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De-Noising and Segmentation of Brain MR images by Spatial Information and K-Means Clustering

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Abstract: Image Segmentation is the process of partitioning a digital image into non-overlapping distinct regions, so that significant information about the image could be retrieved and various analysis could be performed on that segmented image. The aim of this study is to reduce the noise, enhance the image quality by considering the spatial information without losing any important information about the images and perform the segmentation process in noise free environment. K-Means clustering technique is used for the purpose of segmentation of brain tissue classes which is considered more efficient and effective for the segmentation of an image. We tested the proposed technique on different types of brain MR images which generates good results and proved robust against noise. Conclusion had been concluded at the end of this study.

Keywords: Cluster validity index, image segmentation, k-means, MRI, spatial information

INTRODUCTION

The process of image segmentation means dividing a digital image into numerous sets of pixels or segments. The main objective of segmentation is to simplify and/or modify the illustration of an image into something that is more meaningful and easier to analyze (Linda and George, 2001). The segmentation of image is typically used to detect boundaries and objects in images. In particular, image segmentation is the method of allotting a tag to every pixel in an image such that pixels having the same label share certain visual features. There are three basic tissue classes in the human brain, Gray Matter (GM), White Matter (WM) and Cerebrospinal Fluid (CSF). The separation and segmentation of these tissue classes with accuracy while maintaining the image quality is a very challenging task. If noise in the image exist, there is high probability to lose the meaningful information which can cause wrong analysis.

Magnetic Resonance Imaging (MRI) is an imaging technique which is used in the field of radiology for the purpose of visualization of internal structure of the body. MRI contains or provides a wide and sufficient information about the human soft tissues anatomy. MRI uses a magnetic field and pulses of radio wave energy to construct pictures of structures and organs inside the body (Web Source, http://www.webmd.com/a-to-z-guides/magnetic-resonance imaging-mri.). For the acquisition of MRI test, the body part being studied is placed inside a special machine that surrounds a strong magnetic equipment. MRI scanners acquire digital images that can be stored and saved on a computer for the purpose to more study. Images from MRI are acquired for numerous reasons. The images then can be used to find problems like tumors, injuries, blood vessel diseases, or infections etc. Contrast stretching techniques or materials may be used during the process of MRI to express abnormal tissue more distinctively. Echo Planer Imaging or EPI is the most frequent technique for acquiring the fast MRI images. These fast or single-shots acquisitions make scans very sensitive to magnetic susceptibility differences at air/tissues interfaces in the brain. The problems like blurring effects and geometric distortions in EPI in spiral imaging caused by field inhomogeneity and severely affect predictions about the brain of subject (Hien *et al*., 2009).

In the last decade, many researchers proposed a family of algorithms or techniques to perform the segmentation process using MR images. All these algorithms or techniques perform segmentation with different manners to solve the segmentation problems.

K-Means clustering: K-Means clustering algorithm (Ayman *et al*., 2003; Jobin Christ and Parvathi, 2011) is unsupervised method of clustering under the category of Squared Error-Based. It is widely, successfully and effectively applied in fields such as agriculture, astronomy, computer vision, image segmentation, classifier designs and feature analysis etc. K-Means algorithm is dependent on a cost function which is

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