

A Study of Different Methods for Image Segmentation

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Abstract: *Image segmentation is an important method of Image Processing. Image segmentation is a tool used to divide an image into multiple segments. Image segmentation is the fundamental step to examine images and extract data from them. It is the field widely researched and still offers various challenges for the researchers. Image segmentation is a main image processing step, and it is used everywhere if we want to analyze what is inside the image. Whenever we work with the image in any application, initial step is to segment the image in order to solve its complication. Image segmentation is a critical step as it directly influences the overall success to understand the image. It is a challenging task of image processing and the subsequent tasks including object detection, feature extraction, object recognition and classification depend on the quality of segmentation process. This paper is the study of the basic principles of the methods used to segment an image.*

Keywords: *Image Segmentation, Image Processing, Pixon, Cluster, Edge-Based Technique, Region Based technique.*

I. INTRODUCTION

Image segmentation is the separation of an image into regions or categories, which correspond to different objects or parts of objects. Every pixel in an image is allocated to one of a number of these categories. A good segmentation is typically one in which:

- Pixels in the similar category have similar grey scale of multivariate values and form a connected region,
- Neighboring pixels which are in different categories have dissimilar values.

One of the major objective of image processing is to retrieve required information from the given image in a way that it will not effects the other features of that image.

Image Segmentation is one of the important steps of image processing, in which any image is being subdivided into multiple segments. Each segment will represent some kind of information to user in the form of color, intensity, or texture. Hence, it is important to isolate the boundaries of any image in the form of its segments [1]. This process of segmentation will assign a single value to each pixel of an image in order to make it easy to differentiate between different regions of any image. This differentiation between different segments of image is done on the basis of three properties of image, i.e., color, intensity, and texture of that image. Therefore the selection of any image segmentation technique is done after observing the problem domain [2].

It is observed that there is not a flawless method for image segmentation, since each image has its own different type. It is also a very difficult task to find segmentation technique for a particular type of image. Since a method applied to one image may not remain effective to other type of images, therefore segmentation techniques has been divided into three types, i.e. segmentation techniques based on classical method, AI techniques, and hybrid techniques [3].

Some of the most well-known image segmentation methodologies including Edge based segmentation, Fuzzy theory based segmentation, Partial Differential Equation (PDE) based segmentation, Artificial Neural Network (ANN) bases segmentation, threshold based image segmentation, and Region based image segmentation are highlighted in Fig. 1. Image segmentation is normally used to detect objects and boundaries (lines, curves, etc.) in images. It is the fundamental step towards computer vision and image processing operation which includes face detection, medical imaging, locating objects in satellite images etc. More specifically, image segmentation is the process of allocating a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

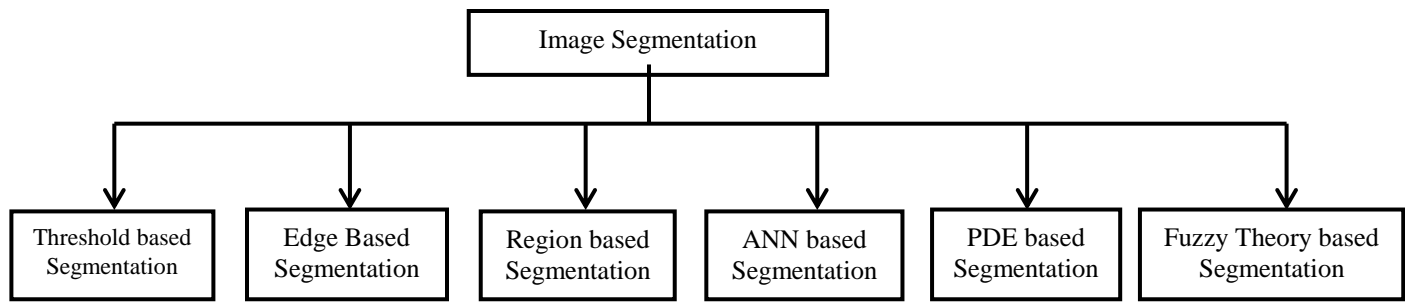


Figure 1. Various Image Segmentation Techniques

II. IMAGE SEGMENTATION TECHNIQUES

A. Threshold Based Segmentation :

In thresholding, pixels are allocated to categories according to the range of values in which a pixel lies. Pixels with values less than specified criteria have been placed in one category, and the rest have been placed in the other category. Salem Saleh Al-amri [4] has applied Mean technique, Pile technique, HDT, and EMT technique on three satellite images in order to select the best segmented image from all above techniques. Experiments and comparative analysis of techniques shows that HDT (Histogram Dependent Technique) and EMT (Edge Maximization Technique) are the best thresholding techniques which outperform all other thresholding techniques. Kaiping Wei [5] have found that current image segmentation techniques are time consuming and require lot of computational cost in order to perform image segmentation. It is a huge problem for real time applications. They proposed a new threshold based segmentation method using Particle Swarm Optimization (PSO) and 2-d Otsu algorithm (TOPSO). TOPSO

B. Edge Based Segmentation:

In edge-based segmentation, an edge Filter is applied to the image, pixels are classified as edge or non-edge depending on the filter output, and pixels which are not separated by an edge are allocated to the same category. Edge detection is a basic step for image segmentation process. It splits an image into object and its background. Edge detection divides the image by detecting the change in intensity or pixels of an image. Gray histogram and Gradient are two main methods for edge detection for image segmentation [11]. Numerous operators are used by edge detection method, i.e., Classical edge detectors, zero crossing, Laplacian of Gaussian (LoG) [12], and color edge detectors etc [13]. In this paper several new approaches regarding Edge detection based image segmentation is discussed from last ten years.

Amjad Zaim [15] has found that segmentation of prostate boundaries from ultrasound images is a challenging task

for surgical procedures. They proposed a new edge based segmentation technique for prostate ultrasound image.

C. Region Based Segmentation:

In region-based segmentation, algorithms operate iteratively by grouping together pixels which are

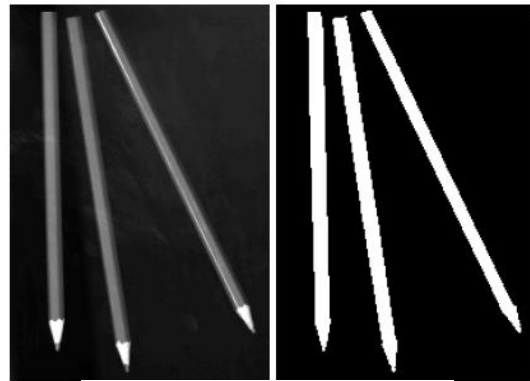


Figure 2. Edge base segmentation

neighbours and have similar values and splitting groups of pixels which are dissimilar in value. Region based segmentation is simple as compare to other methods and also noise resilient. It splits an image into different regions based on pre-defined criteria, i.e., color, intensity, or object. Region based segmentation methods are categorized into three main categories, i.e., region growing, region splitting, and region merging.

Region based segmentation is simple as compare to other methods and also noise resilient. It divides an image into different regions based on pre-defined criteria, i.e., color, intensity, or object. Region based segmentation methods are categorized into three main categories, i.e., region growing, region splitting, and region merging [6]. In this paper several new approaches regarding Region based image segmentation is discussed from last five years. Karoui [7] proposed a new unsupervised image segmentation method using level set methods and texture statistics. They claim that their method is different from other methods since it doesn't assume independent variable, and it doesn't restrict to first order grey features. The implementation contains feature selection step to re-adjust the weights of each feature to get the segmentation. Yong-mei Zhou [8] has introduced new region-based image segmentation technique with the help of mean-shift

clustering algorithm. Initially, their method extract color, texture, and location features of each pixel of an image, then, make the clusters on the basis of those features using mean-shift clustering approach, label the each region, and finally make segments of image on the basis of these labels.

TABLE 1. COMPARISON OF 3 IMAGE SEGMENTATION TECHNIQUES

Parameter	Threshold Based Segmentation	Edge Based Segmentation	Region Based Segmentation
Nature of the Output Image	Black-White	Black-White	Black-White
Computation Complexity	Less	Moderate	High
Detection of Multiple Objects	Poor	Poor	Moderate
Speed	Fast	Moderate	Slow
Accuracy	Moderate	Moderate	Good

D. ANN Based Image Segmentation:

In Artificial Neural Network, each neuron is corresponding to the pixel of an image. Image is mapped to the neural network. Image in the form of neural network is trained using training samples, and then connection between neurons, i.e., pixels is found. Then the new images are segmented from the trained image [21]. Some of the mostly used neural networks for image segmentation are Hopfield, BPNN, FFNN, MLFF, MLP, SOM, and PCNN. Segmentation of image using neural network is perform in two steps, i.e., pixel classification and edge detection [19]. In this paper several new approaches of ANN used for image segmentation is discussed from last five years.

E. PDE Based Image Segmentation:

PDE (Partial Differential Equations) equations or PDE models are used widely in image processing, and specifically in image segmentation. They uses active contour model for segmentation.

Active Contour model or Snakes transform the segmentation problem into PDE. Some famous methods of PDE used for image segmentation are Snakes, Level-Set, and Mumford shah method [20]. In this paper, several new approaches for image segmentation based on PDE are discussed.

F. Fuzzy Theory Based Image Segmentation:

Fuzzy set theory is used in order to analyze images, and provide accurate information from any image. Fuzzification function can be used to remove noise from image as well [16]. A gray-scale image can be easily transformed into a fuzzy image by using a fuzzification function. Different morphological operations can be combined with fuzzy method to get better results [17]. Fuzzy k-Means and Fuzzy C-means (FCM) are widely used methods in image processing [18]. In this section several new approaches of image segmentation using Fuzzy theory is presented.

III. IMPORTANCE OF IMAGE SEGMENTATION

- Segmentation is generally the first stage in any attempt to analyze or interpret an image automatically.
- Segmentation bridges the gap between low-level image processing and high-level image processing.
- Some kinds of segmentation technique will be found in any application involving the detection, recognition, and measurement of objects in images.
- The role of segmentation is crucial in most tasks requiring image analysis. The success or failure of the task is often a direct consequence of the success or failure of segmentation.
- However, a reliable and accurate segmentation of an image is, in general, very difficult to achieve by purely automatic means.

IV. REQUIREMENTS FOR IMAGE SEGMENTATION

Good image segmentation meets certain requirements:

- Every pixel in the image belongs to a region.
- A region is connected: any two pixels in a particular region can be connected by a line that doesn't leave the region.
- Each region is homogeneous with respect to a chosen characteristic. The characteristic could be syntactic (for example, color, intensity or texture) or based on semantic interpretation.
- Adjacent regions can't be merged into a single homogeneous region.
- No regions overlap.

V. APPLICATIONS OF IMAGE SEGMENTATION

Image Segmentation has many applications which are:

- Face recognition
- Fingerprint recognition
- Medical imaging such as:
- Locate tumors and other pathologies
- Measure tissue volumes
- Computer-guided surgery
- Diagnosis

- Treatment planning
- Study of anatomical structure
- Locate objects in satellite images (roads, forests, etc.)
- Iris recognition
- Traffic control systems
- Brake light detection
- Machine vision
- Agricultural imaging – crop disease detection etc.
- Industrial inspection
- Optical character recognition (OCR)
- Tracking of objects in a sequence of images
- Classification of terrains visible in satellite images.
- Detection and measurement of bone, tissue, etc., in medical images.

VI. CONCLUSION

In this paper, various techniques of image segmentation has been studied. An overview of all related image segmentation techniques has been presented in this paper. Recent research in image segmentation techniques is also studied in this paper. After the analysis of different techniques of image segmentation, it is observed that a hybrid solution for image segmentation consists of two or more techniques is being the best approach to solve the problem of image segmentation. It may vary depends on image and need or purpose of image segmentation.

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