Strategic Filter for Noise Removal using Graph Clustering

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ABSTRACT
Image segmentation is to classify or cluster an image into several regions according to the feature of image, for example, the pixel intensity or the distance measure. Up to now, lots of image segmentation algorithms exist and be extensively applied in science and daily life.[2,3]. According to their segmentation method, we can approximately categorize them into region-based segmentation, data clustering, and edge-base segmentation. Clustering data is a fundamental task in machine learning. Given a set of data instances, the goal is to group them in a meaningful way, with the interpretation of the grouping dictated by the domain. In this paper we present a method for noise removal that makes use of graph clustering using both features (pixel intensity and connectivity).In this paper hierarchical clustering as well as centroid-based clustering is used. This will give us clusters and by analyzing these clusters we can identify noisy clusters. This is better method over the standard Vector Median Filter (VMF) [4]when noise ratio is high.

Keywords
Graph Clustering, Image Processing, VMF, noise removal, hierarchical clustering, centroid-based clustering, k-means clustering.

1. INTRODUCTION
The most popular method for image segmentation is K-means algorithm [2,9]. It is widely a used algorithm for image segmentation because of its ability to cluster huge data points very quickly. Hierarchical clustering is also widely applied for image segmentation. In this literature[9] K-means is used for segmentation. K-means algorithm can be used for clustering data with categorical attributes[10]. In this literature[10], mean is calculated to represent centre, and Euclidean distance is used to calculate distance. K-means median filter algorithm and recursive K-means median filter algorithm are designed to solve the defects of standard median filter for noise removal on binary images[6]. Modified K-means[1] is used to clean up the noise embedded in the color regions using Euclidean distance.

Images are often corrupted by impulse noise due to noisy sensors or transmission in a noisy channel. The most popular approach for removing impulse noise is the Vector Median Filter (VMF) because of its good de-noising power and computational efficiency[5]. Various decision-based filters have been proposed where noisy pixels are first identified and then replaced by using the VMF[5]. However, such approaches still have the same drawbacks of the VMF: blurring and low performances when noise ratio is high. This paper propose an approach that identifies corrupted pixels in colored images by analyzing graph. Graph analysis is done by centriod-based clustering or by hierarchical clustering. Clustering of graphs as well as measures of graph similarity is addressed in other literature[3].Using these clusters we identify noisy data.

2. ALGORITHMS USED
This paper proposes weighted seed growing hierarchical clustering for creating sub graphs for the image. For centroid-based clustering a variant of k-means algorithm[1] is used. Here the clusters created by WSG or UsG_k-means represent sub graphs.

2.1. Preliminaries on Weighted Seed Growing
The Weighted Seed Growing (WSG) algorithm is a simple hierarchical clustering method. It performs a clustering of an image graph by examining the neighboring pixels of a set of pixels, known as weighted seeds and determine whether the pixels should be classified to the cluster of weighted seed or not.

This paper proposes the following algorithms:

Step1. We start with a selecting random pixel as starting weighted seed S1(The pixel represent seed and pixel intensity represent the weight of the seed).S1 will initiate a new cluster C1. Similarly Si represents intensity of Ci.

Step2. Compare weights of neighboring pixels of Si (8-connected neighbors) with weight of the seed Si.If Pi (neighboring pixel) has same weight as Si then Pi € Ci.

Step3. Compare weights of neighboring pixels of Pi (8-connected neighbors) with weight of the seed Si. If Pj (neighboring pixel of Pi) has same weight as Si then Pj € Ci.

Step4 . Repeat Step3 for all neighbors of Si having same weight.

Step5. Select new seed Sj such that Sj is randomly selected pixel which does not belong to any cluster Ci .

Step6 . Repeat Step 5 until all pixels in image have been allocated to a suitable cluster. Repeat Step 2 , 3 and 4 for new seed Sj.

This WSG algorithm will cluster the image hierarchically. Drawback of this method is it produces too many sub graphs or clusters.

2.2. Preliminaries on Unseed Growing
The Unseed Growing (UsG) algorithm is a derivative of Weighted Seed Growing (WSG) . Their distinction is that no explicit seed selection is necessary. In the clustering procedure, the seeds could be generated automatically. So this method can perform fully automatic clustering with the added benefit of robustness from being a region-based segmentation.

This UsG algorithm can be implemented using variant of k-means algorithm.

2.3. Preliminaries on k_means Algorithm.

An efficient heuristic method for K-Means clustering is the Lloyd algorithm

K-Means Clustering: Lloyd Algorithm

Step1. Arbitrarily assign the k cluster centers

Step2. while the cluster centers keep changing

Step3. Assign each data point to the cluster Ci corresponding to the closest cluster representative (center) ($1 \leq i \leq k$)

Step4. After the assignment of all data points, compute new cluster representatives according to the center of gravity of each cluster, that is, the new cluster representative is $\Sigma v \setminus |C|$ for all v in C for every cluster C

Lloyd algorithm works on the criteria of Euclidian distance from center. This paper proposes a variant of k-means combining it with Unseed Growing discussed above.

2.4. Preliminaries on UsG_k_means Algorithm

Unseed Growing K-Means Clustering Algorithm (UsG_k-means) is a variant of k-means and has following steps.

Step1. The process initializes with cluster C1 defining single intensity, and the running state of the process compose of a set of identified clusters, C1, C2… Cn. (these clusters are identified on the basis of various intensities throughout the image)

Step2. Now we consider a pixel Pi and put it to cluster Ci , If intensity(Pi) == intensity assigned to Ci.

Step 3. Repeat step2 till all pixels are assigned to some cluster.

3. PROCEDURE ADOPTED

3.1 Procedure proposed for WSG algorithm

The paper impose image as a graph with below logic:

1. First identify vertices as image pixels.
2. Give vertex weight as pixel intensity.
3. Apply WSG for creating sub graphs.
4. This will give us a graph having disjoint sub graphs; these sub graphs represent different continues patches in image.

These sub graphs or clusters can now be analyzed to find out noisy data.

For identification of noisy data we propose a threshold value which is used for the decision of noisy clusters i.e. all clusters having value bellow that threshold value will be considered as noisy clusters.

3.2 Procedure proposed for UsG_k-means

This paper impose image as a graph with below logic:

1. First identify vertices as image pixels.
2. Give vertex weight as pixel intensity.
3. Apply UsG_k-means for creating sub graphs.
4. This will give us a graph having disjoint sub graphs; these sub graphs represent different intensity patches in image.

Now we identify noise in the same way as mentioned above.

3.3 Decision of threshold

This paper proposes following logic: The threshold value depends upon the type of noise to be removed. If it is salt and pepper

type noise, then threshold value can be a fixed number (It can be number of pixels representing single point in image) or threshold can define by following procedure:

1. Define difference threshold Th =10.
2. First find number of pixels in every cluster.
3. Find mean m1 of number of pixels such that m1= (Max number of pixels+ Min number of pixels)/2.
4. Find second mean m2 such that m2=(m1+ Min number of pixels)/2.
5. Repeat process step 3 to 4 unless m1-m2<= Th.
6. Threshold=m2

The difference threshold(Th) can be define as per the requirement.

4. EXPERIMENTAL WORK

The experimental result shows the noise removal with 90% accuracy using UsG method.

Fig.1: Image with salt & pepper type noise

Fig.2: Image after processing (about 90% noise removed)

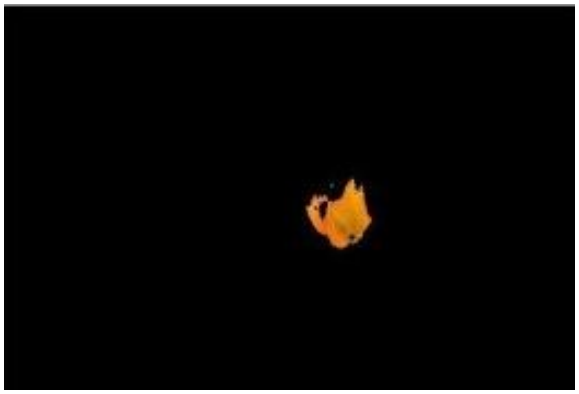

Fig.3.1

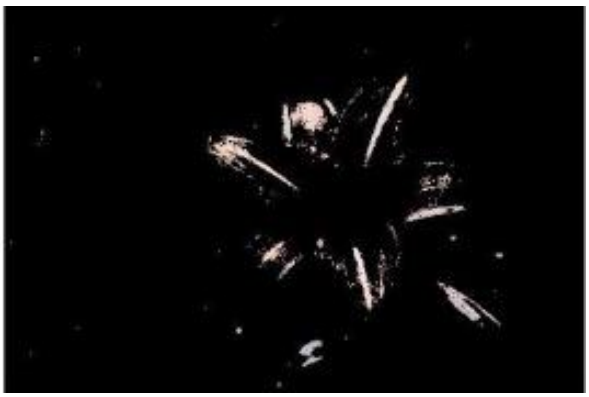

Fig.3.2

Fig.3.3

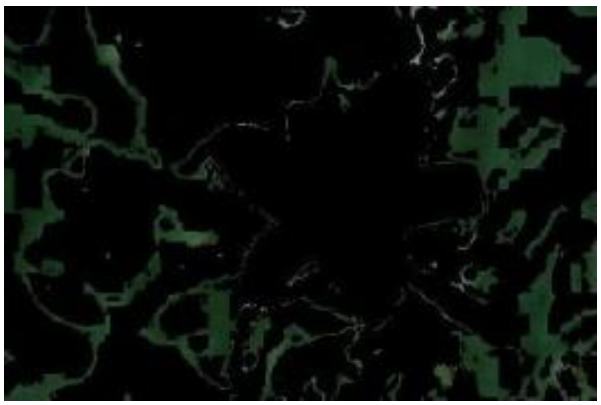

Fig.3.4

Fig.3.1, 3.2, 3.3, and 3.4: Sample Images of clusters created while processing

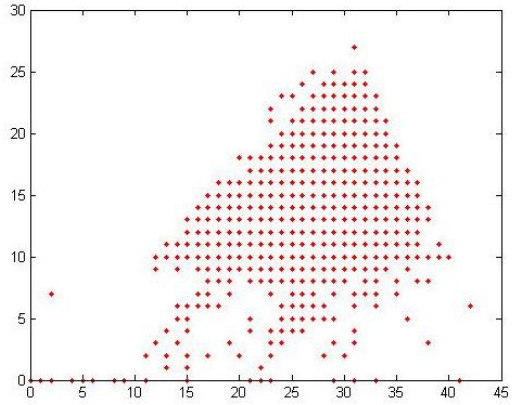

Fig.4.1

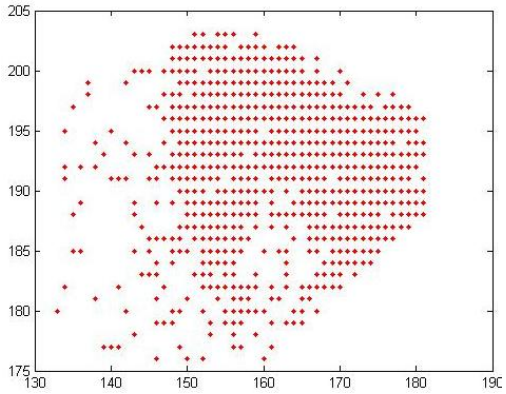

Fig.4.2

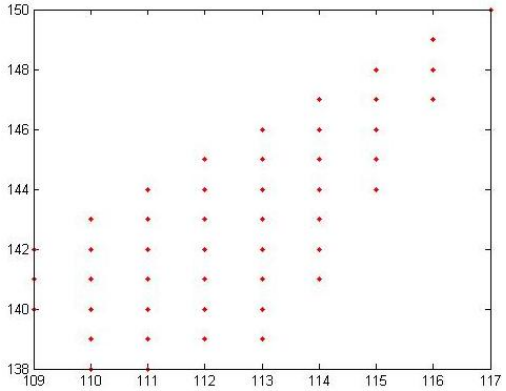

Fig.4.3

Fig.4.1, 4.2, and 4.3: Sample Sub graphs of clusters created while processing

5. FUTURE WORK

In present paper only 'Salt & Pepper' noise is removed; other type of noise can be removed in future.

Implementation of WSG could be done in future for better recognition of 'Salt & Pepper' noise.

Threshold decision algorithm can be improved to reduce iterations as well as to remove Gaussian noise.

6. REFRENCES

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