Review of various Image Segmentation Techniques

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***Abstract*—For applications such as image recognition and image compression , we don't need to process whole image as it is inefficient or impractical. We are not interested in processing whole image,we want only the required portion of an image so we perform segmentation for this purpose. Segmentation identify the region of interest , For this purpose various approaches have been proposed. Segmentation can be categorized as : Region based , Clustering based and Edge based. Ant Colony Optimization (ACO) is a meta-heuristic that has been applied to various optimization problem as well as segmentation. It also has been combined with other techniques to get optimum results. Segmentation do have effect in image analysis and other higher order task. There are various techniques that can be used for various types of images such as hyper spectral, brain MRI, real, synthetic etc images. In this paper there is a review about various techniques that make use of ACO and that does not.**

***Keywords*—Segmentation ; Ant Colony Optimization(ACO) ; K-means Clustering; Fuzzy C-mean Clustering (FCM) ;Brain MRI image segmentation ,CIE Lab color space**

I. INTRODUCTION

To analyze image easily ,image segmentation is used. It converts image into meaningful form and it makes analysis of images easier.In most application it is a preliminary step and follows higher task.Image segmentation refers to partition of an image into different regions that are homogeneous or similar and inhomogeneous in some characteristics. Image segmentation results have an effect on image Analysis includes object description and representation , feature measurement. Higher order task follows classification of object. Characterization , visualization of region of interest plays an important role in image segmentation[1]. The result of segmentation covers the entire image. Adjacent regions are different with respect to the same characteristics. Image segmentation is divided into following Categories , based on two properties of image.

A. Detecting Discontinuities

It requires the detecting discontinuities property. The edge detection which includes image segmentation algorithm. Edge detection is the segmentation process in which pixels on a region boundary are find out. Edge can be described as , a boundary between the adjacent parts of an image.

B. Detecting Similarities

This includes the partition of an image into regions that are similar with respect to predefined properties.This includes image segmentation algorithms such as:thresholding, region growing , region splitting and merging[1].

Clustering can be used for region segmentation in which image is segmented in to clusters of pixels having similarity in some way.

C. Ant Colony Optimization (ACO)

A meta-heuristic is a general algorithmic frame work ,which can be applied to different different optimization problems with few modifications to make them , adapted to a specific problem. ACO is a relatively new meta-heuristic . It is a successful paradigm that takes advantage of the insect's behavior. It was invented by Italian scholar M. Dorigo. It was inspired by the observation of real ant colony and used to find an optimal path from nest to destination in the foraging behavior. In real world scenario , ants are social insects and live in colonies. Ants behavior is directed more to the survival of the colony as a whole than a single individual component of the colony. An important and interesting behavior of ants colonies is their foraging behavior and this is how ants have the capability to find the shortest paths between nest and food. ACO has been applied to solve many optimization problems with good discretion , parallel ,robustness and positive feedback[4].

D. K-means Clustering

Clustering is a process of grouping objects in to disjoint cluster so that objects in same cluster are similar but different to objects in other clusters. Its application areas are image processing , machine learning , artificial intelligence ,biology , data mining ,information retrieval ,marketing , pattern recognition and so on. Cluster analysis is a tool that is used to observe the characteristics of clusters and to focus on a particular cluster i.e of use for further analysis.
Clustering is of unsupervised type and non deterministic in nature, does not make use of predefined classes. Through

clustering task measure of dissimilarity by measuring distance between each pair of objects is done. Distance measure includes Euclidean , Manhattan and Minkowski [1].

K-means is a classical dynamic clustering algorithm that has been widely used in clustering analysis. Its main characteristics are simple in theory and fast in computation. Its clustering results depends on the selection of prototype (i.e initial clustering centers) , this selection can decrease accuracy , even can give erroneous results[3] K-mean is the very popular method of clustering . Firstly it was proposed by Mac Queen in 1967 .In K-mean clustering objects are partitioned in to K clusters so that inter cluster similarity is low and intra cluster similarity is high. In algorithm K is the number of centers. It includes two phases, in first phase randomly selection of K centroid is done and this is the fixed value. In second phase each object in a given data set is associated to the nearest centroid based on the distance between objects and cluster center. Euclidean distance metric is used for similarity. Then compute the new centers for each clusters and update the center values. Repeat this process until criterion is satisfied. Limitations of this method are noise sensitive , no rule for choosing value of K and misclassification.

E. *Fuzzy C-mean Clustering (FCM)*

The Fuzzy C-mean clustering algorithm is proposed by Bezdek ,which is an improvement of hard K-means algorithm. In FCM allocation of data points to clusters is not hard, it is fuzzy in nature as in fuzzy logic. It assigns degree of belongingness to each data points for each clusters rather belonging completely only to one cluster .This is an iterative optimization tha minimizes the objective function. This objective function is minimized when data points that are close to the center of their clusters are assigned high degree of membership and low degree of membership are assigned to data point far from the center. Membership degree and cluster centers are updated in
each iteration until the solution is reached. Each data points will be associated with membership values after the FCM clustering .It is important tool in image processing for clustering objects in an image. The main limitation of Standard FCM for image segmentation is that objective function does not take spatial information into the consideration. It is sensitive to noise and noisy pixel is always classified wrongly because of its abnormal feature.

F. Brain MRI Image Segmentation

Magnetic resonance imaging (MRI) is a medical test that helps physicians in diagnosing an treating medical conditions .It uses a powerful magnetic field , radio frequency pulses and a computer to produce detailed pictures of organs , soft tissues , bone and virtually all other internal body structures.MRI does not use x-rays. These images can then be examined on a computer , transmitted electronically , printed or copied to any other device. Detailed MR images allow physicians to evaluate various parts of body and helps in determining the presence of diseases if any.MRI is the most sensitive imaging test of the head (particularly about brain) .It helps in diagnosing brain tumor , stroke , infections etc. So to analyze it MR brain image segmentation is important and challenging problem. Accurate classification of MR images according to tissue type of gray matter , white matter , cerebrospinal fluid at a voxel level provides a way to assess brain structure. The quantization of gray and white matter volumes may be of major interest .Brain tumors are abnormal growth in the brain and can be either cancerous or non cancerous.

G. *CIE Lab Color Space*

This color space is defined by the CIE based on one chnnel for Luminance (Lightness L) and two color channels (‘a’ and ‘b’). There was a problem that colorimetric distance between the individual colors do not correspond to perceived color differences.For example , in the figure **below** , a difference between green and greenish-yellow is relatively large , whereas the distance distinguishing blue and red is too small. CIE solved this problem in 1976 with the development of the 3-dimenional Lab color space or CIE Lab color space.The CIE solved this problem in 1976 with the development of the three-dimensional Lab color space (or CIELAB color space).

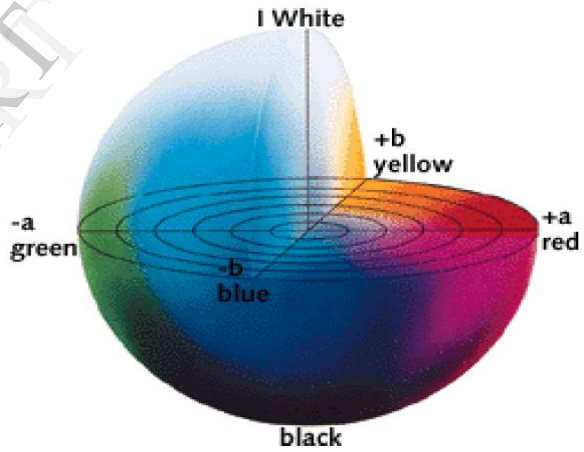

Figure 1.

For eg. The CIE Lab color space is useful for sharpening images and removing artifacts in jpeg images or other images from digital cameras and scanners etc.

II. RELATED WORK

Ping Wang et al [2] proposed a modified FCM algorithm for brain MRI image segmentation. In this paper the problem of standard FCM i.e sensitive to noise because not taking in to account spatial information was noted , and to overcome this problem author used a spatial function to take in to account spatial information and using this function they modified the membership function .It gives better results than standard FCM but are some limitations as it was tested only for two types of noises and images , not easy to

define the no. of clusters and initial prototypes and threshold.

Sun XU et al [3] has proposed an algorithm for hyperspectral image clustering using K-means and Ant colony optimization known as K –means - A CO. They have observed the problem of K-means as misclassification and slow convergence of ACO, so they have used K-means first and then result of K-means as elicitation information for ACO to overcome the problem of both techniques and by doing so clustering result also get im proved .Limitations are: For small scale K–means –ACO works as ACO plus limitations of K-means as mentioned above and elicitation probability value must not be so large and less , must be chosen carefully.

Myung-Eun Lee et al [4] has proposed a novel approach for brain MR Image segmentation using ACO. In order to obtain optimal threshold ACO method is used. In this approach food source is just the optimal threshold of image segmentation. When food is defined ants have the task of finding pixels having similar properties. Ants have the ability to compare pixels to the specific reference food for which they are looking. This specific reference food is the threshold. This approach is tested only one image.

Dr. M. Karnan et al [5] has proposed another novel approach for brain MRI image segmentation in which ACO was hybrid with FCM .This paper is divided in to two steps image enhancement and preprocessing, segmentation. Input brain MRI image is preprocessed

using tracking algo based on intensity to remove film artifacts. After this gradient based enhancement is done. MRF based segmentation is the process of seeking optimal labeling.ACO is used to select optimal labeling. Output of ACO is given to FCM as an input. Aim of this is to extract the suspicious region. Limitations of FCM are noise sensitive and initial prototype can affect the result.

Dr. M. Karnan et al [6] proposed another novel approach for brain MRI image segmentation that was Hybrid markov random field with parallel ACO with FCM (HPACO).This algorithm used to find out optimum label that minimizes the maximizing a posterior(MAP) estimate for image segmentation. Posterior energy values computed by markov random field. This method automatically determine the optimal threshold of input image to select initial prototype and then FCM automatically calculates adaptive threshold for brain tumor segmentation.It gives good results than other methods .Limitations: how to choose the value of pheromone evaporation rate , how to take the no. of iterations and total number of colonies.

Vinod Kumar Dehariya et al [7] proposed a paper on the application of standard K-Means and Fuzzy K-Means algorithm in the area of image segmentation. Fuzzy K-Means gives better results than K-Means algorithm. Standard K-Means is sensitive to initial prototypes , to reduce this K-Means algo will have to run multiple times. FCM is also sensitive to initial prototype and total number of clusters.

Seema Bansal et al [8] proposed an approach for color image segmentation using CIE Lab color space and ant based clustering. Each ant moves randomly around this grid picking and dropping the data items. Data is dispersed on the two dimensional grid. This decision of picking and dropping is not specific but influenced by the data items in the neighborhood of ant's . Similarity is determined using CMC distance. This method automatically calculates no of clusters on the basis of CMC distance and calculated number of clusters depends on the colors in the image. There is a inverse relationship between CMC distance and number of clusters. It gives better segmentation results but the parameters used in this method depends on image to be segmented.

LIU Jiawen et al [9] proposed a fast FCM (MHFCM) using main hue for segmentation beacuase conventional FCM was having problem of great amount of calculation and noise. To get background hue from color image , Hue histogram with added window is used. So effective information i.e without background is used for clustering through FCM. Maximum hue frequency used to be the ground color. Get the hue color component by color space change of image and background hue region from hue form formula .This method best suited for images in which maximal background information is there but not for images having less background information and window size must be chosen carefully.

T. Karthikeyan et al [10] proposed a new algorithm called priority based pheromone algorithm (PBPA), this belongs to ant colony system to give optimal solution. It is similar to ant colony bt different in the sense that it uses priority table system , it allows ant to detect path by using priority value , pheromone and heuristic information , and each ant have the search information for detecting feature combinations.It gives better clustering results than ACO and genetic algorithm but takes more iterations to give optimal results.

De-Yu Tang et al [11] proposed a double weighted fuzzy clustering method for color image segmentation. For improving the performance of image segmentation by FCM algorithm , with use of window based point density weighted method to calculate the membership matrix, at the same time to assign weights to the components of a true

color image relieF algorithm is used.RGB color image is transformed into a HIS space. Then make use of standard FCM for clustering to obtain initial membership values, then these values used for further conducting FCM in next iteration. Its limitation as it is for true color image and the size of window must be chosen carefully because if size is too large computational cost will increase.

III. CONCLUSION

Various approaches have been proposed for various types of image segmentation and image clustering that make use of ACO alone and with other algorithms. These techniques solves various issues but still there are some issues to resolved such as for brain image segmentation need to increase accuracy so that false diagnose would not take place , For color image segmentation more calculation is needed and for hyperspectral image clustering hybrid approach is used that also includes more calculation.

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