

An Efficient Image Segmentation Technique by Integrating FELICM with Negative Selection Algorithm

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Abstract

Segmentation is a efficient technique of dividing the image into different regions or segments. Most of the researchers took clustering as the best method of segmenting an image. In clustering we try to increase the similarity within a same class and decrease the similarity between the classes. Many clustering algorithms were developed like FCM, FLICM and FELICM which are considered as the best algorithms to cluster the data. In our paper, we combine FELICM (Fuzzy Edge and Local Information C-Mean) with the negative selection algorithm. Negative selection algorithm is an evolutionary method which is based on artificial immune systems. The proposed method result shows us high accuracy results and even solves the problem of over segmentation.

Keywords: FCM, FLICM, FELICM, Negative Selection Algorithm

1. Introduction

Image Segmentation is a critical methodology of image transforming and comprehension in digital image processing. This technique is basically used for separating the image into different parts of homogeneity. The motive of image division is to enhance the representation of a picture into something that is more important. The basic use of it is to find the location of objects, boundaries, lines etc. in the digital images. Clustering is a way in which a data set or say pixels are interchanged by groups, pixels may place together because of the same color, composition etc.

There are number of clustering techniques available which are used to segment the image in distinct ways. Out of various techniques available some of the important ones are following: k-mean clustering, Fuzzy C-Mean clustering (FCM), Fuzzy c-mean with local information (FLICM), Fuzzy edge and local information c-mean (FELICM).

K-Mean clustering can also be heard as hard clustering. The neighboring pixels of an image are having almost similar i.e. they are approximately same. So we choose Euclidean distance as a factor to cluster the pixels. Partition of an image into clusters are done with an iterative technique from which the choice of k cluster centers, randomly then every pixel in the image is allocated to the unique cluster. The cluster centre is re-evaluated by averaging all of the pixels in the centre's c-mean shows problems when distinct clusters have different size, shape and density [1]. Fuzzy clustering is also called soft segmentation. It uses the methodology of partial membership of belonging explained by a membership function [2]. In this every point has a degree of belonging of clustering instead of each pixel does belong to one cluster only so it also removed the flaws in the k mean. After it the new technique fuzzy local information c-mean (FLICM) was introduced. It improved the clustering performance when compared with the fuzzy c-means and meantime. In this the main idea on which it works is that it uses fuzzy local (both spatial and gray level) similarity measure, planning to ensure noise insensitiveness and image information preservation [3]. To remove the noise effects spatial relationship between pixels can be used but when we use it most of the times it produces boundary

zones when there are mixed pixels around the edges. To overcome from this problem we have an another technique called fuzzy C-means with edge and local information (FELICM) which is based upon image spatial clustering method that lessens the edge degradation by including the weights of pixels within nearby neighbor's windows [4]. Fuzzy c-means (FCM) with edge and local information (FELICM) also provides the he more edge exactness when compared with the FLICM [11].

In our paper, we introduce a new integrated Negative selection based FELICM approach to improve the accuracy of the segmentation procedure further. The inspiration driving the proposed methodology is basic and powerful. NSA is based on artificial immune systems. The NSA was first utilized by Forrest. It is a standout amongst the most popular models that influence the improvement of the existing artificial immune systems. The use of negative selection technique will allow finding an optimistic, adaptive threshold to segment the image in a more efficient manner. Negative selection based algorithms have been used in different application areas, such as anomaly detection. Forrest (1994) proposed a negative selection algorithm. The main idea behind the algorithm is to produce a set of detectors. Firstly, candidates are generated randomly and then those that recognize training self-data are discarded, and these detectors can later be used to detect anomaly [5]. A set of self elements is defined within that shape space and a set of detectors is derived from them, which decides whether an incoming new feature data from the dynamic process is normal (self) or not (non-self). Thus, in this way, the NSA does its main task of discrimination between self and nonself [9].

2. Proposed Methodology

We have analyzed from the previous methods that there are still some gaps like with the blended area have not been considered and the impact of color have been disregarded [10]. Also, there exist some isolated regions which FELICM was unable to remove properly. So to overcome these issues we have proposed a new method in which we integrated two different algorithms i.e. FELICM and Negative Selection Algorithm. Figure 1: is representing the flow of the proposed methodology. The explanation of the proposed algorithm is given below:

STEP 1: Take the image as an input. It could be either grey level image or color image.

STEP 2: After this FELICM and NSA are applied on the same image separately.

A. APPLY FELICM

(a) Segmentation using FELICM Algorithm

- First of all get the principle component analysis which is mathematical procedure that uses the orthogonal transformation. In this image in RGB form converted into PCA and then each component converted into vectors.

They can be concatenated using equation.

$$IIV = cat(I, I)$$

is input image vector

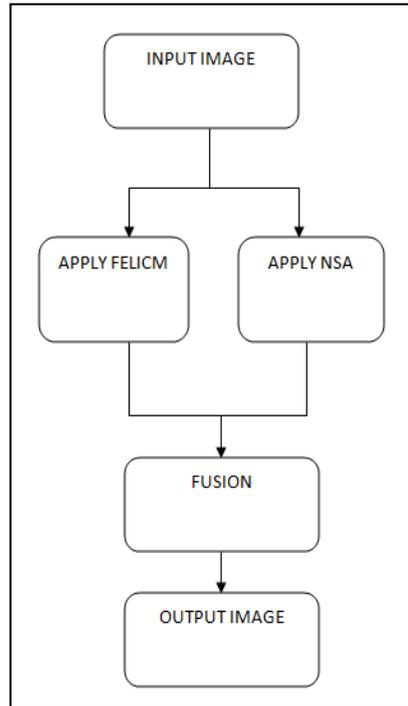


Figure 1. Proposed Algorithm

- Principle component is used for calculating Eigen Values using the following equation where VV represents vector values.

$$VV = \text{princomp}(IIV)$$

- To get PCA Vector using Vector values the following equation can be used.

$$\text{Vector} = VV,$$

- PCA image can be obtained using the following.

$$OVI = IIV * \text{Vector}$$

OVI is output image vector

- Edges are extracted using the canny edge operator along with the information obtained using PCA and otsu method.
- Then FELICM based clustering is done in which the objective function can be defined as

$$J = \sum_{i=1}^N \sum_{k=1}^C [Qki + Gki]$$

B. APPLY NSA

STEP 3. Now fusion will be done on two different images got from the FELICM and NSA.

STEP 4. All pixels of the picture will be allotted to their closest groups and proposed segmentation method will be attained.

STEP 5. After obtaining the results color labeling will be done.

STEP 6. Output of the proposed method is obtained with the improved accuracy.

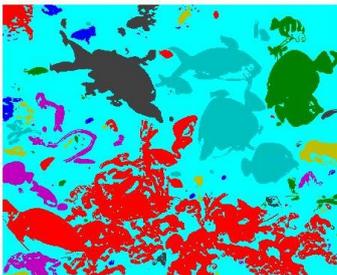
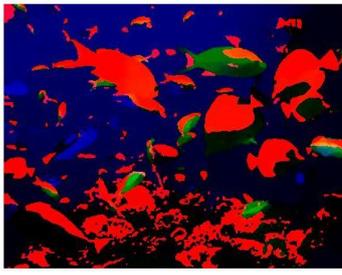
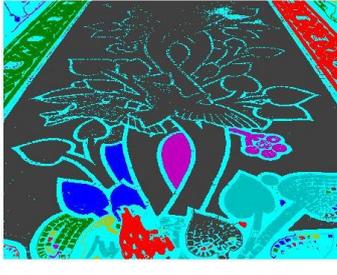
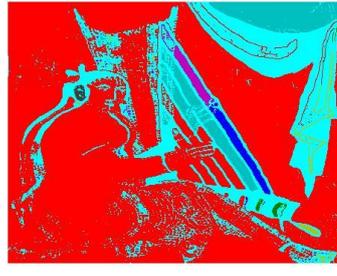
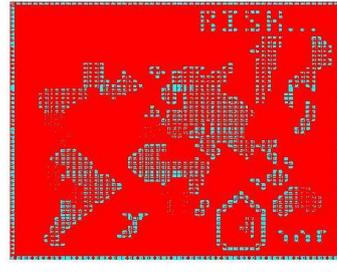
3. Experimental Results

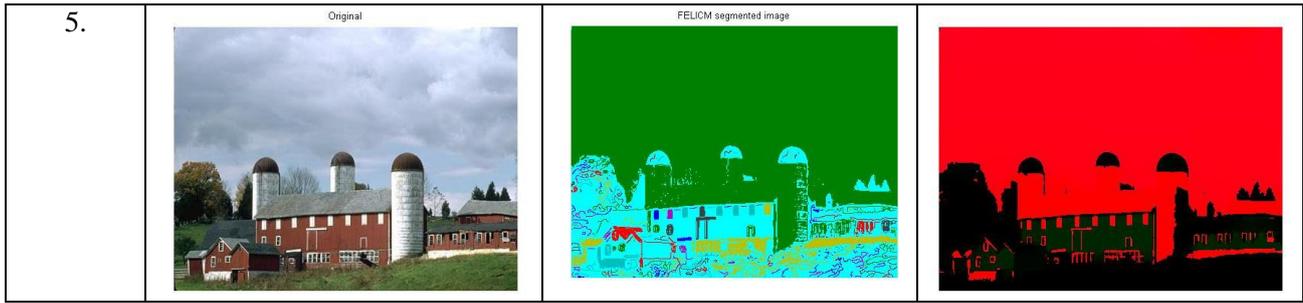
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coordinate conjunctions, or prepositions (unless the title begins with such a word). Please initially capitalize only the first word in other titles, including section titles and first, second, and third-order headings (for example, “Titles and headings” — as in these guidelines). Leave two blank lines after the title.

We implemented the proposed algorithm on a window 7 PC with an Intel® Core (TM) i5-2430M CPU @ 2.4GHz processor, running MATLAB R2012b. we categorize the experimental images into building images containing original image, FELICM images and Proposed algorithm images. We have tested our proposed algorithm on various images and the results for the same are shown in the Table 1

Table 1. Matlab Inbuilt Images Results

Images	Original	FELICM	proposed
1.	<p style="text-align: center; font-size: small;">Original</p> 	<p style="text-align: center; font-size: small;">FELICM segmented image</p> 	
2.	<p style="text-align: center; font-size: small;">Original</p> 	<p style="text-align: center; font-size: small;">FELICM segmented image</p> 	
3.	<p style="text-align: center; font-size: small;">Original</p> 	<p style="text-align: center; font-size: small;">FELICM segmented image</p> 	
4.	<p style="text-align: center; font-size: small;">Original</p> 	<p style="text-align: center; font-size: small;">FELICM segmented image</p> 	



4. Performance Evaluation

We have tested our proposed methodology on the inbuilt MATLAB images of car, flower, butterfly, turtle and octopus. We have analyzed that our proposed algorithm is giving us the three parameters with the improved performance when compared with the previous algorithm. These three parameters are PSNR value, accuracy and entropy. As PSNR, Accuracy and entropy need to be maximize therefore proposed algorithm is showing better results than the previous methods.

$$MSE = \frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} (f_{ij} - f'_{ij})^2 \quad (1)$$

$$0 \leq i \leq M - 1, 0 \leq j \leq N - 1 \quad (2)$$

$$PSNR = 10 \log \frac{(2^n - 1)}{MSE} \quad (3)$$

Accuracy- Accuracy is measured that how close you are to the actual value. For this we need to calculate the error.

$$\% \text{ Error} = \frac{(YV - AV) \times 100}{AV} \quad (4)$$

Where: YV is your measured Value & AV is the Accepted Value.

Entropy gives us the amount of information that is carried by an image.

Table 2. Qualitative Analysis

Images	PSNR			ACCURACY			ENTROPY		
	FCM	FELICM	Proposed	FCM	FELICM	Proposed	FCM	FELICM	Proposed
1	34.8794	59.5368	71.9378	0.1509	0.8302	0.9661	0.7102	7.6697	14.7039
2	31.5645	63.6417	68.2775	0.5128	0.6708	0.8820	3.1233	4.8258	9.2805
3	31.2604	64.4310	79.1339	0.5503	0.6257	0.9801	3.4707	4.2681	17.0035
4	30.8129	58.6155	66.0360	0.5391	0.8457	0.8422	3.3642	8.1150	8.0195
5	35.4205	56.8779	75.9767	0.0781	0.4705	0.9898	0.3533	2.7615	19.8938
6	33.1903	56.1610	62.6521	0.2768	0.7697	0.8338	1.4072	6.3779	7.7948
7	33.0539	64.0907	72.1904	0.2615	0.5143	0.9794	1.3168	3.1360	16.8540
8	33.2940	58.9451	67.8136	0.2275	0.4837	0.9404	1.1211	2.8710	12.2466
9	31.1907	57.6239	73.6801	0.4327	0.8130	0.9287	2.4615	7.2827	11.4678
10	32.5380	57.2507	71.8920	0.3420	0.7327	0.8790	1.8177	5.7308	9.1718

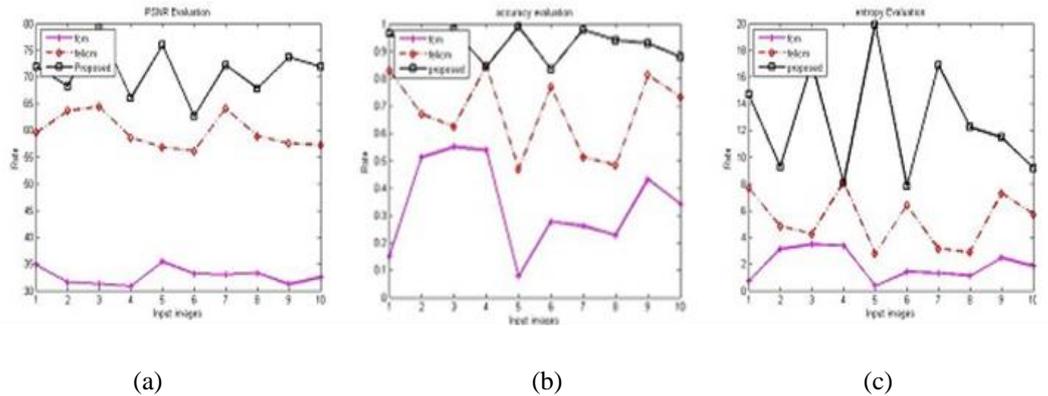


Figure 3. (a) Graph for PSNR, (b) Graph for Accuracy and (c) Graph for Entropy

5. Conclusion

The previous clustering method gives the isolated samples of pixels so mostly it results in isolated regions. Traditional clustering methods are unable to remove isolated regions. FLICM produces boundary zones. FELICM somehow eliminates these problems, but the proposed method gives very efficient result as compared to previous clustering methods. Moreover, it also eliminates the over segmentation which can be clearly seen in the Matlab inbuilt images result. In our proposed methodology when FELICM is integrated with the negative selection algorithm, the three of the parameters i.e. PSNR value, accuracy and entropy are showing the improved and better results when it is compared with the existing FELICM.

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