Chapter 6
Segmentation of Brain Tumor from MRI Images Based on Hybrid Clustering Techniques

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ABSTRACT

The popularity of clustering in segmentation encouraged us to develop a new medical image segmentation system based on two-hybrid clustering techniques. Our medical system provides an accurate detection of brain tumor with minimal time. The hybrid techniques make full use of merits of these clustering techniques and overcome the shortcomings of them. The first is based on K-means and fuzzy C-means (KIFCM). The second is based on K-means and particle swarm optimization (KIPSO). KIFCM helps Fuzzy C-means to overcome the slow convergence speed. KIPSO provides global optimization with less time. It helps K-means to escape from local optima by using particle swarm optimization (PSO). In addition, it helps PSO to reduce the computation time by using K-means. Comparisons were made between the proposed techniques and K-means, Fuzzy C-means, expectation maximization, mean shift, and PSO using three benchmark brain datasets. The results clarify the effectiveness of our second proposed technique (KIPSO).

INTRODUCTION

Image segmentation is a fundamental and critical task in image processing. In most cases, segmentation is a pre-step for many image processing applications. Therefore, if the segmentation is accurate, then also other tasks that depend on it will be accurate. It refers to the process of partitioning a digital image into multiple non-overlapping regions to be more understandable and meaningful (Bai & Wang, 2014). There

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are many image segmentation techniques, such as edge-based, clustering, and region-based segmentation techniques (Patil & Deore, 2013). Although of the variety of the image segmentation techniques, the selection of an appropriate technique is a challenging problem for a special type of images. Not all techniques are suitable for all types of images (Dass & Deni, 2012). The major problems in segmentation algorithms are the over-segmentation and under-segmentation. Medical image segmentation is a quite challenging problem due to images with poor contrasts, noise, and missing or diffuses boundaries (Fazli & Ghiri 2014, Gaber et al., 2015, Gaber et al., 2016, Tharwat et al., 2015, Ahmed et al., 2015, Ali et al., 2015)

On the other hand, the anatomy of the brain can be viewed by imaging modalities, such as magnetic resonance imaging (MRI) scan and computed tomography (CT) scan. The MRI is more comfortable than CT for diagnosis because it does not use any radiation. It is based on the magnetic field and radio waves (Patel & Doshi, 2014). On the other side, a brain tumor is one of the main causes of death among people. Brain tumors are not rare, thousands of people diagnosed every year with tumors of the brain. Typically, brain tumor affects the Cerebral Spinal Fluid (CSF). It is an abnormal growth of the cells in the brain. It is caused by abnormal and uncontrolled cell division, which is normally either in the brain, cranial nerves, brain envelopes or spread from cancers primarily located in other organs. Brain tumors are either primary or secondary. The former includes any tumor that starts in the brain and is classified as benign and malignant (Leela & Kumari, 2014). Benign tumors can be removed, and they rarely grow back. They usually have a border or an edge and not spread. The second type is more serious than the first. They grow rapidly and spread to other parts. The problem of false detection of this disease makes the physician gives the treatment for the strokes, not for the tumor. Therefore, the accurate and early detection of the tumor is critical. Consequently, an efficient medical image segmentation technique should be developed with advantages of minimum user interaction, fast computation, accurate, and robust segmentation results to help physicians in diagnosing and early treatment.

The most widely used techniques for image segmentation are clustering techniques. Clustering is an unsupervised learning technique that needs the user to determine the number of clusters in advance to classify pixels (Neshat et al., 2012). Therefore, the cluster is a collection of pixels that are similar to each other in some attributes and dissimilar with other groups of pixels or other clusters (Madhulatha, 2012). Clustering techniques can perform clustering either by partitioning or by grouping pixels (Acharya et al., 2013). In partitioning, the clustering algorithm divides the whole image it into smaller clusters. In the second type, the algorithm merges the clusters to larger clusters based on some assumptions.

In this paper, we focused on clustering techniques to detect the brain tumor. We experiment the most five famous and currently in used clustering techniques. They are K-means, Fuzzy C-means, expectation maximization, mean shift, and PSO. We selected them from different five categories of clustering, such as exclusive, overlapping, probabilistic, hierarchal, and optimizing successively. We applied these techniques to three different datasets of brain images. The elected techniques were the K-means, Fuzzy C-means and PSO due to the accuracy but Fuzzy C-means, and PSO takes more time than K-means and K-means are less accurate than the formers.

The MRI images were pre-processed at first to enhance the quality of the processed images. We integrated two different image clustering techniques to have advantages of these clustering techniques and overcome the limitations of them. Then, we used thresholding technique to extract the tumor clusters automatically without user interaction. Then we made the post processing by filtering the resulting thresholding image using a median filter. To contour these clusters, we used the level set method. Finally, we