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MEDICAL IMAGE SEGMENTATION USING FUZZY C-MEANS CLUSTERING AND MARKER CONTROLLED WATERSHED ALGORITHM

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Abstract
Segmentation plays a vital role in medical imaging. Segmentation of an image is the partition or separation of the image into disjoint regions of similar feature. We propose a method that integrates Fuzzy C-Means (FCM) clustering and marker controlled watershed segmentation algorithm for medical image segmentation. The use of the usual watershed algorithm for medical image analysis is common because of its advantages, such as always being able to construct a complete division of the image. However, its downsides include over-segmentation and sensitivity to false edges. We concentrate on the downsides of the usual watershed algorithm when it is applied to medical images by using Fuzzy C-Means clustering to produce a primary segmentation of the image before we apply marker controlled watershed segmentation algorithm to it. The Fuzzy C-Means clustering is an unsupervised learning algorithm, while the marker controlled watershed segmentation algorithm makes use of automated thresholding on the gradient magnitude map on the initial partitions to reduce the number of false edges and over-segmentation. The proposed algorithm is compared with conservative watershed method.

Keywords: Clustering, FCM, Watershed, Segmentation, Medical Image.

1. Introduction
Image segmentation is a vital method for most medical image analysis tasks. Having good segmentations will help clinicians and patients as they provide vital information for 3-D visualization, surgical planning and early disease recognition. Image segmentation algorithms are classified into two types, supervised and unsupervised. Unsupervised algorithms are fully automatic and partition the regions in feature space with high density. The different unsupervised algorithms are Feature-Space Based Techniques, Clustering (K-means algorithm, C-means algorithm, E-means algorithm), Histogram thresholding, Image-Domain or Region Based Techniques (Split-and-merge techniques, Region growing techniques, Neural-network based techniques, Edge Detection Technique), Fuzzy Techniques, etc. The watershed segmentation technique has been widely used in medical image segmentation. Watershed transform is used to segment gray matter, white matter and cerebrospinal fluid from magnetic resonance (MR) brain images. The method originated from mathematical morphology that deals with the topographic representation of an image. Watersheds are one of the typical regions in the field of topography. A drop of the water falling it flows down until it reaches the bottom of the region. Monochrome image is considered to be a height surface in which high-altitude pixels correspond to ridges and low-altitude pixels correspond to valleys. This suggestion says if we have a minima point, by falling water, region and the frontier can be achieved. Watershed uses image gradient to initial point and region can get by region growing. The accretion of water in the neighborhood of local minima is called a catchment basin. Watershed refers to a ridge that divides areas shattered by different river systems. A catchment basin is the environmental area draining into a river or reservoir. If we consider that bright areas are high and dark areas are low, then it might look like the plane. With planes, it is natural to think in terms of catchment basins and watershed lines. Two approaches are there to find watershed of an image,

[1] Rainfall approach
[2] Flooding approach

In rainfall approach, local minima are found all through the image, and each local minima is assigned an exclusive tag. An intangible water drop is placed at each untagged pixel. The drop moves to low amplitude neighbor until it reaches a tagged pixel and it assumes tag value. In flooding approach, intangible pixel holes are pierced at each local minima. The water enters the holes and takings to fill each catchment basin. If the basin is about to overflow, a dam is built on its neighboring ridge line to the height of high altitude ridge point. These dam borders correspond to the watershed lines. Advantages of the watershed transform include the fact that it is a fast, simple and intuitive method. More importantly, it is able to produce a entire division of the image in separated regions even if the contrast is poor, thus there is no need to carry out any post processing work, such as contour joining. Its limitations will include over-segmentation and sensitivity to noise. There has also been an increasing interest in applying soft segmentation algorithms, where a pixel may be classified partially into multiple classes, for MR brain images segmentation. Clustering is a method of grouping a set of patterns into a number of clusters such that similar patterns are assigned to one cluster. Each pattern can be represented by a vector having many attributes. Clustering technique is based on the computation of a measure of similarity or distance between the respective patterns. The Fuzzy C-means clustering algorithm is a soft segmentation method that has been used extensively for segmentation of MR brain images. In this work, we use Fuzzy C-means clustering to produce a primary segmentation of the image before we apply the marker controlled watershed segmentation algorithm.

2.Fuzzy C-Means algorithm

Fuzzy C-Means clustering (FCM), also called as ISODATA, is a data clustering method in which each data point belongs to a cluster to a degree specified by a membership value. FCM is used in many applications like pattern recognition, classification, image segmentation, etc. FCM divides a collection of n vectors c fuzzy groups, and finds a cluster center in each group such that a cost function of dissimilarity measure is minimized. FCM uses fuzzy partitioning such that a given data point can belong to several groups with the degree of belongingness specified by membership values between 0 and

1. This algorithm is simply an iterated procedure. The algorithm is given below.

1) Initialize the membership matrix **U** with random values between 0 and 1.
2) Calculates c fuzzy cluster center c_i, $i = 1,\ldots c$., using the following equation,

$$c_i = \frac{\sum_{j=1}^{n} u_{ij}^{m} x_j}{\sum_{j=1}^{n} u_{ij}^{m}}$$

3) Compute the cost by the following equation. Stop if either it is below a certain threshold value or its improvement over previous iteration.

$$J(U, c_1, \ldots, c_c) = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c} \sum_{j}^{n} u_{ij}^{m} d_{ij}^{2}$$

4) Compute a new **U** by the equation. Go to step 2.

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{d_{ij}}{d_{kj}} \right)^{2/(m-1)}}$$

There is no guarantee ensures that FCM converges to an optimum solution. The performance is based on the initial cluster centers. FCM also suffers from the presence of outliers and noise and it is difficult to identify the initial partitions.

3.Marker Controlled Watershed Segmentation Algorithm

Segmentation using the watershed transforms works well if you can identify, or mark, foreground objects and background locations. The gradient magnitude of the primary segmentation is obtained by applying the Sobel operator. The Canny edge detector was also experimented on, but it was found that the results obtained by both methods are comparable. Hence, we decided on the Sobel filter as the Canny edge detector has higher complexity. In addition, the Sobel filter has the advantage of providing both a differencing and smoothing effect. Marker-controlled watershed segmentation follows this basic procedure:

1. Compute a segmentation function. This is an image whose dark regions are the objects we are trying to segment.
2. Compute foreground markers. These are connected blobs of pixels within each of the objects.
3. Compute background markers. These are pixels that are not part of any object.
4. Modify the segmentation function so that it only has minima at the foreground and background marker locations.
5. Compute the watershed transform of the modified segmentation function.

4.Proposed Methodology

The proposed methodology is a two stage process. The first process uses K-means clustering to produce a primary segmentation of the input image, while the second process applies the marker controlled watershed segmentation algorithm to the primary segmentation to obtain the final segmentation map. Fig.1 describes the flowchart proposed method.

5.Results

We applied our proposed methodology of Fuzzy C-Means clustering integrated with marker controlled watershed algorithm to MR brain images of the head and obtained general segmentation maps of them. We evaluated the performance of our proposed methodology by comparing it with conservative watershed algorithm. The use of Fuzzy C-means clustering before applying marker controlled watershed segmentation algorithm has achieved the objective of reducing the problem of over-segmentation when applied to MR brain images. The segmentation results are displayed in Fig.2.

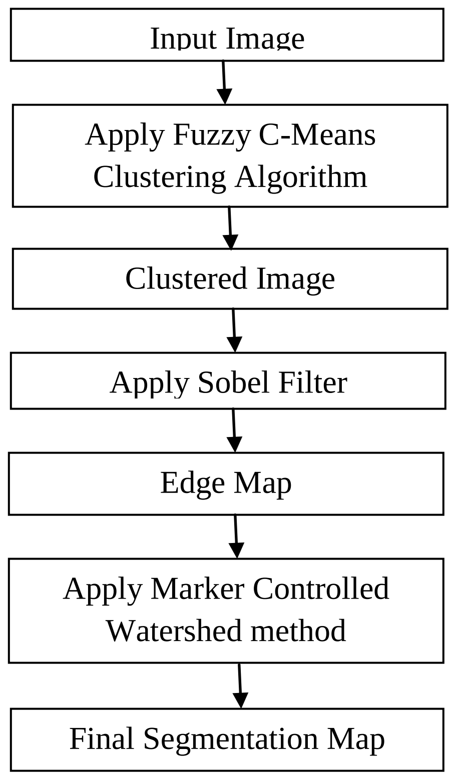

Fig.1 Flow diagram of proposed method

Input Image	Conservative Watershed Algorithm	After Fuzzy C-Means Clustering	Final Segmentation

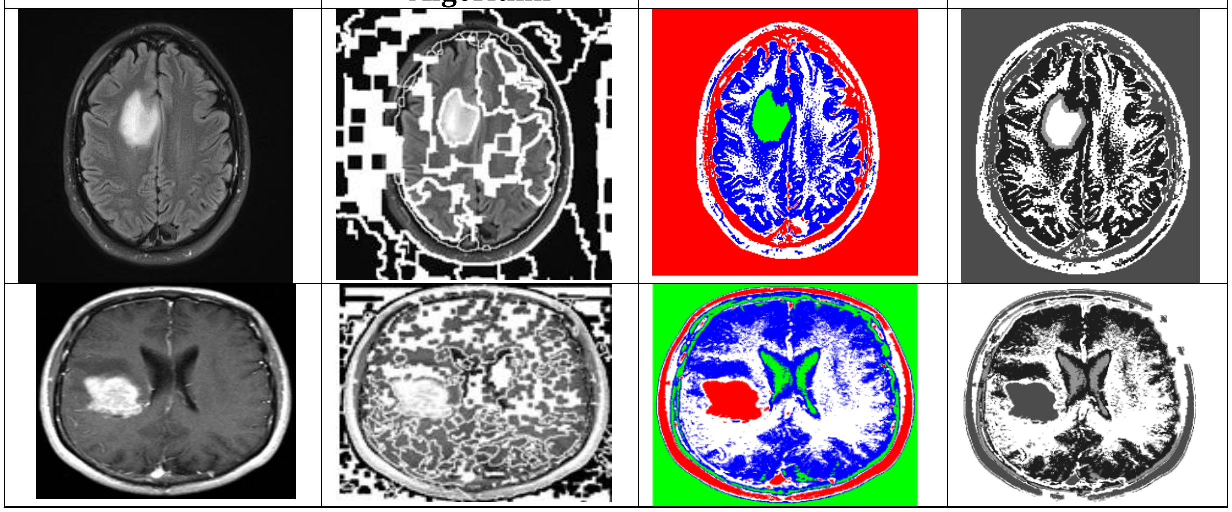

Fig 2. Comparing segmentation maps obtained using proposed method against conservative

6.Discussion

A method which integrated the Fuzzy C-Means clustering algorithm with the marker controlled watershed segmentation algorithm has been proposed. It addressed the limitations of the conservative watershed algorithm, which included over segmentation. The experimental results had shown that our proposed method of using Fuzzy C-means clustering to obtain a primary segmentation of MR brain images before applying the marker controlled watershed segmentation to them is effective. By reducing the amount of over segmentation, we obtained a segmentation map which is more diplomats of the several anatomies in the medical images.

7.References

[1] K.Hari Krishna, R.V.S.Sathyanarayana,"Medical Image Segmentation using Marker Controlled Watershed Algorithm", IJEEE, Vol.1(1), 2009, pp 92-96.

[2] V. Grau, R. Kikinis, M. Alcaniz, S.K. Warfield, "Cortical gray matter segmentation using an improved watershedtransform", Proceedings 25th Annual Int. Conf. of Engineering in Medicine and Biology Society, Vol.1, 2003, pp. 618-621

[3] V. Grau, A.U.J. Mewes, M. Alcaniz, R. Kikinis, S.K. Warfield, "Improved watershed transform for medical image segmentation using prior information", IEEE Transactions on Medical Imaging, Vol.23(4), 2004, pp. 447-458

[4] L. Vincent, P. Soille, "Watersheds in digital spaces: an efficient algorithm based on immersion simulations", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 13(6), pp. 583-598

[5] J.B.T.M. Roerdink, A. Meijster, "The watershed transform: Definitions, algorithms and parallelization strategies", Fundamental Informaticae, Vol.41, 2000, pp. 187-228

[6] J.C. Bezdek, L.O. Hall, L.P. Clarke, "Review of MR image segmentation techniques using pattern recognition", Medical Physics, Vol. 20(4), 1993, pp. 1033-1048

[7] Veronica S. Moertini, "Introduction to five data clustering algorithms", INTEGRAL, 2002, Vol. 7, No. 2.

[8] H.P. Ng, S.H. Ong, K.W.C. Foong, W.L. Nowinski, "An improved watershed algorithm for medical image segmentation", Proceedings 12th International Conference on Biomedical Engineering, 2005

[9] C.W. Chen, J. Luo, K.J. Parker, "Image segmentation via adaptive K-mean clustering and knowledge based morphological operations with biomedical applications", IEEE Transactions on Image Processing, Vol.7 (12), 1998, pp 1673-1683

[10] R. C. Gonzalez, R. E. Woods, "Digital Image Processing", Addison-Wesley, 1992, pp.419