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A SURVEY ON TRADITIONAL DIGITAL IMAGE SEGMENTATION METHODS IN IMAGE PROCESSING

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Abstract - Image segmentation is a classic subject in the field of image processing and also is a hotspot and focus of image processing techniques. Many image segmentation ways are developed by the researchers so as to create pictures sleek and simple to judge. Since there is no general solution to the image segmentation problem, these techniques often have to be combined with domain knowledge in order to effectively solve an image segmentation problem. Till now, there is no perfect algorithm has been developed that could glance at all the factors present in image segmentation can be avoided. The aim of the researchers is to find out the issues of digital image segmentation that challenges the computer vision and enhance its accuracy and performance by planning new algorithms. In this paper, methodologies like K-Means clustering and watershed segmentation are discussed.

KeyWordsImage processing, image analysis,K-mean clustering, Color Segmentation, Watershed segmentation.

I. Introduction

A.Image Engineering

Image engineering is an integrated discipline/subject comprising the study of all the different branches of **image** and video techniques. It mainly consists of three levels: **image** processing, **image** analysis, and **image** understanding. It illustrates the level of the image segmentation in image processing. Image Engineering can be divided into three levels as shown in Fig.

- Image processing
- Image analysis
- Image understanding

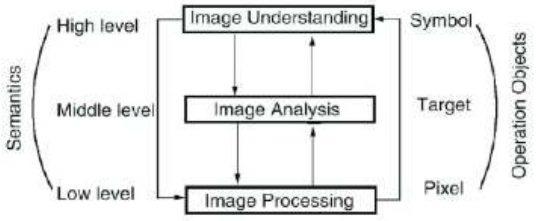

Figure 1.Image engineering processes

a)Image processing

It is low-level operations; it operated on the pixel-level. Image processing techniques have become increasingly important in a wide variety of applications. Segmentation is the process that subdivides an image into its constituent parts or objects. Image processing contains following three stages and each stage is further subdivided into different categories.

- Reconstruction
- Transformation
- Classification

b)Image analysis:

Image analysis is the extraction of meaningful information from images; mainly from digital images by means of digital image processing techniques. Image analysis tasks can be as simple as reading bar coded tags or as sophisticated as identifying a person from their face. There are many different techniques used in automatically analyzing images. Each technique may be useful for a small range of tasks, however there still aren't any known methods of image analysis that are generic enough for wide ranges of tasks, compared to the abilities of a human's image analyzing capabilities. Examples of image analysis techniques in different fields include:

- Image segmentation
- Video tracking
- Medical scan analysis
- 3D pose estimation
- Automatic number plate recognition

c)Image Understanding:

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Image understanding is the process of actually interpreting those regions/objects to figure out what's actually happening in the image. This may include figuring out what the objects is their spatial relationship to each other, etc. It may alsoinclude ultimately making some decision for further action.

II. Related Work

A.Segmentation Methods

Segmentation is a process that divides an image into its regions or objects that have similarfeatures.Numerous segmentation methods wereproposed by various researchers. Some categorization presented here.Image segmentation techniques or methods are classified into two main categories as Layer-Based Segmentation methods and Block-Based Segmentation methods

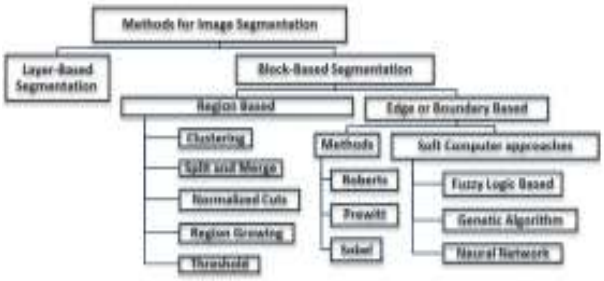

Figure 2.Methods OfSegmentationIn Image Processing

a)Layer-Based Segmentation Methods

Layered model: for object detection and image segmentation that composites the output of a bank of object detectors in order to define shape masks and explain the appearance, depth ordering, and that evaluates both class and instance segmentation.

b)Block-Based SegmentationMethods

It is based on various features found in the image. This might be color information that is used to create histograms, or information about the pixels that indicate edges or boundaries or texture information. Block-Based Image Segmentation methods are categorized on two properties: discontinuity and similarity into three groups:

- Region based : based on discontinuities
- Edge or boundary based : based on similarity
- Hybrid techniques

c)Threshold based Segmentation:

Slicing techniques and histogram threshold arecommonly used to divide the image into various segments. These may be applied as such directly on to a picture. These can also be used in combination with pre- and post-processing techniques.

d)Edge Based Segmentation:

In this technique, it is assumed that the detected edges in a picture represent boundaries of the object and are used to identify these objects.

e)Region Based Segmentation:

This method uses the approach opposite to that of the edge based segmentation. Here, a region somewhere in the middle of the image is chosen initially and it grows outwards until it meets the boundaries.

f)ClusteringTechniques:

Though clustering is typically used as an alternative term for agglomerative segmentation techniques, the same is used here to explain the techniques that are mainly employed in exploratory information analysis of large-dimensional measurement patterns. Here, clump strategies plan to cluster along patterns that are similar in one or the other sense. This is just like what we try to do when we segment a picture. Some clustering techniques are readily available and can be applied for image segmentation.

g)Matching:

When it is known that how an object we would like to identify in a picture looks like, we will use this information to find the object in a picture. This kind of approach to segmentation is termed as matching.Perfect image segmentation i.e., assigning of each and every pixel to the correct object segment is rarely achieved. This can be attributed to the fact that since a pixel might overlap with the "real" boundary of objects like the pixel being belonged to more than one object. Most strategies mentioned here –indeed most current segmentation methods– solely plan to assign a pixel to just a lone segment, which might be adequate for many applications. Methods in which each pixel is assigned with a segment probability distribution are probabilistic methods. This category of strategies is accurate to a greater extent theoretically. However, they add extensive complexity to the process of segmentation in terms of the concept and implementation. This makes it little used.Perfect image segmentation is additionally typically not reached as a result of the incidence of over segmentation or under segmentation. Firstly, pixels of the same object are segregated as belonging to various segments. One object may dramatically be represented by more number of segments. Secondly, the vice versa; pixels of different objects are classified as a set belonging to the same object. One section might contain many objects**.**

III. Methods

AThreshold based segmentation

This is the commonly used method to section an image which is known as Otsu's Method. The threshold operation

is a grey value remapping operation g (v), where v denotes a grey value and t denotes the threshold value, defined as given below.

$$g(v) = \begin{cases} 0 \text{ if } v < t \\ 1 \text{ if } v = t, \end{cases}$$

A grey-valued image is mapped to binary image by threshold. After this, the image will be segmented into two and are given pixel values 0 and 1. In cases where there is an image that has bright objects on a dark background, threshold itself may be applied to segment the image. Threshold is quite suited method to segment a picture into background and objects since in several types of images the background values are different from the grey values of objects. If the objects don't seem to be overlapping, then a separate segment from every object can be created with the help of a labeling algorithm on the binary image which was threshold. This way a unique pixel value can be assigned to each object. There are many methods which help in assigning an appropriate threshold value for segmentation. Most widely used among these is setting the threshold value interactively where the user manipulate the value and then review it until a satisfactory segmentation is attained. The histogram is commonly a useful tool in establishing an appropriate threshold price. A procedural approach to correct non-uniform illumination in an image to easily identify individual grains of rice within the image is presented in figure.

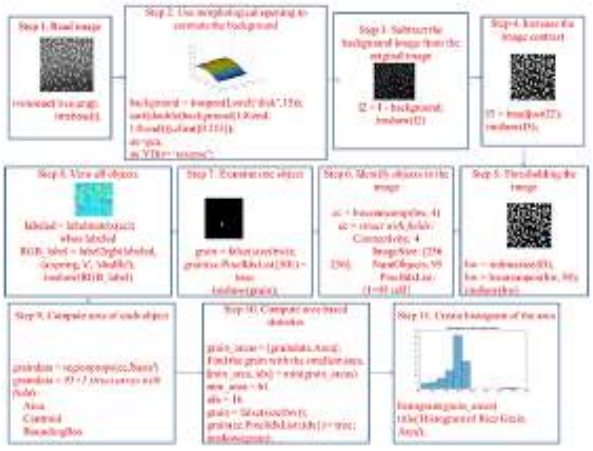

Figure 3.Threshold Based Segmentation Method In Image Processing

BColor Based Segmentation Using K-Means Clustering

Based on variety of colors present in it, the segmentation is done using this technique. Initially, RGB image is converted into HSV image. HSV color space is employed here as it matches with human perception. Later the image is transformed to three red planes and the pixels of same color are combined together. Then total numbers of colors are exhibited and finally the total number of colors is calculated. With the help of an example, the identification of colors in a fabric is shown by analyzing the L*a*b color space by using the procedure given here under. Initially, the image has to be acquired. In this example, a colorful fabric has been chosen. In the fabric, there is mainly six colors viz. the background color, green, yellow, magenta, red and purple. The L*a*b color space, which is deduced from the CIE XYZ tristimulus values, helps us in quantification of these visual differences. The color space comprises of a luminosity 'L*' or bright layer, chromaticity layer 'a*' which indicates where does a color befall through the red-green axis and chromaticity layer 'b*' which indicates where does a color befall through the blue-yellow axis. In second step, sample colors are calculated.The approach here is to select a minute sample region for each and every color present in the image and then compute average color of each of these sample regions in 'a*b*' space. To classify pixels, these color markers are used. Each color maker has a set of ‘a’ and ‘b’ values. Euclidean distance will be calculated between a given pixel and each color marker and thus classify the pixel. Smaller the Euclidean distance, closer is the match of that pixel with the color marker. As an example, if the Euclidean distance between green color marker and a pixel is least, then that pixel is labeled as a green pixel. An array is created with different color labels. In this example, array is created as background = 0, red = 1, green = 2, purple = 3, magenta = 4, and yellow = 5. Then the matrices are initialized as per the code given and classification of pixels is performed. In step 4, using the label matrix which has a color label for each pixel, separation of objects is done. As an example, red objects are displayed in the step 4 of figure 2, which can be extended to any color label that was created in the array. In final step, the values of ‘a’ and ‘b’ for each pixel are displayed. The whole summary of this technique can be shown in the figure.

Figure 4.Color Based Segmentation Method In Image Processing

C.Marker Controlled Watershed Segmentation

This technique practices the application of watershed segmentation to segment objects in a picture. It finds 'watershed ridge lines' and 'catchment basins' in a picture by assuming it as an apparent surface where the dark pixels are low and the bright pixels are high. Watershed transform segmentation gives more accurate results if the objects in the foreground and locations in the background are identified correctly. The procedure of Marker-controlled watershed segmentation is given as below.

a. Calculate a segmentation function, where in, the dark regions of an image are the objects we are attempting to segment.

b. Compute foreground markers, which are connected spots of pixels inside each of the objects.

c. Compute background markers, which are pixels that do not belong to any of the objects.

d. Alter the segmentation function such that it has minimum value at the background and foreground marker locations.

e. Calculate the modified segmentation function's watershed transform.

The example given here highlights various Image Processing Toolbox functions like fspecial watershed, infilter, inclose,incomplement, bwareaopen, imopen, imreconstruct, label2rgb, graythresh, imregionalmax and imposemin. Step by step procedure of the technique is presented in figures 3 & 4.

In step 1, the color image is read and converted to Grayscale.

In second step, the Gradient Magnitude is used as the Segmentation Function. It involves the usage of Sobel edge masks, imfilter and simple math to calculate the gradient magnitude. The value of the gradient is higher at the objects' borders and lower (mostly) within the objects.It must be noted that without additional preprocessing techniques like marker computations, the watershed transform results directly in oversegmentation. In third step, the objects at the foreground are marked. For this, a large variety of methods could be applied, which must be linked to spots of pixels within each of the foreground objects. Here in this example morphological techniques are employed to clean up the image. The morphological techniqueincludes opening-by-reconstruction and closing-by-reconstruction. Application of these gives rise to a flat maximum value inside each object which can be traced with the help of imregionalmax. Opening is erosion subsequently followed by dilation, whereas opening-by-reconstruction is erosion that is subsequently followed by a morphological reconstruction. Comparison between these two is done. Firstly, imopen is used. Then the computation of opening-by-reconstruction is done using imreconstruct and imerode. If the opening is followed with a closing, it can remove any stem marks and dark spots present. imdilate can also be used followed by imreconstruct. Reconstruction-based opening and closing is found to be more effective than the standard ones (opening and closing) that removes small imperfections without having an effect on the overall shapes of the objects. In order to obtain good foreground markers, the regional maxima of Iobrcbr has to be calculated.For interpreting the results, the foreground marker image is now superimposed on the original image. It can be observed that few of the mostly-occluded and shadowed objects are not marked. This means that in the end result, these will not be segmented properly. Also it can be seen that the foreground markers in few objects go right near to the edge of the objects. This means that the edges of the marker spots need to be cleaned and shrink a little. This can be achieved by a closing subsequently followed by erosion.

Using bwareaopen, all spots that have lesser than a given number of pixels can be removed.

These three steps are shown in figure below.

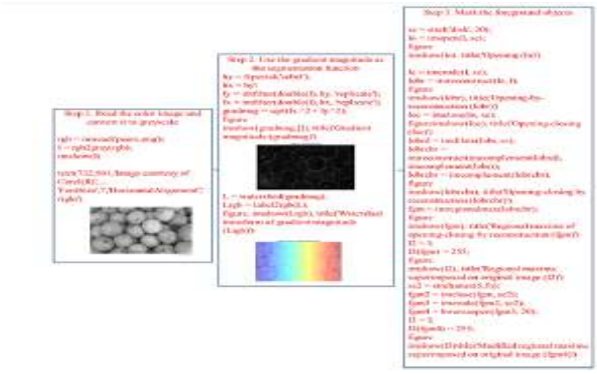

Figure 5.Marker Controlled Watershed Segmentation Method- Initial Steps

In step 4, the background markers are needed to be computed. In the cleaned-up image, Iobrcbr, the dark pixels are owned to the background, giving a hint that a threshold operation could be started. The background pixels are black and ideally the background markers should be maintained away from the edges of the objects that we are attempting to segment. For this, we will thin the background by calculating the skeleton by influence zones, of the foreground of bw, which can be achieved by calculating the watershed transform of the distance transform of bw and later look for the watershed ridge lines (DL == 0) of the result.

In step 5, Watershed Transform of the Segmentation Function has to be computed. For this purpose, function imimposemin can be employed to change an image so that it has local minimum value only in the locations which we

need to have minimal. The function can also be used to change the gradient magnitude image so that only local minimum value befalls at background and foreground marker pixels.The final step is visualizing the result. Of various techniques available, one of the visualization techniques is to superimpose the segmented object boundaries, background markers and foreground markers on the original image. Dilation can also be used to make object boundaries more visible. This visualization exemplifies how the locations of the background and foreground markers have an effect on the result. In a few locations, it can be observed that brighter objects are combined with neighbor partially occluded darker objects since the occluded objects didn't have foreground markers. Alternative visualization technique is displaying the label matrix as a color image. These label matrices, which are produced by bwlabel and watershed can be possibly converted into truecolor images by using label2rgb, for visualization purposes. Transparency can be used to overlay this pseudo-color label matrix on the top of the original image. Steps 4 through 6 are presented in the figure given below.

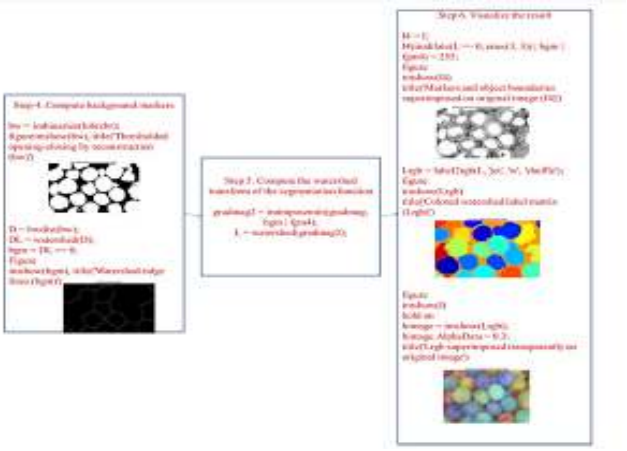

Figure 6.Marker Controlled Watershed Segmentation Method- Next Steps

D. Edge Detection Soft Computer Approaches

a) Fuzzy Logic Based Approach

Here, pixels are divided into fuzzy sets i.e. each pixel may belong partly to many sets and regions of image as Fig. Fig. shows the fuzzy rules for edge detection and neighborhood of a central pixel of the image.

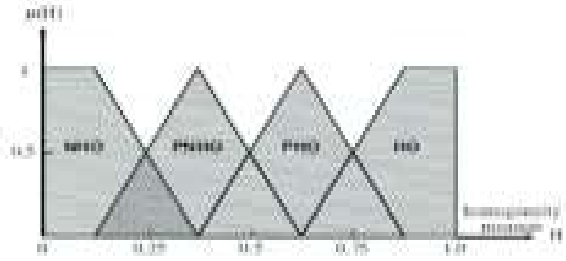

Figure 7.The Fuzzy Sets Used In Image Processing

b) Genetic Algorithm Approach

Derives from the evolution theory, consists of three major operations: selection, crossover, and mutation. GA used in pattern's recognition applications. Fuzzy GA fitness functions were considered.

c). Neural Network Approach

Important differences between neural networks and other AI techniques are their abilities to learn and generalize. The network "learns" by adjusting the interconnection, weights, between layers, and generalizes relevant output for a set of input data. Artificial neural networks (ANN) are applied for pattern recognition. The neural network consists of three layers: Inputlayer, Hiddenlayer, and outputlayer as shown in Fig. A neuron has a normalized between [0-1] as input and output. Each layer is having (I x J), image size and neurons. Each neuron is connected to respective neuron in the previous layer with its d order neighborhood as shown in figure.

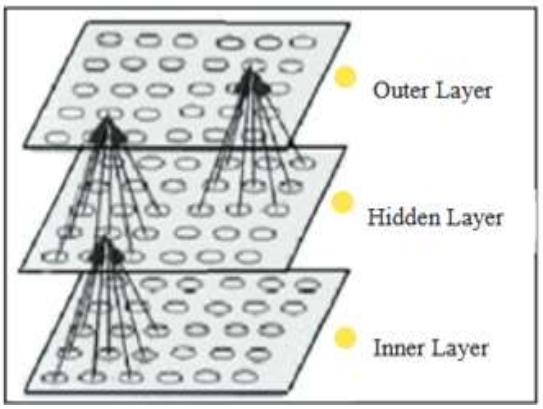

Figure 8.Neural Network Approach In Image Processing

IV. Results

A.ImageSegmentationEvaluation examples

A lot of image segmentation algorithms have been discussed and it is clearly that there is no universally accepted method for image segmentation thus there is no single method which can be considered good for all type of images, nor all methods equally good for a particular type

of image. Due to that, there is no universally accepted method for image segmentation evaluation thus the evaluation techniques that the researchers would flow to evaluate their image segmentation techniques would be varied according many factors such as image type, the application etc., so two examples of how to evaluate image segmentation techniques are followed presented: PDF Image segmentation techniques evaluation and Object class-based image segmentation techniques evaluation

Figure 9.Original image

Figure 10.Using fuzzy method

Figure 10.Using neural network method

Table 1: Comparison Rate Of Different Methods

Table shows the comparison rate of AC Coefficient Based technique and Histogram Based technique for text part extraction from PDF images. AC-coefficient based technique where the time consumption is more in this technique. Whereas the accuracy rate is better in Histogram based technique, as mentioned in the table above. So the user, researcher, would balance time against accuracy.

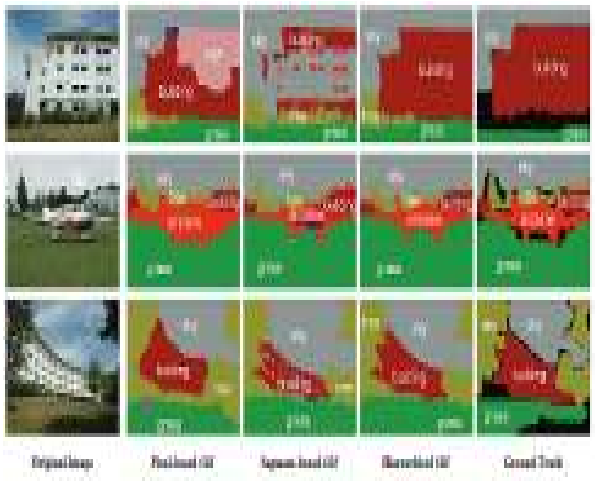

Figure 11.Non-Hierarchical Approaches Against Hierarchical Models Over Segments

V. Conclusion

In this paper, we discuss and evaluate different approaches to do image segmentation viz. threshold method such as K-Means clustering watershed segmentation. The effective approach to perform image segmentation includes using several algorithms, tools and a complete environment for data analysis, visualization and algorithm development. However, there is still a need to develop algorithms for effective image segmentation and hence the scope of research is huge in the area of image processing.The image is segmented using a series of decision and there is no universal segmentation method for all kinds of images and also an image can be segmented by using different segmentation methods. Image segmentation is a challenge in image processing and the researchers would evaluate their image segmentation techniques by using one or more of the following evaluation methods.

References

[1] https://ac.els-cdn.com/S1877050915028574/1-s2.0-S1877050915028574-main.pdf?_tid=ff548738-dc35-11e7-ac23-00000aacb360&acdnat=1512751193_c8c474ebde3e339d5df18852aa8e9845

[2] Amanpreetkaur, “A Review paper on Image Segmentation and its various techniques in Image Processing”, IJSR, Volume 3 Issue 12, December 2014, pp 12-14.

[3] Gudrun J. Klinker, Steven A. Shafer and Takeo Kanade, "A Physical Approach to Color Image Understanding," International Journal of Computer Vision, Vol. 4, No. 1, pp. 7- 38, 1990

[4] https://in.mathworks.com/discovery/image-segmentation.html

[5] Anil Z Chitade "Color based image segmentation using kmeans clustering" International Journal of Engineering science and Technology, Vol. 2(10), 2010, 5319-5325

[6] R. C. Gonzalez and R. E. Woods, Digital Image Processing. Addison-Wesley, 1993

[7] YZang"A review on image segmentation techniques with remote sensing perspective" IAPRS Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII

[8] Navneet Kaur et.al " Bacteria foraging based image segmentation "An International Journal of Engineering Sciences ISSN: 2229-6913 Issue July 2012, Vol. 6

[9] Rajeshwar Dass et.al "Image Segmentation Techniques" IJECT Vol. 3, Issue 1, Jan. - March 2012

[10] Y. Zhong, K. Karu et.al, "Locating Text in Complex Color Images," Pattern Recognition, vol. 28, no. 10, pp. 1523-1535, October 1995

[11] C.Yuan and S.Liang, "Segmentation of color image based on partial differential equations" in Proc. Fourth International Symposium on Computational Conference on Intelligent Computing and Cognitive Informatics (ICICCI), pp. 300-303,2010.

[12] H.Hedberg, "a survey of various image segmentation techniques", Dept.of Electroscience, Box, Vol .118, 2010

[13] Rajiv kumar (December, 2011) "Image Segmentation using Discontinuity-Based Approach", IJMIP, volume 1, pp 72-78.

[14] Krishna Kant Singh, Akansha Singh. (2010, September). "A study of Image Segmentation Algorithms for Different Types of Images".IJCSI International Journal of Computer Science Issues. Volume 7 (issue 5), ISSN (Online): 1694-0784. ISSN (Print): 1694-0814

[15] Dorin Comaniciu, Peter Meer. "Robust Analysis of Feature Spaces: Color Image Segmentation".