Improved Fuzzy C-Means Algorithm for Background Removal

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ABSTRACT

Background removal is an application of image segmentation. There are many methods for image segmentation. In this paper, Fuzzy C-Means (FCM) is used for the image segmentation. In this paper, the clusters centroid is given as input from the histogram of the image. These inputs are updated and passed through FCM algorithm to get segmented images. The segmented images are added to remove the background part with the black color. The morphological operation is performed on the background removed image to improve the quality.

Keywords- Fuzzy C-means Clustering, Fuzzy C-Means Algorithm, Image Segmentation, Background Removal.

I. INTRODUCTION

Background removal is an important technique to analyze objects contained in an image. That's why; it has wide range of application such as robot vision, object recognition, medical image processing, image analysis, remote sensing and geographical information system [1, 2, 3]. Although a lot of techniques have been defined for background removal but it is still a challenge because of overlapping intensities, low contrast of images and noise perturbation. Although the FCM algorithm usually performs well with non-noise images, it is still weak in imaging noise, outliers and other imaging artefacts. This may be caused by two aspects: one is the usage of the non-robust, Euclidean distance function which is not robust under noise perturbations, and the other does not pertain to any information about spatial context [4].

The cluster analysis divides the input data into groups or clusters depends on some similarity criterion. Some similarity measures are distance, connectivity, and intensity. The hence performed partition enables human being in more quantitative decision making and understanding [5].

The benefit of using similarity measure is to attain the more accurate clusters formation. Two types of clustering methods are there for the formation of clusters: First one is Hard Clustering and the other one is Soft/Fuzzy Clustering. In case of Hard Clustering, the input data is divided into a number of different clusters, where each element of input data belongs to exactly one cluster whereas in case of soft clustering, the input data elements belongs to more than one clusters with a degree of some membership value. Areas of applications of fuzzy cluster analysis include data analysis, pattern recognition, background removal and image segmentation [6, 7].

There are many clustering algorithms such as K-means, ISODATA, and Fuzzy c-means (FCM). FCM is one of the partition based clustering algorithms used for background removal. The FCM algorithm has the following limitations.

1. Number of groups need to identify in the resultant image.

2. By changing the set of initial centroids for grouping, the resulting image will change. [8]

II. FUZZY C-MEANS ALGORITHM

Fuzzy C-means (FCM) clustering algorithm is a partition-based clustering algorithm where, each pixel in the image has a membership value associated to each cluster, ranging between 0 and 1. This membership value measures how much the pixel belongs to that particular cluster. It is an iterative partitioning method that produces ideal c-partitions and cluster centers which are centroids. The FCM algorithm minimizes generalized function 'J' and is calculated as follows,

$$J = \sum_{i=1}^{n} \sum_{j=1}^{k} (\mu_{ij})^m ||X_i - C_j||^2 \qquad (1)$$

Where, X= $\{X_1, X_2, X_3 \ldots X_N\}$ be the pixels in an image, n is the number of pixels, C_j is the center of cluster j, k is the number of clusters, μ_{ij} is the degree of membership of X_i in the cluster j, m is the weighting exponent where m ϵ [1, ∞]. Let V= $\{V_1, V_2 \ldots V_K\}$ be the set of cluster centers then the detailed FCM algorithm is as given below,

1. Randomly select k cluster centers.

2. Create a random fuzzy membership u_{ij} such that the sum of all membership function is unity that is

$$\sum_{j=1}^{c} \mu_{ij} = 1 \qquad (2)$$

3. Compute each cluster centroid V_i

$$V_i = \frac{\sum_{j=1}^{N} (\mu_{ij})^k X_j}{\sum_{j=1}^{N} (\mu_{ij})^k} \qquad (3)$$

4. Update the membership matrix $U^{(k)}$ to $U^{(k+1)}$ using $U^{(k+1)}=[\mu^{(k+1)}{}_{ij}]$

$$\mu_{ij} = \frac{1}{\sum_{M=1}^{C} \frac{||x_j - c_i||}{||x_j - c_m||^{(\frac{2}{K-1})}}} \qquad (4)$$

Where, ni is the number of pixels belonging to the cluster of centroid C_i and X_j is the pixels belonged to cluster C_i.

5. If $||U^{(k)}-U^{(k+1)}||$< Threshold then stop, otherwise return to step 3.

The time complexity of the algorithm is O(N) where N is the number of pixels in the image. However, the FCM algorithm suffers from several disadvantages; such as priori specification of number of clusters, huge execution time due to its iterative nature and Different choice of μ_{ij} leads to different local minima 'J', which could lead to poor results. Different combination of centroids and random selection will give different results [9].

III. PROPOSED METHODOLOGY

The proposed methodology includes the selection of image. The selected image is converted into grayscale image. This grayscale image is used to find the histogram which is helpful in selection of cluster centroid. The no. of clusters is equal to the no. of centroids selected from the histogram. The no. of clusters is variable and can vary from image to image. All the selected centroids update its location to the suitable position by using the membership function. These updated cluster centroids is used in FCM algorithm for clustering purpose. The no. of clusters is equal to the no. of centroids selected from the histogram. The suitable clustered images are added to get the desired result. The clusters related to object in the image remain as it are and the rest clusters pixel values is brought to zero for background removal purpose. 2-D median filtering and image filling is performed as morphological operation to get the enhanced and better output. The morphological operations are performed to the resultant image for clearer and better quality.

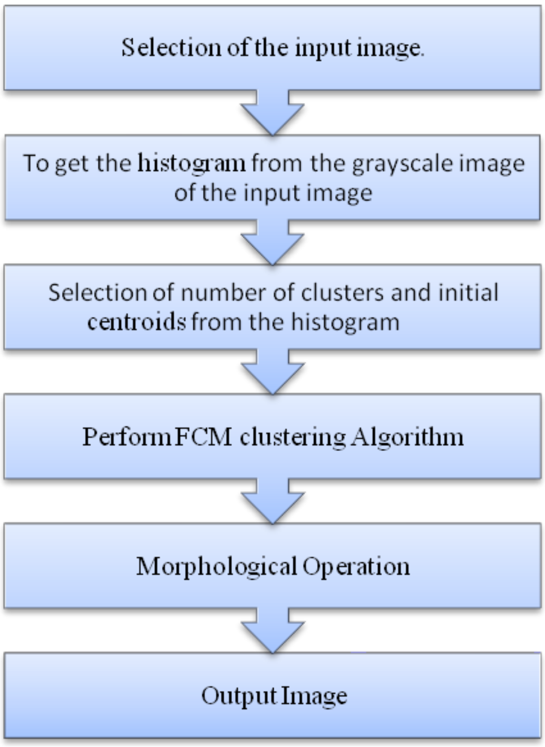
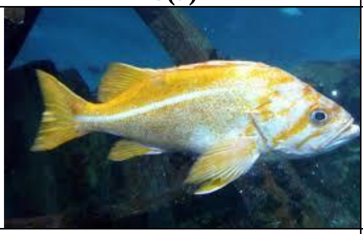
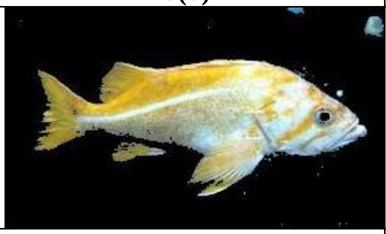
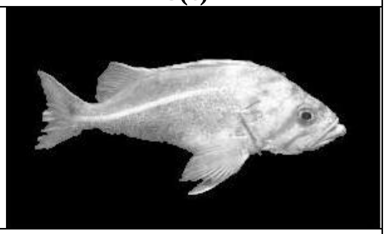


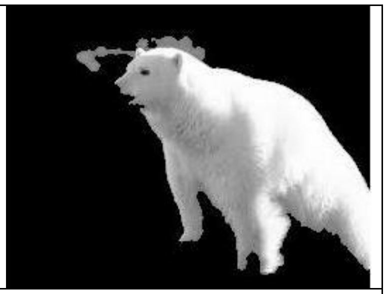
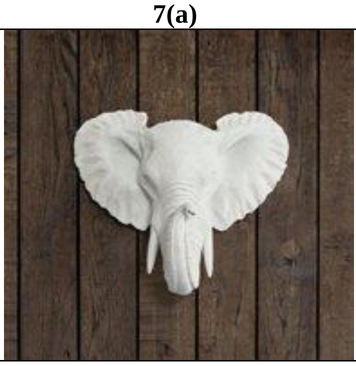
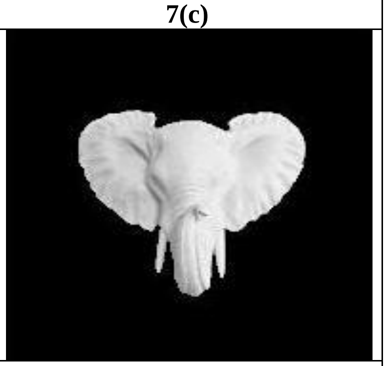
Figure 1: Block diagram of Proposed Method

IV. RESULTS AND DISCUSSIONS

The table below describes completely the results of method proposed in the paper. Experimentation on eight different images namely peacock, flower, tiger, fish, bear, yellow flower, parrot and elephant for background removal was carried out. All these eight images are having different backgrounds. In this paper, we have focused mainly on the background part. This is the reason to select different images with different backgrounds. The column of table is showing original, background removed and post-processed background removed image. The first image is itself a raw image on which above methodology is implemented. The second image is the background removed image and the third image is the image after post-processing of background removed image. It has been analyzed that the third image is black and white image. It is so because the post processing gives best results for binary images. That is the reason the post processing is performed on the background removed image after converting it into binary image. It has been observed that the some part of the desired portion of image is also removed. This is because those missed pixels belong to the undesired cluster. The results shown are concluding its applicability for different kinds of images. The method hence is suitable for the background removal purpose. This method is finding its suitability in the entertainment field, military purposes and many other applications.

Table 1: Experimental results performed on eight images

Image No.	Original Image	Background Removed Image	Background Removed Image (After Post Processing)
1			
	1(a)	**1(b)**	**1(c)**
2			
	2(a)	**2(b)**	**2(c)**
3			
	3(a)	**3(b)**	**3(c)**
4			
	4(a)	**4(b)**	**4(c)**

5			
	5(a)	**5(b)**	**5(c)**
6			
	6(a)	**6(b)**	**6(c)**
7			
	7(a)	**7(b)**	**7(c)**
8			
	8(a)	**8(b)**	**8(c)**

V. CONCLUSION

It is concluded that above proposed FCM algorithm is better suitable for background removal and image segmentation purpose. The results show that the proposed method is clearly removes the background part of the image to get the object. In addition, the proposed clustering algorithm is relatively fast and accurate. The different kind of images supports the methodology. The above results are showing the capability of the proposed method.

VI. FUTURE SCOPE

The above method is further improved for the adaptive methodology. In adaptive methodology, any kind of images can be considered and the selection of different algorithm will be done as per the image. It will improve the segmented image quality.

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