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Image Segmentation and Its Implementation- Basic Survey

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ABSTRACT

Image Segmentation is considered as one of the main steps in image processing. To evaluate a digital image, it splits it into several areas. It's also employed for object classification in images. We only express the image in a more comprehensible fashion during segmentation. In digital photos, segmentation is primarily used to identify objects, borders, and other pertinent information. Segmentation can be implemented using a variety of techniques, including threshold, clustering, transform methods, etc. Following the use of these methods, the segmented image that is produced is a collection of all the image's pixels. The image's pixels represent various aspects of the image, such as texture, color, etc. A survey of the literature from the past five years on fundamental picture segmentation techniques is presented in this work.

Keyword: Fuzzy, MIA, Threshold, Clustering, Segmentation, PDE based image segmentation

I. INTRODUCTION

A crucial area of study in digital image processing is picture segmentation. Image segmentation is used to divide an image into its component parts according to the proper locations. The images are required for the segmentation. However, the pictures are either in color or black and white. The gray level is what produces color visuals. [1]. Renowned image segmentation techniques that researchers continue to employ include Watershed Transformation, Edge Detection, Threshold, Histogram, and region-based approaches. Considering that photos can be classified as either color or grayscale based on their color. As a result, image segmentation for color images differs greatly from that for grayscale images (content-based image retrieval, for example). [2], [3]. The hue of the image also varies as the gray level contrast does. Medical image segmentation relies heavily on picture segmentation. Medical imaging is essential to helping the healthcare system, which in turn helps the healthcare system treat patients. Segmentation is an essential first step in Medical Image Analysis (MIA) for the medical pictures. [5]. A significant and relatively new area in computer history and digital

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image processing is digital image segmentation. Bell Laboratories, the University of Maryland, and a few other locations developed a few of these approaches in 1960. The idea of picture segmentation can be used in satellite images, video phones, medical imaging, and photo enhancement, among other applications. In the realm of medical imaging, it can be challenging to apply appropriate segmentation due to many issues such as brain, head, leg, and illness kind. Therefore, in order to address these issues, we require distinct algorithms for segmenting these images in order to obtain precise outcomes. Artificial intelligence has been blended with machine learning, fuzzy logic, and pattern recognition in digital image processing. Image engineering is a generic framework that may be used to group many image approaches together. Three layers comprise image engineering, which is defined as:

a) Image understanding
b) Image Analysis
c) Image Processing

II. LITERATURE REVIEW ON IMAGE SEGMENTATION TECHNIQUE

There are different techniques of image segmentation. Some ofwhich are following:

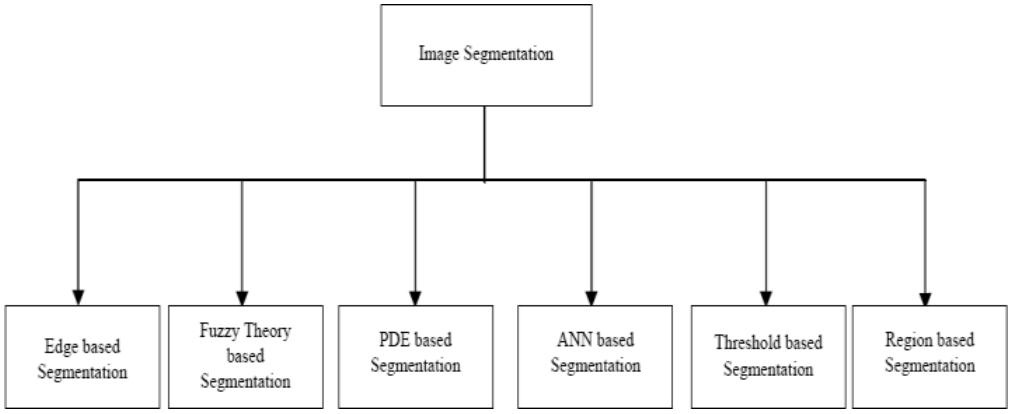

Fig. 1. Image Segmentation techniques

A) Edge Based Image Segmentation

1	1	1
0	0	0
-1	-1	-1

-1	0	1
-1	0	1
-1	0	1

Fig. 2. Horizontal Filter Vertical Filter

An edge is the line separating two areas that have distinct characteristics of the same gray level. Edge detection is the process of identifying each object by its visible, closed border, which is indicated by the image's intensity value. It is crucial for pattern recognition and image analysis since it provides information about the actual size of things. Edgedetection methods are following:

Roberts Edge Detection

In image processing, the Roberts edge operator is used to identify edges. Lawerence Roberts made the proposal in 1963. The first edge detector was this one. The Roberts operator measures a 2-D spatial gradient on an image in a straightforward and fast manner. Hence, it draws attention to areas with a strong spatial gradient, which frequently line up with edges. When the operator is used most frequently, both the input and the output are grayscale images. The estimated absolute magnitude of the input image's spatial gradient at each place in the output is represented by the pixel values at that location.[6]

Sobel Edge Detection

Often referred to as a Sobel filter, the Sobel edge detector bears Irwin Sobel's name. The Sobel edge detector has two masks: a horizontal mask and a vertical mask. 3*3 metrices are typically utilized for these masks. Standard Sobel operators: each simple central gradient estimate for a 3 x 3 neighborhood is the vector sum of two orthogonal vectors. A unit vector that indicates the direction of the derivative is multiplied by a directional derivative estimate for each orthogonal vector. The eight directional derivative vectors make up the vector sum of these straightforward gradient estimations. Consequently, for a location on a Cartesian grid with eight neighbors that have the density values displayed: [7]

Prewitt Edge Detection

In image processing, Prewitt Edge Detector is utilized in conjunction with edge detection methods. Another name for it is the operator for discrete differentiation. It is employed in the computation of the picture intensity function's gradient. Applying a horizontal and vertical filter in order helps the Prewitt Edge filter identify edges. The final output is obtained by applying both filters to the image and adding them together. [8]

III. METHODOLOGICAL ASPECTS

A) Fuzzy Theory Based Image Segmentation

A novel fuzzy morphologically based fusion picture segmentation technique was proposed by Liu Yucheng.[9] After smoothing the image using morphological opening and closing operations, the algorithm applied gradient operations to the resulting image. The over-segmentation of the Watershed algorithm is resolved by the fusion technique, according to a comparison of the suggested fusion algorithm with the Prewitt and Watershed algorithms. It increases speed and saves the image's information data. Syoji Kobashi segmented the cerebral parenchyma region of the

newborn brain MRI image using a fuzzy object model and scale-based fuzzy linked image segmentation. First, the foreground region is isolated; next, the MRI intensity inhomogeneity is corrected; and last, the scale-base Fuzzy Object Model (FOM) is used. [10]Fast Positive Volume Fraction (FPVF) and Fast Negative Volume Fraction (FVNF) are used to evaluate the suggested method's results. The experiment's findings indicate that the FOM (fuzzy object model) has reached its lowest values for FVNF and FPVF. A novel fuzzy rule-based picture segmentation method was put out by Refik Samet [13] in order to segment the extremely thin segment images. They receive an RGB image of a thin section of rock as input and output a segmented mineral image. On extremely thin images, Fuzzy C Means is also used, and the outcomes of the two methods are contrasted. First, the user will select a sample image from minerals; red, green, and blue components of the image are used to discern features.

B) Threshold based Image Segmentation

The most used approach for segmenting images is the threshold method. To distinguish foreground from background, it is employed. This approach creates a binary picture from a greyscale image. All of the information required to determine the position and form of the objects is contained in the binary image. Binary image conversion is advantageous since it simplifies the data.

Threshold methods are following:

Global Thresholding

The input image's intensity value should have two peak values in the global thresholding, representing the signals from the background and objects, respectively. It indicates the amount of intensity difference between two peaks in a picture. Global thresholding, using an appropriate threshold T:

$g(x,y) = 1$ {, if $f(x, y) > T$

0 {, if $f(x, y) \leq T$

Variable Thresholding

Using variable thresholding, we distinguish between the items in the foreground and background of an image by comparing the pixel intensities of each area. if T is allowed to vary throughout the image, variable thresholding.

- Local or regional thresholding, if T depends on aneighborhood of (x, y).
- Adaptive thresholding, if T is a function of (x, y).

Multiple Thresholding:

A gray level image that has been multiplexed is divided into multiple different parts. It separates the image into distinct brightness zones and specifies many thresholds for the supplied image, each of which corresponds to a different object or backdrop.. Multiple thresholding:

$$g(x,y) = \begin{cases} a, & \text{if } f(x, y) > T2 \\ b, & \text{if } T1 < f(x, y) \leq T2 \\ c, & \text{if } f(x, y) \leq T \end{cases}$$

C) Artificial Neural Network based Image Segmentation

In order to distinguish the targeted images from the background, Wencang Zhao [14] introduced a new image segmentation algorithm based on textural data [15] and neural networks [16]. A micro-CT imaging dataset is utilized. As a pre-processing phase, a de-noising filter is employed to eliminate noise from the image. Next comes feature extraction, which is followed by back propagation. Finally, after creating a neural network, the output is saved and the network's weight number is changed. The proposed approach is contrasted with the region-growing and thresholding methods. The suggested technique works better than other approaches in terms of segmentation speed and accuracy, according to the results. A novel neural network-based image segmentation technique for color images was proposed by Lijun Zhang [17]. They presented a method that incorporated the Wavelet Decomposition and Self Organizing Map (SOM). Following initialization, the ANN discovered the segmentation outcome that meets all requirements. Noise reduction is achieved using wavelet decomposition. Therefore, segmentation is carried out by combining wavelet decomposition with SOM-NN. The approach has produced accurate segmentation and reduced noise, according to the results. An Artificial Neural Network (ANN)-based Image Texture Classification approach was proposed by Shohel Ali Ahmed [18]. An picture is first taken and pre-processed, then feature extraction [19] is carried out, and texture classification is handled by an ANN classifier [20]. To distinguish the backdrop from the sub-images, clustering is used. A trained neural network aggregates the input pixels into two clusters that produce output. It generates the segmentation and texture categorization of the image.

D) Region based Image Segmentation

Segmenting a comparable image into different regions is known as region-based segmentation. It is employed directly to ascertain the region. Using the picture pixels' gray values, partitioning is carried out.. Two basic techniques of region basedsegmentation are following:

Region Growing Methods

Using predetermined criteria, region growth is a technique that aggregates pixels or subregions into bigger regions. The process of aggregating pixels begins with a collection of seed points, from which the associated regions expand by adding surrounding pixels with similar qualities (such as color, texture, shape, and/or grayscale) to each seed point. [21]

Region Splitting and Merging

When region splitting occurs, the entire image is first processed as a single region, and this region is subsequently divided into a number of coherent but discontinuous sections. Region splitting is opposed by region merger. Following each split, a merging process compares neighboring regions and combines them. Beginning with small regions, it merges regions that share attributes such as variance, grayscale, etc.

E) Partial Differential Equation (PDE) based Image Segmentation

A new non-linear discontinue partial differential equation (PDE) that describes the level set approach of gray images was suggested by Jinsheng Xiao [22]. In order to construct the filter and discover a numerical solution, a discrete method is also suggested. Using MATLAB, the non-linear discontinue PDE formula is applied to the cameramen's image. The edges and bounds of the image remain blurry and can be moved using the Close operator, according to the results. The suggested plan allows for the saving of more data. For the purpose of de-noising finger vein images, Fengchun Zhang [23] provides a variation model that combines 2nd order PDE with 4th order PDE. In order to precisely extract the region of interest, the Midpoint Threshold segmentation approach is employed. While 2nd order PDE has roughly estimated the noise, 4th order PDE has greatly reduced the noise. Experiments show that the suggested method's PSNR value increases by 2 dB. When the suggested method is compared to a threshold-based segmentation algorithm, it is discovered that the real finger vein image has been accurately segmented. A novel segmentation model for color images was put forth by Chun Yuan [24]. On the Geodesic Active Contour (GAC) model, their model is based. However, GAC can only handle grayscale pictures. As a result, their model—known as the color-GAC model—is likewise an extension of the GAC model. It makes use of the gradient of color image expression.

F) Clustering based Image Segmentation

Grey level picture segmentation is done via clustering-based image segmentation. Grey level techniques are readily applicable and transferable to higher dimensional data. Moreover, color and multispectral pictures can be clustered. There are two main methods in clustering:

K-Means:

The idea behind the k-means clustering techniques is to minimize the total squared distance between each cluster domain's points and the cluster center.

As opposed to the between cluster distance, which is the total of the distances between each cluster center and the global mean of the entire data set, this sum is sometimes referred to as the within cluster. [25]

Fuzzy K-Means

The "coarse" segmentation and the "fine" segmentation are the two stages of the fuzzy K-means algorithm. The process of "coarse" segmentation entails smoothing the histogram for every color component and identifying the troughs that serve as the thresholds by utilizing the first and second derivatives of the smoothed histograms. Following the determination of a safe region around the thresholds, each pixel that does not fall within a safe area is assigned to a cluster based on its red, green, and blue values, and the cluster centers are computed. By computing fuzzy membership functions, each pixel that is part of a safe region is assigned to the closest cluster in the "fine" segmentation process. [25].

IV. CONCLUSION

In order to facilitate picture analysis, we address and assess the primary image segmentation methods in this study. It has been discovered that there is no ideal technique for segmenting photos since the outcome of the process varies on a wide range of variables, including the issue domain, image content, pixel color, texture, and intensity. As a result, neither a single approach nor a set of procedures can be effectively applied to every potential kind of image. Therefore, using a hybrid solution that combines several approaches to solve the image segmentation problem—including image engineering—is a good idea. Studying this subject will help you understand how these methods can be used in a variety of fields, such as medical imaging, object recognition, pattern recognition, etc.

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