ABSTRACT

Medical imaging is an important area which is commonly recognized as key to better diagnosis and patient care. Most commonly used medical imaging modalities are Computed Tomography (CT) and Magnetic Resonance (MR) imaging. The importance of 2-D and 3-D brain segmentation has increased tremendously due to the recent growth in functional MRI (fMRI), perfusion-weighted imaging, diffusion-weighted imaging, volume graphics, 3-D segmentation, neurosurgical planning, navigation and MR brain scanning techniques. Tremendous growth in un supervised and supervised brain segmentation techniques increases the area of research in image processing, computer vision, graphics and pattern recognition. MRI has become one of the most common diagnostic tools, especially in the area of neuro imaging. The three main reasons that the field of neurological imaging using MRI has been very valuable both clinically and diagnostically are: first, its ability to yield spatial resolution to a fine level which helps in the detection and delineation of detailed structures; second, the range of response from the tissues to the MRI stimuli allows for the visual differentiation of various classes of internal tissues; and third, the fast acquisitions of the MRI data sets.

Application of brain segmentation extends towards Surgical Planning, Surgical Navigation, 3-D Visualization and Interactive Segmentation, Multi-Modality Registration, Image-Guided Surgery, Research in Pathology Prediction and its Interface with Other Fields, Quantitative Assessment and treatment Procedures, Brain Functional Mapping. The Brain's Sub-Cortical Segmentation in Relation to the Main Cortex. Some of the main difficulties in brain segmentation are partial volume averaging, tissue inhomogeneity and non-uniformity, shading artefacts, noise randomness, convolutedness and variability of the brain structure, variability in tissue types, size and types of brain tumor, operator variability, imaging variabilities, limited availability of shape models. Due to the large number of complications in segmentation, various research in 2-

D and 3-D segmentation took a different route over the past few years. In recent years, medical image processing has contributed a lot in medical applications; for example, the use of image enhancement, image segmentation, and image guided surgery is so common in medical surgery. Hence, image enhancement and segmentation are the fundamental requirements in medical imaging to provide proper diagnosis.

This thesis addresses the above-mentioned issues and suggests two different contrast enhancement algorithms for brain image enhancement and an enhanced fuzzy level set algorithm for brain tissue segmentation. The proposed approaches are based on fuzzy histogram equalization. Histogram Equalization (HE) is a most commonly used image enhancement method due to its effectiveness and simple implementation. But a problem of HE method is that the local contrast of an image cannot be equally enhanced. To solve this problem, numerous histogram equalization approaches for contrast enhancement have been introduced. Though these approaches yield an output with a significant image contrast enhancement, they may fail to improve the minor details present in the brain image which may leads to inappropriate diagnosis.

In order to solve these problems, a fuzzy logic based weighted distribution algorithm is proposed. In the proposed method, fuzzy dissimilarity histogram is constructed from the neighbourhood characteristics of an intensity to improve the contrast of an image. Then, gamma correction is employed to enhance the details in dark regions. The extended experimental results on different brain images demonstrate that the proposed algorithm can enhance the quality and details of an image efficiently. Objective measures show the competitive performance of the proposed algorithm compared with the other existing methods. The proposed technique offers a good quality brain image for disease examination and diagnosis.

Medical image segmentation is crucial for neuroscience research and computer aided diagnosis. However, intensity inhomogeneity and existence of

noise in magnetic resonance images leads to incorrect segmentation. In magnetic resonance imaging, brain image segmentation plays a major role for measuring and imagining the anatomical regions of interest.

In this research work, an effective method called enhanced fuzzy level set algorithm is presented to segment the white matter, gray matter and cerebrospinal fluid automatically in contrast-enhanced brain images. In this method, first, exposure threshold is computed to divide the input histogram into two sub-histograms of different gray levels. The input histogram is clipped using a mean gray level to control the excessive enhancement rate. Then, these two sub-histograms are modified and equalized independently to get a better contrast-enhanced image. Finally, an enhanced fuzzy level set algorithm is employed to facilitate image segmentation. The extensive experimental results proved the outstanding performance of the proposed algorithm compared with other existing methods. The proposed enhancement method not only enhances the visual quality, but also improves the segmentation capabilities of MR brain images. The proposed MR brain image segmentation technique outperforms well in segmenting all tissues such as CSF, GM and WM. The results conform its effectiveness for MR brain image segmentation. The proposed technique offers flexibility to the radiologist to analyse and monitor the patient according to specific regions of interest within the brain.