CHAPTER 1 INTRODUCTION

This introductory chapter addresses the statement of problem, study objectives, rationale, significance, potential contributions and limitations of this research. The contents of the thesis are outlined before the summary.

1.1 Background

Recent technological advances in imaging technology have contributed to reliable imaging techniques such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Positron Emission Tomography (PET), Ultrasonic Imaging (US), 3-D optical/electron microscopy and 3D confocal microscopy [1][5][12][15]. These techniques have led to a more accurate diagnosis process and thus have gained confidence of the public in accepting such techniques as part of the medical examination process.

For years, the medical images of patients have been kept in manual files for storage and retrieval. Over the years, the patients' information, which includes the images, diagnosis and treatment have accumulated in storage rooms of many hospitals.

The concept of medical image database system began to capture the attention of researchers when faster processors, storage and retrieval

technology became popular and cheaper in the market. However, if there is no proper efficient search mechanism, searching through a large collection of images for a particular image can be unrewarding and time consuming [2][3][7][10].

Many different techniques have been introduced for fast searching and retrieval of medical images. Few of such techniques uses semantic keywords attached to the images and content-based search using color, texture or shape which are more complex than using keywords [3][7][11]. However, searching for MR images may be different from other images. For example, the MR images may be taken in same plane for many patients but the location of the disease may differ from patient to patient. Therefore the search must be focused on the location of the disease in a given MR image [6][8][9].

This is helpful for doctors in comparing a patient's MR image with a previous patient's MR image that had similar heart complications. More significantly, the image retrieval may yield cases of patients with similar diagnostic imaging examinations but different confirmed diagnosis [3].

An MR image can be modeled using Active Shape Modeling (ASM) toolkit. ASM toolkit models the area of interest based on training data thus providing enough information to create a model that effectively

searches for the area of interest in any given MR image of a patient [19][20][21]. In this research, a collection of segmented heart and brain 2D slices of MR images are used as training data.

1.2 Statement of problem

A collection of MR images of heart and brain are used to model the area of interest. The images are modeled using Active Shape Modeling toolkit, which is then used to find a similar area of interest in a given MR image of a patient. The search can be a static search or a multi-resolution search. This research focuses on an effective search of objects in the region of interest in a given MR image, using the trained model data for a set of MR images.

1.3 Purpose and objectives of study

The purpose of this research is to identify the objects in the region of interest in any given MR images based on the model trained. The search and retrieval of the images involves a combination of static and multi-resolution search techniques provided by the ASM toolkit.

For the stated purpose, the MR images are segmented, preprocessed, scanned and stored in files. These images are then read into the ASM application. The objects in the region of interest are then modeled in

these images. These objects are to be determined by the medical personnel based on the disease location. For the purpose of research, a more general region is chosen to do the study. Static search is formed on the set of MR images followed by a multi-resolution search. The search performance is then analyzed to determine which search mechanism is more effective and fast in searching the region of interest for the modeled objects.

1.4 Rationale

The sample 2D MR heart images were obtained from the Department of Radiology, University Hospital and the MR brain images were obtained from online sources.

Looking at the MR image segments before modeling, helps to identify the objects in the region of interest. The objects chosen can differ depending on the type of disease that needs to be diagnosed. For this study, the object that is modeled in a given MR image is the heart itself.

1.5 Significance and contributions

The technological advances in computer hardware and software have combined to make medical image storage and retrieval based on image contents feasible [1][3][7]. The technological advances are in the:

a) Sophisticated image acquisition devices, such as MRI scanners, X-Rays and CT scanners,

b) Storage units that provides larger capacities for lower costs,

c) Fast processors at low costs for image rendering.

Large numbers of scanned MR images are kept either in manual files or in digital format in many hospitals. Manual files are hard to search for and therefore information on the diagnosis and treatment given may not be readily available for a doctor during the decision making process.

On the other hand, the search for medical images stored in digital format using keywords may result in many matching images [1]. This may require a long time for a physician to browse through to find images that can help in diagnosis and treatment of an illness.

Therefore, storage and retrieval of medical images based on the shape of the objects will help in the analysis of disease pattern among different patients and will enable doctors to make better decisions in finding cure for illnesses [18][23]. In addition, this can help in identifying and adopting good treatment or surgery planning, which can reduce or avoid mistakes from being repeated.

1.6 Limitations

The first type of limitation is lack of a variety of images obtained for heart, as only one set was available from the Department of Radiology, University Hospital. The brain images were obtained from online sources and were limited in number to form a model. It is difficult to obtain a large set of samples, as it requires high cost of scanning, sophisticated machinery and technical expertise [6][9][17].

The second limitation is the use of a simple database program to store MR images. These images even though in gray scale can occupy space over time as the number of images grows [3][4]. A simple database program cannot handle large amount of data well. Compressing and decompressing images is an option that can be time consuming during the search and retrieval process [31].

1.7 Thesis Organization

This thesis is divided into six major chapters, appendices, bibliography, index and glossary. Contents of each chapter are outlined here. The first chapter is an introductory chapter in which the background, statement of problem, purpose and objectives of study, rationale, significance, contributions and limitations were identified and explored.

The following chapter, which is chapter 2, looks at studies and research done in the area of magnetic resonance imaging, image processing techniques, and image database storage and retrieval techniques.

Chapter 3 highlights the use of Active Shape Modeling (ASM) toolkit in the area of modeling, searching and viewing the image models from the data presented. The advantages and limitations of the techniques used were also examined.

Chapter 4 explores the methodology used in data acquisition, modeling of the images, region of interest and image search using static and multi-resolution techniques. The development of an image search application based on the trained model was explored using Active Shape Modeling techniques.

Chapter 5 discusses the results of the findings and possible application areas. The final chapter is chapter 6, which concludes the findings and suggests future enhancements.

Each chapter has a chapter summary, which summarizes the overall contents of each chapter. Parameter values and results of experiments are documented in appendices section. The bibliography section contains information about the references used in producing this thesis. The index

section lists the page numbers of keywords used and the glossary section lists various terms used in this thesis.

1.8 Chapter Summary

In recent years, the technological advances have led to many reliable medical imaging techniques. The challenge is to use these images in order to obtain an accurate diagnosis. However, the manual storage and retrieval of these images are tedious and at times useless, for it may take a long time to establish the cause of a patient's illness.

The doctors can use previous patients' images, diagnosis and treatment done to build a knowledge base system that can help in better diagnosis and treatment for future patients, thus reducing human errors. This study is an attempt to develop such a system using the technique of Active Shape Modeling and a simple database. The limitations that were faced were the lack in the variety of MR images and limited database space.