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Image Segmentation Techniques: A Review

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Abstract - *Image segmentation plays a vital role in areas such as computer vision and image processing in order to analyze images and extract meaningful data from them. Image segmentation basically divides an image into different regions and objects. It is a field that is broadly researched due to its various applications and widespread usage. This paper provides an overview of some commonly used image segmentation techniques. The main focus of this paper is to evaluate the various algorithms used for image segmentation along with its benefits and limitations so that researchers can exploit it properly to their advantage.*

***Key Words*: Edge detection, Neural Network based, Region based, Segmentation, Threshold based.**

1. INTRODUCTION

Image processing is a method in which some operations are performed on an image, in order to get an enhanced image or to extract some useful information from it.[1] Digital image processing is widely used for various fields and applications, such as remote sensing, photography, medicine, film and video production, security monitoring. New innovative technologies are rapidly evolving in the fields of image processing, especially in image segmentation domain.

Image Segmentation is the procedure where an image is separated into different locales or sets of pixels. The images are fragmented based on set of pixels in an area that are comparative based on the homogeneity criteria, for example,

Shading, force or surface. Image segmentation is mostly used to streamline or change the portrayal of an image to make it progressively significant and simpler for examination. Image segmentation is generally used to find characteristics such as, focuses, lines, edges and districts in images. The following steps are used in the process of image segmentation: [2]

1. Digital Image Acquisition: This is the first step in which the captured or required image is acquired from various devices such as cameras or sensors.

2. Pre Processing: Pre-processing step is used to identify the region of center in the image. This process is used to remove noise from the image, improve the differentiation of the image and separate the objects of enthusiasm for the image.

3. Image Segmentation: This is the step where the actual segmentation is performed. The focused area of input image is divided into essential parts by using appropriate segmentation techniques.

4. Post Processing: In this step, the boundary of the object is processed from the background in order to generate better segmented image.

5. Feature Extraction: This is the step where the unique features of image, for example, intensity, shape and color information are extracted.

6. Classification: In this step, the image is classified based on the extracted features.

7. Required Segmented Image: Finally the image is segmented and required results are obtained.

2. IMAGE SEGMENTATION METHODS

Some of the commonly used image segmentation methods are discussed below.

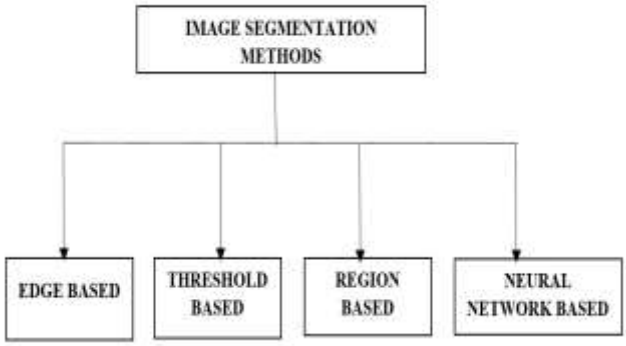

Fig 1. Segmentation Methods

2.1 Edge Detection Method

Edge detection method separates the image by detecting change in intensity or pixels. It separates foreground from the background. It detects the edges or boundaries of an image, thus having benefits from the change of grey tones in the images. The perimeters of the boundaries that is detected must be almost equal to that of the object in the input image in order to obtain precise segmentation results. [4]

2.2 Threshold Based Method

Threshold based methods segment the image based on the intensity levels. A threshold value will be chosen, the set of pixels having value greater than the threshold will belong to one region and the set of pixels with value lesser than the

given threshold will fall to another region. There are three types of threshold methods: [6]

I. Global Thresholding: In global thresholding objects and background pixels are differentiated by comparing it with a chosen threshold value. Binary partition is used to segment an image.

II. Local Thresholding: In local thresholding, threshold values differs over the image depending on the local characteristics of the sub-divided regions of the image.

III. Adaptive Thresholding: In adaptive thresholding, different threshold values for different local areas are used.

2.3 Region Based Method

Region based methods partitions an image into multiple regions containing homogenous areas of connected pixels. Each pixel belonging to a same region should share some similar characteristics or property such as color, intensity and texture. Region growing is a common and simple region based segmentation method. It involves the following process: [7]

- A starting arrangement of little regions are iteratively converged based on similarity constraints.
- Start by choosing an arbitrary seed pixel and contrast it with neighboring pixels.
- Region is developed from the seed pixel by including neighboring pixels that are comparable, expanding the size of the locale.
- When the development of one region stops, we basically pick some other seed pixel which doesn't yet have a place with any area and start once more.
- This entire procedure is repeated until every one of the pixels have a place with some area.

2.4 Neural Network Based Method

Neural network is an information processing model that works in the way a human brain process information. It replicates the most basic functions of the brain. It comprises of huge number of exceptionally interconnected processing elements that work as one to perform explicit tasks. Neural networks can learn by example, which makes them truly adaptable and incredible. Neural networks can be prepared to perform image segmentation. The learning procedure of the neural network could be either supervised or unsupervised. [9]

- Supervised Learning: In supervised learning, the system is trained with some training data to obtain the target output. In supervised learning, the neural network knows exactly what should be emitted as output.
- Unsupervised Learning: In unsupervised learning there is no use of training data, the system obtains some input patterns and organizes these patterns to form clusters. Whenever an input pattern is applied, the neural network gives an output response indicating the class to which the input pattern belongs to.

The use of neural network based methods allows the segmentation to be performed automatically with minimum human intervention.

3. LITERATURE SURVEY

Rajiv Kumar et al. (2013) [4] have presented an evaluation on the various edge detection segmentation methods. In edge detection method, authors have observed different operators, for example, Prewitt, Sobel, LoG and Canny. These distinctive edge operators had been implemented in MATLAB utilizing Image Processing Toolbox (IPT). Results demonstrated that Sobel was 1.26% superior to Prewitt operator. Canny was 10.17%, 11.29% and 70.12% superior to Prewitt, Sobel and LoG administrator separately. Consequently, the Canny edge finder gave better outcomes when contrasted with other edge operators since it gave good recognition and distinction.

Deshmukh P.R et al. (2013) [5] In this paper authors have discussed about some major issues that may occur while using edge detection techniques. They witnessed that edge detection methods have issues with images that are noisy, edge-less, or images with limits that are exceptionally smooth. Some results showed that the segmented images were smaller or larger than the actual image and in some cases the edges of the segmented regions were not connected. Singaraju Jyothi et al. (2014) [6] This paper mainly focused on threshold based techniques and their evaluation. Three types of threshold algorithms were discussed in this paper: Global Threshold (Otsu's Algorithm), Local Threshold and Adaptive Threshold. Otsu's method worked well for some images but gave poor results to certain types of images. The outcomes acquired from Otsu's had too much noise and in some cases it detected the background of the image as the foreground. The results obtained from Otsu's had too much noise and in some cases it detected the background of the image as the foreground. This method did not work well with variable illuminations as well. Its only major advantage was the simplicity of calculating the threshold. Adaptive Threshold was computationally expensive, thus, not considered ideal for real time applications.

Manjot Kaur et al. (2013) [7] have given a review on the region based segmentation method. The authors have examined about region growing technique and how it tends to be utilized to divide an image into regions. Region growing technique included the choice of beginning seed focuses. Seed point determination depended on some user

criterion, for example, pixel texture, dark level surface, or shading. The underlying region started at the precise area of these seeds. The regions were then developed from these seed focuses by looking at neighboring pixels of introductory "seed focuses" and deciding if the neighboring pixels ought to be added to the area. Ghule A.G. et al. (2012) [8] This paper have mainly focused on some advantages and disadvantages of using region growing technique for image segmentation. Some of the advantages mentioned were as follows: The concept was simple for implementation. Only minimum numbers of seed points were required to signify the desired property, then the regions could simply be grown from it. Selection of seed points and criteria were user defined. It also performed well with respect to noise. However, the major drawback of using region growing technique was that it was computationally time-consuming as well as power-consuming.

Alexei Skourikhine et al. (2012) [9] This paper mainly focused on how neural networks can be used for image segmentation. The authors have proposed a method called Pulse Coupled Neural Network (PCNN) and how it can be applied to image segmentation. The results showed that PCNNs performed well for segmentation if image smoothing is performed prior to segmentation. Using this approach, the segmentation was performed automatically and it also gave better segmentation results. Manual intervention was only required to select which image among those generated ones were the best. Amitpal Singh et al. (2015) [10] This paper presented an overview of some well-known image segmentation techniques: Threshold based, Region based and Neural Network based. Experiments on sample images were conducted for the evaluation of these methods and the results obtained were as follows: Neural network performed the best among the methods since it had high strength which made it more resistant to noise. It was, therefore, considered suitable due to its parallel and fast computing capabilities.

Apurv Vashisht et al. (2016) [11] This paper presented an overview of some image segmentation techniques: Threshold based, Clustering based and Edge based. These algorithms were implemented in MATLAB and produced results on three types of images, a Leukemia cell image, a scan of a paper image and a green outdoor image. On the basis of the experimental observations, following conclusions were drawn: Edge based method gave better results among the three methods. The second order edge operators (like Canny) gave quite reliable results, while the first order edge operators gave useful information which can be used as a step in some other edge detection technique.

G.T. Shrivakshan (2012) [12] This paper mainly focused on the performance of edge detection techniques: Sobel, Prewitt and Canny. On the basis of the experimental observations, following results were drawn: The advantage of using Sobel and Prewitt operators was that, it was simple to implement as well as the detection of edges and their orientations was easier. However, it was more sensitive to noise and increase in noise eventually degraded the magnitude of the edges. Canny operator on the other hand, gave better detection of edges even in noisy state since it applied smoothing for removal of noise or outliers in the image.

M. Radha et al. (2011) [13] This paper additionally centered around the accessible edge detection methods and their assessment. An examination was directed to analyze relative execution of different edge detection methods, for example, Sobel, Prewitt, LoG and Canny Edge Operator. The edge detection method were implemented using MATLAB with a sample picture (Bharathiar University). The fundamental goal of directing this experiment was to create a perfect edge map by extracting the principal edge highlights of the picture. The outcomes acquired were as per the following: Results from Sobel and Prewitt operator really deviated from the others. LoG and Canny operators created practically same edge map. However, the results obtained from Canny operator was superior to the other results.

William Thomas H M et al. (2015) [14] In this paper, different edge detection methodologies have been explored and contrasted to extract the tumor from the set of brain images. The different segmentation methods like Sobel, Robert and Prewitt were compared with different parameters like advantages, disadvantages and computation time. Proficiency of Robert, Prewitt and Sobel operator based edge recognition frameworks were also compared. Yogesh et al. (2017) [15] This paper presented an overview of some well-known image segmentation techniques: Region based, edge based and Neural Network based. Results obtained showed that Region growing method gave remarkable results on noisy images but also required large computation time. Edge detection methods gave surprising outcomes to high differentiation images and furthermore gave great outcomes for gray scale images. The only major disadvantage was that it showed sensitivity to noises which affected its performance. However, among the different methods examined in this paper, neural network based calculations gave progressively attractive segmentation results, they were also good with continuous imaging and segmentation forms.

Paras Aggarwal et al. (2018) [16] In this paper, authors basically centered around assessing the productivity of various edge detection methods and contrast their outcome to discover the best operator for Edge Detection Technique. Based on experiments conducted on various 3D pictures, the following conclusions were drawn: Canny operator gave better outcomes when contrasted with Sobel, LoG, Prewitt and Robert operator. Canny operator likewise gave better entropy and differentiation. As far as execution time is concerned, Canny had the highest execution time, yet at the same time demonstrated to give better outcomes and presumed a significant job in edge location.

4. CONCLUSION

Since the segmentation results acquired utilizing any technique basically relies upon the type of input image,

information of the image as well as the level of noise in an image, it is inappropriate to expect one strategy to be superior to the next. As new innovation develops, these calculations can be additionally improved for continuous imaging application in different fields such as medical, object location, X-radiology and many more.

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