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Unsupervised Multi-Spectral Based Image Segmentation and Supervised Based Image Segmentation Technique

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Abstract: Image segmentation is an important and challenging problem in an image analysis. Segmentation of objects in an image is even more difficult and computationally expensive.In this paper all the techniques of an unsupervised based image segmentation and supervised based image segmentation explained. That is Thresholding based image segmentation, edge-based image segmentation, Clustering based image segmentation and region based image segmentation all are unsupervised based image segmentation. Unsupervised learning is basically related to the problem of density estimation in statistics. However unsupervised learning also encompasses many other techniques that seek to summarize the data. Many methods employed in unsupervised learning are based on data mining methods used to pre-process data. K Nearest Neighbor classifier is supervised based image segmentation. A supervised learning algorithm analyzes the training data and hence produces an inferred function, which is used for mapping new examples. An optimal scenario will allow for the algorithm to correctly determine the class labels for unseen instances.

Keywords: Clustering; Segmentation; Supervised based image segmentation; Unsupervised based image segmentation

I. Introduction

Main purpose of image segmentation is to partition an input image into meaningful regions with respect to our particular application. The segmentation is based on measurements taken from the image and might be grey level, colour, texture, depth or motion[10].

A supervised learning algorithm analyses the training data and hence produces an inferred function, which is used for mapping new examples. An optimal scenario will allow for the algorithm to correctly determine the class labels for unseen instances[5].

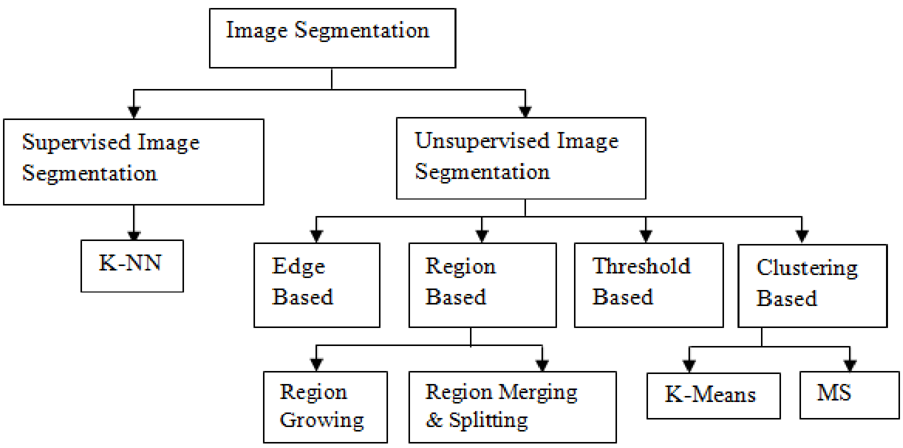


Fig.1 Classification of image segmentation.

Unsupervised learning is that of trying to find hidden structure in unlabeled data. Unsupervised learning is closely related to the problem of density estimation in statistics[6].

In general, there are three advantages in image segmentation. The first advantage is the speed. When segmenting an image, we do not want much time.

The second advantage is good shape connectivity of its segmenting result.

When segmenting an image, we do not want the result of segmenting shape to be fragmentary. If the result of segmenting shape is fragmentary, we need to take many resources to record the boundaries of the over-segment results. It is not desirable results. The third advantage is good shape matching. Consequently, it will be reliable [7].

II. THRESHOLDING SEGMENTATION

The Thresholding technique is simplest method in segmenting images. In this method we have to just set two thresholds on the histogram of image and then take one middle value[2].

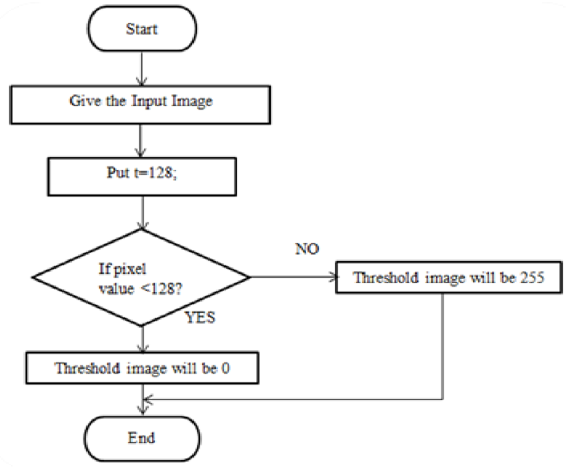


Fig.2 Flowchart of Thresholding Technique

If the pixel with intensity value is below to the middle point then that will be in the black region else it will be on the white region[2].Some of the advantages of Thresholding technique which are it is the simplest method in segmenting images. Although Thresholding has this advantage, it has some disadvantages such as it does not involve the spatial information of the images, so it will bring about the noise, blurred edges, or outlier in the images[2].

III. EDGE BASED IMAGE SEGMENTATION

Detected edges in an image are assumed to represent object boundaries, and used to identify these objects. Edge detection very seldom gives you the perfect unambiguous and closed boundaries you need for a direct segmentation. There will be frequently spurious edges detected where they shouldn't be, and gaps occur where there should be edges [8].

Classification of Edge Based Segmentation Technique

Edge based technique can detect the edges in an image for extracting the object and Edge Based Image Segmentation can be Classified as below.

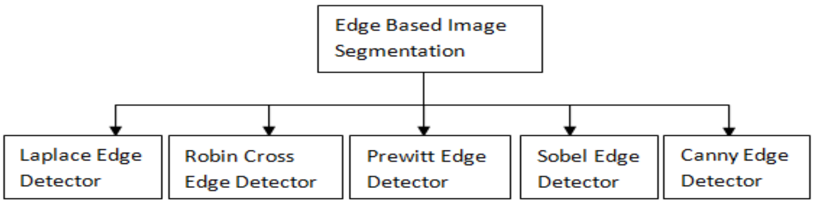


Fig.3 Classification of Edge based Image Segmentation

a) Laplace Edge Detector

The Laplace operator is a very popular operator approximating the second derivative which gives the gradient magnitude only[11].The laplacian is approximated in digital images by a convolution sum. A 3 X 3 mask for 4-neighbourhood and 8-neighbourhood[11].

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} \qquad \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

(a) (b)

Fig.4. (a): 4-neighbourhood 3 X 3 mask, (b): 8-neighbourhood 3 X 3 masks [11]

b) Roberts Cross Edge Detector

The Roberts cross edge detector is an oldest edge detector in digital image processing. It uses the mask to approximate digitally the derivatives G_X and G_Y[11].

$$\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \qquad \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$

Fig.5 Roberts Cross Edge Operators [11]

c) Prewitt Edge Detector

The Prewitt operator, similarly to the Sobel, (as discussed later) and some other operators, approximates the first derivative. Operators approximating first derivative of an image function are sometimes called compass operators because of the ability to determine gradient direction[11]. This is valid for all following operators approximating the first derivative[11].

$$H_1 = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad H_2 = \begin{bmatrix} 0 & 1 & -1 \\ -1 & 0 & 1 \\ -1 & -1 & 0 \end{bmatrix} \quad H_3 = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

Fig.6 Prewitt Edge Operators [11]

d) Sobel Edge Detector

The Sobel operator performs a 2-D spatial gradient measurement on an image. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grey scale image[11]. It is used as a simple detector of horizontality and verticality of edges in which case only masks H1 and H3 are used[11].

$$H_1 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad H_2 = \begin{bmatrix} 0 & 1 & 2 \\ -1 & 0 & 1 \\ -2 & -1 & 0 \end{bmatrix} \quad H_3 = \begin{bmatrix} -1 & 0 & 1 \\ 2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Fig.7. Sobel Edge Operators[11]

The Sobel operator is slower to compute than the Roberts Cross operator, but its larger convolution mask smoothest the input image to a greater extent and so makes the operator less sensitive to noise[11].

e) Canny Edge Detector

The Canny operator was designed to be an optimal edge detector. It takes as input a gray scale image, and produces as output an image showing the positions of tracked intensity discontinuities [8].

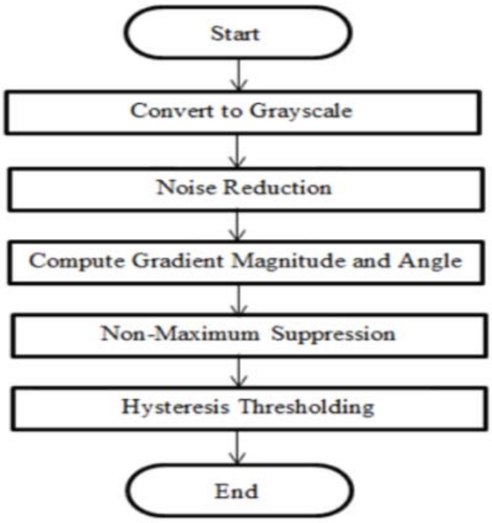


Fig.8. Flowchart of Canny Edge Detector [8]

The Gaussian smoothing (filtering) in that canny edge detector mainly fulfils two purposes. First it can be used to control the amount of detail that appears in the edge image and second, it can be used to suppress noise[8].

IV. FAZZY CMEANS CLUSTERING

Fuzzy c-means algorithm allows data to belong to two or more clusters with different membership coefficient. Fuzzy C-Means clustering is an iterative process. First, the initial fuzzy partition matrix is generated and the initial fuzzy cluster centers are calculated. In each step of the iteration, the cluster centers and the membership grade point are updated and the objective function is minimized to find the best location for the clusters. The process stops when the maximum number of iterations is reached, or when the objective function improvement between two consecutive iterations is less than the minimum amount of improvement specified[7].

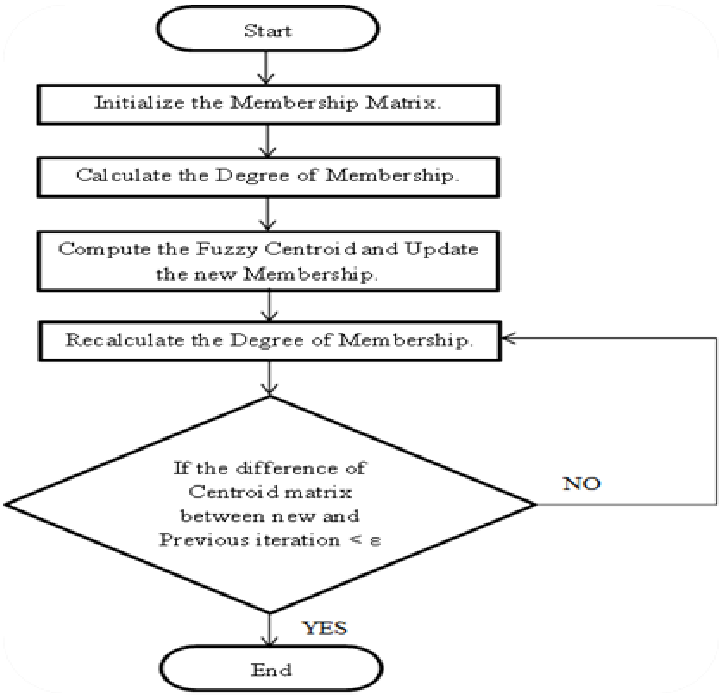


Fig.9. Flowchart of FCM [7]

$$J = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c} \left(\sum_{j}^{n} u_{ij}^{m} \, d\,(X_j - C_i) \right) \qquad (1)$$

Where, J = Cost Function

J_i = Cost of the i^{th} Cluster

$\sum_j^n u_{ij}^m$= fuzziness exponent

$d(X_j-C_i)$ =Distance form point to nearest centroids.

V. K-MEANS CLUSTERING

It is one of the simplest methods which is unsupervised learning algorithms that solve the well-known clustering issue [7].K-means is purposed by Macqueen in 1967. K-means is a simple clustering method which is having low computational complexity as compared to Fuzzy C-means. K-means clustering do not overlap the clusters[7].

$$J=\sum_{i=1}^{c}\left(\sum_{k,x_k \in G_i} d(X_k-C_i)\right) \quad (2)$$

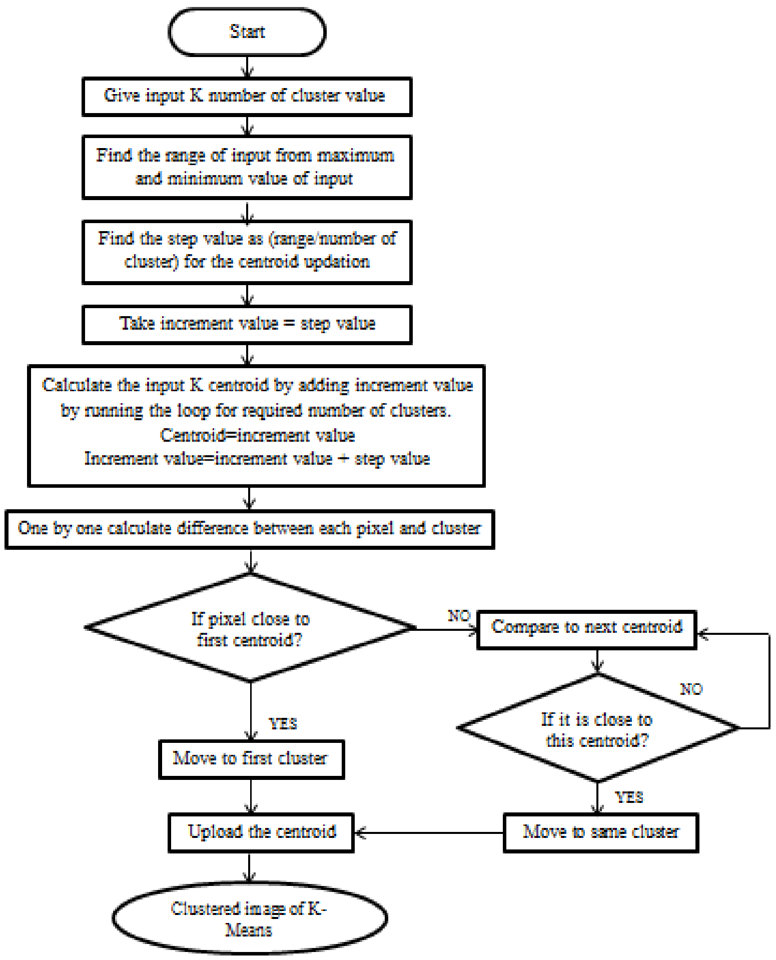


Fig.10. Flow chart of K-Means clustering.

Simplicity and easy implementation are some advantages of k-means but it has several drawbacks as well.

There is no standard for a good set of initial centers. Instead of random choices, k-means algorithms, several initial k-means results can provide the initial points for the next run of the algorithm[7].

VI. MEAN SHIFT CLUSTERING

Mean Shift is defined as finding modes in a set of data samples, manifesting an underlying probability density function (PDF)[3].Mean shift clustering is one of the most non-parametric clustering techniques which do not require any prior knowledge of the clusters. Kernel density estimation (known as parzen window technique in pattern recognition) is the most popular density estimation method [1].

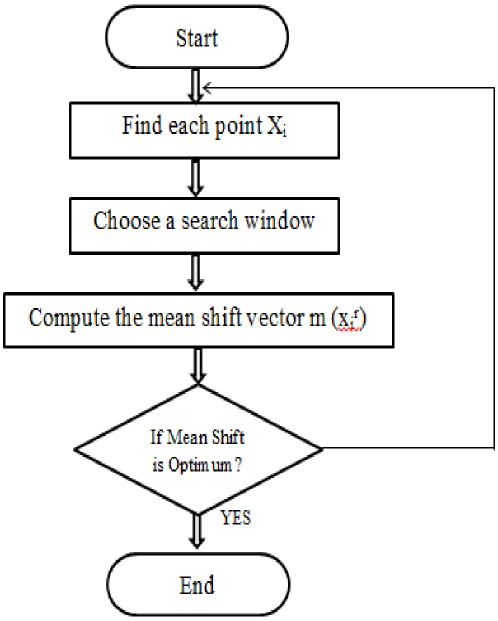


Fig.11. Flow chart of Mean Shift Filtering

The Parzen-window estimate is defined as

$$P(x) = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{h_n^d}k\left(\frac{x-x_i}{h_n}\right) \quad (3)$$

Where k(x)=window function (Kernel in D-dimensional)

$h_n>0$ =Width of the Kernel.

Where k(x) is the window function or kernel in the d-dimensional space such that

$$\int_{R^d} K(x)\,dx = 1 \quad (4)$$

$$\int_{R^d} xK(x)\,dx = 0 \quad (5)$$

The Mean shift clustering has two actions first is mean shift filtering followed by mean shift segmentation. The procedure is shown in following section. Let {xi},where i=1…n,be the original image points. {zi},where i=1… n, be the points of convergence, and {Li},where i=1…n, be a set of labels.

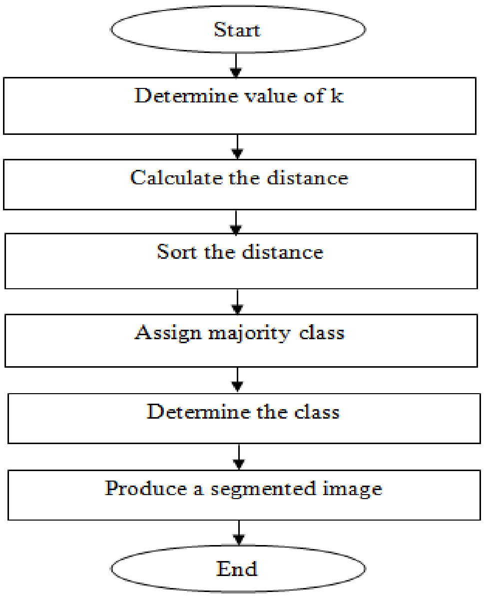
hs: Spatial resolution parameter, which affects the smoothing, connectivity of segments Chosen depending on the size of the image objects.

hr: Range resolution parameter, which affects the number of segments and it should be kept low if contrast is low.

M: Size of smallest segment and it should be chosen based on size of noisy patches.

VII. KNEAREST NEIGHBOR CLASSIFER

K-Nearest Neighbor (k-NN) classification technique is the simplest technique conceptually and computationally that provides good classification accuracy [4].



The k-NN algorithm is based on a distance function and a voting function in k-Nearest Neighbors, the metric employed is the Euclidean distance [4].

$$d(P,Q)=\sqrt{\sum_{i=1}^{n}(pi-qi)^{2}} \qquad (6)$$

Where, pi refers to the instance pixel points and qi is concerns with the values of training samples. Test Samples s given, the k Nearest Neighbor classifier searches the k training samples which are closest to the unknown sample. K-NN is used in classification and prediction. The closeness is usually defined in terms of Euclidean distance [4].The main application of the K-NN algorithm is for the classification prediction of the input image. There are some advantages of the K-NN algorithm[9]: i.e. It is very simple to implement and easy to justify the outcome of K-NN, Getting fine details of input image.

VIII. Comparison of Different Image Segmentation Method

Table I shows the comparison of Different Image Segmentation. In that image segmentation is classified in two types as Unsupervised based image segmentation and Supervised based image segmentation.

TABLE I

Comparison of Different Image Segmentation Method

Parameter	**Unsupervised learning based image segmentation**				**Supervised learning based image segmentation**
	Region Based Segmentation		**Edge Based Segmentation**	**Thresholding based segmentation**	**k-NN Classifier**
	Mean Shift	**K-Means**	**Canny Edge detector**	**Thresholding**	**1-NN Classifier**
Noise	Removing the noise by filtering.	Cannot remove noise.	Only Detected the boundary of that image.	It will bring about noise, blurred edges.	Cannot remove noise.
Smoothing	More Smoothed image is produced.	Different initial centroids will bring about the different results.	Smoothed Image but Less Compare to Mean Shift.	Outlier in the images.	Can't perform smoothing

Separation	Can separate the face and shoulders.	Other region can also separate.	Can separate all edges of particular image.	Only separate binary image.	Can separate all small regions
Over segmentation	Guarantees an over-segmented image.	Does not over segmented image.	Does not over segmented image.	Does not over segmented image.	Guarantees an over-segmented image by varying the threshold.

IX. Conclusion

Image segmentation is to partition an image into meaningful pixels with respect to a particular application. Here whatever unsupervised based algorithms mention for the image segmentation that are working with region so we cannot get fine details of the image so that, by applying supervised based k-NN algorithm for the image we can find the fine details of the images. k-NN algorithm is used for classification and prediction of the input image.

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