OBJECTIVES

Medical images form an essential source of information for various important tasks such as diagnosis of diseases, surgical planning, medical reference, research and training. Therefore, effective and meaningful search and classification of these images are vital. Most of the medical image classification and retrieval systems use visual feature matching technique; that is extracting low-level visual features of shape, color and texture from an image and matching these features with features in the database. However, there is a semantic gap which is a gap between a low-level feature and high-level concept, the way humans interpret an image. Manual annotation is often used for medical domain image database system; that is a user enters some descriptive keywords about the image and this description is stored as metadata. However, manual annotation has problems and limitations such as domain knowledge needed by an annotator, cost incurred to annotate large amount of images, time consuming and inconsistency whereby different annotators or domain experts might use different keywords. This drawback can be overcome with the help of automatic image processing achieved by digital computer.

One of the most important problems in image processing and analysis is segmentation. MRI Segmentation assumes great importance research and clinical applications. There are many methods that exist to segment the brain. Of these, conventional methods that use pure image processing techniques are not preferred because they need human interaction for accurate and reliable segmentation. Unsupervised methods, on the other hand, do not require any human interference and can segment the brain with high precision. For this reason, unsupervised methods are preferred over conventional methods. However, advances in computational intelligence, machine learning has made researchers to explore the new techniques for meaningful segmentation.

Our research work targets novel and efficient segmentation method, used to extract an anatomical object of interest from a stack of sequential full colour, two-dimensional medical images from the MRI imaging. This method will be explored to facilitate one or few of the objectives from followings:

- This method can be specific to objective of diagnosis such that system would indicate the presence of disease and its extent in which it appears to be in subject.
We may use the segmented regions from each image to achieve clinical objective of forming a three-dimensional visual representation of the object of interest. The quality of the visualization of the 3D structure is highly dependent on the success of the segmentation algorithm used to extract the object from the 2D images.

The segmentation method can be used to retrieve the image on the basis of its contents from various MRI dataset.

This method can be embedded with computational intelligence to assist the physicians to take diagnosis steps reliably, efficiently and hence, speed up the diagnosis procedure.

This system may become important block in application of diagnosis decision system by bringing together various expert physicians in one room virtually, irrespective of where they are located in the world.

The extension and modification of this system can be utilised in the sub modalities of MR imaging such as fMRI, CMRI.

Scope:

The possible extended applications for the segmentation methods using images processing are described below:

Diagnosis System

General objectives of diagnosis system using MRI image processing can be:

i) localizing the objects of interest, i.e. different organs

ii) taking the measurements of the extracted objects, e.g. tumors in the Image

iii) interpreting the objects for diagnosis

Functional MRI (fMRI)

The brain functioning needs a continuous supply of glucose and oxygen which is supplied by CBF. Within the brain the distributions of blood is heterogeneous, with grey matter receiving several times more flow per gram of tissue than white matter. The cerebral blood flow is the rate of delivery of a particular mass of tissues. The cerebral blood volume is the fraction of
the tissue volume occupies by blood vessels. In the experimental observation by Fox and Raichle in 1986. The fact of imbalance in CBF and oxygen metabolism was discovered. In a somatosensory stimulation experiment they found a focal CBF increase of 29% in the appropriate area of brain but only 5% increase in CMRO₂. When flow increase more than O₂ metabolism, less O₂ is removed from the blood and the venous blood oxygenation increases. The magnetic resonance (MR) signal is sensitive to this change because deoxyhemoglobin(dHb) is paramagnetic and the presence of dHb reduces the MR signal at rest. In the resting state the normal brain extracts about 40% of the O₂ delivered to it. Taking the average numbers measured by Fox and Raichle, if the flow then increased by 30% and O₂ metabolism only increases by 5%, the O₂ extraction fraction must drop to about 32%. Thus, Deoxyhemoglobin concentration will be reduced in capillary and venous blood and MR signal will increase slightly. This MR signal increase during brain activation has now been measured during wide range of sensory, motor and cognitive tasks due to change in blood oxygenation. Thus, functional MRI measures blood–oxygenated-level – dependent(BOLD) signal changes caused by regional hemodynamic adjustments in response to changes in neuronal activity.

The statistical analysis of blood oxygen level dependent (BOLD) is a critical part of the brain mapping with functional magnetic resonance imaging. Aim of such analysis is to produce an image identifying the region which show significant signal change in response to the task. Several statistical methods have been proposed. With the flexibility of fMRI and the range of possible experiments, number of different statistical processing approaches can be applied to yield strategy applying several methods to the same data may be the best approach for pulling out and evaluating the full information contents of the fMRI data.

A major analytical challenge with the analysis of fMRI data comes from the fact that the observable changes in signal intensity due to changes in the concentration of deoxyhemoglobin are noisy and small-only a few percentage points. The earlier methods to analysis of fMRI data assumes a model function to be compared with actual response. However, wavelet based multiresolution methods are suitable in applications where no realistic assumptions regarding the shape, smoothness and location of the signal to be detected can be made. In the specified resolution approach, time-resolution is kept almost unchanged with higher order wavelets. The
time resolution changes as scale of wavelet changes. In specific resolution approach, set of wavelet is obtained by modifying the number oscillations of the higher order wavelets and thus having almost same time shift for all wavelets in the set.

**Cardiac MRI (CMRI)**

The study of biomechanical properties of normal and abnormal heart muscle are fundamentals to investigate the cardiovascular disease and therapeutic interventions on ventricular performance. In order to make abnormal motion of heart as a indicator of heart and lung disease, its normal function should be characterized before abnormal states can be detected. The quantification myocardial strain due to contraction has been a crucial process in clinical assessments. The important issue in measuring local wall motion is the capability to localize the same point within myocardium on two images at separate parts of the cardiac cycle. Two most common techniques used in MRI to measure myocardial motion are myocardial tagging and myocardial velocity mapping. However, tagged cardiac imaging has been well established in clinical research, despite its time consuming post processing procedure. Tagged cardiac imaging permits the visualization of the muscle movements in the beating heart which can be used as diagnostic information regarding the strain patterns in the heart. We have here essential elements used in MR tagging and generation of tagging lines in image SPAMM (spatial modulation of magnetization) is used to have tagging, tracking which in the images of different phases in cardiac cycle describes the motion of heart wall. Finally, recent technique used for motion analysis and generation of strain pattern, is discussed here. The earliest developed techniques for quantifying myocardial motion were based on a radiopaque fiducial markers. However due to limitation in existing methods capabilities and being it invasive, the development of new methods was the need of clinical world. The tagged MRI was developed to examine the heart wall motion as a noninvasive tool, by magnetically “tagging “ different regions of the heart wall.

Characterization of myocardial deformation during systolic contraction is a fundamental step toward understanding the physiology of the normal heart and the effect of cardiovascular disease. The motion tissue and corresponding strain has been determined in the system by using HARP method. However some of difficulties has been seen in literature, are such as to
design a optimized band pass filter to detect the spectral spreading and unwrapping techniques. The 2D HARP method can be extended to 3D motion display while keeping challenges of computational complexity.