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Review of Various Image Segmentation Methods

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Abstract:
One of the most challenging task in computer vision which is carried to segment the regions which resemble the objects is image segmentation. The paper is a survey paper which gives the various segmentation methods used in computer vision, their advantages and disadvantages. The paper concludes with the fact that deep learning has becoming the promising approach for the semantic image segmentation. Convolutional neural networks is widely used for doing the segmentation process.

Keywords: *Computer Vision, Convolutional neural networks, Segmentation*

I. INTRODUCTION

Image Segmentation is the most crucial step in image processing research. It is the method of dividing a image into uniform and non overlapping regions in order that purposeful data is extracted from the segmental image.. So, segmenting noisy images does not produce an accurate analysis result. So, we require some pre-processing methods to remove artifacts, outliers or noises from the images before going for the next analysis step Image improvement is such a preprocessing technique wherever our goal is to suppress the noise whereas conserving the integrity of edges and also the different careful data (Gonzalez et al., 2014; Malik et al., 2014).

e first need to segment the images to obtain the area of interest. The process of segmentation is

the first step for any future analysis of an image. There are a large number of segmentation techniques

that are available for this process. There is no specific customary technique or methodology that has been known because the best suited or best for a selected kind or size of image. The algorithms are mostly based on one of the two basic properties of intensity values: Similarity means partitioning an image into regions that are similar according to a set of predefined criteria. The basic approaches in this criteria are based on thresholding, region growing,and region splitting/merging.

Discontinuity means detecting boundaries of regions based on local discontinuity in intensity. The main

approach within this criteria are detection of isolated points, lines ,and edges in an image.

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
- Detect objects in satellite images (roads, forests, etc.)

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- Iris recognition
- Traffic control systems
- Brake light detection
- Machine vision
- Agricultural imaging – crop disease detection etc.

Although number of methods are available for image segmentation, but each method is not suitable for every type of image. So the standard methods are not suitable for each class of image [34]. This paper discusses the standard method of image segmentation in Part II. In part III Literature review the recent innovation of convolutional neural network in the area of image segmentation has been reviewed. In part IV conclusion is given.

II. SEGMENTATION METHODS

A. Threshold based*:*

Threshold is one of the widely used method for image segmentation. In this approach giving a threshold for finding a region of area of interest. Choosing a specific value gives the better result. It is a most common segmentation algorithm which directly divides the image gray scale information processing based on the gray value of different objects. This segmentation can be divided into local threshold method and global threshold method. The Local threshold are based on the local properties of the pixels and their neighborhoods. The global threshold methodology divides the image into two regions of the target object and the background by a single threshold. It is simple, but selecting a threshold value gives the good segmentation results [31].

B. Edge based*:*

The discontinuity intensity change in the image is given by edge of the image. The edge of the object is most important part which makes division among the object boundary. The discontinuity can be detected by the first order derivates. So these pixels on an edge are known as edge points. An edge is extracted by computing the derivative of the image function.. They are various kinds of edges Step-edge, Ramp-edge, Ridge-edge and Ramp-edge which are easier to identify.[35]. There are various operators by which edges can be detected 1. Canny operator 2. Laplacian operator. 3. Sobel operator.

C. Clustering based:

It is a method by which pixels are mapped into regions based on the intensity of pixel values. It is one of the popular methods for performing the segmentation. It partions an image into K regions or clusters. It does this by adding pixels, p, to the cluster where the difference between the pixel and cluster center is smallest. [37]. There are various kind of clustering like hard clustering, fuzzy clustering. Hard clustering provides sharp boundaries between clusters. shape-based image segmentation algorithm. Clustering is widely used in medical imaging and security systems. clustering algorithms like K-means clustering doesn't ensure continuous areas. The drawback is over-comed by split and merge techniques[31].

D. Deep Learning Based

In the recent years, the deep learning concept has been widely used in the image classification, detection, segmentation. In this context weakly and semi-supervised learning of deep convolutional neural networks is very useful.

E. Region Based

It is one popular approach in era of segmentation. It gives the regions with similar grey level value. The main advantage of this method it always provide closed contour.

II. LITERATURE REVIEW

The deep convolutional neural network is promising approach for semantic image segmentation. The training has done with datasets yielding the appropriate results. For doing these it uses CNN or RNN which obtains the object segmentation. The Conditional Random field is used to jointly train deep convolutional neural network. This approach makes remarking success in the field of image segmentation.

Liu et al. [6] in his paper explored a strong unary term and a simple pairwise term with help of deep learning

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for object detection. Rest of techniques pay the focus on pairwise potentials. High-order potentials [7, 8], semantic label contexts [4, 9], and long-range dependencies [10, 11] are the keys for working on the pairwise term.

Jifeng Dai [5] in their paper used Box Sup approach for performing semantic segmentation, The dcnn is trained with human annotated image. This approach gives accuracy but it it mandatorily require bounding box annotations. The process will give the region resembling the objects.

Guosheng Lin [13] et.al.in their paper emphasized that contextual data among the object will be helpful for object segmentation . They used 'object-object' context between the image regions, and 'object-background' context. They used CRF along with CNN for to perform 'object-object' segmentation.

Recently, some works [12, 13] have also tried to integrate the merits of deep learning and conditional Random field for giving the good quality of object. Restricted Boltzmann Machine (RBM) is alternate choice, besides CNN and RNN in the field of image segmentation.

Eslami et al. [14, 15] in their paper implemented two hidden layer Boltzmann Machine for identifying the object and giving the correspondence between the local features of object and its global part. The correlation between pixels is illustrated by pairwise term. Still it is big challenging task to label each pixel of image correctly, since different class labels may be overlapped with each other. Keeping in view the color ,texture and grey level intensity range the numerous regions can labeled by the respective class.

P. Arbelaez [16] in their paper used super pixels to individually locate the specific regions for object identification. The approach of super pixel has given better results than the traditional multi-class classifier. The convolutional layer easily point out the basic features like points, edges, curves, regions etc.

CHEN ET AL. [17] IN THEIR PAPER USE THE METHODS OF CNN AND CRF TO PERFORM THE PIXEL LEVEL CLASSIFICATION. THIS COMBINATION HAS RESULTED INTO ACCURATE RESULTS. AT HIGHER END THEY USED CNN AND PROBABILISTIC GRAPHICAL MODELS TO PROVIDE GOOD QUALITY SEGMENTATION.

Teo et al. [18] to identify border ownership which is a key function of V2 area in primate visual cortex have used Structured Random Forests (SRF) They developed the concept of border ownership in segmentation task and exploit not only ownership indicated borders but also all foreground and background contexts in an image separated by the borders.

Hariharan et al. [24] in their paper provide a connected CNN architecture for semantic object detection by using proposal method. Each region resembling the specific object giving entirety to the image.

Ross [22] in their paper used robust convolutional neural networks (CNNs) in order to locate and segment objects and if in case the labelled training data is scarce, supervised pre-training for an auxiliary task, followed by domain-specific fine-tuning, yields a significant performance boost.

Guotai Wang et.al [39] in their paper applied deep learning along with convolutional neural networks (CNNs) for performing automated medical image segmentation. These approach does not result into accurate and good quality segmentation due to the poor medical images.

The interactive segmentation methods are widely useful, since they combine the user's knowledge which will help for faster segmentation.[2]. These interactive methods of segmentation becomes a promising path-way for existing commercial surgical planning and navigation products. With the user interactions it is easier to give accurate segmentation. It gives the response in less user time. Based on these observations, authors founded combining CNNs with user interactions for medical image segmentation leads to achieve higher segmentation accuracy and robustness. There are very few studies on using CNNs for interactive segmentation. This is mainly

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due to the requirement of large amounts of annotated images.

Z. Liu, [6] in their paper have used pre -trained Gaussian Mixture Model (GMM) helps to improve segmentation accuracy. GMM are simple to use as compared to the CNN. They can be relatively easily achieved for 2D images, but become much more problematic for 3D images.

Based on the literature review of the various papers it is founded that CNN-based interactive segmentation method efficient to use. Enabling CNNs to respond quickly to user interactions and to work on a machine with limited GPU resources (e.g., a standard desktop PC or a laptop) is required.

Author	Tittle	Year	Work [Methodologies]	Limitations
Shuai Zheng et.al.	Conditional Random Fields as Recurrent Neural Networks	2016	In this paper authors have given trained system that combines both CNN and CRF-RNN in one deep network for performing the semantic object segmentation. For training BPNN is used	The training time is more.
Guosheng Lin et. al	Efficient Piecewise Training of Deep Structured Models for Semantic Segmentation	2016	In this paper authors used 'patch-patch' information between image regions, and 'patch-background' contextual information for improving segmentation. For learning from the patch-patch context, they used Conditional Random Fields (CRFs) with CNN-based pairwise potential functions to capture semantic correlations between neighbouring regions.	The result will be based on how contextual information is provided by the user. for semantic image segmentation that
Karen Simonyan & Andrew Zisserman	VERY DEEP CONVOLUTIONAL NETWORKS FOR LARGE-SCALE IMAGE RECOGNITION	2016	In this paper authors have given network of increasing depth using CNN architecture with very small (3×3) convolution filters, by pushing the depth to 16-19 weight layers for the large-scale image recognition setting. It is very good for the classification accuracy.	The Conv-net which is used is to be properly trained for the deep neural networks.
Jifeng Dai	BoxSup: Exploiting Bounding Boxes to Supervise Convolutional Networks for Semantic Segmentation	2015	In this paper, authors propose a method using bounding box annotations which achieves competitive accuracy .The fundamental idea is to iterate between automatically generating region proposals and training convolutional networks.	The proper value of bounding box is required for getting the desired output.
Yuheng Song et.al	Image Segmentation Techniques Overview	2017	In this paper, an overview of region based, edge detection based, clustering, segmentation based on CNN has been done. The authors predicted that combination of various algorithms will be used for better segmentation results.	It is found that there is no standard method for image segmentation to adapt with all images.
Kavita Khanna et. al.	Ant Colony Optimization towards image processing.	2016	In this paper authors have given how ant colony optimization will be used in different areas of image processing.	It is a review paper giving where only the concept of aco is applied.
V.Sheshathri, Sukumaran	A Hybrid Clustering Based Color Image Segmentation using Ant Colony and Particle Swarm Optimization Methods	2019	This paper introduces color image segmentation using the Hybrid Clustering based Ant Colony Optimization and Particle Swarm Optimization methods. This hybrid method gives good result for object segmentation	Proper parameter setting has to be done to give accuracy of the result.
Ross Girshick et.al.	Rich feature hierarchies for accurate object detection and semantic segmentation	2014	In this paper author has given the approach combines two key points: (1) high-capacity convolutional neural networks (CNNs) is used to detect bottom-up region proposals in order to localte and segment objects and (2) when labelled training data is scarce, supervised pre-training for an auxiliary task, followed by domain-specific fine-tuning, yields a significant performance boost.	After the features are extracted and training labels are applied, it requires one linear SVM per class. As the training data is very large to fit in memory, which make it ineffeicient.

FIG 1. Table giving the review of papers.

IV. CONCLUSION

We conclude that numerous segmentation methods are available, but no method is perfect for every type of image. Now days, convolutional neural network has become the most promising approach for segmentation Based on the literature review and the contributions in the existing work, we can observe that there is a need of an integrated algorithm for doing segmentation. To design a CNN-based interactive segmentation method efficient to use, enabling CNNs to respond quickly to user interactions and to work on a machine with limited GPU resources (e.g., a standard desktop PC or a laptop) is needed.

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