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A Survey on Image Segmentation and Image Matting

Henita R. Rana[1]
Department of Computer Science and Engineering
Parul Institute of Engineering and Technology (PIET)
Vadodara – India

Shashwat Kumar[2]
Asst. Prof.
Department of Information Technology
Parul Institute of Engineering and Technology (PIET)
Vadodara – India

Hemang J. Shah[3]
Department of Computer Engineering
Parul Institute of Engineering and Technology (PIET)
Vadodara – India

Abstract: ***As feature extraction and pattern recognition process grows more and more, image segmentation and image matting are one of the fundamental approaches of digital image processing. This paper enumerates and reviews main image segmentation algorithms and image matting processes, then presents basic evaluation methods for them. Some valuable characteristics of image segmentation and image matting come out after a large number of comparative experiments. Many of the algorithms are too slow or too unpredictable to be of practical use. Assessing the performance of different algorithms is also a complex task. This paper presents an optimization which can be applied to many algorithms in order to allow them to run at interactive speeds and presents a technique which can be used as a formal test-bench to measure the performance of matte algorithms. There is a lot of information in any image. There are different algorithms for image segmentation and matting for feature extraction and pattern recognition. The classification of segmentation algorithm is given here. Each of them has their different advantages and limitations. Natural image matting can be applied with different algorithms like KNN (K nearest Neighbour) matting, Close-form solution etc. In this paper, because of many advantages and accurate object extraction in few seconds, here KNN matting is described in detail than among all other image segmentation and image matting algorithms.***

Keywords: Image segmentation, Image matting, KNN, thresholding, object extraction.

I. INTRODUCTION

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it [15]. As feature extraction and pattern recognition process grow more and more, image segmentation and image matting are one of the fundamental approaches of digital image processing. The image contains lots of information. The object extraction can be done using different methods of image segmentation and image matting. In extraction method, the required object is separated from its complex surrounding. But there are several difficulties to extract object from entire image because there is lot of information in the image. There are many holes and uncertainty in foreground image edges. Image foreground and background are not smooth because there are many edges in image. There are several methods by which required object can be extracted, but there are some drawbacks of the existing methods.

To extract required object from entire image, there are mainly two methods: Image segmentation and image matting. However these two methods have their own application field. Both have their own advantages and limitations which are discussed in next in this paper.

In this paper, firstly, classification of main image segmentation algorithms is given and they are reviewed; then image matting is described and comparison of different image matting processes is given in tabular form. And at last KNN matting is discussed in depth.

II. Classification of Image Segmentation Algorithms

Segmentation is very important to image retrieval. Both the shape feature and the layout feature depend on good segmentation. In this subsection we will describe some existing segmentation techniques. In image segmentation the image is divided into different partitions according to segmentation method used. Segmentation is done according to discontinuity of image like edge, color texture etc. There are different types of image segmentation algorithms. Each has their own advantages and limitations.

The Table I shows classification of different segmentation algorithms with their advantages and disadvantages if any. More detail is given in [1, 2, and 3].

TABLE I

Classification of Image Segmentation Algorithms

Edge Based Segmentation	**Gray-Histogram Technique**	Uneven for the impact of noise and difficult to search for the maximum and minimum gray value	
	Gradient-Based Method	If the change of gray value near edge is intense enough and there is little image noise then it works well. The segmentation result is adaptive to the direction of gradient	
Region Based Segmentation	**Thresholding:** Chooses proper thresholds *T* to divide image pixels into several classes and separate the objects from background	**Global Thresholding**	T depends only on gray value f(x, y). Only one threshold value for all regions. E.g.: Otsu, which have very high, Processing rate and it is very slow
		Local Thresholding	T depends on both f(x, y) and p(x, y). Different threshold value for different region. E.g.: K-means, which is more efficient, less computing time and faster in 3D thresholding
		Dynamic Thresholding	Several objects taking up different gray level regions
	Region Operating: Find the aim regions directly. Requires lots of computation time	**Region Growing**	Group up pixels or sub regions into larger regions based on predefined criteria
		Region Splitting and merging	Users can divide an image into a set of arbitrary, unconnected regions

III. Image Matting[4]

Image matting is a process of initial foreground and background segmentation of the image. The produced image is called "matt or alpha image". The matt is grayscale, where values are between one and zero and which indicate that foreground and background is bled together. Recently there has been interest in the generation of mattes from images without the need for a special matte pass. This process is also called Natural Image Matting. In this process input image is taken, which is also called hint image or trimap. Hint image or trimap has area of known background and foreground and band of pixel between these two known areas which is unknown. For unknown area it is necessary to classify each pixel into foreground or background.

TABLE II

Comparison between different matting processes

Alpha estimation in natural images[5]	First, Split background and foreground clusters and test every alpha value between zero and one. Then search for optimal value by using measure which is based on probability distribution interpolated between background and foreground. Computation time is very large.

A Bayesian approach to digital matting[6]	Use similar approach as above but based on maximum like hood approach and find best alpha value after testing all background and foreground subcluster pair. It has less computation time.
Alpha estimation in high resolution images and image sequences[7]	It is based on observation and has less computation time. In this in RGB space the cluster uses the principle axis along which the cluster is formed from long cigar-shaped prolates.
Poission matting[8]	Use totally different approach then all of above. It uses nearest background and foreground points for clean color and it is a global version. Then refine this estimation along with estimate alpha channel by solving Poission equation.
Close-Form solution of natural image matting[9]	Foreground and background are solved by using estimated alpha and composition equation with spatial coherence term. Use Local color line model

To do so alpha values are used which are always between one and zero. For image matting following composition equations (1) and (2) are used:

$$P = \alpha F + (1-\alpha) B \quad (1)$$

$$B = [P - \alpha F] \div (1 - \alpha) \quad (2)$$

Where, P is the observed or source image, F is the clean foreground image, B is the clean background image and α is the matte image. The Table II given next shows different matting techniques and its overview description of process with some limitation.

IV. KNN MATTING[10]

In KNN Matting the nonlocal principle is applied to general alpha matting for the simultaneous extraction of multiple image layers; each layer may have disjoint as well as coherent segments typical of foreground mattes in natural image matting. This approach does not assume the local color-line model and does not require sophisticated sampling or learning strategies. The matting method generalizes well to any color or feature space in any dimension, any number of alphas and layers at a pixel beyond two, and comes with an arguably simpler implementation. The matting technique called KNN matting, capitalizes on the nonlocal principle by using K nearest neighbors (KNN) in matching nonlocal neighborhoods, and contributes a simple and fast algorithm. Here KNN matting has a closed-form solution that can leverage the preconditioned conjugate gradient method which produces an efficient implementation. Experimental evaluation on benchmark datasets indicates that the matting results are comparable to or of higher quality than state-of-the-art methods requiring more involved implementation.

In this paper, the nonlocal principle beyond alpha estimation and extract overlapping image layers using the same Laplacian framework. Given the alpha value, the closed form solution can be elegantly generalized to solve the multilayer extraction problem. The qualitative and quantitative comparison is performed to demonstrate the accuracy of the extracted image layers. Matlab implementation runs in a few seconds on 800 X 600 examples available at the alpha matting evaluation website and the results were ranked high among the state of the art in natural image matting, which may require a complicated implementation. In most cases, only one click is needed for extracting each material layer in material matting.

Following the derivation $D\alpha \approx A\alpha$, where $A = |K(I, j)|$ is an N x N Affinity matrix, D= diag (Di) is N x N Diagonal matrix and N= total number of pixels. Thus $(D-A)\ \alpha \approx 0$ or $\alpha^T L_c\ \alpha \approx 0$, where $L_c = (D-A)^T (D-A)$ is called the clustering Laplacian quadratic. It solves the minimization problem. Here implementation was made easy by using FLANN which is the library for performing fast approximate nearest neighbor schemas in high dimension spaces. It contains a collection of algorithm written in C++.

V. CONCLUSION

There are different segmentation algorithms and also natural image matting is used to separate required object image from the background. They all have their related limitations which are described throughout this paper. These all are the research aspects to be further explored in order to extract required object effectively from an image.

The result of image segmentation is affected by lots of factors, such as: homogeneity of images, spatial structure character of the image, continuity, texture, image content, physical visual character and so on. A good image segmentation algorithm should take all-sided consideration on those factors. So a robust procedure for extracting image can be obtained by using KNN matting which will accurately extract the object image. This method is selected because of its efficiency to segment out different regions and shows optimum results for a given image.

There is no more general approach for required object extraction. But KNN matting will provide simple, fast and better solution image extraction. KNN matting doesn't assume local color-line model and doesn't require sampling or learning strategies. There is no issue of kernel size in KNN matting Matlab implementation of KNN matting runs in few (about 18-20) second on 800×600 examples available at alpha matting evaluation site. Quality and performance are main motivation to choose KNN matting for tree image extraction. KNN matting method generalizes well to any color or feature space in any dimension, any number of alphas and layers at a pixel beyond two, and comes with an arguably simpler implementation. KNN matting, capitalizes on the nonlocal principle by using K nearest neighbours (KNN) in matching nonlocal neighbourhoods, and contributes a simple and fast algorithm that produces competitive results with sparse user mark-ups. KNN matting has a closed-form solution that can leverage the preconditioned conjugate gradient method to produce an efficient implementation. The matting results are comparable to or of higher quality than state-of-the-art methods requiring more involved implementation.

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AUTHOR(S) PROFILE

Henita R. Rana received the B.E degree in computer engineering from Mahatma Gandhi Institute of Technical Education and research Center (MGITER), Navsari, India in 2012.

She is currently studying toward the M.E. degree in computer science and engineering at Parul Institute of Engineering and Technology (PIET), Vadodara, India. Her research area includes image processing.

Shashwat Kumar received the B.Tech. degree in Information Technology from IEC College of Engineering and Technology, Greater Noida, India in 2011 and M.Tech degree in Computer Science and Engineering from SVNIT, Surat, India in 2013.

He is currently working as Asst. Prof. at Parul Institute of Engineering and Technology (PIET), Vadodara, India. His research areas include Image processing and Wireless Communication.

Hemang J. Shah received the B.E. degree in Computer Engineering from Mahatma Gandhi Institute of Technical Education and research Center (MGITER), Navsari, India in 2012.

He is currently studying toward the M.E. degree in Computer Engineering at Parul Institute of Engineering and Technology (PIET), Vadodara, India. His research area include image processing.