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Overview on Graph Cut Segmentation Technique

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Abstract:
Digital Image Processing is very important and fundamental task to image analysis, whose main task is the separation or isolation of image regions, reducing the data space to be analyzed. In image processing segmentation of image is avery important technique which is used to study what is inside the image. To change the representation of an image into something that is more meaningful and easier to analyzeis the purpose of imagesegmentation. Segmentation of the image can be done by using many methods but only some methods gives the better results in image segmentation. Some of the image segmentation techniques won't work properly for all the images. Among the many methods in performing image segmentation, graph based approach is gaining fame primarily by reason of its ability in reflecting global image properties. Based on certain image features like pixel intensity values, color, textures, space etc. which helps in segmentation of image. There is various image segmentation techniques are used for different images. This various image segmentation techniques and graph cut based segmentation technique are reviewed and discussed in this paper.

Keywords **—Image segmentation techniques, Graph cut segmentation.**

I. INTRODUCTION

Currently, image processing is among rapidly growing technologies. Image processing is a method which is used to perform some operations on an image, so as to get abetter quality image or to extract some useful information from it where input is an image and output may be image or characteristics or features associated with that image. It bring into being core research area within engineering and computer science fields too. Image segmentation is an important image processing technique. Image segmentation is the process of dividing a digital image into multiple chunks. The aim of segmentation is to simplify the image representation into something that is more significant and easier to study. Image segmentation is typically used to trace objects andboundaries in images. Segmentation of image is the process of assigning a tag to every pixel in an image such that pixels with the same tag share certain uniqueness.There are many image segmentation techniques that are established to segment the image inenhanced way. There are two basic properties of intensity values on which image segmentation algorithm based:

- Discontinuity based
- Similarity based

• **Discontinuity based-** In this partition is done based on some abrupt changes in grey level intensity of the image.

- Detection of Isolated Points and lines
- Edge Detection

• **Similarity based-** In this segmentation is done based on grouping of pixels based on some features.

- Thresholding
- Region growing
- Region Splitting and Merging
- Clustering
- K–Means Clustering
- Fuzzy C Means Clustering

II. LITERATURE REVIEW OF IMAGE SEGMENTATION TECHNIQUES

Various techniques have been developed for image segmentation. The image is segmented into numbers of parts so that it could be analysed easily and the objects in image could be recognized. All basic image segmentation methods currently being used by the researchers and industry will be discussed and evaluate in this section.

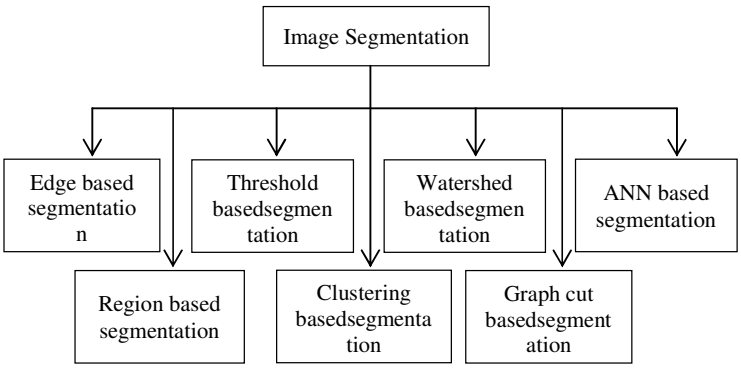

Fig1: Image segmentation techniques

A. Edge based segmentation

Sheng Yan, Jianping Yuan, ChaohuanHou has proposed a new Chan-Vese level set method for ultrasound image segmentation. This paper introducesa method wavelet multi resolution analysis which creates an edge representing mask to spot edge info of the image. The average edge energy of zero level set curves is calculated by the mask to control the curve stop at the desired boundary. Method is more responsive to intensity inhomogeneity, and more vigorous to the natural speckle noise in ultrasound images [1].

SimranpreetKaur and PrabhpreetKaur proposed various techniques of image processing for detection like sift, Canny detection. It is figured edge detection using ant colony optimization is better technique than others. As operating rate of ACO is slow therefore there's need of improvement inside it and also improvement in Peak Signal to Noise Ratio and Mean Square Error [3].

Advantage: Good for images having better contrast between objects

Disadvantage: not suitable for wrong detected or too many edges

B. Region based segmentation

M. Mary Synthuja Jain Preetha; L. Padmasuresh; M. John Bosco proposed work comprises of three stages: Threshold Generation with Dynamic Modified Region Growing phase, Texture feature generation and Region Merging phase. Firstly by dynamically changing two thresholds regions are grown and the firefly algorithm is used to optimize the thresholds. In the second phase, it extracted the texture feature using entropy based operation from the input image. The result False Positive and False Negative Rates were extremely low for each image and which was helpful for making very good results of segmentation accuracy [4].

Yang Liu, Lei Huang, Siqi Wang, Xianglong Liuhave proposed a novel Region-based Image Retrieval oriented image segmentation algorithm named Edge Integrated Minimum Spanning Tree. The difference between Edge Integrated Minimum Spanning Treeand the traditional MST-based methods is that Edge Integrated Minimum Spanning Tree generates MSTs over edge-maps rather than the original images, which done high retrieval performance conjoining with state-of the-art matching policies. [5].

Advantage: More immune to noise, useful when it is easy to define similarity criteria

Disadvantage: expensive method in terms of time and memory

C. Threshold based segmentation

M. P. Akila Devi, T. Latha, C. Helen Sulochana proposed an iterative thresholding based on 2D improved Otsu method using a novel threshold value recognition function is proposed which is used to locate the optimum threshold value in different types of histograms and separate into two classes. This method performs better than the other thresholding methods for segmenting the weak objects and also the fine details in an image to produce binary images with a much superior accuracy, which can be used in further analysis and processing [8].

AbolfazlMirkazemi, S. EnayatolahAlavi, GholamrezaAkbarizadeh has proposed a new

method for color image segmentation is presented. The method is based on histogram thresholding and correlation between the differences of colour components. This method does not transform the image into grey scale and it is able to segment colour image with good accuracy and high speed which has the capability to use parallel processing and has real time complexity [9].

Advantage: no need of previous information, simplest method

Disadvantage: highly dependent on peaks, spatial details are not considered

D. Clustering based segmentation

A. Pugazhenthi, JyotiSinghaigives a K-means clustering based image segmentation algorithm which select the centroids repeatedly. It eliminates the limitations related with Kmeans clustering such as selection of initial centroids and dead centres. The proposed algorithm uniformly parts the regions of interest over casually proposed algorithm and random centroids selection is matched with some validity parameters. Comparison with the existing algorithms confirms the improvement in qualitative parameters [13].

ShiluTresaVinod, N. M Siva Mangai, D. Abraham Chandy proposes a clustering based image segmentation approach for elephant recognition. The k-means algorithm uses the notion of fitness and belongingness to provide a better clustering practice as compared to several conventional algorithms. For the recognition elephant shape features are extracted. For each class recognition rate is calculated for performance evaluation. For different K values in KNN classifier recognition rate is calculated to find a proper K value for the proposed design [14].

YanniZou, Bo Liu surveys the image segmentation methods based on the clustering. From the survey it is clear that clustering plays an important role in image segmentation. A lot of subjectsinvolves in FCM clustering algorithm, fuzzy mathematics is the theory basis of it. The construction of the model is quite flexible. The potential data of the image can be fully mined. The limitation of the local extreme value is overcome by using the present intelligent optimization theory [15].

Advantage: fuzzy uses partial membership therefore more useful for real problems

Disadvantages: determining membership function is not easy

E. Watershed based segmentation

DibyaJyoti Bora, Anil Kumar Gupta, Fayaz Ahmad Khan proposed an efficient approach for the colour image segmentation. The input image is changed from RGB to HSV. Then, V channel is extracted from the converted image and normalized between 0 and 1. The resultant image is then finally segmented with watershed algorithm. The result obtained from the proposed approach is found to be better in comparison to that obtained from the classical watershed algorithm [16].

Sheng Chen, ZhanfengShen, JianchengLuo, LijingGao proposed a fast watershed-based image segmentation algorithm Firstly, a homogeneity gradient image named after H-image is produced. Traditional watershed segmentation is then used to initially segment the H-image to produce over-segmented image regions. Textural, colour and shape information of segments is used in the merging process. Experiments demonstrate the validity of the algorithm [17].

Advantage: results are more stable, detected boundaries are continuous

Disadvantage: complex calculation of gradients

F. Graph cut based segmentation

Yuri Boykov, Vladimir Kolmogorov proposed an experimental evaluation of the efficiency of min-cut/max flow algorithms for applications in vision and compares the running times of several standard algorithms, as well as a new algorithm that they have established. The algorithms they study comprise both Goldberg-Tarjan style "push-relabel" algorithm and algorithms founded on Ford-Fulkerson style "augmenting paths." They target these algorithms on a number of typical graphs in the perspective of image restoration, stereo, and segmentation[20].

Alexander Fix, Aritanan Gruber, EndreBoros, RaminZabih propose an alternative construction to Ishikawa's, with improved theoretical and experimental performance. Instead

of considering terms in the energy function one at a time, they consider many terms at once and review prevailing methods for solving higher-order MRF's with graph cuts [21].

Hironori Shigeta, Tomohiro Mashita, Takeshi Kaneko, Junichi Kikuta, SheegetoSenoo, HaruoTakemura, Hideo Matsudaand Masaru Ishii proposed a method for the analysis of a sequence of bone tissue images taken to quantify blood permeability of bone marrow by a two-photon microscope. By graph cuts which extended according to the images this method segments the input image sequence to blood vessel, bone marrow and bone regions. Permeability is quantified by the intensity of the segmentation result [24].

Shuangfeng Dai, Ke Lu, Jiyang Dong proposed a new lung segmentation method which is based on an improved graph cuts algorithm from the energy function. The lung CT image ismodelled with Gaussian mixture models, and the optimized distribution parameters can be obtained with expectation maximization algorithm. The lung image information of edges is used to improve the boundary penalty item of graph cuts energy function [25].

Advantage: fastest method, best for time critical applications

Disadvantages: more computational complexity.

G. ANN based segmentation

Ngo Quang Long, Dangchi Jiang, Changhai Ding proposed the challenging issue of automatic determining the cartilage volume. First, algorithms based on classical segmentation methods are combined and tailored to develop a clustered segmentation method. Second, artificial neural network (ANN) is applied to improve the developed methodthrough better coping with the nonlinearity and unidentified MRI image noises. This ANN is then put on with the active contour models to provide the desirable outcome [26].

MahuaNandy(Pal), Minakshi Banerjee proposes an automated segmentation scheme ehich is based on retinal vasculature using Gabor filter bank, which isoptimized on the basis of entropy. Different distributions of filterresponses are prearranged into features and the vasculature of normaland abnormal retina are segmented by artificial neuralnetwork(ANN). The training set of labelled pixels is obtained from the ground truth images of DRIVE database. [27].

Advantage: no need to write complex programs

Disadvantage: more wastage of time in training

III. TABLE SHOWING IMAGE SEGMENTATION TECHNIQUES

Reference no.	Working	Phases	Type of input image	Parameters	Conclusion
A. Edge based Segmentation					
1	The Chan-Vese level set method is introduced. The working range of the Delta function to solve the object boundaries in ultrasound image segmentation. Average edge energy of zero level set curves is make known to the evolution function to control the evolving speed.	1.Type style and fonts 2.Creation edge representing mask 3. result	Ultra sound image	Robust to the inherent speckle noise, intensity inhomogeneity of objects and images with missing boundaries	Experimental results show that method is robust to speckle noise and can effectively segment ultrasound images with missing boundaries.
B. Region based segmentation					
4	To solve the problems in segmentation work, Firefly based Dynamic Modified Region Growing and Region Merging is given.	1. Generation ofThreshold with Dynamic Modified Region Growing phase 2.Generation	Brain Images	performance measures Sensitivity, Specificity and correctness	Algorithm provides 91.06% of Sensitivity, 85.12% of Specificity and 93.50% of Accuracy

		phase 3. Merging phase			values, on whole.
C. Threshold based segmentation					
10	Using thresholdingalgorithm on the scalogramsextract the repetitive patterns.	1.image decomposition in colour bands 2.image decomposition in colour bands 3.Binarizing images 4. Result	DNA colour image	Pixels, three colour bands	In comparison with other segmentation techniquesthat methodology is more appropriate in repetitive pattern enhancement.
D. Clustering based segmentation					
12	Segmentation by Adaptive Fuzzy K-means clustering is used to segment the MRI brain image into three different regions.	1.Adaptive Fuzzy K-Means clustering Algorithm 2.Acquisition and analysis 3. Result	MRI Brain Image	Cluster, Centroid	This process is a good for segmenting MRI image into three region.
14	Uses K-NN classifier for classification. The pixels of same characteristics belong to one group of object recognition is segmenting the image. For segmentationK-means clustering algorithm is used.	1.K-means algorithm 2. Extraction of feature 3.Classification of Object 4.Result and analysis	Raw infrared (IR) image	K nearest neighbour, cluster distance	The experiment and analysis is done using 23 different IR images and all those images gave the proper segmentation result using k=2 k-means clustering technique.
E. Watershed based segmentation					
17	Traditional watershed Segmentation algorithm is used to initially segment the H-image to produce over-segmented image regions	1.Watershed algorithm 2.Region merging 3. Result	homogeneity gradient image	Textural, colour and shape information	Experiments show that the watershed transform is an effective method in image segmentation. However, a better definition of region merging cost plays an important role.
F. Graph cut based segmentation					
22	For first-order MRF's, the performance of graph cut methods is viable with message passing, and sometimes exceeds it. That's why this has lead to significant interest in applying graph cuts to higher-order MRF's.	1.Higherorder MRF's 2.Reduction skills 3.Reducing groups	noisy input image	Clique function, image pixel	Result suggests that method may be particularly well suited to a number of important vision problems.
23	A new image Segmentation method J-Cut(JSEG Cuts) algorithm is used. It calculatesthe value of J is simplified. Then uses the regional growth method and finally use the Ncut method to merger based on small areas.	1. JSEG and Graph theory 2.J-cut algorithm 3. Experimental Result	Nature image	Class map, image pixel	Algorithm is effective for improving the complex iterative process of the JSEG. It reduces complexity
24	Blood vessels and bone marrow has the green channel in images so extract the green	1. Overview of Graph cut 2. Application of	Blood vessel, Bone marrow	Colour channel	The recognition method and quantification method

	channel and use it as input to graph cuts. To input seeds in advanced, it show the first frame of the data set and instruct to select 50 points for foreground and background.	graph cut 3.Implementation 4. Result			has area for some enhancement, quantification. The results shows that proposed method is capable to quantify nearly ground truth values.
G. ANN based segmentation					
26	ANN is applied to improve the developed method with the nonlinearity and unidentified MRI image noises. This ANN is then applied with the active contour models to provide the desirable outcome.	1.Classical segmentations 2.Image segmentation tool 3. active contour model	MRI scan image	Image pixel, energy function	Experiments show the value of the proposed approach.

IV. CONCLUSION

In this review of graph cut image segmentation techniques, various image segmentation techniques are thorough described and compared. Few papers on image segmentation have been studied and reviewed in this paper. None of the developed techniques has been established universally for image segmentation. Since, new algorithms are being developed every day to recover efficiency of segmentation. In Recent times, there has been growing interest in using graph based methods as aeffective tool for segmenting images. This paper has discussed some of the major graph based technique and show up their strengths as well as limitations.

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