MAGNETIC RESONANCE IMAGE SEGMENTATION USING STANDARD IMAGE SEGMENTATION METHODS TO ISOLATE A BRAIN TUMOR

G.M.N.R. Gajanayake[1], R.D. Yapa[1] and B. Hewawithana[2]

[1]Department of Statistics and Computer Science, Faculty of Science, University of Peradeniya, [2]Department of Radiology, Faculty of Medicine, University of Peradeniya

Introduction

Medical image segmentation is a complex and challenging task due to the complex nature of the images. Brain has a particularly complicated structure and its precise segmentation is very important for detecting tumors, edema, and necrotic tissues in order to prescribe appropriate therapy. Magnetic Resonance (MR) imaging is an important diagnostic imaging technique for the early detection of abnormal changes in tissues and organs. It possesses good contrast resolution for different tissues and has advantages over computerized tomography for brain studies due to its superior contrast properties. In all applications of image processing, segmentation plays an important role.

Classical image segmentation techniques are based on two basic pixel characteristics: discontinuities and similarities. Many of these classical techniques have been applied on different segmentation problems, but the accuracy of these techniques highly depend on the type and quality of images. The objective of this research is to assess the quality of segmentation using available standard image segmentation techniques to segment brain tumors on MR Images. In this research a set of MR images have been segmented using standard image segmentation techniques to isolate a brain tumor from the other regions of the brain.

Materials and Methods

MR images are gray images. Because of this characteristic nature of the MR images, only, gray level image segmentation methods were considered for this study.

Gray level image segmentation methods can be categorized in to three main classes, namely; intensity thresholding, clustering and region growing. The methods used for segmentation quality evaluation are, Otsu's method (Otsu, 1979) and an Iterative thresholding method as intensity thresholding, mean-shift segmentation (Pantofaru and Hebert, 2005), Fuzzy C-means (Albayrak and Amasyali, 2003), K-means (Albayrak and Amasyali, 2003), Expectation maximization, Discrete Topological Derivative and Continuum Topological Derivative as clustering methods and a seeded region growing method.

All MR images were acquired from the Department of Radiology of the Teaching Hospital Kandy, Sri Lanka. The original magnetic resonance images were of 256 × 256 pixel size.

All the MR images used in this study had been diagnosed as having tumors. The objective of this study was to assess, how accurately the tumor area of each of the selected images are segmented by each of segmentation methods. Ten different raw MR images were segmented to isolate the brain tumor area, then the segmented images (Figure 1) were given to three well experienced radiologists and they were asked to scale each image within the range from 1 to 10, where 1 means the quality is very low and unacceptable and 10 means the quality is highly acceptable, to assess the quality of the resultant images (Figure 1).

Results

The results from the segmentation process for one MR image is shown in Figure 1.

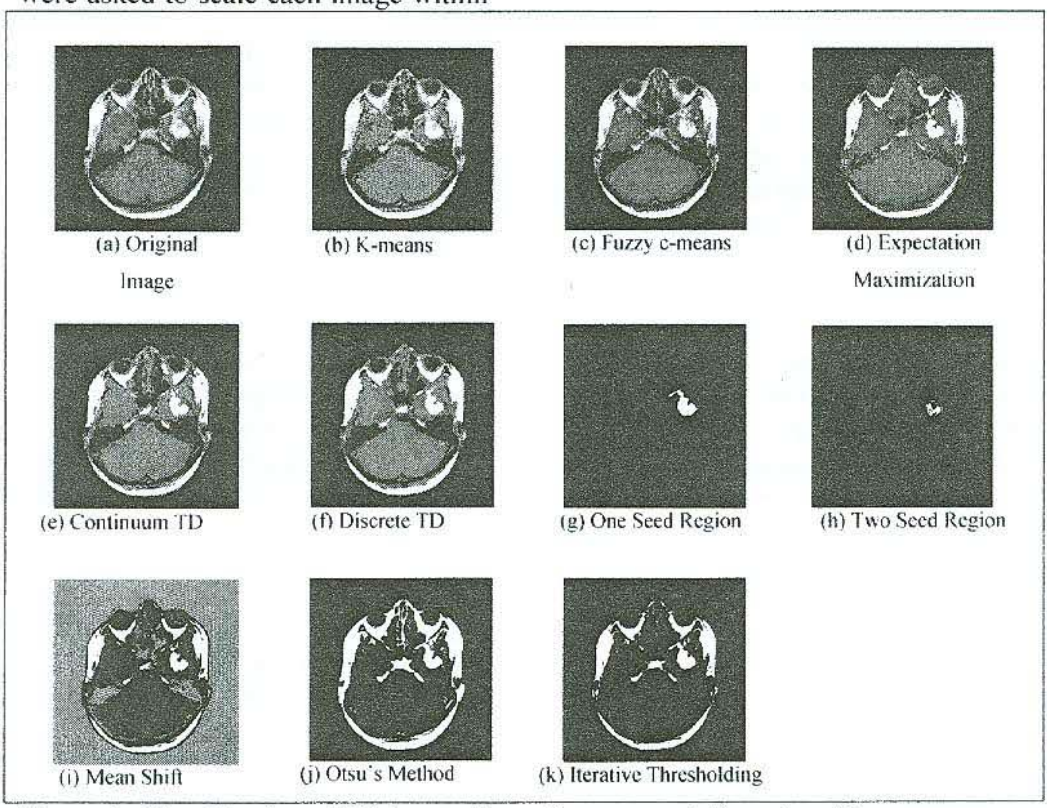

Figure 1. Results of one MR image from the segmentation algorithms

Responses from the three radiologists were averaged and accuracy of each method was presented as a percentage value where lower percentage values represent lower-level of accuracy and higher percentage values represent higher-level of accuracy. The accuracy is in relation to how much the actual tumor area (which the radiologists estimate) the results from the segmentations represent. The accuracy would decrease if the results represent more than the actual tumor area or if they represent less than the actual tumor area.

Table 1. Results of the questionnaire

Segmentation Method	Average Percentage of Accuracy of the Segmentation (%)
Otsu's method	80.6
Mean Shift	61.3
K-means	60.3
Fuzzy c-means	52.3
Expectation maximization	44.6
Discrete Topological Derivative	42.0
Continuum Topological Derivative	39.6
Iterative thresholding	36.7
Two Seed Region Growing	22.0
One Seed Region Growing	21.6

Discussion

The aim of this research was to find out which standard image segmentation algorithm would segment a brain tumor from an MR image to the best extent. In this study, 10 standard image segmentation algorithms were used to segment a set of MR images obtained from the local hospital. The resultant images had significant differences from each other. The response of the radiologists revealed that some segmentation methods did not perform well in the segmentation of MR images of the brain while some performed well. According to the results (Table 1) it can be seen that Otsu's method performed significantly better than other algorithms while Mean Shift algorithm, K-means algorithm and Fuzzy C-means algorithms perform fairly well.

Conclusion

According to the above results we can recommend as the most suitable algorithms for segmenting brain tumors in magnetic resonance images as the algorithms with accuracy above 50 %. Therefore the Otsu's method can be recommended as the best whereas Mean Shift, K-means and Fuzzy C-means can also be recommended.

References

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