CHAPTER 1

INTRODUCTION

1.1 Project Background

Automated classification and detection of tumors in different medical images demands high accuracy since it deals with human life. Also, computer assistance is highly sought in medical institutions due to the fact that it could improve the results of humans in such a domain where the false negative cases must be at a very low rate. It has been proven that double reading of medical images could lead to better tumor detection. But the cost incurred in double reading is very high, therefore good software to assist humans in medical institutions is of great interest nowadays.

Different approaches that can produce medical images must be studied. Also, the technique that produces those images is very important in order to know what to apply to a certain medical image in order to get better results. A lot of methods have been proposed in the literature for CT (Computed Tomography), such as scans, different types of X-rays, MRI images and other radiological techniques. With all this effort done in the research field, there is still a lot of place for improvements and the medical image processing is a domain in continuous expansion. Why is this domain in continues expansion and without and good accepted method? This is due to the fact that in such an important domain, the accuracy must be very high and the false negative rate must be low. The problem is that it is not very easy to obtain such results. The idea is to reduce human error as much as possible by assisting

physicians and radiologists with some software that could lead to better results. This is important since it involve saving human lives.

In this project the automated classification of brain magnetic resonance images by using some prior knowledge like pixel intensity and some anatomical features is proposed. Since currently there are no widely accepted methods, therefore automatic and reliable methods for tumor detection are of great need and interest. The application of neuro fuzzy systems in the classification and detection of data for MR images problems are not fully utilized yet. These include the clustering and classification techniques especially for MR images problems with huge scale of data which consumes time and energy if done manually. Thus, fully understanding the detection, classification or clustering techniques is essential to the developments of neuro fuzzy systems particularly in medical-related problems. Furthermore, fuzzy set theory plays an important role in dealing with uncertainty when making decisions in medical applications [1]. Neuro fuzzy systems are fuzzy systems which use ANNs theory in order to determine their properties (fuzzy sets and fuzzy rules) by processing data samples. A specific approach in neuro fuzzy development is the adaptive neuro fuzzy inference system (ANFIS), which has shown significant results in modelling nonlinear functions. The ANFIS learns features in the data set and adjusts the system parameters according to a given error criterion [2]. Successful implementations of ANFIS in biomedical engineering have been reported, for classification [3] and data analysis [4].

1.2 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a procedure used to produce high resolution images of the inside of the body, including the brain. MRI is a type of *nuclear magnetic resonance* (NMR), which is used by chemists to study the properties of molecules. The technique is called magnetic resonance imaging rather than nuclear magnetic resonance imaging because of the public's negative associations with the word *nuclear* in the late 1970's. MRI, like other imaging techniques such as CAT and PET, is primarily a tomography imaging technique

("tomo" means slice). This means that it produces an image in a thin slice through the body. This form of imaging is, in some respects, very much like a real anatomical slice through the body. In fact, to the untrained eye, an MRI image may be indistinguishable from a slice taken from a post-mortem body. However, unlike a post-mortem slice, the MRI is formed by an MRI camera or scanner and the slices are composed of groups of picture elements or *pixels* displayed on a computer monitor. In MRI the subject or patient is placed inside the scanner which is made up of a moveable bed-like structure and a large hollow tube. The tube contains a thick coil of wire that generates a very intense magnetic field (between 1.5 and 4 Tesla) which is strong enough to accelerate a paper clip to near lethal velocities across the distance of a small room. In order to generate a magnetic field of this strength the coil is cooled to near absolute zero with liquid helium. This very strong magnetic field is then used to align the hydrogen nuclei of the tissue to be imaged. Also placed near the tissue to be imaged is another coil of wire called an RF coil (RF because it generates/reads radio frequency fields). The RF coil is used to both change the energy state of the hydrogen nuclei and to record the RF output of these perturbations. The latter are the raw data of an MRI which are recorded by the computer, transformed and then displayed [5]. Figure 1.1 shows a picture of an MRI machine and Figure 1.2 shows the schematic of an MRI machine.

Figure 1.1: MRI machine

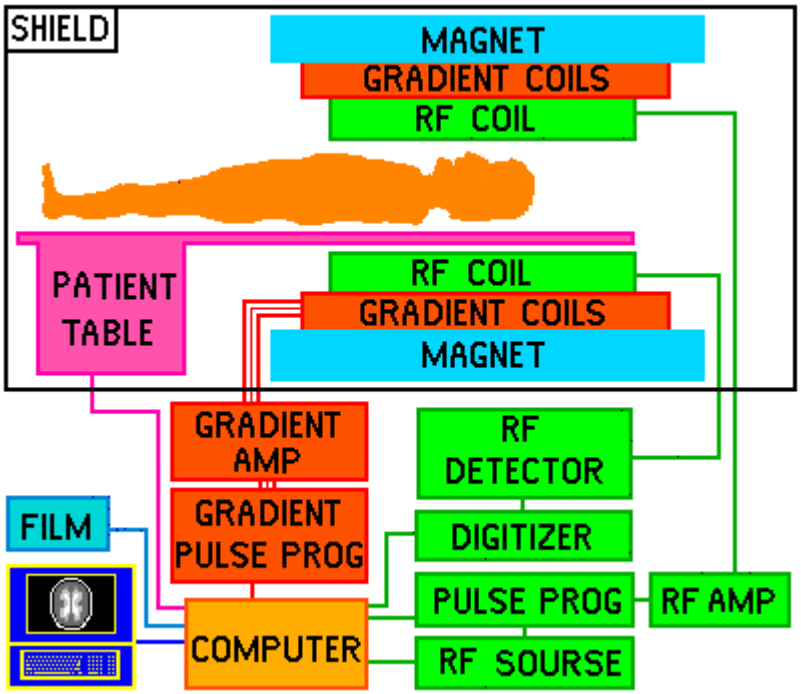

Figure 1.2: Schematic diagram of MRI machine

In MRI, water molecules give off radio signals which are converted into high resolution images that look like a picture shown in figure 1.3.

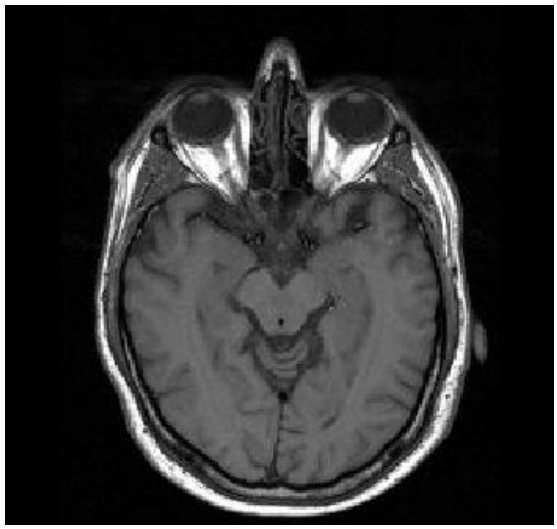

Figure 1.3: Brain MRI

1.3 Problem Statement

The conventional method in medicine for brain MR images classification and tumor detection is human inspection. Operator-assisted classification methods are impractical for large amounts of data and are also non-reproducible. MR images also always contain a noise caused by operator performance which can lead to serious inaccuracies classification. The MR images data is by nature, a huge, complex and cognitive process. Accurate diagnosis of MR images data is not an easy task and is always time consuming. In some extreme scenario, diagnosis with wrong result and delay in delivery of a correct diagnosis decision could occur due to the complexity and cognitive process of which it is involved.

The use of artificial intelligent techniques for instance, neural networks, fuzzy logic, neuro fuzzy has shown great potential in this field. With the involvement of soft computing, the pattern matching, classification and detection of algorithms which have direct applications in many medical problems have become much easier to be implemented and diagnosed.

Hence, this project tries to find out how the neuro fuzzy system or the hybrid combination of neural network and fuzzy logic techniques can be applied in the classification and detection purposes, particularly on the medical field.

1.4 Objectives

The main objective of this project is to propose an efficient classification technique for magnetic resonance (MR) images using neuro fuzzy. Hence, the study on the fundamental theory of neuro fuzzy system have to be done. This includes the neuro fuzzy architecture and the adaptation algorithm for the neuro fuzzy structure itself. The neuro fuzzy models hereby refer to the ANFIS (Adaptive Neuro Fuzzy Inference System). Besides, a sample medical image will be tested on the model to observe the classification and detection performance and subsequently optimization

of the chosen technique will be carried out. As the ultimate goal of this project, hopefully an automated system that provides high accuracy of brain medical images classification and symptoms detection that probably can replace the current human visual inspection methods is achieved.

1.5 Scope of Work and Methodology

The scope of the project is as follows:-

i. Convert the brain medical images into a form of data using MATLAB.
ii. Process the brain medical images using PCA.
iii. Develop the neuro fuzzy algorithm for classification using MATLAB.
iv. The neuro fuzzy model considered hereby refers to ANFIS (Adaptive Neuro Fuzzy Inference System).
v. Deal only with the same size of the brain medical images slice.
vi. Distinguish between normal and abnormal of the brain medical images.
vii. Extract the region of abnormal tissues using image processing tool in MATLAB.
viii. Training, testing and tuning or optimization parameters.
ix. Analyzing the neuro fuzzy model performance accuracy.

The methodologies of project are as follows:

i. Involves the neuro fuzzy model coding, simulation, adaptation and training of the neuron using the MATLAB.
ii. This project starts with converting the brain medical images into a form of data using MATLAB.
iii. The brain medical images also have to be pre-processed using PCA to reduce the dimensionality of the data.
iv. Classify the abnormal brain medical images based on the region of abnormal tissues using neuro fuzzy.

v. Then, this proposed technique will be coded in MATLAB and subsequently to be trained and tested with the brain medical images data.

vi. Finally, optimize the performance of the proposed technique.

1.6 Thesis Outline

This thesis is organized as follows. In Chapter 1, some overview including the background, problem statement, objectives, scope of work and methodology are presented. Some literature reviews, related works and also theories regarding this project are included in Chapter 2. Chapter 3 contains a research methodology of the proposed method, the extraction of a region of interest, transformation of image into a form of data and also data and ANFIS modelling. The neuro fuzzy architecture and software development and implementation for classification are discussed in Chapter 4. Chapter 5 presents the result from the simulation and discusses the performance analysis. Lastly, the conclusion of this project and some recommendations for future work are discussed in Chapter 6.