INTENSITY BASED IMAGE SEGMENTATION USING WAVELET ANALYSIS AND CLUSTERING TECHNIQUES

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Abstract
Image segmentation is becoming popular as it plays a active and dominant role in image analysis and image retrieval.Inorder to speed up the process of segmentation the concept of wavelets has been introduced that is a multiresolution technique that considers the approximation band of image discrete wavelet transform that contains the significant information of the input image. This paper throws a great deal of light towards the classification of segmentation techniques that use intensity as the prime feature to segment the images such as histogram based, edge based, region growing, Model based techniques etc.The in depth study reveals that fine details and small segments are detected well using wavelets and clustering methods..

Keywords: Segmentation; Discrete wavelet transform; clustering.

1. INTRODUCTION

Images are considered as one of the most important medium of conveying information. Understanding images and extracting the information from them such that the information can be used for other tasks is an important aspect of Machine learning. One of the first steps in direction of understanding images is to segment them and find out different objects in them. Thus image segmentation plays a vital role towards conveying information that is represented by an image and also assists in understanding the image.

Image segmentation is the process of dividing the given image into regions homogenous with respect to certain features, and which hopefully correspond to real objects in the actual scene.Segmentation plays a vital role to extract information from an image to create homogenous regions by classifying pixels into groups thus forming regions of similarity. The homogenous regions formed as a result of segmentation indwell pixels having similarity in each region according to a particular selection criteria e.g. Intensity, color etc. Segmentation plays an important role in image understanding, image analysis and image processing.

1.Image Understanding:- The key point of the image understanding is further study on the nature of each target and the linkage of each other as well obtain an explanation of objective scenario for original image as result guide and plan to action.

2.Image analysis: Image analysis task mainly monitors and measures the interested targets in the image in order to get its objective information as a result build up a description of the image.

3. Image processing: Image processing is emphasis on the transformation between the images and improves the visual effects of image.

The segmentation process is perhaps the most important step in image analysis since its performance directly affects the performance of the subsequent processing steps in image analysis. In image processing the input is an image and the output is either an image or parameters related to the image is used to solve identification problems, such as forensic medicine or creating weather maps from satellite pictures.

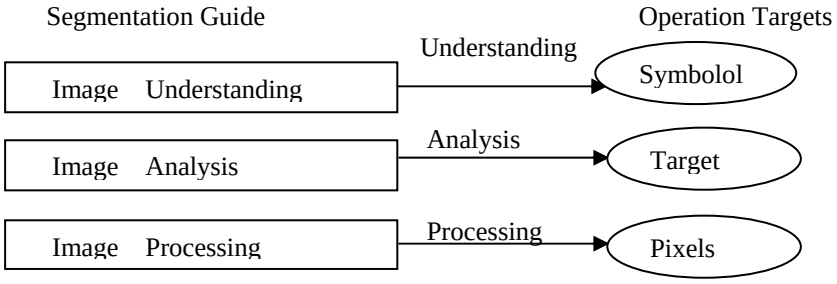

Fig.1. Segmentation guide

A plethora of segmentation algorithms has been proposed in the literature as a consequence of shortcomings faced by the various algorithms that range from simple ad hoc schemes to more sophisticated ones using object and image models.

1.2 Characteristics of Segmentation Algorithms

1. Correctness: the ability to produce segmentations which agree with human intuition. That is, segmentations which correctly identify structures in the image at neither too fine nor too coarse a level of detail.

2. Stability with respect to parameter choice: The ability to produce segmentations of consistent correctness for a range of parameter choices.

3. Stability with respect to image choice: The ability to produce segmentations of consistent correctness using the same parameter choice on a wide range of different images.

1.3 Classification of Image segmentation

i) Manual:-Manual or supervised method involves interactive role of the user in order to identify pixels belonging to the same intensity range that are pointed out manually and segmented.The major Stumbling Block in supervised segmentation is that it consumes more time due to the user intervention into the process to influence the segmentation and becomes the worst when image is of large Size. Larger is the image size greater is the time consumed.

ii) Automatic i.e., unsupervised which is more complex and algorithms need some prior information such as probability of the objects having a special distribution to carry out the segmentation. Unsupervised segmentation groups elements of an image automatically according to some criteria.Unsupervised methods have gained popularity as they agree to a large extend with human intuition.

iii) Semi-automatic is the combination of manual and automatic segmentation [1].

2. Intensity Based Techniques

The pixel intensity based image segmentation is obtained using the following methods [1]

- Histogram method.
- Edge-Based method.
- Region-Based method .
- Model-Based method.

2.1 *Histogram-Based method (Thresholding)*

The prime motto of thresholding is to determine the belongingness of the pixels into parts, zones, function with respect to certain homogeneity such as luminous intensity level. Threshold technique evaluates each image pixel to determine whether it belongs or not to the object generating a binary image. Pixels showing belongingness to the object are indicated with a color while those that lack belongingness are represented with another color.

This method lacks its fame in certain applications due to the difficulty of optimal choice of threshold due to the presence of noise, vagueness and ambiguity among the classes produced by overlapping among them in the histogram.

2.2 *Region Growing*

The basic idea of region growing is to collect pixels with similar properties to form a region. First, we need to find a seed pixel as a starting point for each of needed segmentation. And then merge the same or similar property of pixel (Based on a pre-determined growing or similar formula to determine) with the seed pixel around the seed pixel domain into the domain of seed pixel. This process continues until no more pixels that satisfy the condition can be included, and then the region has grown. In the practical application of this method we need to address three questions:

1. First, chose or determine a group of seed pixel which can correctly represent the required region.
2. Second, fixed the formula which can contain the adjacent pixels in the growth;
3. Third, formulate rules or conditions to stop the growth process

The major advantage of region growing algorithm is easy to complete and compute but at the same time suffers from certain disadvantages such as:-

1. First, it needs human interaction to obtain the seed point, so that the user needs to
Implant a seed point in every region which needs to extract.
2. Second, the patterns of regional growth are also sensitive to noise as result the extracted region has empty or links the separate region under the case of local effect.

2.3 *Edge Detection Technique*

Image edge detection forms the base that guides in image processing and analysis. The edge is a set of those pixels whose grey have step change and rooftop change, and it exists between object and background, object and object, region and region, and between element and element. Edges mark their presence due to grey level being discontinuous.

***1. Gradient Edge Detectors*:** It contains classical operators and uses first directional derivative operation. It includes algorithms such as: Sobel (1970), Prewitt (1970),Robert's operators.

2. Laplacian of Gaussian (LoG): It was invented by Marr and Hildrethw (1980) who combined Gaussian filtering with the Laplacian.This algorithm is not used frequently in machine vision. The Laplacian is a 2-D isotropic measure of the 2nd spatial derivative of an image. The Laplacian of an image highlights regions of rapid intensity change and is therefore often used for edge detection. The operator normally takes a single gray level image as input and produces another gray level image as output.

3. *Gaussian Edge Detectors*

This is symmetric along the edge and reduces the noise by smoothing the image. The significant Operators here are Canny which convolves the image with the derivative of Gaussian for Canny. The Canny edge detection algorithm is known as the optimal edge detector.

These edge detection operators can have better edge effect under the circumstances of obvious edge and low noise. But the actual collected image has lots of noises. So many noises may be considered as edge to be detected. In order to solve the problem, wavelet transformation marked its presence to denoise the image.

2.4 *Model Based*

Model based algorithms are used for efficient segmentation of images where intensity is the prime feature. Since the year 1988 wavelet transforms have wide acceptance in the field of image processing applications. The Wavelet transform solves the problem of resolution which can indicate the signal without information loss and

reduces the complexity. Wavelet transform is a new theory integrated mathematics and signal processing which developed during recent years. The wavelet transform is a mathematical tool in time frequency domain that has been developed and applied to create the multiscale expression of an image. The two dimensional wavelet transform is performed consecutively applying one- dimensional wavelet transform to the rows and columns of the original image [2].

In Fourier analysis, a signal is broken into harmonics of various frequencies whereas wavelet analysis consists of the breaking up of a signal into shifted and scaled versions of the mother wavelet. It has superior analyzing performance and multi-resolution properties, so it is suitable for image analysis. Wavelet transform can be applied for localization and multi-resolution analysis of signal and simply for edge detection of all complicated images. The wavelet is a small wave start at zero and increase then decrease back to zero and able to multiple scaling analysis technique use for image analysis. The three types of the several wavelet transformations are as follows:-

1.. Continuous wavelet transform (CWT) is used to divide a continuous time function, wavelet function is a continuous function in time domain and frequency domain.

2. Complex wavelet transform is extension to the standard discrete wavelet transform (DWT). It is a wavelet transform that provides multi resolution.

3**.** Discrete wavelet transform (DWT) use for discrete sample, which is based on sub-band coding. Discrete wavelet transform decomposes the signal into a coarse approximation and detailed information by analyzing the signal at different frequency bands with different resolutions[14]. The discrete wavelet transform is associated with two sets of functions namely:-

- Scaling functions: Scaling functions are associated with low pass filters. Low pass filter is applied for each row of data and down sampled by 2, in order to obtain low frequency components of the row.
- Wavlet functions : Wavlet functions are associated with high pass filters. High pass filter is applied for same row of data to which low pass filter was previously applied and down sampled by 2 ,in order to obtain high frequency components of the row.

After first level decomposition, the width and height of the sub-image are reduced to half of the original image, which allows the computational speed to be increased. After first level of decomposition, the original image is decomposed into four sub-images which are approximations of the source image and details in the vertical, horizontal and diagonal directions.

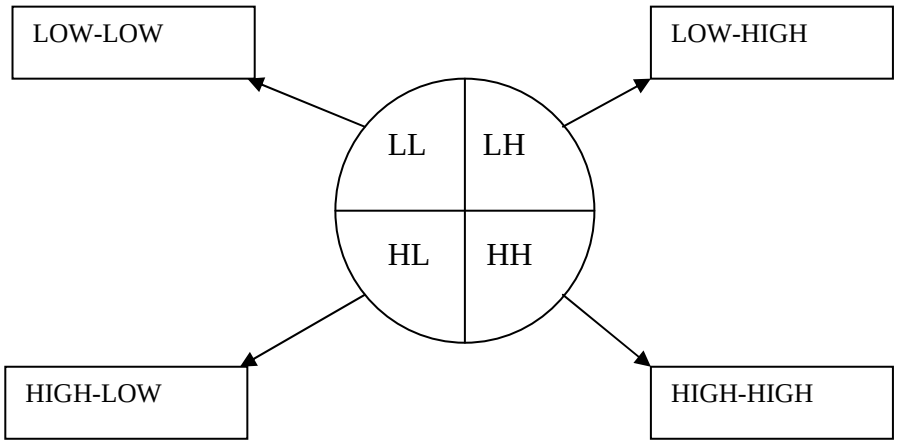

Fig.2. Level 1-Decomposition

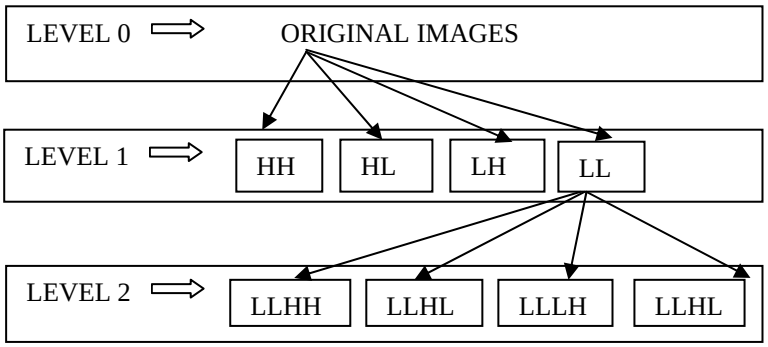

Fig.3. Level 2 -Decomposition

2.5 *Clustering*

Clustering refers to the method of division of data vectors into small amount of groups. Vectors in certain group have to be similar between themselves and dissimilar to vectors of other groups [3]. Distance metric plays a active role to compute the membership degree of a given data vector to any cluster. Different clustering algorithms use different distance metrics.The membership degree is dependent on the distance between the data vector and cluster center i.e smaller the distance between the data vector and cluster higher is the membership degree and vice versa. Most image segmentation algorithms require a prior knowledge of the number of partitions in the image to be segmented [3].

Clustering Techniques

2.5.1 *K-means clustering*

The k-means is a clustering algorithm that depends on the distance measure to partition a data set into clusters.K-means algorithm proceeds with the assumption that the number of segments in the image is known K-means is a unsupervised classifier that classifies the input data points into multiple classes based on their inherent distance from each other.

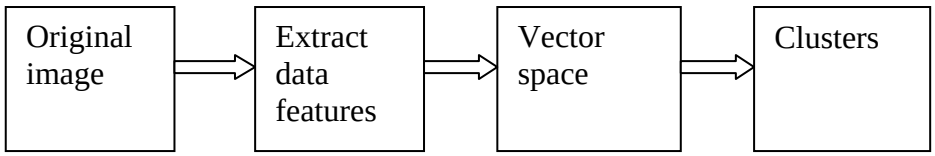

Fig.4. Clustering Process

2.5.2. *Fuzzy c-means clustering*

Bezdek proposed FCM algorithm that employs a fuzzy membership function. Fuzzy *C*-means clustering algorithm is one of most important and popular fuzzy clustering algorithms. At present, the FCM algorithm has been extensively used in feature analysis, pattern recognition, image processing, classifier design, etc.The distance metric computes the membership degree of a given data vector to any cluster. The distance measure used by fuzzy-c means clustering is fixed Euclidean distance that results in fixed shape hyper-spherical clusters. The fuzzy partitioning of data vectors is represented by the fuzzy membership matrix U where the values of its elements represent the membership degrees of every data vector to every cluster [3].

A good clustering algorithm has to distribute the cluster centers as far as possible from each other and at the same time has to assign all the data vectors as close to the correct cluster centers as possible[3].

2.5.3. *Gustafson –Kessel*

The (GK) is a fuzzy clustering algorithm that generates a degree of membership of each data vector to a given cluster[4]. This method is based on adaptive distance rule to identify clusters of different geometrical shapes in a

data set. The algorithm employs wavelet transform to decompose the image into different spectral components and build a feature vector for every pixel. The advantages of GK algorithm are:

- Less sensitive to fall into local minima.
- Generates clusters with different geometric shapes.
- Requires no predefined number of partitions nor the number of textures in the image.

The GK algorithm firstly maps the image to the feature apace using wavelet transform.After the mapping process reduction of features is carried out using PCA that has the ability to transform a number of features into principal components. Each component may be either the original feature itself or a linear combination of original features.The next step would be to define the allowable minimum number of clusters and the maximum one.The definition of clusters should be followed by the process to compute the CS measure. The number of clusters that results in the minimum CS has to be found. Apply the GK to partition the entire data to the best number of clusters.Postprocess clustering results to assign each pixel to the nearest cluster.

CONCLUSION

In this Paper, we discussed various segmentation techniques that use intensity as the prime feature Model based algorithms are used for efficient segmentation of images as in model based method segmentation is carried out using wavelet transform that is faster since approximation band coefficients of DWT are considered.Hence due to approximation band computation time reduces as compared to other non-parametric methods.Segmentation using wavelets performs much superior in terms of computation time and image quality index. It has been analyzed from the studies that fine details and small segments are detected well using Wavelet and GK clustering algorithm and even GK algorithm eliminates certain problems such as local minima problem of Fuzzy c-means clustering. But still GK method consumes a great deal of time due to the Clustering of the entire data many times.

Future efforts have to be presented to select a reduced set of data that could represent the entire data. At last emphasis should be laid down towards developing algorithms that reduce convergence time, computation time and are much superior in terms of image quality index in comparison to the existing methods.

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