ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 9, September 2014

Generalized Forgy's Algotithm For Efficient Image Segmentation

N.P.Dharani[1], N.Keerthi[2] and K.Thirumalesh[3]

Assistant Professors, Department of ECE, Chadalawada Ramanamma Engineering College, Tirupati, India[1, 2]

Assistant Professor, Department of ECE, Sreenivasa Institute of Technology and Management Studies, Chittoor, India[3]

Abstract: The use of the conventional watershed algorithm for different image analysis is widespread, such as always being able to produce a complete division of the image. However, its drawbacks include over-segmentation and sensitivity to false edges. We proposed a methodology which incorporates Forgy's and improved watershed segmentation algorithm for image segmentation. The Forgy's algorithm is an unsupervised learning algorithm, while the improved watershed algorithm makes the use of automated thresholding on the gradient magnitude map and post-segmentation merging on the initial partitions to reduce the number of false edges and over-segmentation. By comparing the number of partitions in the segmentation maps of images, we showed that our proposed methodology produced segmentation maps which have 92% fewer partitions than the segmentation maps produced by the conventional watershed algorithm.

Key words: Thresholding, Segmentation, Clustering and Watershed algorithm.

I. INTRODUCTION

Image segmentation is an important process for different image analysis tasks. The watershed segmentation technique has been widely used in medical image segmentation. Examples include the work presented in which make use of the watershed transform to segment gray and white matter from magnetic resonance (MR) images. The algorithm originated from mathematical morphology that deals with the topographic representation of an image. The set of pixels with the lowest regional elevation corresponds to the regional minimum. The minima of an image are the groups of connected pixels with their grey level strictly lower than their local neighboring pixels. The rainfall simulation describes that when rain falls onto the surface, any rain drop reaching a point in the surface will flow along its steepest descent until it reaches a minimum. The paths of pixels, which converge towards a common minimum, constitute a catchment basin. Watersheds are the elevated areas that divide the different catchment basins. The partitions, which we aim to obtain, are the catchment basins, and the boundaries between the partitions are the watersheds. 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 complete 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 drawbacks 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 images segmentation. The fuzzy C-means clustering algorithm (FCM) is a soft segmentation method that has been used extensively for segmentation of MR images. However, its main disadvantages include its computational complexity and the fact that the performance degrades algorithm on the other hand, is a simple clustering method with low computational complexity as compared to FCM.

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 complete 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 drawbacks 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 images segmentation. The fuzzy C- means clustering algorithm (FCM) is a soft- segmentation method that has been used extensively for segmentation of MR images. However, its main disadvantages include its computational complexity and the fact that the performance degrades significantly with increased noise. K-means clustering algorithm, on the other hand, is a simple clustering method with low computational complexity as compared to FCM. The clusters produced by K- means clustering do not overlap.

The watershed transform proposed by Vicent and Soille is a well known segmentation technique, which is based on immersion simulation, and allows the generation of an initial image partition into regions and consequently, other region-based techniques can be used in order to produce closed, one pixel-wide contours or surfaces. The technique is based on the assumption that image contours correspond to the crest lines of the gradient magnitude image which can be detected via watershed tracing. The principle is briefly described as following: let *I* be a grayscale digital image, the gradient image is computed; for each object of interest, an inside particle is detected (either interactively or automatically); flood waves are propagated from the set of markers and flood the topographic surface Watersheds are defined as the lines separating the so-called catchment basins, which belong to different minima. The catchment basin will flow down to the minimum *M*. When the water

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 9, September 2014

reaches the maximum grey value, the edges of the union of all dams form the watershed segmentation.

The watershed lines always correspond to the most significant edges between the markers. So this technique is not affected by lower-contrast edges, due to noise, that could produce local minima and, thus, erroneous results, in energy minimization methods.

Even if there are no strong edges between the markers, the watershed transform always detects a contour in the area. This contour will be located on the pixels with higher contrast

II. OVERVIEW OF METHODOLOGY

The proposed methodology consists of 2-stages.The first stage uses Forgy's algorithm to produce a primary segmentation of the input image, while the second stage applies the improved watershed segmentation algorithm to the primary segmentation to obtain the final segmentation map.

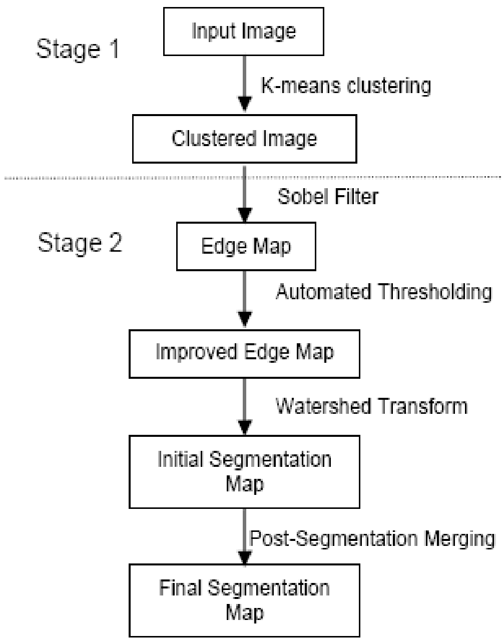


Fig.1.Flowchart of proposed methodology

III. FORGY'S ALGORITHM

Forgy's algorithm also known as **K-means clustering** is one of the most well-known methods for data clustering. The goal of k-means is to find k points of a dataset that can best represent the dataset in a certain mathematical sense. These k points are also known as cluster centers, prototypes, centroids or codewords and so on. After obtaining these cluster centers, we can use them for numerous tasks, which include:

- Data compression: We can use these cluster centers to represent the original dataset. Since the number of centers is much less than the size of the original dataset, the goal of data compression can be achieved.
- Data classification: We can use these cluster centers for data classification such that the computation load is lessened and the influence from noisy data is reduced.

Fig 2. Original images used in the simulations
(a) Cameraman image (b) cell image

IV. ALGORITHM FOR IMPROVED WATERSHED SEGMENTATION

Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, is the image segmentation process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in Medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes.

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 a smoothing effect. Unlike the conventional watershed algorithm, we perform thresholding on the gradient magnitude image to reduce the number of false edges. We introduce an automated thresholding technique, which is based on the histogram of the normalized gradient magnitude.

The initial segmentation map is heavily over segmented. Hence we implement a post-segmentation merging process in our improved watershed algorithm. This is unlike the conventional algorithm.

The objective of this post-segmentation merging step, which is based on spatial criteria, is to reduce the number of partitions significantly without affecting the accuracy of the segmentation map. We provide a description of this post-segmentation merging step here:

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 9, September 2014

(1) Let the original image be I(x, y).
(2) Let the initial partitions obtained from the watershed segmentation be R = {R1, R2, R3 … RN}, where R_i denotes the i^{th} partition and N is the total number of partitions.
(3) Let the size of each partition R_i be denoted by N_i.
(4) calculate the mean intensity of each partition R_i and denote this by: $M_i = \frac{1}{N} \sum_{(x,y)\varepsilon R_i} I(x,y)$
(5) Define two measures between any two neighboring partitions i and j.

(i) The first is the difference in the mean intensities between partition i and partition j. This is defined as: $M_{ij} = | M_i - M_j |$
(ii) The second measure is the difference in the intensities between partition i and partition j.

$$B_j = \frac{1}{N_{ij}} \sum_{(x_i,y_i),(x_j,y_j)} |I(x_i,y_i - I(x_i,y_i)|$$

where $(x_i,y_i)\in R_i$ and $(x_j,y_j)\in R_j$ of the summation are all the 8-connected pixels which lie on the boundary between partitions Ri and Rj, and Nij is the number of boundary pixels between partitions i and j.

(6) Define a criterion C_{ij} which is a measure of similarity in intensity values between two partitions I and j, and define it as: Cij = ½ (M_{ij} + B_{ij}) After determining C_{ij} for all partitions i and j, we decide on the threshold T_c which C_{ij} must satisfy before partitions i and j can be merged. If C_{ij} is less than T_c, it implies that partition i and partition j are similar based on the spatial criterion set and hence they should be merged. We make use of the automated thresholding technique described earlier in this section to determine T_c.

V. EXPERIMENTAL RESULTS

The use of Forgy's algorithm before applying our improved watershed segmentation algorithm has achieved the objective of reducing the problem of over-segmentation when applied to two standard images. In order to verify the applicability of proposed segmentation algorithm, we have considered two standard images namely cameraman image and cell image. Image segmentation is carried out using Forgy's algorithm, watershed algorithm and combined Forgy's and watershed algorithms. The obtained results are displayed for two sets of segmentation as shown below; it is observed from the results that Forgy's algorithm together with watershed algorithm provide better segmentation results when compared to Forgy's algorithm as well as watershed algorithm.

Fig.3. Original images used in the simulations (a) Cameraman image (b) cell image

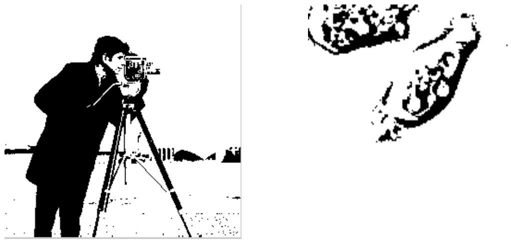


Fig.4.Segmentation using K-Means algorithm for K=2

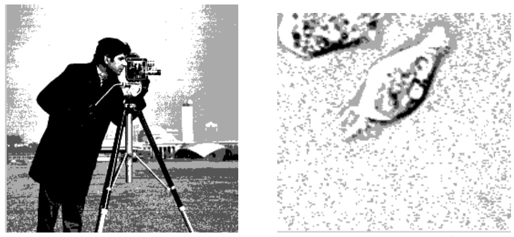


Fig.5.Segmentation using K-Means algorithm for K=4

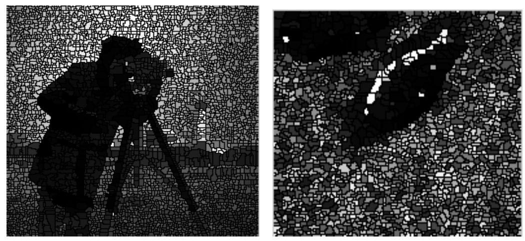


Fig.6. Segmentation using Watershed algorithm

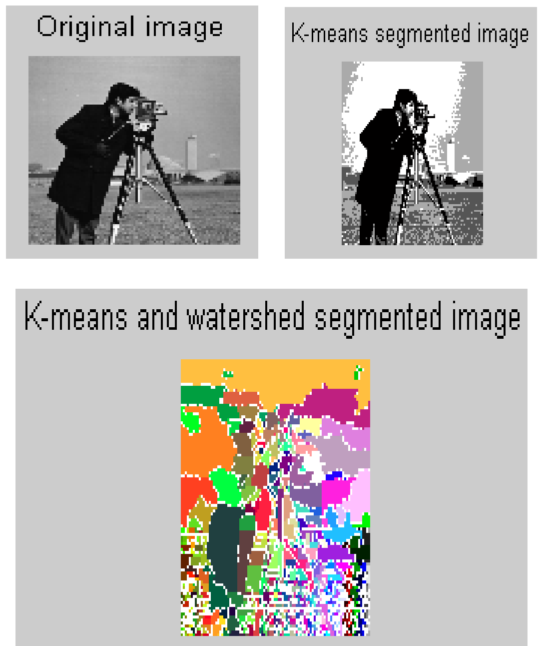
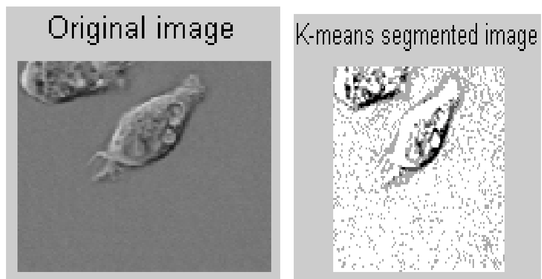


Fig.7. Segmentation results of cameraman image



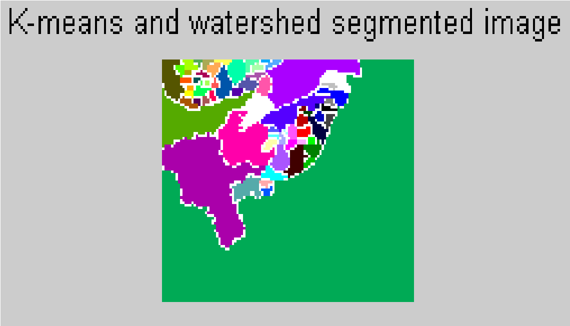


Fig.8. Segmentation results cell image

VI. CONCLUSION AND FUTURE ENHANCEMENT

In our proposed method, the segmentation regions were defined well and results are shown clearly from Figure 4 to Figure 8. A methodology which incorporates combined Forgy's algorithm and improved watershed segmentation algorithm has been proposed and this is a good technique to perform image segmentation and also to reduce the amount of over segmentation. This technique gives efficient results as compared to previous researches. Experiments are applied on various images and results were extraordinary. Our proposed research is easy to execute and thus can be managed easily. Our future work is to extend our proposed method for color based segmentation of 3D images. For this purpose we need a classification method to organize three dimensional objects

ACKNOWLEDGEMENT

This paper is dedicated to our parents and friends for their support without which the successful completion of this paper would not have been possible.

REFERENCES

[1] K. Alsabti, S. Ranka, and V. Singh. An Efficient K-Means Clustering Algorithm**.** http://www.cise.ufl.edu/_ranka/,1997**.**
[2] T. H. Cormen, C. E. Leiserson, and R. L. Rivest. Introduction to Algorithms. McGraw-Hill Book Company, 1990.
[3] R. C. Dubes and A. K. Jain. Algorithms for Clustering Data. Prentice Hall, 1988.
[4] Farmer, M.E, Jain, A.K. , ―A wrapper-based approach to image segmentation and classification‖, Page(s): 2060 -2072 , Image Processing, IEEE Transactions onjournals and magazines, Dec. 2005.
[5] Jianbo Shi & Jitendra Malik (1997) Normalized Cuts and Image Segmentation,Proc. IEEE Conf.Computer Vision and Pattern Recognition, pp. 731-737.
[6] T. Kanungo, D. M. Mount, N. Netanyahu, C. Piatko, R. Silverman, & A. Y. Wu (2002) An efficient k-means clustering algorithm: Analysis and implementationProc. IEEE Conf. Computer Vision and Pattern Recognition, pp.881-892
[7] Rajeshwar Dass, Priyanka, Swapna Devi, "Image Segmentation Techniques", International Journal on Electronics & Communication Technology (IJECT), Vol. 3, Issue 1, pp. 66-70, Jan. -March 2012
[8] V. K. Dehariya, S. K. Shrivastava, R. C. Jain, "Clustering of Image Data Set Using K-Means and Fuzzy K-Means Algorithms", International conference on CICN, pp. 386-391, 2010
[9] N. R. Pal, S. K. Pal,"A Review on Image Segmentation Techniques", Pattern Recognition, Vol. 26, No. 9, pp. 1277-1294, 1993
[10] W. X. Kang, Q. Q. Yang, R. R. Liang,"The Comparative Research on Image Segmentation Algorithms", IEEE Conference on ETCS, pp. 703-707, 2009.

BIOGRAPHY

Mrs. N.P.Dharani received her M.Tech degree in Digital Systems and Computer Electronics from BITS, Warangal, affiliated to JNTUH, Hyderabad in 2012 and received B. Tech degree in Electronics and Instrumentation Engineering from SITAMS, Chittoor, affiliated to JNTUH, Hyderabad in 2007. She is planning for her Research in Image Processing and Communication Engineering. She has published two International journals and attended National and International Conferences.

Mrs. N.Keerthi received her M.Tech degree in Communication Systems from SITAMS, Chittor, affiliated to JNTUA, Anantapur in 2012 and received B. Tech degree in Electronics and Communication Engineering from Narayana Engineering College, Gudur, affiliated to JNTUA, Anantapur in 2009. She has published two International journals and attended National and International Conferences. She is planning for her Research in Wireless Communication Engineering.

Mr. K.Thirumalesh received his M.Tech degree in VLSI Design and Embedded Systems from Visweswaraya Technological University, Belgum in 2006 and received B. Tech degree in Electrical and Electronics Engineering from Sree Vidhyaniketan Engineering College, Tirupati, affiliated to JNTUH, Hyderabad in 2003. He is planning for his Research in Embedded Systems. He has published 4 International journals.