Image Segmentation Engineering: Various Techniques and related Issues

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Abstract— **Due to the introduction of computer technology image-processing techniques have become increasingly significant in a wide variety of applications. Image segmentation is a classic matter in the field of image processing and also is a hotspot and emphasis of image processing techniques. With the improvement of computer processing competences and the increased application of color image, the color image segmentation are more and more concerned by the researchers. Several general-purpose algorithms and techniques have been developed for image segmentation. Since there is no general solution to the image segmentation problem, these techniques often have to be combined with domain knowledge in order to effectively solve an image segmentation problem for a problem domain. This paper presents a comparative study of the basic image segmentation techniques i.e., Edge- Based, K-Means Clustering, Thresholding and Region-Based techniques.**

Index Terms—**About four key words or phrases in alphabetical order, separated by commas.**

I. INTRODUCTION

People are only interested in certain portions of the image in the research and application of the image. These parts are frequently referred to as a target or foreground (other part is called background), they generally correspond to the image in a specific and unique nature of the area. It needs to extract and separate them in order to identify and analyze object, on this basis it will be possible to further use for the target. To illustrate the level of the image segmentation in image processing, the concept of "image engineering" is introduced, it bring the involved theory, methods, algorithms, tools, equipment of image segmentation into an overall framework [6]. Image Engineering is a new subject for research and application of image field, its content is very abundant. According to the different of the abstract degree and research methods, it can be divided into three levels: Image processing, image analysis and image understanding. As shown in Figure 1 Image processing is emphasis on the alteration between the images and improves the visual effects of image. Image analysis 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, 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.

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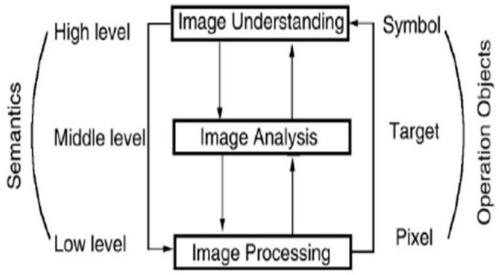


Fig.1 Engineering of Image Segmentation

Image processing, image analysis and image understanding have different operations, refer to Figure 1. Image processing is relatively low-level operations; it is mainly operated on the pixel-level. Then image analysis enters the middle-level, it focuses on measuring, expression and description of target. Image understanding is mainly highlevel operation; essentially it focuses on the operation and illation of data symbol which abstracts from the description [8]. Image segmentation is a key step from the image processing to image analysis, it occupy an important place. On the one hand, it is the basis of target expression and has important effect on the feature measurement. On the other hand, as the image segmentation, the target expression based on segmentation, the feature extraction and parameter measurement that converts the original image to more abstract and more compact form, it is possible to make high-level image analysis and understanding. For example, satellite image processing in the application of remote sensing; the brain MR image analysis in the applications of medicine; the plates of illegal vehicle region segmentation in the traffic image analysis; the image region of interest extraction in the objectoriented image compression and contentbased image retrieval.

II. DIGITAL IMAGE PROCESSING

Digital image processing is important domain for many reasons. Actually Digital image processing is a recent subject in computer history. In 1960s; Bell Labs and University of Maryland, and a few other places started to develop several techniques for digital image processing. With application to satellite imagery, wire photo standards conversion, medical imaging, videophone, character recognition, and photo enhancement. But the cost of processing was fairly high with the computing equipment of that era. In the 1970s, image processing proliferated, when cheaper computers and dedicated hardware became available. Images could then be processed in real time, for some dedicated problems such as television standards conversion. As general-purpose computers became faster, they started to take over the role of

dedicated hardware for all but the most specialized and compute-intensive operations. In digital image processing, we use computer algorithms to perform image processing. Actually digital image processing has several advantages over the analog image processing; first it gives a high number of algorithms to be used with the input data, second we can avoid some processing problems such as creating noise and signal distortion during signal processing. In 2000s, fast computers became available for signal processing and digital image processing has become the popular form of image processing. Because of that, signal image processing became versatile method, and also cheapest. Image segmentation is important part in many signal processing technique and its applications.

III. THE STUDY OF COLOR IMAGE SEGMENTATION

Image segmentation is the process of separating or grouping an image into different parts. These parts normally correspond to something that humans can easily separate and view as individual objects. Computers have no means of intelligently recognizing objects, and so many different methods have been developed in order to segment images. The segmentation process in based on various features found in the image. This might be color information that is used to create histograms, or information about the pixels that indicate edges or boundaries or texture information. The color image segmentation is also widely used in many multimedia applications, for example; in order to effectively scan large numbers of images and video data in digital libraries, they all need to be compiled directory, sorting and storage, the color and texture are two most important features of information retrieval based on its content in the images and video. Therefore, the color and texture segmentation often used for indexing and management of data; another example of multimedia applications is the dissemination of information in the network [7]. Today, a large number of multimedia data streams sent on the Internet, However, due to the bandwidth limitations; we need to compress the data, and therefore it calls for image and video segmentation.

A. METHODS FOR COLOR IMAGE SEGMENTATION

Image segmentation methods are categorized on the basis of two properties discontinuity and similarity. Methods based on discontinuities are called as boundary based methods and methods based on similarity are called Region based methods Segmentation is a process that divides an image into its regions or objects that have similar features or characteristics. Mathematically complete segmentation of an image R is a finite set of regions R1…Rs, [1].

$$R=U^{s}_{i=1}R_i \quad R_i \cap R_j=\Phi \quad i\neq j \; j$$

Image segmentation methods can be categorized as below:

- Edge Based Methods
- Region Based Methods
- Hybrid Techniques

A. Region Based Techniques

Region based methods are based continuity. These techniques divide the entire image into sub regions depending on some rules like all the pixels in one region must have the same gray level. Region-based techniques rely on common patterns in intensity values within a cluster of neighboring pixels. The cluster is referred to as the region, and the goal of the segmentation algorithm is to group the regions according to their anatomical or functional roles.

B. Clustering Technique

Given an image this methods splits them into K groups or clusters. The mean of each cluster is taken and then each point p is added to the cluster where the difference between the point and the mean is smallest. Since clustering works on hue estimates it is usually used in dividing a scene into different objects. The performance of clustering algorithm for image segmentation is highly sensitive to features used and types of objects in the image and hence generalization of this technique is difficult. Ali, Karmarkar and Dooley [2] presented a new shape-based image segmentation algorithm called fuzzy clustering for image segmentation using generic shape information (FCGS) which integrates generic shape information into the Gustafson-Kessel (GK) clustering framework. Hence using the algorithm presented in[2] can be used for many different object shapes and hence one framework can be used for different applications like medical imaging, security systems and any image processing application where arbitrary shaped object segmentation is required. But some clustering algorithms like K-means clustering doesn't guarantee continuous areas in the image, even if it does edges of these areas tend to be uneven, this is the major drawback which is overcome by split and merge technique.

C. Split and Merge Technique

There are two parts to this technique first the image is split depending on some criterion and then it is merged. The whole image is initially taken as a single region then some measure of internal similarity is computed using standard deviation. If too much variety occurs then the image is split into regions using thresholding. This is repeated until no more splits are further possible. Quadtree is a common data structure used for splitting. Then comes the merging phase, where two regions are merged if they are adjacent and similar. Merging is repeated until no more further merging is possible. The major advantage of this technique is guaranteed connected regions. Quad trees are widely used in Geographic information system. Kelkar D. and Gupta, S[3] have introduced an improved Quad tree method (IQM) for split and merge .In this improved method they have used three steps first splitting the image, second initializing neighbors list and the third step is merging splitted regions. They have divided the third step into two phases, in-house and final merge and have shown that this decomposition reduces problems involved in handling lengthy neighbor list during merging phase. The drawbacks of the split and merge technique are, the results depend on the position and orientation of the image, leads to blocky final segmentation and regular division leads to over segmentation (more regions) by splitting. This drawback can be overcome by reducing number of regions by using Normalized cuts method.

D. Normalized Cuts

This technique is proposed by Jianbo Shi and Jitendra Malik is mostly used in segmentation of medical images. This method is based on graph theory. Normalized cuts aim at splitting so that the division is optimal. Each pixel is a vertex in a graph, edges link adjacent pixels. Weights on the edge are assigned according to similarity between two corresponding pixels. The criterion for similarity is different in different applications. Similarity can be defined the distance, color, gray level, textures and so on. The advantage of this technique is that it removes the need to merge regions after splitting. It gives better definition around the edges Shi and Jitendra Malik [4], in their paper Normalized cuts and image segmentation shows how normalized cut is an unbiased measure of disassociation between subgroups of a graph and it has the nice property that minimizing normalized cut leads directly to maximizing the normalized association, which is an unbiased measure for total association within the subgroups. Wenchao Cai, JueWu, Albert C. S. Chung [5] improved the performance of the normalized cut by introducing the shape information. This method can correctly segment the object, even though a part of the boundary is missing or many noisy regions accompany the object. Thus there are various advantages of this method like it presents a new optimality criterion for partitioning a graph into clusters, different image features like intensity, color texture, contour continuity are treated in one uniform network. But there are certain disadvantages like lot of computational complexity involved especially for full-scale images .The performance and stability of the partitioning highly depends on the choice of the parameters.

E. Region Growing

Of the many proposed image segmentation methods, region growing has been one of the most popular methods. This method starts with a pixel and will go on adding the pixels based on similarity, to the region. When the growth of a region stops another seed pixel which does not belong to any other region is chosen, and again the process is started. The whole process is repeated until all pixels belong to some region. The advantage of this technique is, connected regions are guaranteed. Matei Mancas, Bernard Gosselin and Benoit Macq [6] have used in their research a method which only needs one seed inside the region of interest (ROI). They have applied it for spinal cord segmentation but have found that it also shows results for parotid glands or even tumors. There are various applications where region growing techniques is mostly used like, to segment the parts of human body during treatment planning process e.g. segmentation of prostrate, bladder and rectum from contrast CT data. There are certain advantages of this technique like multiple criterions can be selected at the same time, gives very good results with less noisy images. But the various disadvantages of this technique are, if seeded region growing method is used then noise in the image can cause the seeds to be poorly placed, over segmentation may take place when the image is noisy or has intensity variations, cannot distinguish the shading of the real images, this method is power and time consuming.

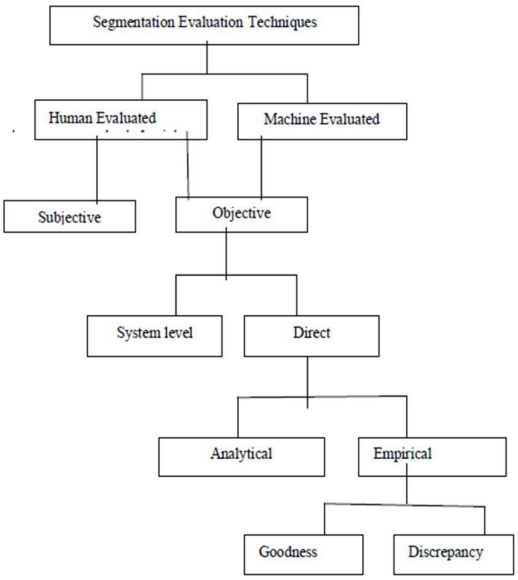
F. Thresholding

This is the simplest way of segmentation. Using thresholding technique regions can be classified on the basis range values, which is applied to the intensity values of the image pixels. Thresholding is computationally inexpensive and fast, it is the oldest

segmentation method and is still widely used in simple applications. Using range values or threshold values, pixels are classified using either of the thresholding techniques like global and local thresholding. Global thresholding method selects only one threshold value for the entire image. Local thresholding selects different threshold values for different regions. To segment complex images multilevel thresholding is required.

G. Edge Based Techniques

Segmentation Methods based on Discontinuity find for abrupt changes in the intensity value. These methods are called as Edge or Boundary based methods. Edge detection is the problem of fundamental importance in image analysis. Edge detection techniques are generally used for finding discontinuities in gray level images. Edge detection is the most common approach for detecting meaningful discontinuities in the gray level. Image segmentation methods for detecting discontinuities are boundary based methods Edge detection can be done using either of the following methods Edges are local changes in the image intensity. Edges typically occur on the boundary between two regions. Important features can be extracted from the edges of an image (e.g., corners, lines, curves).Edge detection is an important feature for image analysis. These features are used by higher-level computer vision algorithms (e.g., recognition). Edge detection is used for object detection which serves various applications like medical image processing, biometrics etc. Edge detection is an active area of research as it facilitates higher level image analysis. There are three different types of discontinuities in the grey level like point, line and edges. Spatial masks can be used to detect all the three types of discontinuities in an image.



CONCLUSION

There have been many image segmentation methods created and being created using many distinct approaches and algorithms but still it is very difficult to assess and compare the performance of these segmentation techniques. Researchers would evaluate their image segmentation techniques by using one or more of the following evaluation methods in Fig.2.

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