. 3. Patients to hold very still for extended periods. 4. Orthopedic hardware (screws, plates, artificial joints) in the area of a scan can cause severe artifacts (distortions) on the images. 5. MRI systems are very, very expensive to purchase 6. the exams are also very expensive.

Table 2.1 The Advantages and Disadvantages of MRI

2.3.5 MRI segmentation

The goal of image segmentation is to find regions that represent objects or meaningful parts of objects. Division of the image into regions corresponding to objects of interest is necessary before any processing can be done at a level higher than that of the pixel. Identifying real objects, pseudo-objects, and shadows or actually finding anything of interest within the image requires some form of segmentation. A reliable and robust image segmentation method is necessary for obtaining meaningful results from any image processing system.

Magnetic resonance imaging (MRI) is a popular diagnostic tool that allows the physician to examine internal anatomical structures (e.g., organs, muscles, blood vessels, and other soft tissue). It produces images of good contrast and relatively low noise. The process essentially involves determining the density of hydrogen nuclei within the body.

2.3.5.1 Partial Segmentation

Partial segmentation in which regions do not correspond directly with image objects. Image is divided into separate regions that are homogeneous to a chosen property such as brightness, colour, reflectivity, texture and others. In a complex scene, a set of overlapping homogeneous regions may result. The partially segmented image must then be subjected for further processing. The final image segmentation may be found with the help of higher-level information.

However, there is a whole class of segmentation problems that can be solved using low-level processing only. In this case, the images commonly consists of contrasted objects on a uniform background simple assembly tasks, blood cells, printed characters and others. A simple global approach can be used and complete segmentation of an image can be obtained. Such processing is context independent no object-related model is used and no knowledge about expected segmentation results contributes to the final segmentation. Totally correct and complete segmentation of complex scenes usually cannot be achieved in this (low-level) processing phase. A reasonable aim is to use partial segmentation as an input to higher level processing. Image data ambiguity is one of the main segmentation problems, often accompanied by information noise. Segmentation methods can be divided into three groups according to the dominant features:

1. Global knowledge
2. Edge-based segmentations
3. Region-based segmentations

Global knowledge is about an image. The knowledge is usually represented by a histogram of image features. Edge-based and region-based segmentation approaches solve a dual problem, border region. Each region can be represented by its closed boundary and each closed boundary describes a region. Because of the different natures of the various edge-based and region-based algorithms, they may be expected to give different results and different information. The segmentation results of these two approaches can therefore be combined in a single description structure. (http://www.math.pku.edu.cn/teachers/jiangm/courses/dip/html)

2.3.5.2 Segmentation Methods

2.3.5.2.1 Gray-level thresholding

Gray-level thresholding is the simplest segmentation process. Many objects or image regions are characterized by constant reflectivity or light absorption of their surface; a brightness constant or threshold can be determined to segment objects and background. Thresholding is computationally inexpensive and fast. It is the oldest segmentation method and is still widely used in simple applications. Thresholding can easily be done in real time using specialized hardware.

2.3.5.2.2 Edge-based segmentation

Edge-based segmentation represents a large group of methods based on information about edges in the image; it is one of the earliest segmentation approaches and remains very important. Edge-based segmentations rely on edges found in an image by edge detecting operators these edges mark image locations of discontinuities in gray level, color, texture, etc. However, the image resulting from edge detection cannot be used as a segmentation result. Supplementary processing steps must follow to combine edges into edge chains that correspond better with borders in the image. The final aim is to reach at least a partial segmentation -- that is, to group local edges into an image where only edge chains with a correspondence to existing objects or image parts are present. We will discuss several edge-based segmentation methods which differ in strategies leading to final border construction, and also differ in the amount of prior information that can be incorporated into the method. The more prior information that is available to the segmentation process, the better the segmentation results that can be obtained. The most common problems of edge-based segmentation, caused by image noise or unsuitable information in an image, are an edge presence in locations where there is no border, and no edge presence where a real border exists. (http://www.math.pku.edu.cn/teachers/jiangm/courses/dip/html/)

i. Edge image thresholding

Almost no zero-value pixels are present in an edge image, but small edge values correspond to non-significant gray level changes resulting from, e.g., quantization noise, small lighting irregularities, etc. Simple thresholding of an edge image can be applied to remove these small values. The approach is based on an image of edge magnitude processed by an appropriate threshold. Selection of an appropriate global threshold is often difficult and sometimes impossible; threshold can be applied to define a threshold

Edge relaxation. Borders resulting from the previous method are strongly affected by image noise, often with important parts missing. Considering edge properties in the context of their mutual neighbours can increase the quality of the resulting image. All the image properties, including those of further edge existence, are iteratively evaluated with more precision until the edge context is totally clear -- based on the strength of edges in a specified local neighbourhoods, the confidence of each edge is either increased or decreased. A weak edge positioned between two strong edges provides an example of context; it is highly probable that this inter-positioned weak edge should be a part of a resulting boundary. If, on the other hand, an edge (even a strong one) is positioned by itself with no supporting context, it is probably not a part of any border. (http://www.math.pku.edu.cn/teachers/jiangm/courses/dip/html/)

ii) Edge relaxation

Borders resulting from the previous method are strongly affected by image noise, often with important parts missing. Considering edge properties in the context of their mutual neighbours can increase the quality of the resulting image. All the image properties, including those of further edge existence, are iteratively evaluated with more precision until the edge context is totally clear -- based on the strength of edges in a specified local neighbourhood, the confidence of each edge is either increased or decreased. A weak edge positioned between two strong edges provides an example of context; it is highly probable that this inter-positioned weak edge should be a part of a resulting boundary. If, on the other hand, an edge (even a strong one) is positioned by itself with no supporting context, it is probably not a part of any border.

Figure 2.1 The results of edge finding techniques based on zero crossing

2.4 Pulse-Coupled Neural Networks for Medical Image Analysis

Pulse-coupled neural networks (PCNN) have recently become fashionable for image processing. There are some of the advantages and disadvantages of PCNN for performing image segmentation in the realm of medical diagnostics. PCNN were tested with magnetic resonance imagery (MRI) of the brain and abdominal region and nuclear scintigraphic imagery of the lungs (V/Q scans).

Results show that PCNN do well at contrast enhancement. They also do well at image segmentation when each segment is approximately uniform in intensity. However, there are limits to what PCNN can do. For example, when intensity significantly varies across a single segment, that segment does not properly separate from other objects. Another problem with the PCNN is properly setting the various parameters so that a uniform response is achieved over a set of imagery. Sometimes, a set of parameters that properly segment objects in one image fail on a similar image.

2.4.1 Introduction

Neural Networks are different from paradigm of computing. It is based on the parallel architecture of animal brains. Von Neumann machines are based on the processing/memory abstraction of the human information processing. Neural Networks are a form of multiprocessor computer system with simple processing elements, a high degree of interconnection, multi-scalar messages, and adaptive interaction between elements. Neural networks cannot do anything that cannot be done using traditional computing techniques, but they can do some things which would otherwise be very difficult. In particular, they can form a model from their training data (or possibly input data) alone. This is particularly useful with sensory data, or with data from a complex (e.g. chemical, manufacturing, or commercial) process. There may be an algorithm, but it is not known, or has too many variables. It is easier to let the network learn from examples.

Neural networks are being used:

- In investment analysis:

Attempt to predict the movement of stocks currencies from previous data. They are replacing earlier simpler linear models.

- in signature analysis:

As a mechanism for comparing signatures made (e.g. in a bank) with those stored. This is one of the first large-scale applications of neural networks.

- in process control:

There are clearly applications to be made here, most processes cannot be determined as computable algorithms.

- in monitoring:

Networks have been used to monitor the state of aircraft engines. By monitoring vibration levels and sound, early warning of engine problems can be given.

- in marketing:

Networks have been used to improve marketing mail shots. One technique is to run a test mails hot, and look at the pattern of returns from this. The idea is to find a predictive mapping from the data known about the clients to how they have responded. This mapping is then used to direct further mail shots.

A neural network is a powerful data-modelling tool that is able to capture and represent complex input/output relationships. The motivation for the development of neural network technology stemmed from the desire to develop an artificial system that could perform "intelligent" tasks similar to those performed by the human brain. Neural networks resemble the human brain in the following two ways:

1. A neural network acquires knowledge through learning.
2. A neural network's knowledge is stored within inter-neuron connection strengths known as synaptic weights.

The true power and advantage of neural networks lies in their ability to represent both linear and non-linear relationships and in their ability to learn these relationships directly from the data being modeled. Traditional linear models are simply inadequate when it comes to modeling data that contains non-linear characteristics.

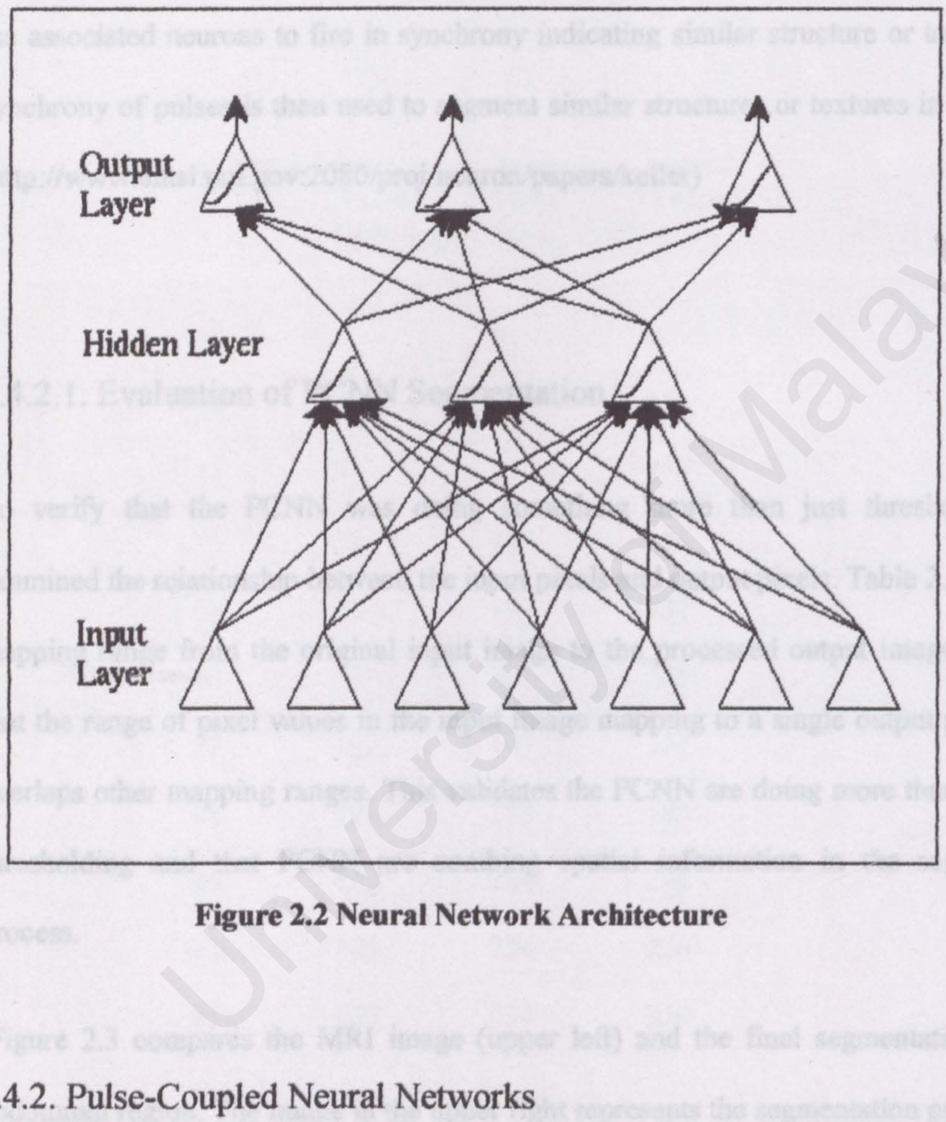

Figure 2.2 Neural Network Architecture

2.4.2. Pulse-Coupled Neural Networks

A PCNN is a physiologically motivated information-processing model based on the mammalian visual cortex. This model is different than other artificial neural network models in both its structure and operation. In the PCNN model, each neuron in the processing layer is directly tied to an image pixel or set of neighbouring image pixels.

Each neuron iteratively processes signals feeding from these nearby image pixels (i.e., feeding inputs) and linking from nearby neurons (i.e., linking inputs) to produce a pulse train. There is no training involved for the PCNN. Similarities in the input pixels cause the associated neurons to fire in synchrony indicating similar structure or texture. This synchrony of pulses is then used to segment similar structures or textures in the image. (http://www.emsl.pnl.gov:2080/proj/neuron/papers/keller)

2.4.2.1. Evaluation of PCNN Segmentation

To verify that the PCNN was doing something more than just thresholding, we examined the relationship between the input pixels and output pixels. Table 2.2 show the mapping range from the original input image to the processed output image. It shows that the range of pixel values in the input image mapping to a single output pixel value overlaps other mapping ranges. This validates the PCNN are doing more than just level thresholding and that PCNN are combing spatial information in the segmentation process.

Figure 2.3 compares the MRI image (upper left) and the final segmentations of the abdominal region. The image in the upper right represents the segmentation produced by the PCNN. The two lower images represent straight thresholding of the raw images. White regions indicate fat and muscle tissue. Black regions indicate organs, cavities, vertebrate, and the region outside the body.

Table 2.2 Pixel value range mapping from the input to the output.

Segment	Input Value (low end)	Input Value (high end)	Output Value
#1	0	91	0
#2	62	101	101
#3	73	112	112
#4	84	124	124
#5	85	137	137
#6	97	151	151
#7	102	167	167
#8	122	185	185
#9	129	204	204
#10	143	226	226
#11	160	250	250

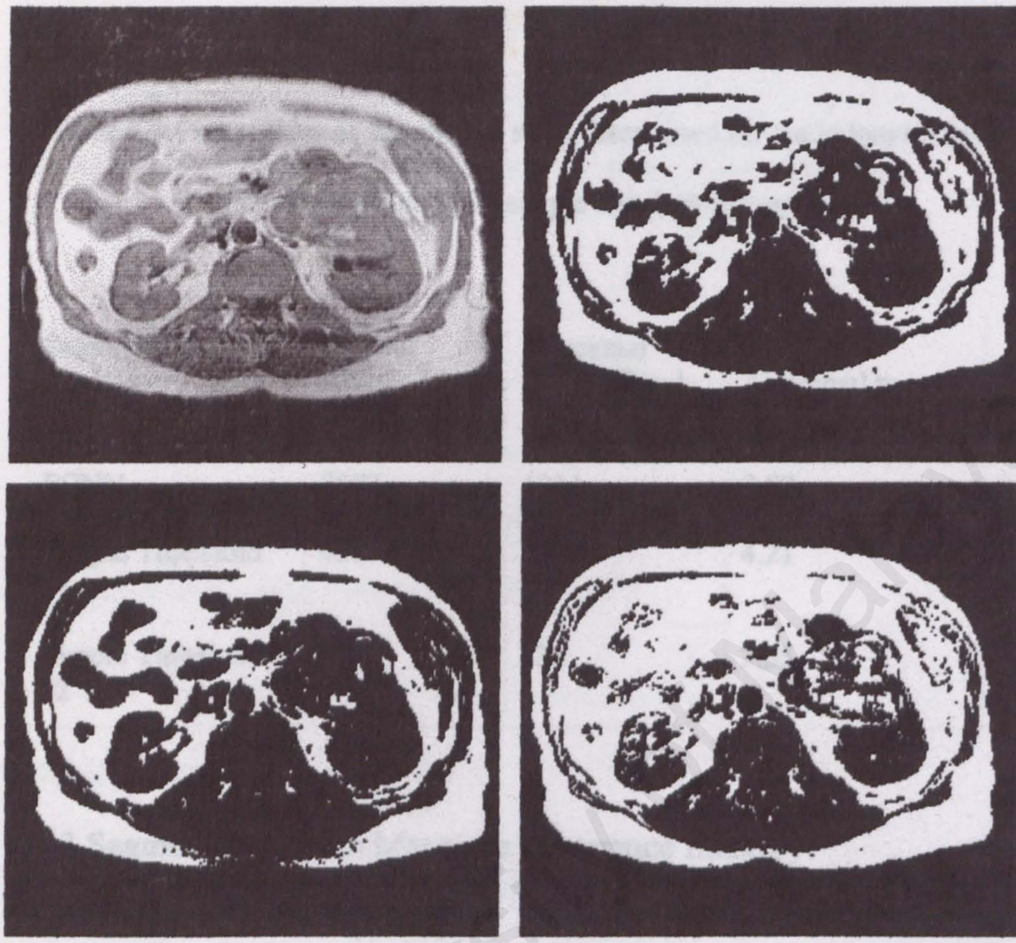

Figure 2.3 Final segmentations of the abdominal region.

Table 2.3 Comparison of the relative sizes determined for the kidneys based on the PCNN model and two simple thresholding techniques.

Segmentation Method	Normal Kidney Pixel Count	Abnormal Kidney Pixel Count	Ratio of Abnormal to Normal
PCNN	3877	1014	3.82
Simple Threshold #1	4803	1216	4.21
Simple Threshold #2	2966	836	3.55

2.4.3 Segmentation from Magnetic Resonance Imagery

To determine the effectiveness of PCNNs on high quality (low noise and uniform contrast) images, sets of magnetic resonance images of the brain and of the abdomen as the examples because they are good representations of high quality medical images.

2.4.3.1 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a popular diagnostic tool that allows the physician to examine internal anatomical structures such as organs, muscles, blood vessels, and other soft tissue. It produces images of good contrast and relatively low noise. The process essentially involves determining the density of hydrogen nuclei within the body. This is done by placing the subject in a magnetic field and sweeping a radio frequency across the resonance frequency of the magnetic spins of hydrogen nuclei.

MRI has excellent soft tissue differentiation yielding a good boundary contrast between anatomical structures. It is most commonly used in the evaluation of patients suspected of having tumours, multiple sclerosis, inflammatory diseases, disc disease, cartilage and soft tissue abnormalities, and tendon problems.

2.4.3.2. Automated Segmentation

In MRI, tumours show up either as areas of denser tissue mass, which results in a different intensity within the image, or as an enlarged area. While manual evaluation works well to identify and locate tumours, image segmentation is useful to calculate the volume and evaluate the progression of tumour growth.

Figure 2.4 An MRI horizontal cross sectional image of the brain

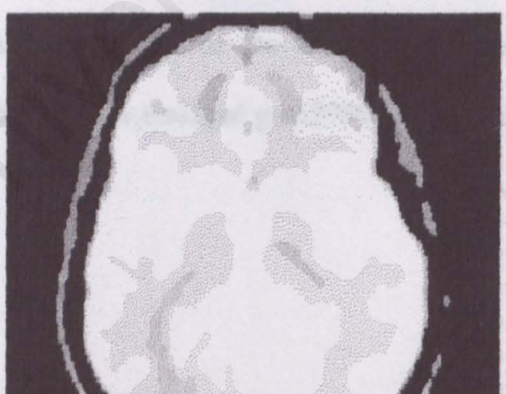

Figure 2.5 PCNN processed image

2.4.3.3. Segmentation Results

Figure 2.6 illustrates an anterior perfusion image from a person suffering chest pains but with no ventilation or perfusion defects. This figure shows that even though the image is quite noisy, the PCNN does a better job of segmenting the lung boundaries than a simple threshold. However, a simple threshold combined with a median window filter provides almost the same result.

Figure 2.7 illustrates a ventilation and perfusion image pair from a person diagnosed as having an intermediate to high probability of pulmonary emboli (one in the upper left lobe and the other in the lower right lobe). This figure shows that the PCNN combined with a median window filter was able to highlight the lack of blood flow in the lower right lobe indicating a possible perfusion defect. However, the PCNN processing of the ventilation image from the left lung makes it look as though there is an air obstruction in the upper left lobe. A trained physician would probably recognize that the shape was wrong and that the perfusion image of the left lung was more likely indicating a perfusion defect only. (http://www.emsl.pnl.gov:2080/proj/neuron/papers/keller).

Figure 2.6 The PCNN processed image (middle left), a PCNN segmentation of the lungs (middle right), and a simple threshold image (far right).

Figure 2.7 A posterior ventilation and perfusion image pair (left) of a patient with a high probability of a pulmonary emboli in the upper left lobe and lower right lobe and the resulting image pair processed by a combination of PCNN and median window filter (right).

2.4.4 Development Analysis

2.4.4.1 Operating Systems Consideration

2.4.4.1.1 Windows 2000 Professional

Windows 2000 Professional includes both improvements to the operating system and several features that enhance the user experience. The most noticeable change in Windows 2000 is the user interface, which includes the revised Start menu and updated Task Bar. The new looked is possible because Windows 200 can be skinned, which lets the interface be changed dramatically with a new facility called themes.

Windows 2000 also introduces fast user switching, which allows multiple users to be logged onto their own sessions at the same time on the same machine and, as the name implies, they can switches back and forth quickly.

Windows 2000 Professional was designed from the ground up to be the most integrated, comprehensive easy server operating system and to provide several premises such as scalability, reliability, and manageability necessary for mission-critical applications.

2.4.4.1.2 UNIX

UNIX originated from efforts of US Defence Department, IBM, AT&AT, UC-Berkeley and MIT. The UNIX versions were used in universities for research about 20-30 years ago. Fast forward to the 1980's, where high-powered workstations used in multi-national corporations were designed with UNIX

Without a common standard and stable support for UNIX, its position as a prominent workstation operating system was weakened.

2.4.4.1.3 LINUX

A world of operating systems created one and enhanced by millions, Linux gaining steady around as an alternative to Windows. UNIX is a version of Linux that was introducing in 1991. Created by Finnish programming genius Linus Torvalds, Linux has experienced phenomenal growth since its humble beginnings.

The number of Linux users has grown tremendously from the hundreds recorded in the initial stages. Since Linux is a freeware, it is very difficult to get the actual figures. Furthermore, users do not have to register the software. After nearly eleven years, a lot has been done for the desktop versions. Linux is compatible with 386, 486, and Pentium group of processors with ISA, EIS, PCI, and VLB bus systems. Features of desktop Linux operating systems are multi-user support, networking, multi-tasking.

2.4.4.2 Development tools Consideration.

2.4.4.2.1 MATLAB

2.4.4.2.1.1 Algorithm Development and Application Deployment

MATLAB easily encapsulate image-processing solution in a customized software application. Helpful features include an interactive GUI builder to rapidly develop custom graphical front ends for image processing applications. In addition, the built-in programming tools in MATLAB such as a visual debugger for algorithm development and refinement and an algorithm performance profiler can be used to accelerate development.

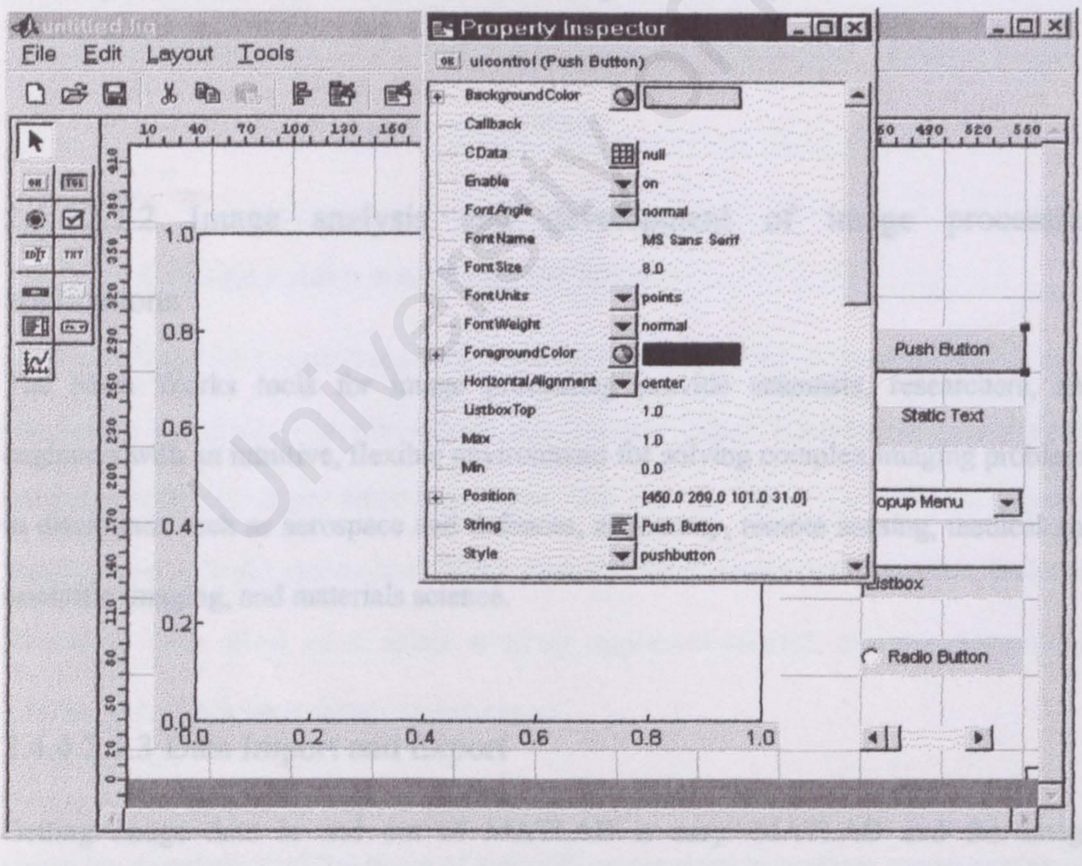

Figure 2.8 The MATLAB Graphical User Interface Design Environment

Image processing algorithms created in the MATLAB language across all MATLAB supported platforms, integrate algorithms with existing C programs, or deploy the developed algorithms and GUIs as stand-alone applications. With the MATLAB Compiler, automatically convert image-processing algorithms into C and C++ code.

Solve challenging multidisciplinary problems using the Image Processing Toolbox in combination with other MATLAB Toolboxes such as Signal Processing, Wavelet, Mapping, Neural Network, and Statistics. The MATLAB language facilitates the creative use of computation, visualization, and specialized techniques that can be drawn from any of the toolboxes within the MATLAB product family.

2.4.4.2.1.2 Image analysis and development of image processing applications

The Math Works tools for image processing provide scientists, researchers, and engineers with an intuitive, flexible environment for solving complex imaging problems in disciplines such as aerospace and defences, astronomy, remote sensing, medical and scientific imaging, and materials science.

2.4.4.2.1.3 Data Import and Export

Getting image data in and out of MATLAB is easy. MATLAB and the Image Processing Toolbox support many standard data and image formats from areas such as medical imaging, remote sensing, and astronomy. Some supported formats include JPEG, TIFF, HDF, HDF-EOS, and DICOM, can also create AVI movies from sets of images. MATLAB supports other industry standard file formats, such as Microsoft® Excel.

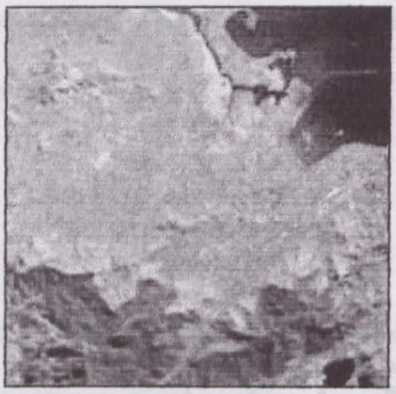

Figure 2.9 Multispectral Data(image of Rio de Janeiro from Landsat Thematic Mapper data)

2.4.4.2.1.4 Image Analysis and Enhancement

MATLAB® and the Image Processing Toolbox support a broad range of advanced image processing functions. We can extract and analyze image features, compute feature measurements, and apply filter algorithms. We can use filters for different types of image noise or build customized filters with the filter design tools that are included. Interactive tools allow us to select arbitrary regions-of-interest, measure distances in images, and obtain pixel values and statistics.

Using the morphological functions of the toolbox can quickly perform image-processing tasks, such as edge detection, noise removal, skeletonization, and granulometry.

Specialized morphology functions include hole filling, peak detection, and watershed segmentation. All morphology functions support multidimensional images. The Image Processing Toolbox lets us use advanced techniques to alter different aspects of images. The included functions let us easily align, transform, and deblur images. We can also interactively crop and resize images. The control point selection tool helps us select landmark points and align images.

2.4.4.2.1.5 Visualization

MATLAB® visualization tools depict the information contained in image data through histograms, contour plots, montages, pixel profiles, transparent overlays, and images texture-mapped onto surfaces. View and measure image attributes, such as the location and value of pixels in an image, or display colorbars to view the mapping of colours to values.Using the powerful volume visualization features in MATLAB, we can create graphical representations, including an isosurface display of multidimensional image data sets, helping to highlight certain characteristics or values. Also use multiple light sources for colored surfaces and a camera-based viewing and perspective control to enhance graphical representations.

2.4.4.2. Matlab PCNN toolbox

Pulsed-Coupled Neural Network software was originally developed at the Royal Institute of Technology (KTH) in 1996. It includes a Graphical User Interface that gives an intuitive simulation of the PCNN network dynamics. The Matlab environment makes it easy to alter, monitor and in other ways experiment with the code, without the need of compilation and analysis of trace files etc.

2.4.4.2.2.1 Image Processing Toolbox

1) Images in MATLAB and the Image Processing Toolbox

The basic data structure in MATLAB is the *array*, an ordered set of real or complex elements. This object is naturally suited to the representation of images, real-valued ordered sets of color or intensity data. MATLAB stores most images as two-dimensional arrays (i.e., matrices), in which each element of the matrix corresponds to a single *pixel* in the displayed image. (Pixel is derived from picture element and usually denotes a single dot on a computer display.) For example, an image composed of 200 rows and 300 columns of different colored dots would be stored in MATLAB as a 200-by-300 matrix.

2) Storage Classes in the Toolbox

By default, MATLAB stores most data in arrays of class double. The data in these arrays is stored as double precision (64-bit) floating-point numbers. All MATLAB functions work with these arrays. For image processing, however, this data representation is not always ideal. The number of pixels in an image may be very large; for example, a 1000-by-1000 image has a million pixels. Since each pixel is represented by at least one array element, this image would require about 8 megabytes of memory.

Summary of Chapter 2

In chapter 2, the definition and purposes of doing literature review as one of the system development process(2.1) had been discussed. Literature review is an important approach to search and gather system requirements and relevant information. Several case studies were being done to achieve some guideline in developing the system. All details regarding the MRI (2.1), pulsed coupled neural network (2.2), segmentation (2.3 also reviewed. Several MRI segmentation Using PCNN tools were chosen for discussion and comparison of their strengths and weakness. The reviewing of similar segmentation using PCNN systems provides an idea on the range of information and requested features that should be included in the system.

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The Future of MRI. Retrieved April 16, 2003 from World Wide World: (http://electronics.howstuffworks.com/)

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CHAPTER 3

METHODOLOGY

CHAPTER 3 – METHODOLOGY

3.1 Fact Finding Techniques

There are a few main resources that I took into account in order to attain information to build a system. This part of the proposal is very important for further development of the system. Therefore, it involved quite a lot research. Information sought for this project is from three main resources, described as follow:

3.1.1 Internet Surfing

Today, one can acquire information about thing through one of the most popular informative source, which is via internet. Internet is the largest knowledge and information repository in the world. Therefore, various type of information can be gathered from the Internet such as the existing tools for image processing, application programming language, databases and many more by using Web portals and search engines.

This may be the most popular way of retrieving information and it provides us with more related information. The important context here is to specify the keywords correctly. Search result may always return a lot of unrelated subject, so it is important to narrow up each search result.

Search engines that I used to gather information on Magnetic Resonance Imaging, Segmentation, and Pulsed-coupled Neural Network using Association Technique are as follows:

- www.google.com
- www.yahoo.com
- www.amazon.com
- www.msn.com
- www.altavista.com
- www.whatis.com
- www.infoseek.com

3.1.2 Library Resources

Library has a large collection of books, journal, magazines, and newspapers therefore it is the best place to get hold of books and references. Main library in University of Malaya is visited frequently to search on related materials for system development by using the OPAC system.

Some of the related magazines such as PCWeek, Computimes Shopper, etc are available in the library. These magazines normally contain article on software tools review, product comparison, innovative technologies and many more.

3.1.3 Documentation Room

Another source for gathering information is the Documentation Room in the FSKTM. There are many previous theses from seniors stored at the Documentation Room. There is a lot of information about segmentation, but a very few examples about Pulsed-coupled Neural Network. The documents provide me some of the guidelines on how to do my thesis and generate a good report.

3.2 Introduction and Concept of Methodology

Methodology is the study that deals with the science of method concerned with the application or the principles of reasoning to scientific and philosophical enquiry. It deals with the philosophical assumptions underlying the development process [3].

A system development methodology is a precise system and very formal development process that defines a set of activities, best practices, methods, deliverables and automated tools for system developers to develop and maintain most of software and information system.

Methodologies enable one to follow a certain procedures, where its basis is laid down in the way a problem is encountered. Methodologies are also flexible enough to provide for different types of project and strategies.

3.3 System Development Methodology

3.3.1 The Waterfall Model

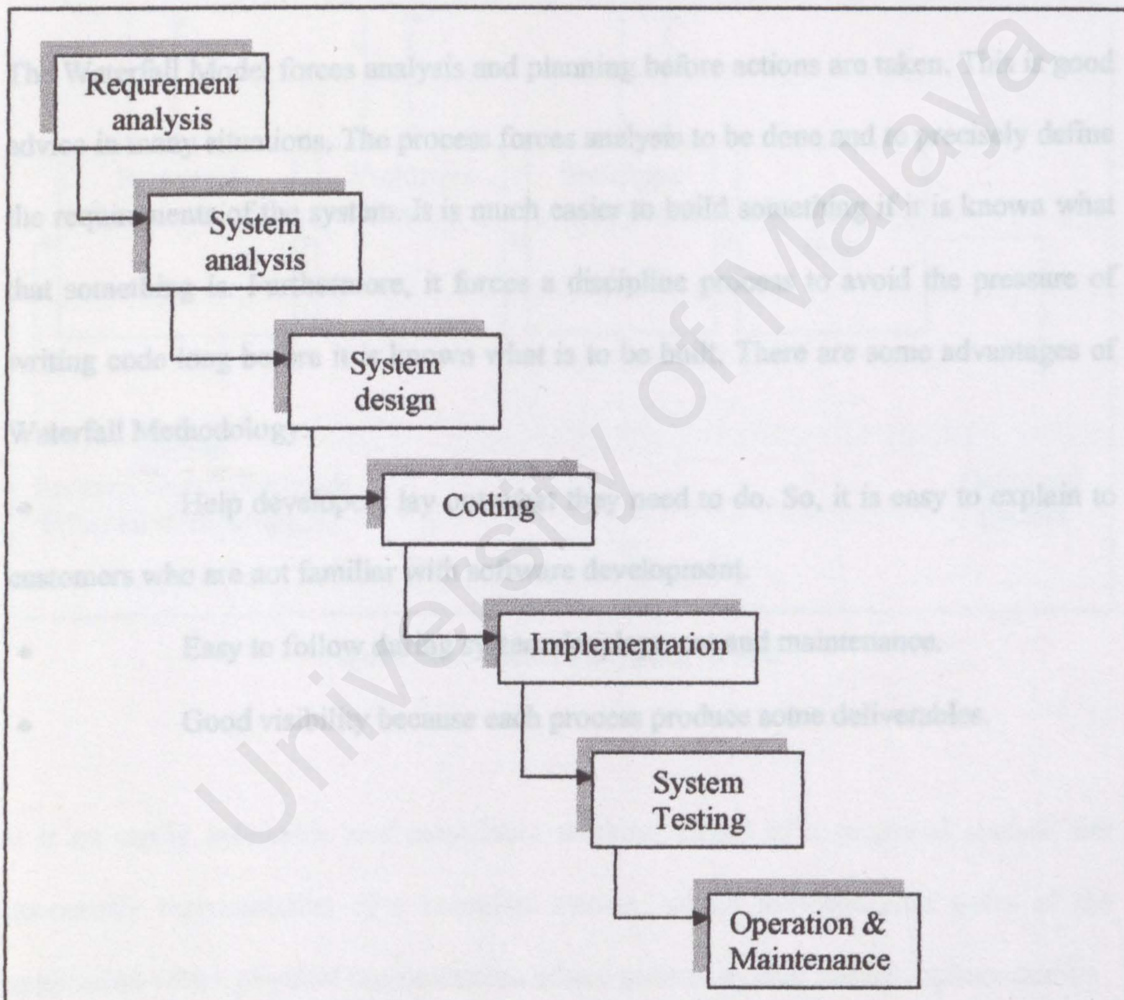

Figure 3.1: The Waterfall Model

The Waterfall Model presents a very high-level view of what goes on during development. However, the Waterfall Model also is a model for the development of 'something', that means not necessarily an entire system. It may be used for the development of a subsystem, or evolutionary delivery. The product only emerges at the end of the process. Therefore, when an entire system is being developed, the customers and users do not have the opportunity to test or use it until it is complete [4].

The Waterfall Model forces analysis and planning before actions are taken. This is good advice in many situations. The process forces analysis to be done and to precisely define the requirements of the system. It is much easier to build something if it is known what that something is. Furthermore, it forces a discipline process to avoid the pressure of writing code long before it is known what is to be built. There are some advantages of Waterfall Methodology:

- Help developers lay out what they need to do. So, it is easy to explain to customers who are not familiar with software development.
- Easy to follow during system development and maintenance.
- Good visibility because each process produce some deliverables.

3.3.2 The Prototyping Model

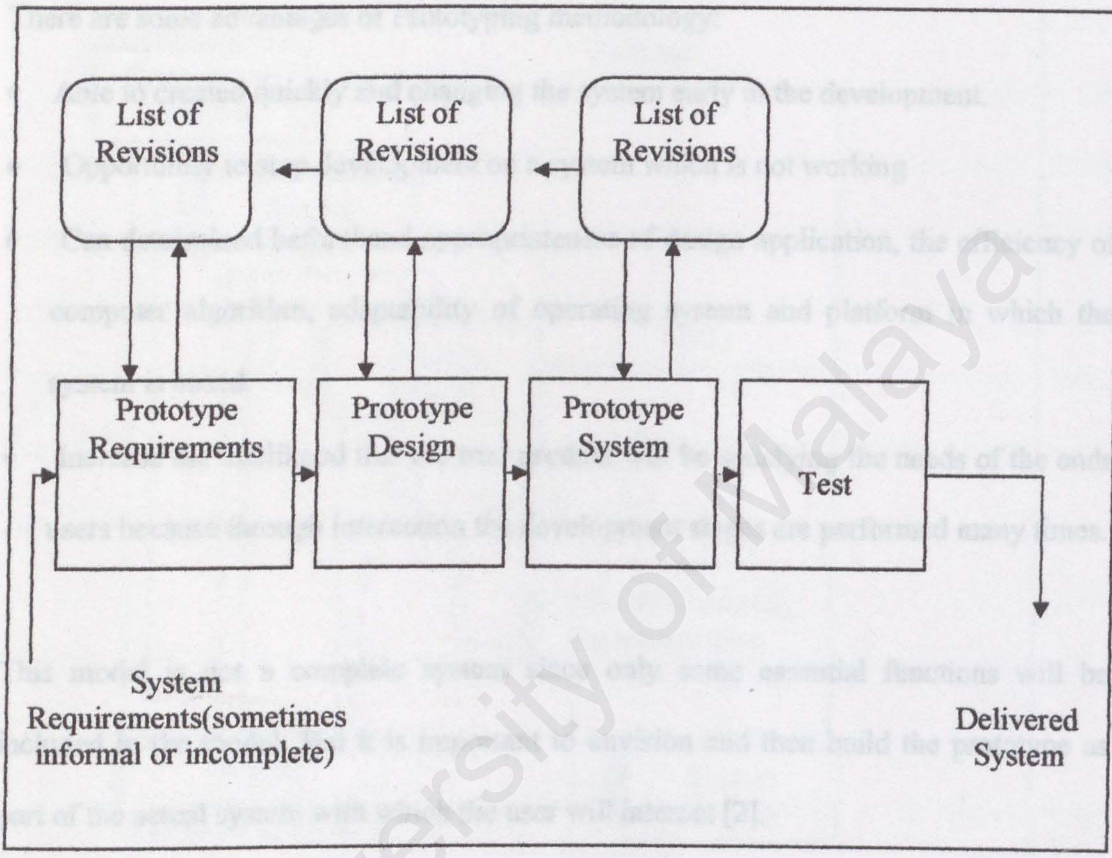

Figure 3.2: The Prototyping Model

It is an easily extensible and modifiable working model of a proposed system, not necessarily representative of a complete system, which provides later users of the application with a physical representation of key parts of system before implementation.

Prototyping provides a basis communication for discussing all the groups involved in the development process, especially between developers and users. In addition, it also enables us to adopt an approach to software construction based on experience and experiment.

There are some advantages of Prototyping methodology:

- Able to created quickly and changing the system early in the development.
- Opportunity to stop development on a system which is not working
- Can determined beforehand appropriateness of design application, the efficiency of computer algorithm, adaptability of operating system and platform in which the system is based.
- Increase the likelihood that the trial product will be satisfying the needs of the ends users because through interaction the development stages are performed many times.

This model is not a complete system since only some essential functions will be included in the model. But it is important to envision and then build the prototype as part of the actual system with which the user will interact [2].

3.3.3 The Waterfall Model with Prototyping

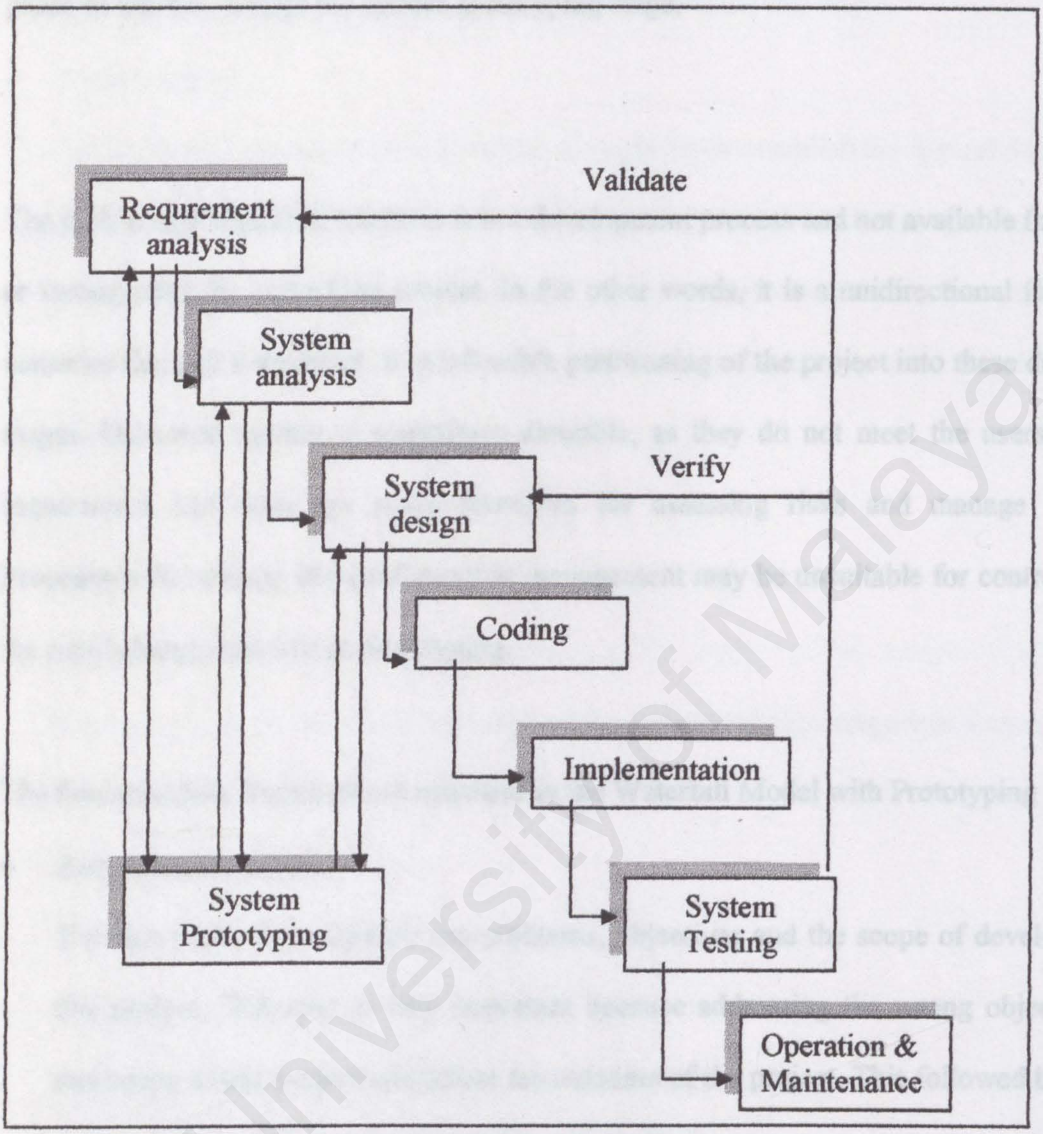

Figure 3.3: The Waterfall Model with Prototyping

For the development of this project, the Waterfall Model with Prototyping methodology has been chosen to assist in my project because the combination between Prototyping Model and Waterfall Model will give a better solution for the problems that occur on

their own. The project consists of separate process phases, which cascade from one phase to another, except the system prototyping stage.

The problem of Waterfall Model is it is a development process and not available for trial or testing until the end of the project. In the other words, it is a unidirectional flow of activities through the project. It is inflexible partitioning of the project into these distinct stages. Delivered system is sometimes unusable, as they do not meet the users' real requirement and does not make provision for assessing risks and manage them. Procedures for change and configuration management may be unsuitable for controlling the rapid change inherent in prototyping.

The fundamentally development activities in the Waterfall Model with Prototyping are:

- Requirement analysis

  The first phase is to identify the problems, objectives and the scope of developing this project. This step is very important because addressing the wrong objectives and scope of this system will affect the outcome of the project. This followed by the requirements gathering process, which is intensified and focus specially on system.

- System analysis

  The next phase is to analysis the system needs and chooses the suitable system development methodology to develop the system for Magnetic Resonance Imaging

Segmentation using Pulsed-Coupled Neural Network using Associations Technique. Analysis on the system architecture is also made during this stage.

- System design

In this phase, the information gathered is needed to accomplish the logical design of the system. The design of the overall system structure, flow chart, page flows, and accurate data flow diagrams are planned so that the processes within the system are correct and functional. There will be a data dictionary to represent the database design.

- System coding

This phase transforms algorithms defined the detailed design stage into a computer-understandable language.

- System prototyping

System prototyping allows all part of the system to be constructed quickly to understand or clarify issues. The requirements or design require repeated investigation to ensure that the developer, user, and customer have a common understanding both of what is needed and what is proposed.

- Implementation

After all the scripts or codes and the system requirements are ready, the implementation phase will take place. Implementation is a procedure to integrate the entire system that is being developed which includes all the hardware and software in order for it to function properly and as a complete system.

- System testing

System testing is very important to assure the quality of the system. The main objectives of system testing are to detect the fault of errors in developed system so that it can be corrected before the system is fully operational. During this stage, various bugs will be eliminated.

- Operation & Maintenance

Maintenance is crucial to ensure that the system remains useful. Normally, this is the longest life cycle phase. The changes may involve changes to correct existing errors, more extensive changes to correct design errors or significant enhancement.

Summary of chapter 3

In chapter 3, the fact-finding techniques (3.1) that were used to gather information had been touched. Initially, the fact-finding techniques elaborate the methods being used during conducting the researches. This includes Internet surfing, browsing previous theses at the Documentation Room of FSKTM, books and references at library. Meanwhile, the introduction and concept of methodology (3.2) and also the system development methodology (3.3) also discussed. The system development methodology that is chosen to develop this system is the Waterfall Model with Prototyping. The reason is because it is very powerful, industry standard and a time-proven approach to system development.

References of Chapter 3

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CHAPTER 4

SYSTEM DESIGN

CHAPTER 4: ANALYSIS OF SYSTEM DESIGN AND DEVELOPMENT

4.1 Introduction

System analysis is a problem solving technique that decomposes a system into its component pieces for studying how well those component parts work and interact to accomplish their purpose. System analysis is a process of defining a problem, gathering pertinent information, developing alternative solutions, and choosing among these solutions to develop the system. A system comprises a set of interrelated components of the function together to achieve some overall purpose. System analysis is important in systematically analyze data input or data flow, processing or transforming, data storage and information output within context of a particular system. Furthermore, using computerized information system to analyze, design, and implement improvement in the functioning of the system using system analysis.

Fundamental of any system analysis activities are the focus and adherence to the people, procedures, and policies. People are the critical aspect to be determined as they are the eventual users of the system and the interface is the important to them, as it is the only means through which interactions with the system accommodated. Procedures define the steps in a method by which organizations get things accomplished. All entities come with their own set of procedures and this must be honour in the new system. Policies in the other hand are the rules by which users must abide to and they are the determinant to procedures in the first place. As such, they should be approach and examined cautiously during analysis as well.

Systems design (also called systems synthesis) is a complementary problem solving technique (to systems analysis) that reassembles a system's component pieces back into a complete system, it is hoped an improved system. This may involve adding, deleting, and changing pieces relative to the original system.

4.2 User Requirement Specification and Analysis

The purpose of system requirements analysis is to determine functional and non-functional requirements of this project. Then the analysis also help to ensure the system built can solve the right problem, functional as expected, easy to the users to understand and make the requirement testable.

4.1.1 Functional Requirement Analysis

A functional requirement analysis described an interaction between the system and its environments. Further, functional requirement described how the system should behave given the certain stimuli (Pfleeger, S.L., 1998). This project consist of several major tasks. Below are the functional requirement respectively:

4.1.1.1 The Administrator Module

The Administrator Module will allow authorized administrators to access and conduct maintenance and other operations on the system. Normal users will not be able to modify information entered into databases system. To do that, user will be requested for login ID and password.

1. The Authentication and Authorization Function

   This function provides access for the administrator and allows access to administrative functions. The authorized administrator is required to enter his/her user name and password in order to access the administrator module. They can register and set user user-level security which is authorized to use the system by providing them with username and password in order for them to mine the certain data from certain databases. The sole purpose of this function is to ensure the security of the system.

2. The Login Function

   Allows users to login to the system with their login (user name) and password.

3. The New Users Function

   Allow new users to enter their personal details such as name, login ID, and password. Password will be confirmed for authentication.

4. The Change Password Function

Allow users to change their login password periodically.

4.1.1.2 The Segmentation Model Module

The segmentation Model Module lets the users to specify the segmented image functions to be performed. Here, the user can decide the type of image they would like to discover from the user interface. However, this project is mainly focus on Pulsed-Coupled Neural Network segmentation.

1. Import Data Function

To begin, the users need to import and examine data set or data sources by selecting related tables from databases by setting image code or database name that set as global variable. The attribute or variable, which try to discover, must be make sure by the users. After that, users can choose the segmentation of image they would like to segment by select the segment function.

2. Exploration functions

Lets users to begin running preliminary segmentation on image by allows the Pulsed-coupled Neural Network (PCNN, with Matlab) to be used. In this case, users do not have to put any model to work on PCNN. PCNN do not requiring any training.

3. Report Generator or Visualization Function

Analytical and useful reports can be generated whenever needed this module to allow the users to review the segmentation results or outputs as well as visual the image. As a result the segmentation results can be retrieved by using PCNN.

4. The knowledge Based Module

Provides users some additional functions to retrieve their preferred historical or current segmentation results. User also can view such types of image by select the image code the would like to reach.

4.1.1.3 The Report Printed Module

The Report Printed Module lets user to print out a hard copy of the segmentation results. Here, users are allowed to select the certain image of segmentation, which is the previous or latest segmentation result before printing task begins.

4.1.1.4 The Help Module

This will provide the guideline about the procedures to track the certain image and steps to mine that massive data in order to get the potentially useful information. this help or user manual is a reference guide for system administrators as well as the users. The manual should be complete and understandable. It presents the system to users in layer, beginning with the general purpose and progressing to detailed functional description. User manual consists of system interface. The functions are described one by one. In order to enable users to find needed information quickly and easily, a user manual functional descriptions include:

1. major functions description and relationships between them.
2. a description of each function in terms of the screens the user can expect to see, the purpose of each, and the result of each menu choice or function key selection.
3. Description of input expected by each function.
4. Description of output can be created by each function.
5. Description of special features that can be invoked by each function.

4.1.2 Non-functional requirement analysis

Non functional specification are the constraints under which a system must operate and the standards which must be met by the delivered system (Sommerwille, 1995). The concluded non-functional requirements of the project are user-friendliness, flexibility, efficiency, reliability, fast retrieval information, security, and maintainability.

4.1.2.1 User- Friendliness

The system is required to have a user-friendly interface. Therefore, the design of the user screen must include:

- Attractive, simple toolbars and icon buttons and direct, short menu options
- Field description where necessary

4.1.2.2 Flexibility

the system must possess the capability to take advantages of new technologies and resources, and can be implemented in fat changing environment. It must be able to cater for all types and levels of data in the online business large databases.

4.1.2.3 Efficiency

efficiency in the computer world is understood as the ability of a process or procedure to be called or accessed unlimitedly to produce similar performance outcomes at an acceptable or creditable speed (Sommerwille, 1995). It is vital that the system will not add to the agony of users but solve their problem in handling huge databases under time constraints.

4.1.2.4 Reliability

a system that does not produce dangerous or costly failure in the typical user environment and data is preserved. This definition recognizes that a system may not always be used in ways of which its designer expects. All potential and possible failures and errors must be taken into account during the design and development phase.

4.1.2.5 Fast Retrieval Information

users should be able to retrieve, modify the information or database needed within reasonable time.

4.1.2.6 Security

The system shall ensure the usage and modification can only be done by an authorized person by asking them to enter valid password before entering the module. Only the authenticated users shall have the access rights to view and modify the data in the specified databases.

4.1.2.7 Maintainability

Maintenance Module has to be easy to manage in every parts of the system such as the database, functions and features, user interface of the system and many more. It should also have some sort of user manual for the administrators and also the customers for easy reference of anything regarding the system.

4.3 Concepts and Guideline of User Interface Design

4.3.1 Concepts

Concept of User Interface Design is, integrate output and input design into an overall user interface that establishes the dialogue between users and computer. The dialogue determines everything from starting the system or logging into the system, to setting options and preferences, to getting help. And the presentation of the outputs and inputs is also part of the interface. The screen- to- screen transitions that can occur need to examine.

4.3.2 Guidelines

Guidelines that affect user interface design is types of users, human factors, and human engineering guidelines.

- Types of computer users

System users can be broadly classified as either expert and novice user. An expert user is an experienced computer user who has spent considerable time using specific applications programs. The use of computer is usually considered nondiscretionary. Novice user is a less experienced computer user who will generally use a computer on a less frequent. The use of a computer may be viewed as discretionary.

- Human Factors

Before designing user interfaces, it may useful to understand those elements that frequently cause people to have difficulty with computer systems. To solve these problems, the overriding commandments of user interface design:

-understand users and their tasks

-involve the user in interface design

-test the system in actual users

-practice iterative design

- Human engineering Guidelines

Given the type of user, a number of important human engineering factors should be incorporated into the design:

1) the system user should always be aware of what to do next

-tell the user what the system expects right now

-tell the user that data has been entered correctly

-tell the user that data has not been entered correctly

-explain to the user the reason for a delay in processing

-tell the user a task was not completed or was not completed

2) The screen should be formatted so that the various types of information, instructions, and messages always appear in the same general display area.

3) Messages, instruction, or information should be displayed long enough to allow the system user to read them.

4.4 User Interface Design

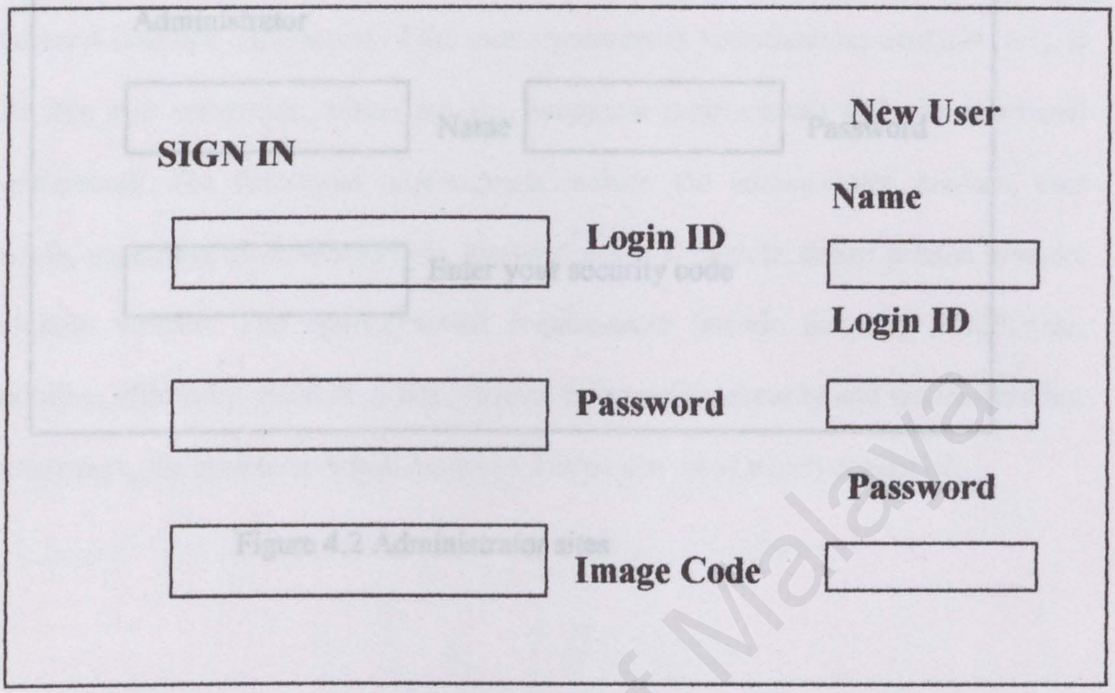

Figure 4.1 Main Page of Magnetic Resonance Imaging segmentation using PCNN

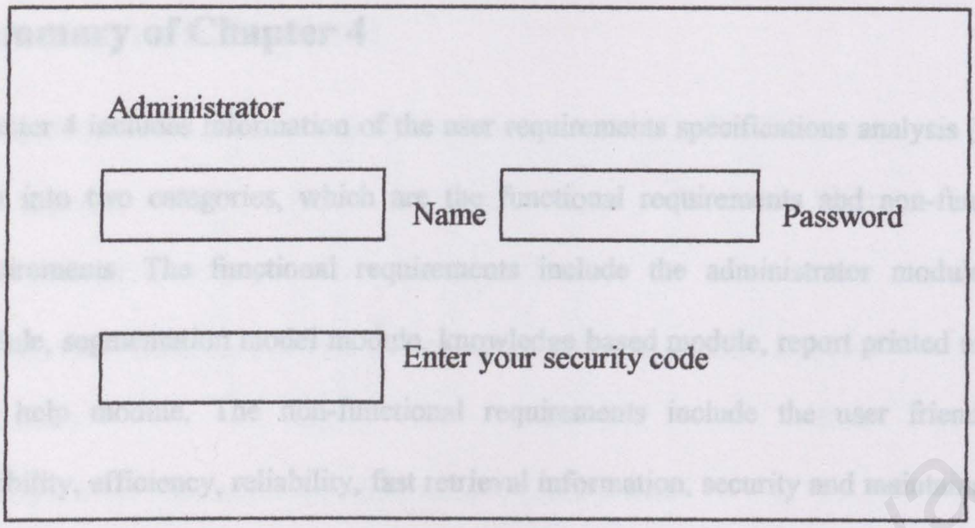

Figure 4.2 Administrator sites

Summary of Chapter 4

Chapter 4 includes information of the user requirements specifications analysis (4.1). It falls into two categories, which are the functional requirements and non-functional requirements. The functional requirements include the administrator module, user module, segmentation model module, knowledge based module, report printed module, and help module. The non-functional requirements include the user friendliness, flexibility, efficiency, reliability, fast retrieval information, security and maintainability. Furthermore, the system interface design (4.2) also discussed which consist of

References of Chapter 4

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2. Microsoft windows 200 Professional. Microsoft Corporation. Retrieve March 23, 2003, from http://www.microsoft.com/windows2000/professional/

3. System analysis and Design Methods, 5th edition, Jefrey L.whitten, Lonnie D. Bently, Kevin C. Ditmann. www.mhhe.com/whitten

CHAPTER 5

SYSTEM IMPLEMENTATION

Chapter 5 System Implementation

5.1 Introduction

System implementation is the physical realization of the database and application design. On completion of the design stages (which may or not have involved prototyping), here comes the stage where the database and the application have to be implemented. The transaction process continues when a compiler accepts source code as input and produces machine-dependent object-code as output. Compiler output is further translated into machine code – the actual instruction that drives micro-coded logic in the central processing unit (CPU). So, coding and debugging is the major works involved in the implementation phrase.

In a software project, the requirements analysis, system design and implementation phases do not have a clear boundary. Each phase tends to overlap one another. This phase at times involves some modifications to the previous design.

5.2 Development Environment

Development environment has certain impact on the development of a system of a system. Using the suitable hardware and software will not only help to speed up the system development but also determine the success of the project. After implementing the system, the requirement of hardware and software that was stated in the previous chapter can be finalized. The final list of the hardware and software tools used to develop the entire system is listed below.

5.2.1 Actual Hardware Requirements

The hardware used to develop the system is as listed below:

1. 400 MHz Intel Pentium Processor and above.
2. 256 MB RAM and above.
3. Hard disk: 10 GB hard disk space with a minimum of 1 GB free space.
4. Other standard desktop PC components.

5.2.2 Actual Software Tools Requirements

5.2.2.1 Software Tools for Design and Report Writing

There are a lot of software tools, which can be used in designing and writing report. The design process involved the drawing of structure chart, data flow diagram and others that form the foundation of the software development. The purpose of this graphically logical design is to provide an overall view of system and interconnection between the modules. Visio Professional and Microsoft Word are the software that used to design and write report.

5.2.2.2 Software Tools for Development

During the Magnetic Resonance Imaging Segmentation using Pulsed-coupled Neural Network, Matlab and Microsoft Office software tools were used. Table below used to develop the system.

Software	Purpose	Description
Microsoft Windows 2000 Professional	System Requirement	Operating System (OS)
Microsoft Office 2000(Access)	Database	Build the database to store and manipulate the data
Matlab 6.5 Release 13	System Development	Coding for segmentation and PCNN algorithm
Matlab 6.5 Release 13	User Interface Design	Create interface using GUI matlab environment
PCNN Toolbox	System Development	PCNN implementation

Table 5.1 Software tools used for MRI Segmentation Using PCNN

5.3 Platform Development

The platform development will include setting up the development environment, create design with Matlab, create a database in Microsoft Access 2002 and configure PCNN toolbox. Development tools installations are the very first step before starting off with any development work. When using Microsoft's products, it is essential to know the sequence of products installations to ensure smooth execution without system errors.

5.3.1 Setting Development Environment

1. First, install Microsoft Windows XP Professional
2. Install Microsoft Office 2002
3. Install Matlab 6.5 Release 13
4. Download PCNN Toolbox.

5.3.2 Creating Design in Matlab GUI

After installing the Matlab, a project named MRI Segmentation Using PCNN was created. The coding phase can be started now by adding Matlab source code into the project and begin to design the user interface according to the user interface design which have been done before.

5.3.3 Creating Database in Microsoft Access 2002

A database named login are created after Microsoft Office had been installed successfully. Then the table created according to database design. The table is created for keeping the data such as username and password used in login the system. Small hard disk space is used in the database.

5.4 System Development

The design must be translated into the form that can be understood by the machine. The code generation step perfumes this task. MRI Segmentation Using PCNN is accomplished with the well and detailed design and coding. System development consists of the following 5 steps.

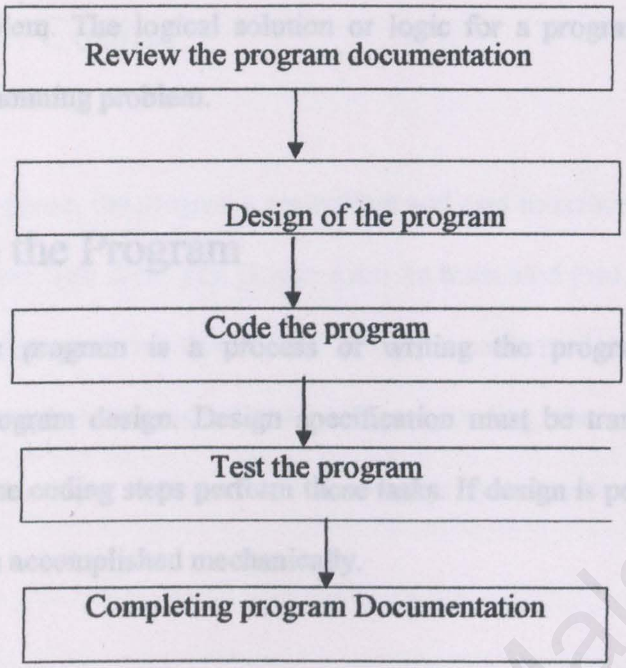


Figure 5.1 System Development

5.4.1 System Development Process

5.4.1.1 Review the Product Documentation

Review the product documentation that was prepared during the previous phases. The program documentation catalogue system consists of simple process check, report layout, data dictionary entries and the source documentation. This documentation has the author to understood better of work that need to cover during the coding phases.

5.4.1.2 Design of the Program

After the program documentation review, the second level of program design needs to completed level of program design; exactly what the program can accomplish is declared. This is the process of what it must do by developing a logical solution to the programming problem. The logical solution or logic for a program is a step-by-step solution to a programming problem.

5.4.1.3 Code the Program

Coding the program is a process of writing the program instruction that implements the program design. Design specification must be translated to machine-readable format. The coding steps perform these tasks. If design is performed in detailed manner, coding can accomplished mechanically.

5.4.1.4 Test the Program

During the testing program level, the program is process actual data and produces information on which user will be relying on.

5.4.1.5 Documentation of the Program

Completing the program is essential for the successful operation and maintenance of the system's user manual that may be needed by must of the customer as well as system administration.

5.4.2 Program Coding

During this phase, the programs are written and user interfaces are developed and database is initialized with data. The design must be translated into a machine-readable form. The coding step performs this task. If design is performed in a detailed manner, coding can be accomplished mechanistically. During coding, the components built are during development are put into operational use. The system is built according to the original design that was done.

5.4.2.1 Coding Approach

Coding is an iterative process whereby it is done until the programmer obtains the desired results. There are two types of coding approach, top-down and bottom-up. The bottom-up coding is based on coding some complete lower-levels modules and leaving the high-levels modules merely as skeleton that are used to call the lower modules, whereas the top-down approach is the reverse.

5.4.2.1 A. Top-Down Approach

Top-down approach involves building the high-level software modules that are refined into functions and procedures. That means the higher-level modules to be coded first before the lower-levels modules. This approach will ensure that the most important modules will be developed and tested first. It also gives a preliminary version of the system sooner.

5.4.2.1 B. Bottom-up Approach

As opposed to the top-down approach, the bottom-up approach begins with the coding of the lower level modules first before the higher-level modules. However, the higher modules are just skeletons that call the lower modules. This approaches is used if the critically of lower-modules is high and need to be completed first to test their efficiency.

5.4.2.2 Coding Style

Coding style is an important of source code and it determines the intelligibility of a program. An easy to read source code makes the system easier to maintain and enhance. Languages used to develop the system are Matlab Programming Language and PCNN toolbox source code. With the Matlab Compiler, automatically convert image-processing algorithms into C and C++ code. The challenge of coding in Matlab is we have to learn new environment of programming language. It is different from other language such as C or C++. Matlab is a batch programming or interpreter. It is meaning that Matlab is different from programming in C or C++, which are we have to write all programs before running the program. The following list some of the styles:

1. Code each variable so that it corresponds as closely as possible to verbal description of the substantive hypothesis the variable will be used to test.
2. Error in coded should be corrected when they occur and the code rerun.
3. Each program should perfume only one task.
4. Each section of a program should perfume only 1 task.
5. Use of constant style regards lower and uppercase letters.
6. Use variable names that have substantive meaning.
7. Use approach white space in your program in a consistent that marks them easy to read.
8. Include comments before each block of code describe the purpose of the code
9. Include comments for only line of code if the meaning of the line will not unambiguous.

5.5 Scripting Language

5.5.1 Pcnn Toolbox

5.5.1.1 Pcnn0

The scripting language used by Pcnn0 is specified by initializing variables in pcnn toolbox. The entire variables have to initialize before we can use them.

The variables that is initialized before running the GUI such as:

```
i = 0;
    maxIter             = 100;
    jumpOver     = 0;
    viewFactor=[1 0.85 0.70];
```

```
viewIndex=2;

stopTrue=0;

continueTrue=0;

wanaQuitPCNN=0;

quietMode=0;

StartWithNew=0;

autoLoadType=0;

intensityMap=1; % Gray
```

5.5.1.2 Pcnnalgo

Contains different PCNN algorithms and gives intensity function of firing neurons (time signal) as output. The following variables are global variables and needs to be initialized before calling PCNNalgo:

PCNN_T	Threshold matrix
PCNN_L	Linking matrix
PCNN_F	Feeding matrix
PCNN_A	Feedback matrix
PCNN_K	Linking kernel (weights to neighboring neurons)
PCNN_S	Stimuli (normalized intensity input)
PCNN_Y	Output matrix

The standard pcnn algorithm:

```
PCNN_F      = PCNN_S +  exp(-alfa_F) * PCNN_F  +  V_F * work;
```

PCNN_L = exp(-alfa_L) * PCNN_L + V_L * work;

5.5.1.3 Pcnniter

Pcnniter contains iterating loop, also saves variables and frames. The iteration loop starts with this function below:

```
while i~=maxIter & ~stopTrue
   i = i + 1; % Increment current iteration i.
```

Frame contains the results each of iteration. While running the iteration, the processing images are saved by write this function:

```
        cd Frames
            imwrite(255*PCNN_Y+1, map0, [frameName '.bmp'])
set(xLabel2,'Fontsize',8,'String',...
                ['Frame saved in Frames/' frameName '.bmp'])
            cd .. % Return to working dir.
        end % if jumpOver
    end  % if saveFrameTrue
```

5.5.1.4 Pcnnrun

Pcnnrun contains only while loops with incremental changes of variables before each run {i : 1 -> maxIter}.

5.6 Database Connection

In this system, Microsoft Access is used for connect database to Matlab. Microsoft access contains function that use for performed the data login activities. Below is the example of select record from database, which taken from the project with file name as "login".

```
global p1
global p2
str=['select * from login where login=''' p1 ''' and password=''' p2 '''']
conn=database('pcnn','','')
a=exec(conn,str)
b=fetch(a)
b = rows(b)
if b==0
   set(handles.text3,'String','Login Error!')
else
   main
   delete(handles.login);
end
```

From these coding, first objects being created to connect to the database. Then, a record set was created to keeping the records. Following by creating a connection string, which link to the database of Microsoft Access. Finally, the program will selected all the records from the table named Login.

5.7 Program Documentation

Program documentation is a set of written descriptions that explain to a reader what the programs do and how they do it. Internal documentation is a description material written directly within the code. It means that internal documentation refers to comments within the codes. Comments can explain the action, like a color commentary, which can be a great help in understanding the code. Whether as a teaching tool or to simply remind programmer what the code does, comments are best sprinkled liberally throughout a program.

For Matlab programming language or Matlab statements, there is an appropriate syntax for demarcating text as a comment. The comment tag is simply preceding the text with single code. Any text after this symbol '%' will be ignored during execution time. All the comments are in green color.

For example:

```
% this is a comment
```

Codes are also formatted to enhance understanding. Spacing or line brake in between different section of the codes will enhance readability too.

5.8 Module Implementation

For this system there is a module implementation for users. Module implementation for users including:

a) System login modules

User have to login before they can get into the system. For new user they also can create their username and password and submit it to the system database. If users want to change their password they can do it also.

b) PCNN segmentation modules

After users have key in their password and username, they can get into the system automatically. Users can select images from the image folder before running the system.

5.9 Summary

Under this stage, the design model of Magnetic Resonance Image segmentation Using Pulsed-coupled Neural Networks being turned into a workable product. Stages involved are setting development environment, system coding and modules implementation. Chapter 5 describes the approaches used in writing codes, scripts languages used to enhance the whole system and algorithms used in implementing the system. The design of the algorithm is important to make sure a stable system to be developed and minimized the problems occur in future enhancement. Error checking is important as well to make sure that the system runs smoothly and without showing unnecessary error messages.

CHAPTER 6

SYSTEM TESTING

Chapter 6 Testing

6.1 Introduction

Many programmers view testing as a way to demonstrate how their program performs properly. However, the idea of demonstrating correctness is really the reverse of that testing is all about. We test a program to demonstrate the existence of a fault. Because our objectives are to find faults, we consider a test successful only when a fault is discovered. This is achieved by using carefully planned test strategies and realistic data so that the entire testing process can be methodically and rigorously carried out.

Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design, and code generation. In this chapter, software testing fundamentals, testing strategies and software debugging methods will be presented.

Following are some of the objectives of software testing:

- Testing is a process if executing a program with the intent of finding an error.
- A good test case is noted that has a high probability of finding an as-yet undiscovered error.
- A successful test is one that uncovers as-yet undiscovered error.

6.2 Fault

The objectives of testing are to find error and fault. Fault identification is the process of determining what fault or faults caused the failure, and fault correction or removal is the process of making changes to the system so that the fault are removed.

6.2.1 Types of Fault

When no obvious fault exists, program is tested to isolate more faults by creating conditions where the code does not react as planned. Therefore, it is important to know kind of faults to seek.

Faults can be categorized as below:

1. Algorithmic faults
2. Syntax faults
3. Documentation faults

6.2.1.1 Algorithmic Faults

Algorithmic faults occur when a component's algorithm or logic does not produce the proper output for given input because something is wrong with the processing steps. These faults are easy to spot by reading through the program (call desk checking) or by submitting input data from each of the different classes of data that we expect the program to receive during its regular working.

Typical algorithmic faults include:

1. Testing for the wrong condition.
2. Forgetting to initialize variables or set loop invariants.
3. Forgetting to test for a particular condition (such as when division by zero might occur).

6.2.1.2 Syntax Fault

Syntax fault can be checked while parsing for algorithmic faults. This will ensure that the construct of programming language is used properly. Basically, syntax faults within this system can only be traced after the system has been published.

6.2.1.3 Documentation Fault

When the documentation does not match what the application does, the application has documentation faults. Usually, documentation is derived from system design and provides a clear description of what the programmer would like to program to do, but the implementation of these functions is faulty. Such fault can lead to other fault later.

6.3 Test Planning

The purpose of having test planning is to help in designing and organizing tests, so that testing is carried out appropriately and thoroughly. A test planning has the following steps:

1. Establishing test objectives.

At the beginning, we have to know what we are going to test on. So, we have to establish our test objectives that tell us what kinds of test cases to generate.

2. Designing test cases.

After establishing test objectives, we begin to design the test cases that are used to test the system. If test cases are not representative and do not thoroughly exercise the functions that demonstrate the correctness and validity of the system, then the reminder of the testing process is useless.

3. Writing test cases.

After designing, we have to start writing the test cases.

4. Testing test cases.

At the same time, we also test the test cases.

5. Executing test.

After all testing have been done, we execute our tests on the system.

6. Evaluating test results.

After executing tests, we evaluate the test results.

6.4 Testing Technique

To Test a component, a range of inputs and conditions are chosen. The component of the software will be allowed to manipulate the data, and the output will be observed. A particular input is chosen will demonstrate the behavior of the code behind the entire GUI. A test point or a test case is a particular choice of input data to be used in testing program. However the data are entered with the express intent of determining whether the system will process them correctly.

Different test cases are needed on different type of testing strategies. There are four categories of test cases that are created for testing purposes namely erroneous test data, normal test data, and extreme test data. These categories are explained in the following section.

6.4.1 Erroneous Test Data

Using test data that are erroneous is a good way to determine how the system handles such errors and how it behaves under such situation. Image with unsupported format are not allowed to be uploading into the system of MRI Segmentation Using PCNN until the user gives an images with supported format. Therefore, an unsupported format is use as erroneous test data.

6.4.2 Normal Test Data

The normal test case is use to check whether the system will work well under normal condition. That is means to test whether a given correct data will produce the expected results.

6.4.3 Extreme Test Data

The extreme test data is use for exhaustive testing. Data that out of the range specified will be used to test the system because errors may occur at the extreme point. For example, images data that are used to test the system is too big, the system will not produce the output of the images tested. It may be takes time to produce the output of the images. Besides that, here also got some methods, which can be used for debugging. They are:

a) Comments.

Comments can be used for debugging by comment "out" sections of the code to prevent them from being executed. In doing so, the programmer may learn more about why a certain problem is occurring in the program.

b) Methods of Using Semicolon (;) in a Statement.

Case A

In command window, when we type:

```
>>a = 1;
```

And then press enter, we can see that the variables of a will send to workspace. Nothing will be happen after the symbol:

```
>>
```

Case B

In command window, when we type:

```
>>a=1
```

and then press enter, we can see that the answer is such below:

```
>> a=1
```

```
a =
    1
>>
```

There is different command when we are using semicolon. These also can be used for debugging.

6.5 Testing Strategy

Testing is a process of exercising or evaluating a system by manual or automatic means to verify that it has satisfied requirements or to identify differences expected and actual results. Testing is probably the least understood part of a software development project. A bug is any unexpected, questionable, or undesired aspect of behavior displayed, facilitated or caused by the software being tested. Testing can uncover different classes of errors in a minimum amount of time and with minimum amount of effort. The strategies used for testing are unit testing, module testing, integration testing and system testing.

6.5.1 Unit Testing

Historically, quality software is relied on testing each function or module. Unit testing is sometimes referred as function testing or component testing, which is extremely time-consuming. For Magnetic Resonance Image, unit testing was done during the coding phrase.

The first step is to examine the program code by reading through it, trying to spot algorithm, data and syntax faults. Then, followed by comparing the code with specifications and with the design to make sure that all relevant cases have been considered. Finally, test cases are developed to show that the input is properly converted to the desired output.

Unit testing involves the tests on each function module independently. If error is found, debugging of the codes will be carried out immediately. If the compilation of the function module is completed successfully, another function module will be coded. The following steps specify how unit testing is carried out for this system:

1. Examining the code

The code of the program is examined by reading through it to spot for algorithmic faults and syntax faults. This method is useful to identify faults that have been left out by the programmer.

2. Control objects testing

Command buttons are clicked to test their functionality and text boxes are tested with different data types and also null value to make invalid data will not cause any fault.

3. Different data type testing

Different data types like numbers, characters or date is used to test certain function because some control objects will only accept certain data type, invalid data type can be traced by the system without causing any error.

4. Choosing test cases

Test cases are developed to ensure that the input is properly converted to the desired output. So, to test a component, input data and condition are chosen. Then the component is allowed to manipulate the data, and output is observed.

6.5.2 Module Testing

A module is a collection of dependent components. A module encapsulates all of the related components. Module testing enables each module to be tested independently. This testing will ensure that the module calling sequence in this project is systematic.

6.5.3 Integration Testing

When the individual components are working correctly and meet the objectives, these components are combined into a working system. In other words, integration testing is the process of verifying that the system components work together as described in the system and program design specifications. This integration is planned and coordinated so that when a failure occurs, some idea of what caused it can be got.

The motive behind this testing is to make certain that all modules can be executed as a complete module. As mentioned earlier, an individual module calls other module to perform certain tasks. Parameters will be passes among these modules and if not tested, then the parameter may be passed incorrectly.

6.5.3.1 Example of Integration Testing

There were too many integration test case involved. Therefore, only a few will be shown as example.

Integration test case example 1:

The image folder is being created in the PCNN Segmentation module and then displayed them when we click on the image button. Integration testing is carried out to ensure that the image was being displayed successfully.

Integration test case example 2:

The image is being loaded into the system and then generated in PCNN Segmentation module. Integration testing is carried out to ensure that the record was being inserted and generated successfully.

6.5.4 System Testing

The last testing procedure done is system testing. Testing the system is very different from unit testing, module testing and integration testing. The objective of unit testing, module testing and integration testing is to ensure that the code has implemented the design properly. In other words, the code is written to do what the design specifications intended. In system testing, a very different objective is to be achieved, that is to ensure that the system does what the users want it to do.

MRI Segmentation Using PCNN is involves two kinds of system testing. They are function testing and performance testing.

6.5.4.1 Function Testing

Function testing is based on the system functional requirements. In other words, a function test is used to check that whether the integrated system performs its functions as specified in the requirements.

6.5.4.2 Performance Testing

Performance testing addresses the nonfunctional requirements of the system. That means once the functions are convinced work as specified, the performance test compares the integrated components with the nonfunctional system requirements. The types of performance tests are:

a) Compatibility Tests

This test was performed to find out that the interface functions perform according to the requirements. The accuracy of data retrieval was high in this system. Besides, the speed of data retrieval was acceptable too.

b) Human Factors tests

This test was performed to investigate requirements dealing with the user interface to the system. In this system, simple forms and related messages are displayed to determine user friendliness. These tests are sometimes called usability tests.

c) Recovery Tests

This test was performed to address response to the presence of faults or to the loss of data, power, devices or services.

d) Timing Tests

This tests was performed to evaluate the requirements dealing with the time to respond to a user and time to perform a function. The response time of this system is acceptable.

6.6 Summary

Testing is one of the important steps in developing a system. Precision and accuracy of output data is considered during this process. Unit, module, integration and system testing has been carried out for the MRI Segmentation Using PCNN. These testing approaches lead to delivering a quality system to users. The objective of a system will only achieve after all the thorough testing done by different user with different aspect.

CHAPTER 7

SYSTEM EVALUATION

CHAPTER 7 System Evaluations

7.1 Introduction

After all the handwork of designing and developing as well as implementing MRI Segmentation Using PCNN, the end product of the project is brought up for evaluation. They were many evaluation techniques that used to evaluate the final system. The following section will explain in detail about the system strength and its limitation. Some future enhancements are used to enhance the performance of this system.

7.2 Problem Encountered and Solution

The following are the major problems encountered from the beginning of the project through the end of the system development process.

✓ <u>Lack of knowledge in Matlab programming language.</u>

At the beginning of the built MRI Segmentation Using PCNN system, besides, I still green in Matlab Programming language. It is difficult to learn matlab language. Thus, I face many problems in the beginning of doing this task.

Solution:

My course mates and friend willing to help me for solve my difficulties whenever I face a problem. Some solution is found from the matlab help menu. Its provide a lot of example that we can use for solving my problems.

✓ <u>Difficulties In choosing a Development Technology, Programmnig Language and Tools.</u>

There are many software tools available to develop system. Choosing a suitable echnology and tool was a critical process as all tools have their strengths and weaknesses. In addition, the availability of the required tools for development is also a major consideration.

Solution:

In order to solve this problem, advises and views were sought from project supervisor, course mates and even seniors engaging in similar project. Furthermore, surfing the internet and visiting the library helped to clarify some doubts.

7.3 System Strengths

Below are the strengths of MRI Segmentation Using PCNN:

- Scalability

Hardware and applications could be easily added to the existing system without influence the existing applications. This was because the system was not hardware dependent.

- Simple and User Friendly Interface

MRI Segmentation Using PCNN is specially designed on the principle for ease to use; therefore all forms are kept simple. The inclusion of graphic user interface has contributed vastly to aid users. So, the learning curve is foreseen to be short and a user will be able to use the system with ease within minutes.

- Provide Database Maintenance

Users are able to do housekeeping for database maintenance. Thy can create, add, and modify their password and username login. Therefore, the database will not accumulate with a lot of useless data. This can reduce the storage of the database.

7.4 System Constraints and Limitation.

Below are constraints and limitations of MRI Segmentation Using PCNN:

- Slow Response Time

The system will have to take some times for loading an image. If there is a big image size load into the system, the running process will take more time because the system has to segment through the image and then generate results for the user.

- Language Limitation

This system only supports single communication language, which is English.

- No Encryptions of Password and Username.

To narrow down the scope, there are no encryptions of password and username.

7.5 Future Enhancements

Future enhancement can be done to make the system more advances in order to improve the quality of the system and easier to use. A system development knows no boundaries as new requirements and better implementation methods continue to arise and evolve. There are several enhancements that could extend after developed the system.

- Using more modules and functions

Adding more modules and functions, for example, providing a generating to other segmentation algorithm, having help module and so on.

- Encryptions of password and username

Sensitive data such as password and username should be encrypting. Thus, this can keep from eyes others.

▪ Support Multi Lingual

The current system is only limited to one language. Therefore, it needs to be enhanced to support more than one language.

7.6 Knowledge and Experience Gained

From the beginning of this project until the final documentation, a number of problems have occurred and experiences are learned from there. The following are some of the knowledge that I gained from the project.

❖ The Importance of AII phases in SDLC

System analysis is an important phase in the system development life cycle (SDLC). This phase capture user requirements and the goal of the system. If this phase is wrong defined, it will cause faulty to the system development and later progress. With a complete and thorough system analysis, the system that is developed will fulfill all the requirements and achieve its goal.

System testing is also an important phase in SDLC. There is no application that is free of error in this world. However, with the procedures in this phase, errors and faults in the system can be minimized. The functionality of each module or form can also be tested and confirmed that it meets the user requirements.

❖ Developments Tools Knowledge

Developing this system has given me the opportunity to learn Matlab and its toolbox. Matlab is used to create the system where all the coding of interface design and functionality are written here. Meanwhile, Matlab is a program which suitable for MRI Segmentation Using Pulsed-coupled Neural Networks System due to able to process images in the system.

Reading about this software is not enough to understand its characteristic. By developing this system, I learn more about these software characteristics and those characteristics cannot be gain from reading books.

❖ Self Expression

Developing MRI Segmentation Using PCNN System has really given me a great chance to express myself in designing and coding of the system. Finally, before graduating, I have the chance to build application software by myself. Doing this project has greatly improved my self-esteem and self-confidence.

7.7 Summary

Evaluation of a system is indeed to ensure its objectives and intended functions have been achieved. This chapter covers all the aspect of evaluating application software. At the end of evaluation, comes the conclusion of this thesis project.

APPENDIX

USER MANUAL

Table of contents

Chapter 0ne Introduction

Magnetic Resonance Image Segmentation Using Pulsed-Coupled Neural Network is a stand-alone application which is designed to segment the MRI image using PCNN algorithm. There only one section in this system. It is single user module. It is easy to use and learn because the user interface is user-friendly. All the function in this system can easily be executed by a simple point and click on the available function button.

The objectives of the system are such as below:

1. To understand what is Magnetic Resonance Image, meaning of the Segmentation & the use of PCNN.

2. To apply one of the segmentation method to get a better image or choose the best segmentation methods that can produce clearer image.

3. To apply the benefits of Pulse-Coupled Neural Network since it is unique if we were to compare with other neural networks.

4. The method developed and presented uses a PCNN to both filter and segment medical resonance image.

5. Using PCNN to segment the images to arrive at the final result.

6. To access and validate the results of the segmentation method.

1.1 Runtime Requirement

1.1.1 The hardware that are used to develop this system are as listed below:

- ✓ 400 MHz Intel Pentium Processor and above.
- ✓ 256 MB RAM and above.
- ✓ Hard disk: 10 GB hard disk space with a minimum of 1 GB free space.
- ✓ Other standard desktop PC components.

1.1.2 Software Requirement such as below:

- ✓ Operating System: Microsoft Windows 2000 Professional.
- ✓ Database Management: Microsoft Office 2000(Access)
- ✓ System Development: PCNN Toolbox and Matlab 6.5 Release 13

1.2 User Manual Overview

There are a few chapters in the user manual.

Chapter 1 Introduction

Gives a general description of the MRI Segmentation Using PCNN. The hardware and software requirements of the system are also stated.

Chapter 2 Login Section

This chapter highlights and describes the 3 modules, username and password, change user, add new user.

Chapter 3 PCNN Segmentation Section

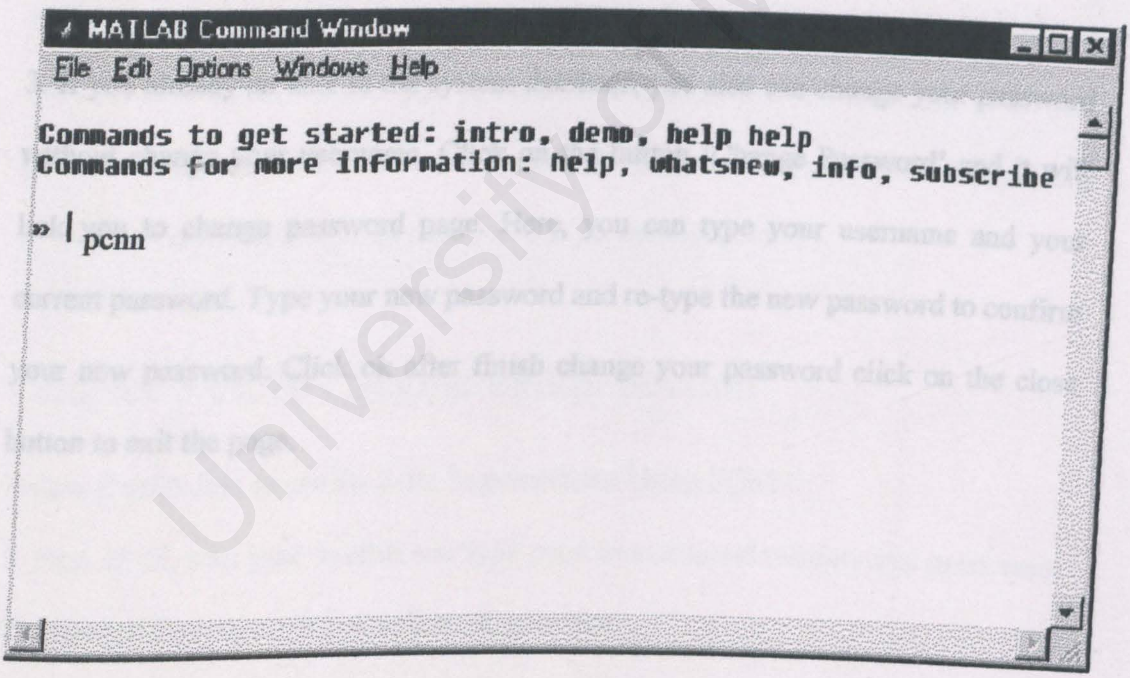
This chapter highlights and describes the 3 modules, select images/ browse image, running PCNN, select iteration.

Chapter 2 Login Section

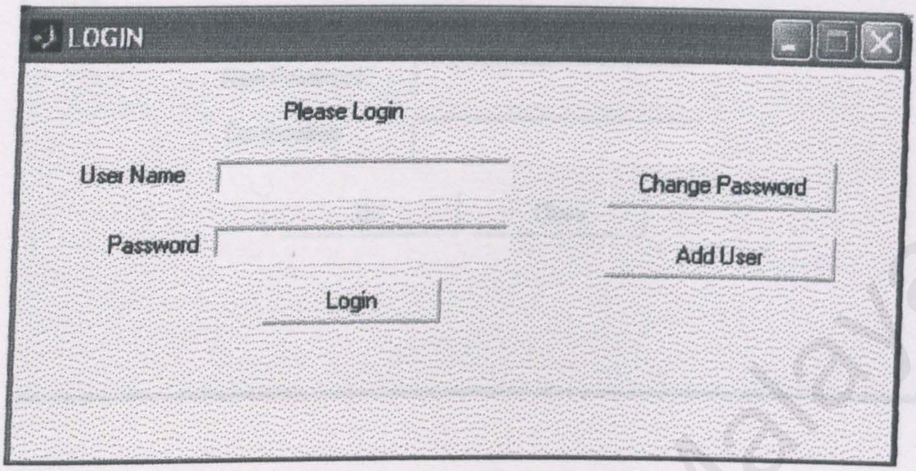
Below is the guideline to use this MRI Segmentation Using PCNN system:

1. First of all, open your Matlab program, and type pcnn in the Matlab Command Window and press enter. The Matlab Command Window is such as below:

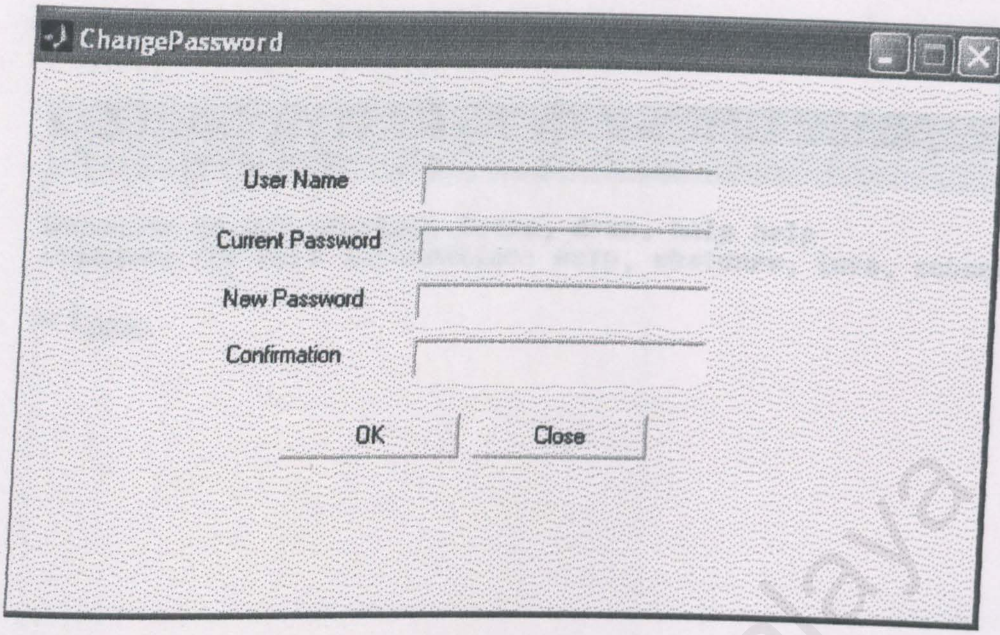
Matlab "Command Window"



2. After type pcnn, you have to login before you have the authorized to access image segmentation using PCNN. It will link you to such as page below. Type your username and password in the available field and then click login.



3. If you already an user in the system database, you also can change your password without change your username. Click on the button 'Change Password' and it will link you to change password page. Here, you can type your username and your current password. Type your new password and re-type the new password to confirm your new password. Click ok after finish change your password click on the close button to exit the page.



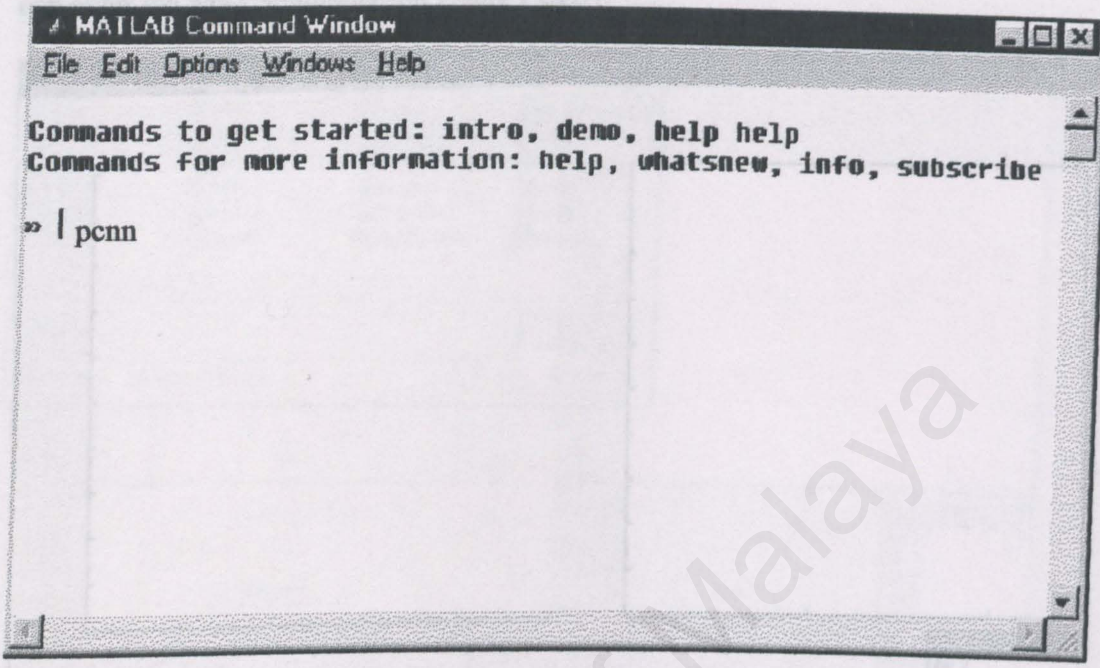
4. For the new user, you can enter the MRI Segmentation Using PCNN by click on the Add User button. There, you can create your password and username to let you get into the system. There is no rule to be a new user to the system. You can just key in all the information required then you can access the system.

Chapter 3 PCNN Segmentation Section

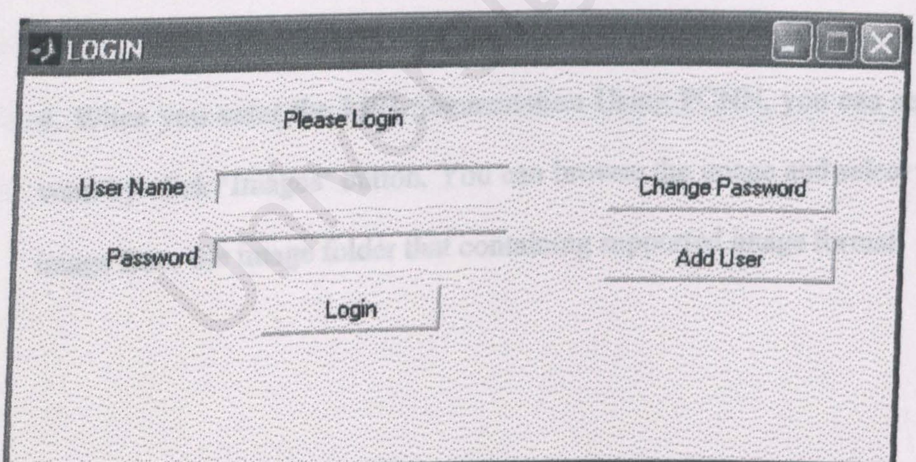
Below is guideline to use the MRI Segmentation Using PCNN:

1. First of all, start your matlab and type pcnn in command window and press enter. The Matlab Command Window is such as below:

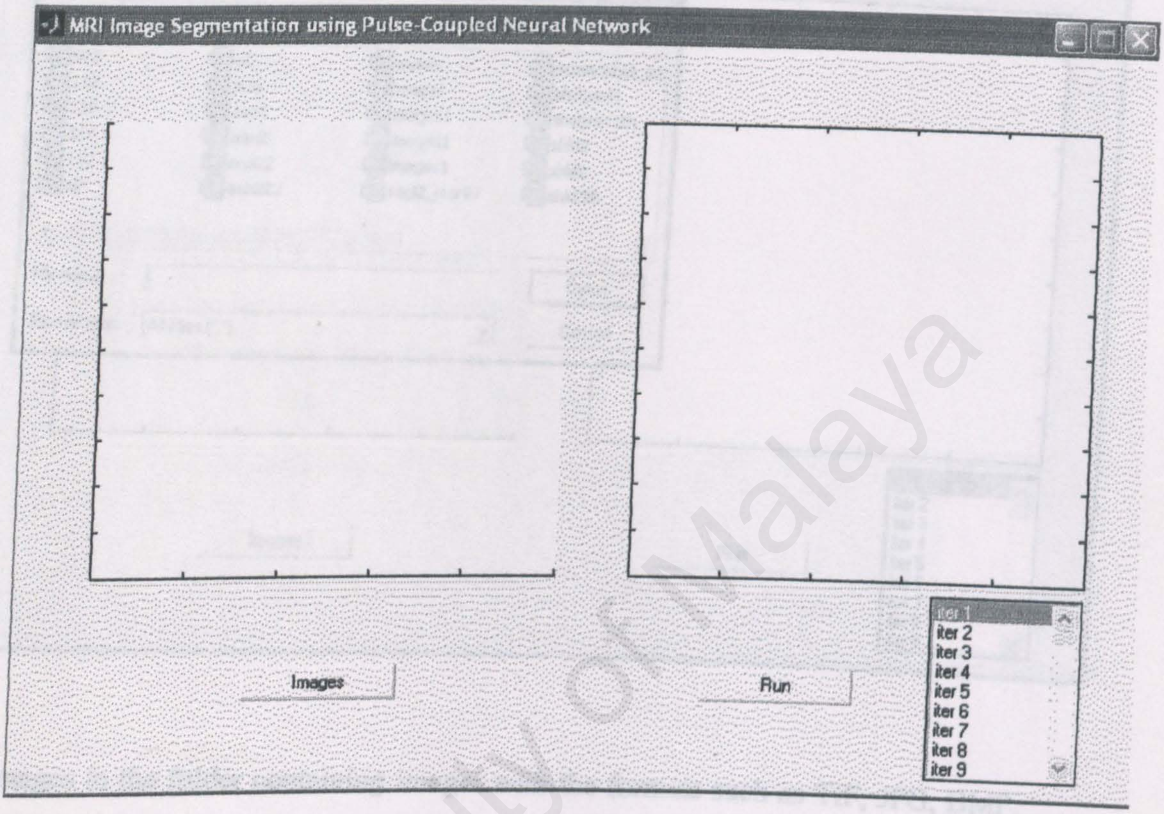
Matlab "Command Window"



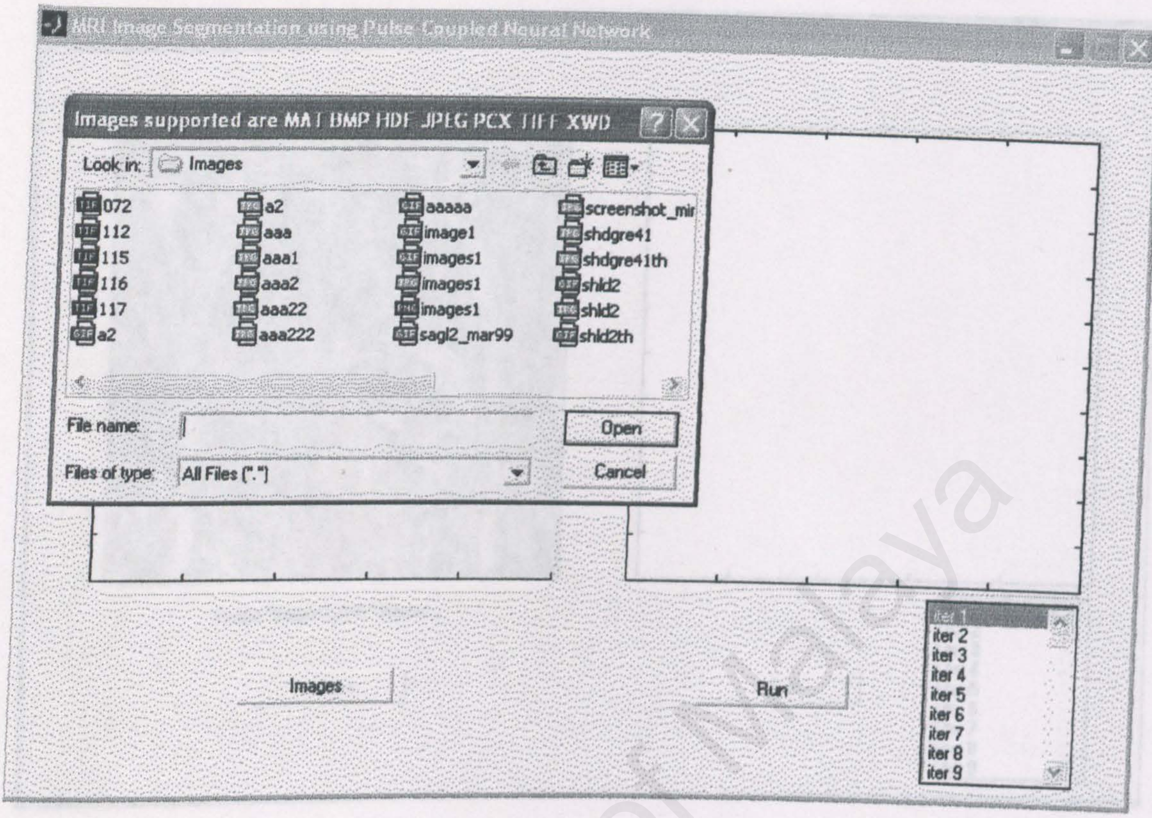
2. You will link to the page such as below. Type your password and username in the fields and click login.



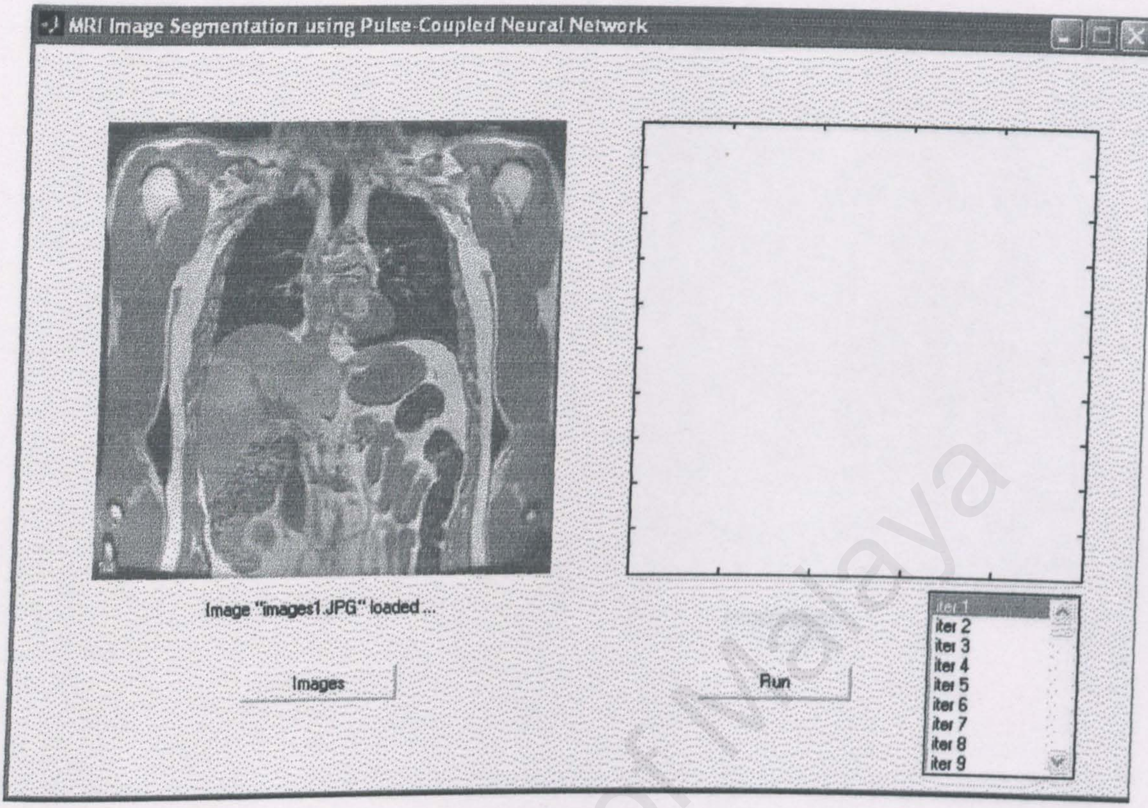
3. You will link to the page such as below. By type your password and username you can enter the MRI Segmentation Using PCNN.



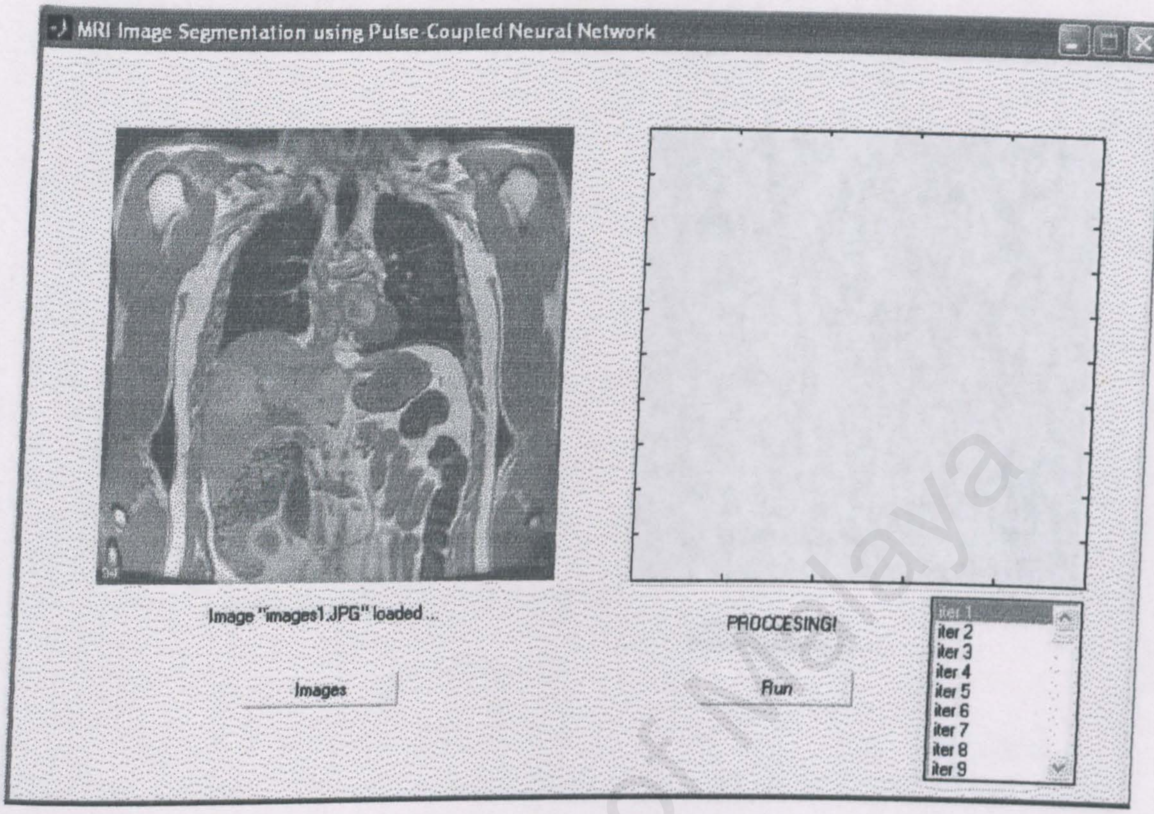
4. When you enter the MRI Segmentation Using PCNN, you can select image you want by click 'Images' button. You can browse the image and select the category of image from the image folder that containing supported image format.



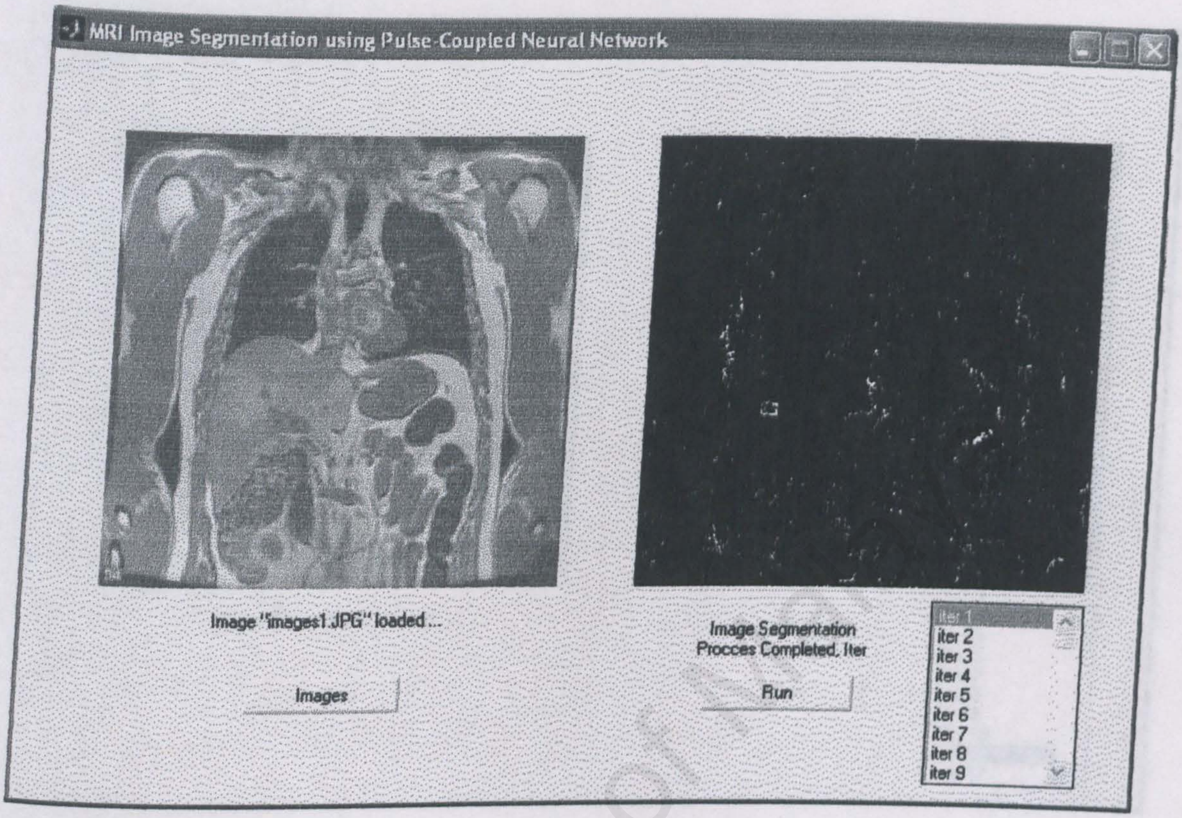
5. Images in the folder containing images with the formats such as TIF, JPG, BMP, and GIF. But, only supported image formats can be loaded into the PCNN segmentation such as JPG and BMP. After selecting the image you want click open. Image will be loaded into the system.



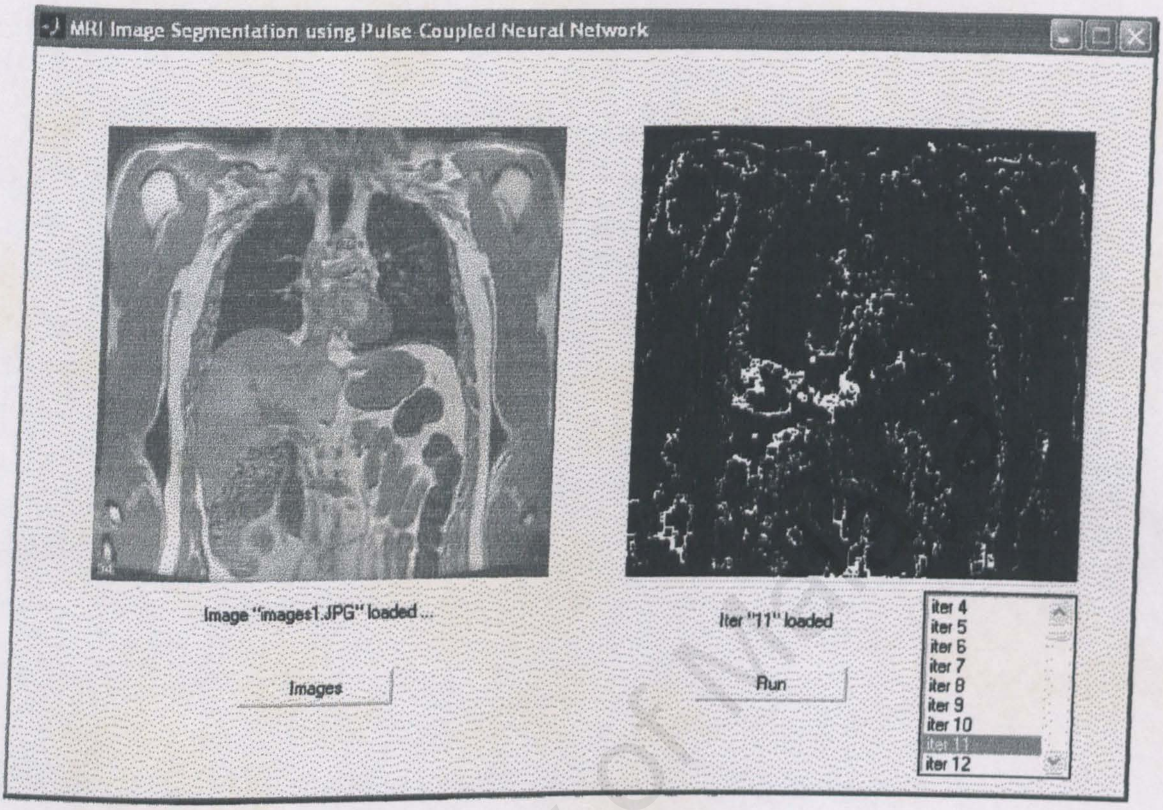
6. Image that has been selected can be running by the PCNN Segmentation. It will take a few minutes to get the results of MRI segmentation using PCNN. Click on the Run button.



7. The results of PCNN segmentation will be display in the box beside of the original image. The image segmentation result is showing you the max iteration 100. You can select iteration of the image using the drop down list box.



8. Iteration 1 to 100 is listed down. Click on which iteration you want and it will display in the box. For example 'iter 11 is loaded' in the box.


MRI Image Segmentation using Pulse Coupled Neural Network
Image "images1.JPG" loaded ...
Images
Iter "11" loaded
Run
iter 4
iter 5
iter 6
iter 7
iter 8
iter 9
iter 10
iter 11
iter 12