Image Segmentation using Improved JSEG with Fuzzy Weighted Moving K-Means

Nini
Computer Science Department
SBSCET
Ferozepur, India

Sonika Jindal
Assistant Professor, CSE
SBSCET
Ferozepur, India

ABSTRACT
Image segmentation is an important step towards good image analysis. In this paper, a new method of image segmentation using fuzzy weighted moving k-means and JSEG images is proposed. Although JSEG provides an efficient approach towards image segmentation but it suffers from the problem of over segmentation. In order to overcome this problem we have used fuzzy weighted moving k-means to quantize the image. In JSEG, first color quantization is done. Each color is given a label and pixels in the image are replaced by these labels. Thus class-maps are formed. Then J-images are obtained from those class maps by applying this to local windows. The technique has been applied with both moving k-means and fuzzy weighted moving k-means. In the end, the results of both these clustering methods are compared. It is seen that weighted moving k-means segment the image better than moving k-means in terms of time taken and visible improvement that is seen for over segmentation reduction**.**

Keywords
Image Segmentation; K-means; Moving K-means; region growing and JSEG images

1. INTRODUCTION
Image Segmentation is an important part of image processing. In order to analyze an image better, it needs to be properly segmented first. Image segmentation is useful for many purposes like object recognition, image database lookup, image compression, image analysis and image editing. Segmentation is based on properties of the pixels of the image, mainly, color, texture and intensity [1]. The image is segmented on the basis of similarity and dissimilarity of pixels with respect to their properties. Pixels are similar if they have same grayscale of multivariate values and form a connected region. Pixels which are similar to each other are put in same category or region. When a pixel cannot be categorized into the existing ones then a new category is formed. These categories are called regions. The threshold where two different regions meet is called an edge. Hence, image segmentation results in an image broken down into regions and edges. Proper image segmentation is one of the biggest challenges of image processing [2].

Segmentation can be categorized into different types [3], namely: threshold based, region based, edge based, feature based clustering and model based [4]. In region based segmentation, the image is divided into closed boundary regions covered on the outside by edges. This is also called similarity based segmentation as the regions are formed based on similarity of the pixels.

In edge based segmentation, edges are detected using dissimilarities in the pixel values. This can be achieved by using canny edge detector, laplacian edge detector, sobel edge detector and many others [5]. In feature based clustering, image is first converted into a histogram and then the clustering technique fuzzy C is applied on it. For color images, Fuzzy Clustering technique is applied. For texture based clustering, K-means is applied.

K-means is one of the most widely used unsupervised learning algorithms. The algorithm for K-means is as follows:

Step1: Randomly choose k number of centroids in the image.

Step2: Form a cluster around each centroid based on the distance of surrounding pixels from it. This distance is the Euclidean distance between the centroid and the pixel.

Step3: The centroid of each cluster is recalculated till they become fixed for a given cluster.

Although, K-means is very easy to implement still it has its drawbacks. For example, the final set of centroids largely depends on the initial selection.

1.1 Jseg Image
JSEG stands for J-segmentation images. It is an unsupervised color-texture segmentation algorithm. It is mainly used to segment natural scenes in images without manual parameter adjustment. The segmentation of images based on JSEG passes through two stages: color quantization and spatial segmentation, hit rate regions with similar color regions merging [6].

In color quantization, the image is divided into labels based on their similarity. These color labels are used to differentiate regions in the image based on colors. The original color pixels of the image are replaced by color labels to form class-maps. These class maps then form the different regions of the image. Spatial segmentation is applied on these class maps so obtained through region growing [7]. In region growing, some initial seed points are determined first [8]. Then neighboring pixels are examined and it is determined whether the pixel neighbors should be added to the seed point region or not. The process is repeated till all the pixels belong to some seed point. This can be achieved in two ways: either by 4-connected neighborhood or 8 – connected neighborhood. But the main aim is to divide the image into similarly based pixels. The main advantage of region growing method is that pixels can be divided on the basis of different criteria at the same time. The main issue in region-growing method is suitable selection of seed points. Based on user's requirements, seed points should be selected carefully as it is very crucial for the formation of end results.

Steps of JSEG algorithm are shown in fig 1.

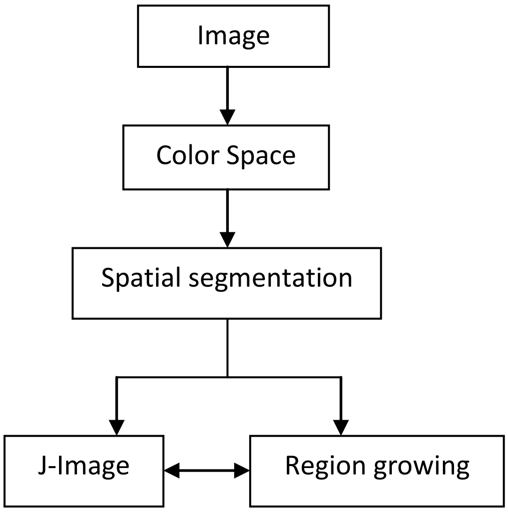


Fig 1: Steps in JSEG segmentation

2. RELATED WORK

In [1] K. Madhu and **R. I. Minu** have proposed a method of image segmentation using top-down and bottom-up approach. It uses semantic information of the image to group together pixels with common semantic information. Semantic texton forest is used for implementing this approach by applying semantics rules on the image. In the bottom up approach JSEG which is region based segmentation technique is applied. It takes heuristic approach to group the pixels according to their spatial adjacency and boundary continuity. It gives more accurate boundaries as compared to top down approach. Here in the bottom-up approach, an improved version of JSEG is implemented to focus on how to find out a class specific value for region merging parameter that will increase the accuracy of segmentation.

Shilpa Dantulwar and Prof R K Krishna et al, (2014) in [8] have proposed a method of seed growing to reduce the cost and execution time for segmentation. It improvises by taking the center pixel of the image as the initial seed as this decreases the computational cost and execution time required for initial seed section in previous algorithms. To improve the value of parameters, fuzzy logic optimization is done. Otsu's method has been used as threshold selection algorithm. The similarity index between two neighborhood pixels is calculated by Euclidean distance. The stopping criterion for the grow formula is determined from the Otsu's adaptive threshold method. If the distance between labeled pixel and non labeled pixel is less than the threshold, then we label both pixels as belonging to same region. The parameters improved are rand index (RI), global consistency error (GCE) and time.

Gurwinderjit Kaur and Balkrishan Jindal et al, (2014) in [6] have improved the JSEG algorithm by using moving k-means algorithm to create clusters of image pixels into similar regions. First, color image or gray scales image is quantized in several representing class through 24 classes without losing visual quality significantly. So, that they used to differentiate regions in the image. The segmented regions are classified on the basis of a variety of features like contour, texture, color etc. Then, image pixels are replaced by their corresponding color class-map of the image. Then, clustering is used to segment the image through k-means and moving k-means. The results are compared with k-means algorithm and give more accurate results.

Tejaswini C1, Mamatha Y N2 et al, (2015) in [9] have combined JSEG technique along with region growing method to segment satellite images. At first color quantization is done to represent various regions in the image. Then a class map of that image is formed by replacing the image pixel colors by their corresponding color class labels. Applying this to local windows, results in ―J-image. Finally region growing method is used to segment based on the multi-scale J- images. The JSEG algorithm is tested on a real time satellite image. The results obtained are efficient and reasonable. The results depend on the nature of the image. The result of the image that contains homogenous colors is different from the image that contains inhomogeneous colors.

Khamael Abbas, Mustafa Rydh et al, (2012) in [10] have proposed a fully automatic method for satellite image segmentation using JSEG, "JPEG image segmentation" technique. It is followed by region growing method to obtain segmented images based on j-value classification. The images containing homogeneous distribution of colors give different results as compared to non-homogeneous images.

Amritpal Kaur, Amandeep Kaur et al, (2014) in [11] has used JSEG and Artificial neural networks for the purpose of image segmentation. While JSEG provides character recognition and classification, ANN is used for pattern recognition. The parameters on which the performance of the system has been improved are computational time, peak signal to noise ratio and mean square error. The system has been developed for natural scene images.

A S Abdul Nasir, Z Mohamed et al, (2012) in [12] have provided an unsupervised clustering algorithm, moving k-means (MKM) for more prompt and accurate diagnosis of malaria parasite in human blood cells. MKM has been applied on the hue, saturation, intensity (HSI) components for separating the infected cells from background. Median filter and seeded region growing method have been used for smoothing the image and removing any unwanted regions. It has improved the accuracy of results compared to intensity component segmentation.

3. PROPOSED WORK

In this work JSEG segmentation method has been improvised by using Fuzzy Weighted Moving K-means as the clustering algorithm for color quantization.

The work has been implemented in MATLAB. Color quantization has been implemented using both MKM and FWMKM. The results have been compared for time and visible segments seen.

The proposed algorithm is given below:

Step1: Read Input image. Let $x_1,x_2.......x_m$ are N data points in input image, Let k be number of initial clusters.

Step2: Divide image into regions based on illumination

Step3: Fuzzify input data points

Step4: Choose c_1, c_2,....c_k cluster centers randomly

Step5: Initialize weights W such that all regions have equal weight initially

Step6: find distance between each pixel and cluster center

Step7: Distance function is given by:

$J = |xi - cj|$ for i=1,2,......N and j=1,2.....k where $|xi\text{-}cj|$ is absolute distance between pixel xi and cluster center cj

Step8: Distributes the data points among k clusters using relation:

$x \in cj$ if $|x - cj|$ for i=1.......k and $i \neq j$ the set of data points whose cluster center is cj

Step9: Update cluster center is given as

$$cj = \frac{1}{mi \sum x} x \in cjx \quad \text{for i=1....k}$$

Where mi is number of objects in dataset cj, cj is jth cluster center

Step10: Repeat steps 5 to 8 while convergence is met OR max iterations

Step11: Defuzzify output data points

Step12: Plot input on the image

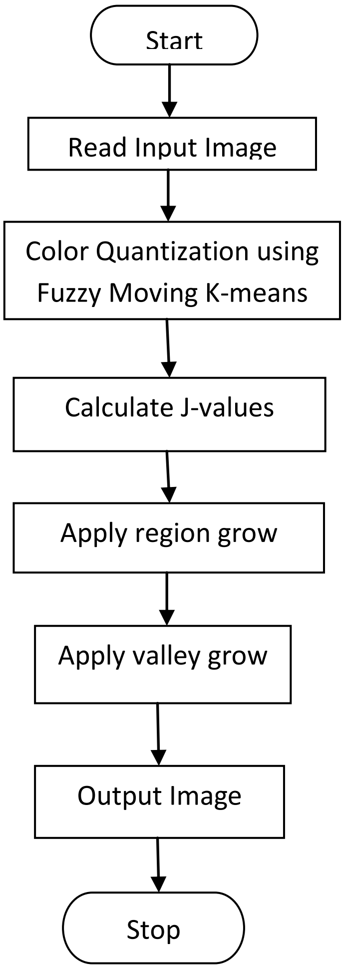


Fig 2: Flowchart of the proposed method

4. RESULTS AND DISCUSSION

The implementation and results of proposed method are discussed in this section. The images have been segmented using both moving k-means and weighted moving k-means. In this paper the results for Pepper image in fig 3 through fig 7 have been presented. Fig 3 shows the original image, fig 2 shows the J-images formed by moving k-means, fig 3 shows the segmented images formed with moving K-means, Figure 4 shows the J-images formed with weighted moving K-means and Figure 5 shows the segmented images formed with weighted moving K-means. The first three images in figures from Figure 4 through Figure 7 are the images obtained by segmenting the original image. The fourth image is the final image obtained by merging the first three images.

The images are segmented on three scales. These scales are the three local windows used in step two of JSEG, i.e. spatial segmentation. The three scales are 64*64, 32*32 and 8*8 (in the order of images shown from Figure 4 through Figure 7). Smaller the scale, larger is the number of regions formed and vice-versa. The merged image is formed by simultaneously overlapping the first three images.

The table shown below compares the j-values obtained from MKM and WMKM.

Table 1: Comparing the J-values

Scale	MKM	WMKM
64*64	0.289870737	0.287669249
32*32	0.431749561	0.428382302
8*8	0.594091679	0.591042373
Merged Image	0.739965589	0.736155599

The other parameter on which the results have been compared is time. **Time taken using MKM is 25.283087 minutes whereas the time taken by WMKM is 14.85709 minutes.**

After taking a look at the resultant image it can be seen that the number of regions obtained with WMKM reduces as there are no undesired segmented regions. Thus it can be concluded that using **WMKM technique reduces over segmentation**.

WMKM performs better because in this algorithm clusters are assigned weights based on the variation in color intensity and image region. But in case of MKM the centers are formed randomly and image regions do not play any role in clustering. Also in moving K-means there is over segmentation in regions where there is variation in intensity but it does not happen in weighted moving K-means because it takes into account the intensity variation when weights are assigned. The number of clusters formed in case of moving K-means is fixed but vary as per requirement in case of weighted moving K-means. The proposed algorithm can be further improved by using a more effective quantization algorithm, or by taking other features like texture of the image into consideration for segmentation.

5. REFERENCES

[1] Madhu, K. and Minu, R., "Image Segmentation using Improved JSEG", IEEE Transaction on Pattern Recognition, Informatics and Mobile Engineering, Salem, pp. 37- 42, 2013.

[2] Puri.C, and Singh.S, "Image Segmentation and Classification- A Review", International Journal of Innovative Research in Science, Engineering and Technology, Volume 3, Issue 4, 2014.

[3] Nida M. Zaitoun and Mushab J. Aqel, "Survey on Image Segmentation Techniques" Procedia Computer Scheme 65 797-806, 2015.

[4] R.Yogamangalam, B.Karthikeyan, "Segmentation Techniques Comparison in Image Processing", International Journal of Engineering and Technology Volume 05 Issue 1, 2013.

[5] Rajeshwar Dass, Priyanka and Swapna Devi "Image Segmentation Techniques" IJCET volume03 Issue 01, 2012.

[6] Gurwinderjit Kaur and Balkrishan Jindal, "Enhancing Image Segmentation Using Moving K-means with improved JSEG" Progress in Science and Engineering Research Journal Volume 02 Issue 04/06, 2014.

[7] Shilpa Kamdi and R.K.Krishna "Image Segmentation and Region Growing Algorithm" International Journal of Computer Technology and Electronics Engineering Volume 02 Issue 01.

[8] Shilpa Kamdi and R.K.Krishna "Performance Analysis Using Single Seeded Region Growing Algorithm" International Journal Of Innovative Research In Advanced Engineering Volume 1 Issue 6, 2014.

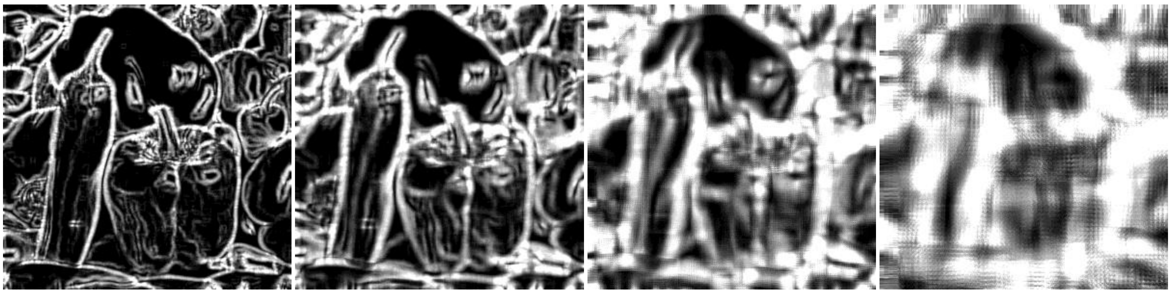
[9] Tejaswini C, Mamatha Y N, "Region Based Satellite Image Segmentation Using JSEG Algorithm" IJCSMC, Volume 4, Issue 5, May 2015, pages 1012 – 1016, 2015.

[10] Khamael Abbas, Mustafa Rydh "Satellite Image Classification and Segmentation by Using JSEG Segmentation Algorithm" I.J. Image, Graphics and Signal Processing, 10, 48-53, 2012.

[11] Amritpal Kaur, Amandeep Kaur "Evaluation Of Parameters Of Image Segmentation Algorithms- JSEG & ANN" International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 3, Issue 8, 2014.

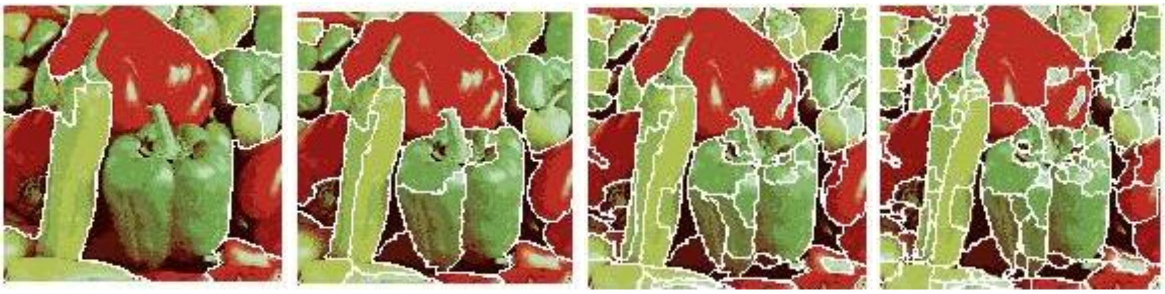
[12] A S Abdul Nasir, Z Mohamed "Segmentation Based Approach for Detection of Malaria Parasites Using Moving K-Means Clustering" IEEE EMBS International Conference on Biomedical Engineering and Sciences, 2012.

Fig 3: Original Image



64*64 window **32*32 window** **8*8 window** **merged image**

Fig 4: J- images obtained using MKM



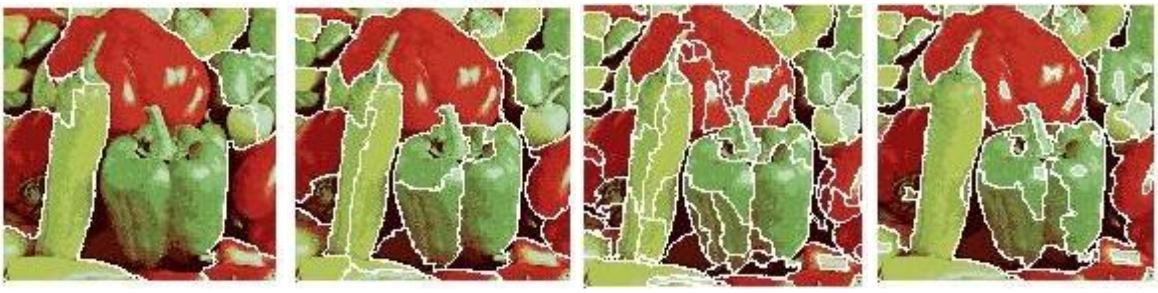
64*64 window **32*32 window** **8*8 window** **merged image**

J-value 0.289870737 **J-value 0.43749561** **J-value 0.594091679** **J-value 0.739965589**

Fig 5: Segmented images obtained using MKM

64*64 window 32*32 window 8*8 window merged image

Fig 6: J-images obtained using WMKM



64*64 window 32*32 window 8*8 window merged image

J-value 0.287669249 J-value 0.428382302 J-value 0.591042373 J-value 0.736155599

Fig 7: Segmented images obtained using WMKM