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SEGMENTATION USING MEAN SHIFT ALGORITHM WITH MODIFICATIONS:A REVIEW

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***Abstract*—Technique of Mean Shift is used for segmentation of present image and it can be clubbed together with numerous other techniques plus applications. As one of its feature of vast time consumption other algorithms are considered over mean shift. But feature of discontinuity preservation and edge preservation of an image is a plus point of this technique. The work emphasis on technique of Mean Shift in detail with some alteration, so that disadvantage of Standard Mean shift can be eliminated. An alteration like K- distance based technique is used for estimating bandwidth of the kernel. To limit the size of the cluster a termination condition is defined. Extracting the feature using GLCM technique to calculate features of present image and EDISON Mean Shift due to which time taken to calculate Mean Shift is reduced. The result observed due to Mean Shift is an over segmented image and it is further grouped or merge to form segmented image using merging technique.**

Keywords—Segmentation, Mean Shift, K-Distance Based Technique, GLCM feature extraction , EDISON Mean Shift

I. INTRODUCTION

The image segmentation [1] process extracts the backgrounds of the objects by determining particular regions. The segmentation [2] is split in three parts first step is pre-processing; here the image feature is determined from the pixels of image in an object to change the data. The next step or second step is the activation of the segmentation algorithm, if required and the last step or third step is the segmentation itself. Partitioning an image into similar groups such that every region is of same kind but two adjacent regions mixture should not be similar. Image segmentation and its efficiency in automatic image processing are very risky to be preserved. In different applications image segmentation has been used differently. It is used in applications like machine learning, it is observed as a bridge between low level and high level subsystems, as an aid for anatomical structure in medical imaging and other regions of interest whose knowledge is generally available and in statistical analysis, it is assumptive problem, with assumed distributions on image structure, which is widely used in remote sensing In image processing and remote sensing application, it is observed as an aid for land use/land cover classification and landscape change detection [3].Image segmentation is present in every kind of image analysis. There are various technique which are used for segmentation of image which are classified into Graph partitioning method, Region growing method, Thresholding method, Histogram based method, k ++ means, fuzzy C means and Neural network based methods [3],[4],[5] all these technique are time saving technique but the major disadvantage of these techniques are edges of the images are not preserved and these techniques are parametric so calculation becomes difficult so another approach is used for image segmentation called mean shift technique. Some of the applications foe dividing an image into segments are managing content based imaging, in medical imaging it is used for surgical treatments, measure tissue volume, locate tumours and the pathologies, Object detection- Face recognition, Fingerprint recognition, Traffic control system, Video surveillance. Data clustering [6],[7],[8]forms different clusters on the basis of image features by dividing an image.

Main importance of mean shift (MS) algorithm [9],[10],[11],[12] is storing and saving discontinuity and smoothing of an image followed by image segmentation. The features present in the whole image are restored due to its edge storing and saving property. This property is important for segmenting remotely sensed images in which an image is divided into several distinct regions which represents the whole scene of an image. However, it is difficult to divide an image which is remotely sensed into different land covers solely based on the Mean Shift algorithm as it is an unsupervised technique where the number and shape of the data clusters are unknown though comparatively smaller values of the bandwidth parameter used for the Kernel Density Estimation and the smallest region size allowed can assure over segmentation in the output. Hence, MS based method is a good choice to perform the initial over segmentation. Then the merging techniques are used to merge over segmented image into segmented one.

Paper contemplates division of satellite image into different segments using standard mean-shift technique. The steps which has been discussed are as follows,

• An alteration to the standard mean-shift clustering has been determined.

• A k-distance based method for Parzen window width estimation technique has been developed here. For each point, k-distance calculates, its distance to the nearest neighbor. The distance measure at the sharpest transition point of the distance plot is usually considered as the window size for density based clustering algorithms.

• The terminating condition is contemplated here which guarantees fast convergence of the algorithm.
• Feature Extraction Technique to calculate feature of an image is discussed
• EDISON technique is compared with standard mean shift so that time taken by both the techniques is evaluated.

The paper is structured as follows. In Section II, a literature review of the Standard Mean Shift algorithm is presented. The alteration contemplated for the standard Mean Shift based clustering are mentioned in Section III along with Feature extraction from the segmented objects is dealt with in this section using GLCM (gray level co-occurrence matrix) technique. Section IV details the EDISON Mean Shift Technique. Section V concludes the article along with the possible future extension.

II. LITERATURE REVIEW

A. Standard Mean Shift Algorithm

Figure 1 and 2 shows original image and image after Mean Shift Segmentation.Technique of Mean Shift is used for smoothing the quality of image and for segmentation. It is an repetative process and it estimates probability density functions gradient. Method is very simple starting with any region just iterativety shifting the clusters.It is explained by giving an example of billiard balls. Distribution of identical billiards balls is considered in two dimension from which densest region is found .Initially starting off with any region of interest determining its center, then a center of mass is determine which is the point facing the densest region and the center of region is shifted to that mass and the process repeats itself till it attains a zero vector. The shift is called as mean shift vector.This method is non parametric method because there is no equation provided for this distribution of the data points. Each information of the data points have to be stored and as there are millions and millions of data points so it is a time consuming algorithm.

Kernel and Profile

$$K(x) = ck(\| x \|^2) \quad (1)$$

Where k represents profile.

$$P(x) = \frac{1}{n} \sum K(\| x - xi \|^2)$$

$$P(x) = \frac{1}{n} c \sum k(\| x - xi \|^2) \quad (2)$$

Where Equation 1 shows kernel calculation and Equation 2 shows probability density function of Kernel.

Mean-Shift based image segmentation is achieved using the following steps,
· Start off with any cluster of pixel in an image.
· Determine its center of mass.
· Repeat the process till it reaches the densest region of pixels.
· Calculate the mean shift vector.
·Calculate probability density.

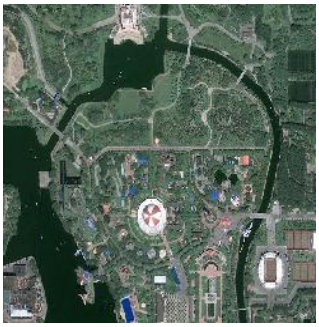

Figure 1:Original Satellite Image.

Figure 2:Image after Mean Shift Segmentation application.

Advantages of Mean Shift are: It is an independent aid, which is suitable for real time data analysis, Shape of the cluster has not been given any supreme importance, Colour and Spatial features of an image can be determined, k-means can be used to choose 'h' (window size). Mean Shift Weaknesses are: The window size (bandwidth selection) is important as window size can cause modes to be clubbed, or it creates "shallow" modes and to eliminate this several alterations in Standard Mean Shift are required.

Properties of mean shift technique**:**

1) Vector of Mean Shift points in the direction of gradient to estimate probability density.
2) It is repetedly calculated so that maximum density in the neighborhood can be acquired.

B. Mathematical Calculation of Standard Mean Shift

$$P(x) = \frac{1}{n} c \sum k(\| x - xi \|^2)$$

$$\nabla P(x) = \frac{1}{n} c \sum_{i=1}^{n} \nabla k(\| x - xi \|^2)$$

$$\nabla P(x) = \frac{1}{n} 2c\Sigma(x - xi)\dot{k}(\| x - xi \|^2)$$

$$\nabla P(x) = \frac{1}{n} 2c \Sigma(x - xi) g(\| x - xi \|^2)$$

$$g(x) = \dot{k}(x)$$

$$\nabla P(x) = \frac{1}{n} 2c \Sigma xi * g(\| x - xi \|^2) - \frac{1}{n} 2c \Sigma x * g(\| x - xi \|^2)$$

$$\nabla P(x) = \frac{1}{n} 2c \Sigma g(\| x - xi \|^2) * \left[\frac{\Sigma xi * g(\|x-xi\|^2)}{\Sigma g(\|x-xi\|^2)} - x \right]$$

$$g(\| x - xi \|^2) = gi$$

$$\nabla P(x) = \frac{1}{n} 2c \Sigma gi * \left[\frac{\Sigma xi * gi}{\Sigma gi} - x \right]$$

$$\nabla P(x) = \frac{1}{n} 2c \Sigma gi * m(x)$$

$$m(x) = \left[\frac{\nabla P(x)}{\frac{c}{n} \sum_{i=1}^{n} gi} \right] \quad (3)$$

So equation of probability density function provides us with Mean Shift vector. The quantity m(x) from equation 3 is called the mean-shift vector. So a technique which is dynamically used for segmentation of image is called Mean Shift. For every data point the cluster containing pixel repeatedly moves.

C. Modified Mean Shift Algorithm[15]

There are four modifications which are applied on Standard Mean Shift Algorithm each of them are discussed below :

1. k_{dist} Based Bandwidth Selection

Density estimation of Kernel[13],[14],[17],[18],[19]is used to calculate density function of a random variable in a non parametric form.This method is very famous for calculating the density function of the Kernel.Another name for this method is Parzen window technique.And more over Nearest Neighbor (NN) technique for bandwidth calculation is also very famous in the clustering study. Hence an enlongation of famous k-dist technique (used with density based clustering) to calculate bandwidth parameter. Consider a particular cluster with n number of points in it the k_{dist} method works as follows:

· Select k a random data point which is approximately in the center of cluster
· k^{th} neighbor distances, for every data sample is readed.
· Separate every distance.
· Curve distance where the sharpest transition occurs is found
· Record k_{dist} value.

. The k_{dist} linked with k is used as the width of the Parzen window.

This technique is used so that clusters which are formed due to numbers of iteration taking place in Standard Mean Shift size can be determine i.e. its width which is also called kernel or Parzen window. The plus point of modification to mean shift is once the width is determined the cluster formed in mean shift iterations will be of equal size and shape. The major challenge facing the mean shift algorithm is determining widths (also known as bandwidths) according to the data statistics in the image and color domains. These parameters are severe in determining the segmentation result. A very huge result concludes loss of necessary details, or under-segmentation; and very small result concludes unrequired boundaries and creation of multiple unnecessary regions, or over-segmentation this can be controlled by calculating Kernel density.

2. Termination Condition

Consider n number of points in a cluster with iteration i and n+1 number of points in other cluster with iteration i+1.The covariance matrix of both the clusters are determined Now, termination condition[15] is defined in equation (4)

$$| v_{i+1} - v_i | \; xcount(x_i \cap y_j), \{i \in n, \; j \in m\} \quad (4)$$

If the data points in two clusters belongs to same class the the calculated variance will be less.i.e.if there is any intersection of points with previously labeled points, we merge those two clusters Data points belonging to the same class have less variance and data points belonging to several different classes has more variance Hence, with the movement of the window, once the termination condition attains the minimum value, it suggests that we are at the mode for that single cluster. So data points belonging to all windows in this iteration form a single cluster.So from this alterations clusters of varions shape and size are avaliable. In this way creation of small clusters and large clusters are reduced which can lead to over segmentation or under segmentation.

3. Feature Extraction Technique

A matrix of co-occurrence, which is also called co-occurrence distribution, is the distribution of co-occurring values of an image at a particular set off Or It compares the distance and spatial relationship of an image and even compares specific parts of the image like region size. Gray Scale image is created using GLCM (gray level co-occurrence matrix) technique [20], [21]. The GLCM calculates gray-level (grayscale intensity or Tone) value of a pixel and how frequently value i occurs either horizontally, vertically, or diagonally to adjacent pixels with the value j where i and j denotes gray level values of the image.

GLCM directions of Analysis

- Horizontal (0°)
- Vertical(90°)
- Diagonal
  a.) Bottom left to top right (-45°)
  b.) Top left to bottom right (-135°)

Co- occurrence matrix, Fractals, Gabor filters, variations of wavelet transform are some of the techniques used for calculating texture. More techniques is also been created describing the local patterns using texture spectrum, for improvisation of texture using a composition of edge information and matrix properties. The identification of specific textures in an image is achieved primarily by modeling texture as a two-dimensional gray level variation [21] or Gray Level Co-occurrence Matrix (GLCM).

GLCM is used to calculate features like Entropy, Correlation, Contrast, Energy, Auto correlation mathematical details are given in [20].

4. EDISON Mean shift

Edge Detection and Image Segmentation (EDISON) System is a software which consists of windows new edge detection window ,new segmentation window.EDISON Mean Shift is similar to Standard Mean Shift both the process are same .It is a software based on C programming which makes it faster than use of edge information improves the results. Time taken by EDISON Mean Shift is very less as compared to Standard Mean Shift. An edge –saliency measure is used to modify the weight function used in mean equation. This clears above bond, preserving the weak boundaries during the segmentation by reducing over-segmentation.

III. CONCLUSION

A literature survey on Standard Mean Shift has been carried out. A criteria is been discussed for modification which guarantees fast convergence while performing near optimal clustering by the MS algorithm. K-distance based technique and termination condition are used as modifications to Standard Mean Shift. The output of this step is an over segmented version of the original image. A feature extraction is performed to extract colour and texture features from each object. Comparison between standard mean shift and EDISON mean shift is been discussed. It is a step for the object based satellite image analysis model and work is being carried out to perform object based high level analysis of satellite images which is carried out by segmentation of image.

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