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# Image Segmentation Techniques for Dental Image Extraction

Image segmentation is the process of partitioning a digital image into multiple segments and often used to locate objects and boundaries (lines, curves etc.). In this paper, we have proposed image segmentation techniques: Region-based, Texture-based, Edge-based. These techniques have been implemented on dental radiographs and gained good results compared to a conventional technique known as Thresholding based technique. The quantitative results show the superiority of the image segmentation technique over three proposed techniques and conventional technique.

Digital Images are used as one of the most important media for carrying information in the field of computer vision. By image segmentation, we can extract information or objects of images. This information can be used for other functions, for example, human identification, detection of cancerous cells, synthetic aperture radar (SAR) images. So the image segmentation is the first step in the image analysis.

Image segmentation is a fundamental step in many areas of computer vision including stereo vision and object recognition. It provides additional information about the contents of an image by identifying edges and regions of similar color and texture while simplifying the image from thousands of pixels to less than a few hundred segments. Additionally, image segmentation has applications separate from computer vision; it is frequently used to aid in isolating or removing specific portions of an image. Image segmentation methods are categorized on the basis of two properties discontinuity and similarity. Methods based on discontinuities are called boundary based methods and methods based on similarity are called Region-based methods.

Segmentation is a process that divides an image into its regions or objects that have similar features or characteristics. Mathematically complete segmentation of an image  $R$  is a finite set of regions  $R_1 \dots R_n$ .  $R = \bigcup_{i=1}^n R_i$  and  $R_i \cap R_j = \emptyset$  for  $i \neq j$ .

The following sections present the study of basic image segmentation called Threshold based and proposed techniques Region-based, Texture-based, Edge-based. These techniques have been tested on dental radiographs to identify similarities like infected teeth. In this paper, these techniques segment the dental image into regions called dental work (DW). The result section provides simulation results of segmentation techniques. Based on source data (area of DW, the distance between DW, the angle between DW) of the image of different techniques, this paper shows the superiority of technique over proposed and existing techniques.

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## Image segmentation techniques

A. Existed technique: Thresholding Technique: It is a simple image segmentation technique but powerful approach for segmenting images. From a grayscale image, thresholding can be used to create binary images. This technique is based on space regions i.e on characteristics of an image. In the thresholding process, first convert a grayscale image into a binary image, by choosing proper threshold value  $T$ , divide image pixels into several space regions and separate objects from the background. For example,  $f(x,y)$  is intensity value of image pixel of the object, if it is greater than or equal to  $T$  i.e.,  $f(x,y) \geq T$  then it belongs to that object otherwise it belongs to the background. There are two types of thresholding methods with regarding selection of threshold value  $T$ : global and local thresholding. In global thresholding threshold value,  $T$  is constant whereas in local thresholding values is variable because of uneven illumination. Threshold selection is typically done interactively however, it is possible to derive automatic threshold selection algorithms. Threshold technique can be expressed as

$$T = T(x,y), p(x,y), f(x,y) \dots \dots \dots (1)$$

Where  $T$  is threshold values,  $y$  are the coordinate of the threshold value point.  $p(x,y), f(x,y)$  are points of grayscale image. The threshold image  $g(x,y)$  is defined as:  $g(x,y) = 1$  if  $f(x,y) \geq T = 0$  if  $f(x,y) < T \dots \dots \dots (2)$

B. Proposed Techniques: Texture-based segmentation: Texture segmentation is an important task in image processing. It works at segmenting a textured image into several regions having similar patterns. Texture segmentation has been an effective and efficient technique, so used in many applications like in analysis of biomedical images, seismic images. The texture feature extraction methods can be classified into statistical, structural and spectral. In statistical approaches, texture statistics such as the moments of the gray-level histogram, or statistics based on gray-level co-occurrence matrix are computed to discriminate different textures. In structural approaches, "texture primitive", the basic element of texture, is used to form more complex texture patterns by applying grammar rules, which specify how to generate texture patterns. Finally, in spectral approaches, the textured image is transformed into the frequency domain.

Region-based segmentation: Region-based algorithms are relatively simple and more immune to noise. Region-based segmentation is based on the connectivity of similar pixels in a region. There are two main approaches to region-based segmentation: region growing and region splitting. Let  $R$  represent the entire image region. Segmentation is a process that partitions  $R$  into sub-regions,  $R_1, R_2, \dots, R_n$ , such that (a)  $\bigcup_{i=1}^n R_i = R$  (b)  $R_i$  is a connected region,  $i = 1, 2, \dots, n$  (c)  $R_i \cap R_j = \emptyset$  for all  $i$  and  $j, i \neq j$  (d)  $P(R_i) = \text{TRUE}$  for  $i = 1, 2, \dots, n$  (e)  $P(R_i \cap R_j) = \text{FALSE}$  for any adjacent regions  $R_i$  and  $R_j$  Where  $P(R_k)$ : a logical predicate defined over the points in set  $R_k$ . For example  $P(R_k) = \text{TRUE}$  if all pixels in  $R_k$  have the same gray level. Region splitting is the opposite of region growing. Region splitting and merging method can divide an image into a set of arbitrary unconnected regions and then merge the regions in an attempt to

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satisfy the conditions of reasonable image segmentation. Region splitting and merging are usually implemented with a theory based on quadtree data.

In region splitting and merging method the procedure is as follows: Let R represents the entire image region and select a predicate Q<sub>i</sub>) We start with entire image if Q(R) = FALSE we divide the image into quadrants, if Q is false for any quadrant that is, if Q (R<sub>i</sub>) = FALSE, We subdivide the quadrants into sub quadrants and so on till no further splitting is possible.

1. If only splitting is used, the final partition may contain adjacent regions with identical properties. This drawback can be remedied by allowing merging as well as splitting i.e. merge any adjacent regions R<sub>j</sub>&R<sub>k</sub> for which, Q (R<sub>j</sub> U R<sub>k</sub>) = TRUE.
2. Stop when no further merging is possible. The portioned and corresponding quadtree is shown in figure 1.

### Edge-based segmentation:

An object can be easily detected in an image if the object has sufficient contrast from the background. Edge-based segmentation represents a large group of methods based on information about edges in the image. There are three basic types of gray-level discontinuities in a digital image: points, lines, and edges. The most common way to look for discontinuities is to run a mask through the image. We say that a point, line, and edge has been detected at the location on which the mask is centered if  $|R|=T$  Where  $R=w_1z_1+w_2z_2+\dots+w_9z_9$

Canny edge detection method is a more robust gradient-based edge detection algorithm. It uses linear filtering with a Gaussian kernel to smooth the noise in the image, then it computes the strength and direction of the edge for every pixel in the smoothed image by differentiating the image in the horizontal and vertical directions. Next, it computes the gradient magnitude as the root sum of squares of the derivatives and the gradient direction using arctangent of the ratio of the derivatives. Finally, the edge strength of each edge pixel is set to zero if its edge strength is not larger than the edge strength of the two adjacent pixels in the gradient direction. The remaining pixels after this process are labeled as candidate edge pixels and an adaptive thresholding method is applied on the thinned edge magnitude image to obtain the final edge map. The Canny edge detection follows below algorithm:

1. Compute  $f_x$  and  $f_y$ .  $G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$ , is the Gaussian function,  $\sigma$  is the standard deviation,  $\sigma^2 = \frac{1}{2}$ ,  $\sigma = \frac{1}{\sqrt{2}}$
2. Compute the gradient magnitude,  $G = \sqrt{f_x^2 + f_y^2}$
3. Apply non-maxima suppression.
4. Apply hysteresis edge linking.

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## Simulation results and discussions

In this paper, the image segmented techniques have been implemented in MATLAB 2009a. The test images are shown in figure 2a and figure 3a represents dental radiographs and corresponding segmented images are shown in figures (2b-2e) and (3b-3e). The source data of different techniques are tabulated for test images are tabulated in Table 1 and Table 2 for comparison purpose.

Image segmented methods are very useful in image processing applications. In this paper, we proposed a comparative study of three image segmented techniques: region based, texture based, edge based. Three conclusions we have made on characteristics of dental works (DW).

1. Based on area dental work: In the region-based method area for minute detail is considered. So that the area in region-based is larger as the total area is considered. The results obtained by the texture method similar to when compared to other methods but the one advantage is that it can be implemented to color images. Compared to three methods edge-based segmentation gives better results.
2. Based on the distance between DWs: In the region-based method the area, which is considered may be varied accordingly the distance between DW also varies. This gives the advantage of detection of any minute abnormalities in dental images. In both texture and edge methods the distance between DW same as existing methods.
3. Based on the angle between DWs: In all the methods the angle is the same as an existing method. Comparing three proposed methods, Region: Gives the freedom for selecting the area of minute detail for the dental process.

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