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Developing the range operator in the segmentation methods depending on dermatology infection

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Abstract—**Medical image segmentation is a frequent processing step in image understanding and computer aided diagnosis. In this paper, we propose developing on the range operator in image segmentation using depending on dermatology infection. Three different block size are utilized on the range operator and the developing ones to enhance the behavior of the segmentation process of medical images. We propose to exploit the concept of range filtering to extract the texture content of medical image. Experiment is conducted on different medical images and textures. Results show the efficacy of our proposed medical image texture segmentation.**

Keywords-image segmentation; medical images; range filter.

I. INTRODUCTION

Computer Aided Diagnosis (CAD) is an effective tool for analyzing the particular anatomical structure of medical images leading to better diagnosis and decision-making. The number of medical images has grown significantly in the recent years. These images are very important for clinical diagnosis, localization of pathology, study of anatomical structure, treatment planning, evolution of therapy, computer integrated surgery, surgical planning, post surgical assessment and abnormality detection. It is well-established fact that segmentation plays an important role in anatomical structure recognition. Segmentation is used to extract the anatomical structure in medical images.

There exist many methods for automatic and semi-automatic medical image segmentation. However, medical image segmentation may fail to segment well the anatomical structure, the region of interest. Unknown noise, poor image contrast, in homogeneity and weak boundaries existing in medical images has made the segmentation process extremely difficult. Further, medical images contain complicated structures [1].

The techniques such as thresholding [2], region growing [3], fast greedy algorithm [4], Fuzzy C-mean (FCM) and statistical models [5], active contour model [6], watershed segmentation [7, 8] and clustering [8] have been proposed for medical image segmentation. Felzenszwalb and Daniel [9] proposed Minimum Spanning Tree (MST) for segmentation of medical images. MST is one of the graph-based segmentation methods that it is computationally efficient for capturing perceptually the important aspects of image regions. However, it is prone to cause the problem of over segmentation with some long and narrow redundant areas between two regions. In [10], authors describe an improved segmentation algorithm based on Minimum Spanning Tree (MST). To overcome the problem of over segmentation, an adaptive neighbor mode is defined by adding links between non-neighbor pixels of an image. They explored their proposed segmented method on three different modalities of medical images such as MR, CT and X-ray.

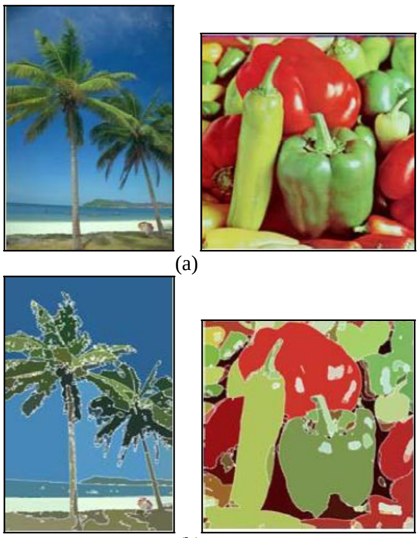
From the literature survey it is observed that a number of segmentation methods are applied on only specific anatomical structure. Moreover, the proposed methods are exploited on particular medical imaging modalities. Furthermore, the well-known characteristics of medical images such as poor image contrast, inhomogenity and weak boundaries affect the anatomical structure resulting in poor segmentation. In this direction, we propose an algorithm to segment medical images that include various anatomical structures belonging to different medical imaging modalities. The characteristic of regions in an image are analyzed by their texture content.

The rest of the paper is organized as follows. Image filtering is discussed in section 2. Our proposed algorithm for image segmentation of medical images is explained in section 3. Section 4 gives the details of the experiments followed by the results. The paper is concluded in section 5.

III. IMAGE SEGMENTATION

Image segmentation is important in many computer visions and image processing application .The goal of image segmentation is to find regions that represent objects or meaningful parts of objects. Division of the image into regions corresponding to objects of interest is necessary before any processing can be done at a level higher than that the pixel. Identifying real objects, pseudo-objects, and shadows or actually finding anything of interest within the image requires some form of segmentation [11]. “Fig. 1” shows types of the segmentation process [12].

Image segmentation methods will look for objects that either have some measure of homogeneity within them or have some measure of contrast with the objects on their border. Most image segmentation algorithms are modifications, extensions, or combinations of these two basic concepts. The homogeneity and contrast measures can include features such as gray level, color, and texture. After we have performed some preliminary segmentation, we may incorporate higher-level object properties, such perimeter and shape, into the segmentation process.



(a)

(b)

Figure 1. Image segmentation (a) original image, (b) segmented image.

We can divide image segmentation techniques into three main categories 1) region growing and shrinking, 2) clustering methods, and 3) boundary detection. The region growing and shrinking methods use the row and column (r,c) based image space, whereas the clustering techniques can be applied to any domain (spatial domain, color space, feature space, etc.). The boundary detection methods are extensions of the edge detection techniques [11].

A. *Boundary detection*

Boundary detection, as a method of image segmentation, is performed by finding the boundaries between objects, thus indirectly defining the objects. This method is usually begun by marking points that may be a part of an edge. These points are then merged into line segments, and the line segments are then merged into object boundaries. The edge detectors are used to mark points of rapid change, thus indicating the possibility of an edge. These edge points represent local discontinuities in specific features, such as brightness, color; or texture. After the edge detection operation has been performed, the next step is to threshold the results. One method to do this is to consider the histogram of the edge detection results, looking for the best valley. Often, the histogram of an image that has been operated on by an edge detector is unimodal (one peak), so it may be difficult to find a good valley. This method works best with a bimodal histogram. Another method that provides reasonable results is to use the average value for the threshold. With very noisy images, a good rule of thumb is to use 10-20% of the peak value as a threshold. After we have determined a threshold for the edge detection, we need to merge the existing edge segments into boundaries. This is done by edge linking. The simplest approach to edge linking involves looking at the threshold test and connecting it to all other such points that are within a maximum distance. This method tends to connect many points and is not useful for images where too many points have been marked; it is most applicable to simple images. Instead of thresholding and then edge linking, we can perform edge linking on the edge-detected image before we threshold it. If this approach is used, we look at small neighborhoods (3 * 3 or 5 * 5) and link similar points. Similar points are defined as having close values for both magnitude and direction. The entire image undergoes this process, while keeping a list of the linked points. When the process is complete the boundaries are determined by the linked points [11].

IV. Image Filtering

Filtering is perhaps the most fundamental operation of image processing. The term filtering can be defined as the value of the filtered image at a given location. It is a function of the values of the input image in a small neighbourhood of the same location. Filter operations can be used to sharpen or blur images, to selectively suppress image noise, to detect and enhance edges, or to alter the contrast of the image. The filters use the local statistical variations in an image to reveal [1]

A. *Analysing the texture of an image*

Texture analysis refers to the characterization of regions in an image by their texture content. Texture analysis attempts to quantify intuitive qualities described by terms such as rough, smooth, silky or bumpy as a function of the spatial variation in pixel intensities. In this sense, the roughness or bumpiness refers to variations in the intensity values or gray levels.
Texture analysis is used in a variety of applications, including remote sensing, automated inspection and medical image processing. Texture analysis can be used to find the texture boundaries and texture segmentation. Texture analysis can be helpful when objects in an image are more characterized by their texture than by intensity and hence, traditional thresholding techniques cannot be used effectively. The texture analysis functions such as range filtering, standard deviation filtering and entropy filtering, filter an image using standard statistical measures. These statistics can characterize the texture of an image. They provide information about the local variability of the pixels intensity values in an image. In the areas with smooth texture, the range values in the neighbourhood around a pixel will be small and similarity, the range values are large in the areas of rough texture.

The texture functions all operate in a similar way. They define a neighbourhood around the pixel of interest calculate the statistic for that neighbourhood and use the computed statistic value as the value of the pixel of interest in the output image. The example shown in "Fig. 2" illustrates how the range filtering function operates on a simple matrix. In this example, the value of element B (2, 4) is calculated from A (2, 4). Range filtering function use m by n pixels, in this example 3 × 3, neighbourhood around the pixels [1].

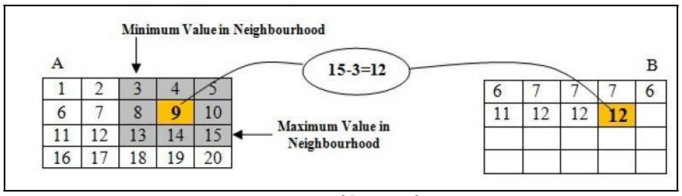


Figure 2. Range filtering function.

B. Continuity based methods

These approaches look for similarities or consistency in the search for structural units. These approaches can be very effective in segmentation tasks, but they all suffer from a lack of edge definition. This is because they are based on neighborhood operations and these tend to blur edge regions, as edge pixels are combined with structural segment pixels.

The larger the neighborhood used, the more poorly edges will be defined. Unfortunately, increasing neighborhood size usually improves the power of any given continuity-based operation, setting up a compromise between identification ability and edge definition. One easy technique that is based on continuity is low pass filtering. Since a low pass filter is a sliding neighborhood operation that takes a weighted average over a region, it enhances consistent characteristics [2].

Image features related to *texture* can be particularly useful in segmentation. "Fig. 3" shows three regions that have approximately the same average intensity values, but are readily distinguished visually because of differences in texture. Several neighborhood-based operations can be used to distinguish textures: the small segment Fourier transform, local variance (or standard deviation), the *Laplacian* operator, the *range* operator (the difference between maximum and minimum pixel values in the neighborhood), the *Hurst* operator (maximum difference as a function of pixel separation), and the *Haralick* operator (a measure of distance moment).

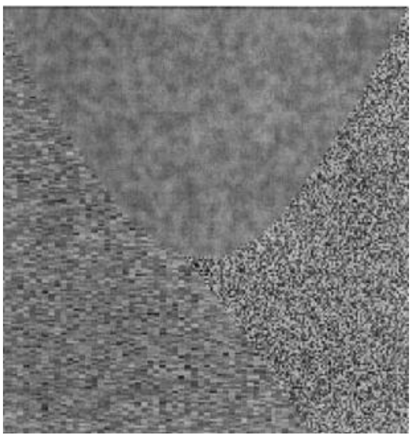


Figure 3. An image containing three regions having approximately the same intensity, but different textures.

V. PROPOSED METHOD

Medical image segmentation is a critical task for analyzing the structural content of the images. Surgical planning, early disease detection and 3D visualization can be provided for the physicians by proper image segmentation. Medical image texture segmentation can be widely applicable to evaluate an area of body that is not externally visible. The texture filter function can detect the texture regions of a medical image. It can be argued that there is a little variation in the gray level values of the background of medical images since the background is smooth. Hence in the foreground the surface contours of the anatomical structure exhibit more texture.
Therefore, the foreground pixels of medical images have more variability and thus higher range values. Range filtering is one of the texture analysis methods that filter an image. Range filtering makes the edges and contours of the anatomical structures of medical images become more apparent. Consequently, the range filtering is explored for medical image texture segmentation as explained in the following sub section.

A. Range Filtering

A local sub range filtering uses the statistical sub range of the pixel intensities within the window. The range distance is often used in statistics as a measure of the sample variation. Edges are typically characterized by discontinuities in mean intensity. If the variations existing among the local intensity values are low then the local range distance is small. Similarly, the local range distance is large if a region has large discontinuities in intensity values. Hence, range filtering is able to detect pixel intensity values of the edges within a window. The output of the range filtering is the difference between maximum and minimum range values of the filtered window. The range values in the filtered window are multiplied by a constant value to provide strong edges. Local range filtering tend to have short calculation time as it operates on only a small number of input for each output pixel. Moreover, range filtering can have better segmentation through creating a structure element to extract the neighbourhood for the local range of values. Hence a structuring element is created to extract the neighbourhood for the local range of values. "Fig. 4" illustrates the range filtered medical image using the defined structure element. "Fig. 5" illustrates the original and range histogram.

(a) (b)

Figure 4. (a) Original medical image, (b) Range filtered medical image.

The algorithm used for the proposed method is as follows:

1. Load image which contains three regions having the same average intensities, but different textural patterns.
2. Pick one color of the RGB color space by splitting the image to three images.
3. Apply the "range" nonlinear operator using 'nlfilter'.
4. Choose the range filter from the five range filteres used.
5. Choose the local range (x) between several ranges used (such that x is chosen between 3 and 15).
6. Rescale intensities.
7. Plot original and range images and original and range histograms and filtered image.

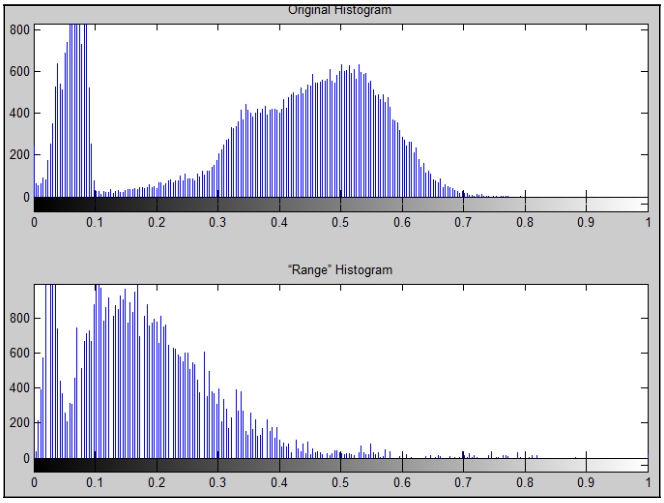
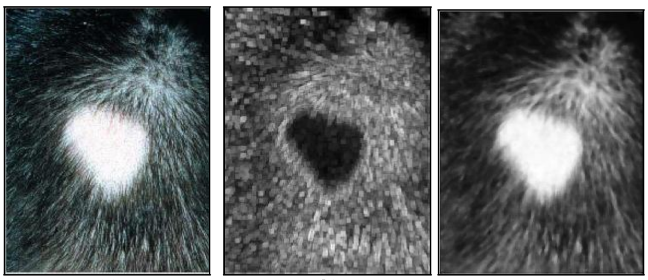


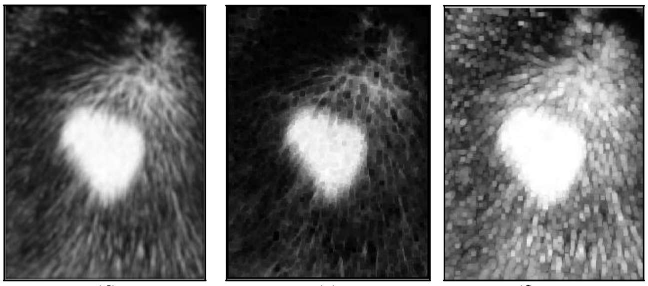
Figure 5. Original and range histograms.

VI. EXPERIMENTAL RESULTS

In this work five different range filters are used maximum minus minimum, median value, mean value, minimum value only and finally maximum value only. All these filters have good results for segmentation. "Fig. 6" shows those different ones.



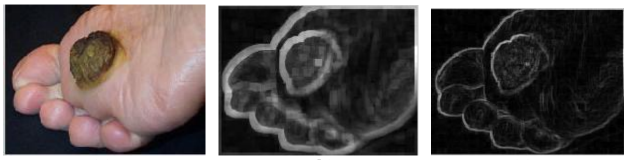
(a) (b) (c)



(d) (e) (f)

Figure 6. (a) original image, (b) max-min range filter, (c) median range filter, (d) mean range filter, (e) minimum range filter, (f) maximum range filter.

Also different local range filters are tested on different dermatology medical images [7×7], [3×3], and [11×11] are some examples on the block size of the range filter. "Fig. 7" shows these different block size.



(a) (b) (c)

(d)

Figure 7. (a) original image, (b) [7×7] , (c) [3×3], (d) [11×11].

The proposed method compared with other segmentation methods such as thresholding, and region growing algorithm and we find good results compared with them. Table I shows the results between those methods with our proposed method. For further measuring the performance of the segmented images, two objective performance measures were applied as a partial indication of performance. One is the uniformity measure defined as

$$U = 1 - \sum_j \left(P_j \ \sigma_j^2 / \sigma_{\max}^2 \right) \tag{1}$$

where $\sigma^2_{\max}$ is the maximum variance for all regions, σ^2_j and P_j are the variance and weighting factor associated with the region j. A larger U value (maximum value 1.0) indicates a more homogeneous segmented image. Another measure is the evaluation function defined as

$$E = \sqrt{N} \sum_{j=1}^{N} \left(e_j^2 / \sqrt{N_j} \right) \tag{2}$$

where e^2_j is the sum of Euclidean distance between the original and segmented image pixels in the region j, N_j is the number of pixels in the j-th region, and N is the total number of regions. A smaller E indicates a better performance. Table I shows the performance measured from using these 2 criteria.

One can observe that the uniformity measure is close to 1.0, indicating that the segmented images are rather homogenous (although this measure does not penalize small region sizes). The results of evaluation function E have indicated an improved performance after the refined segmentation.

TABLE I. COMPARISION RESULTS

Img	Pre-segment			Refined-segment			Uniformity		
	Prop	***Thr***	***RG***	***Prop***	***Thr***	***RG***	***Prop***	***Thr***	***RG***
I1	3.27	3.98	4.55	3.13	3.87	3.93	0.98	0.95	0.96
I2	4.01	4.77	5.12	3.87	3.91	4.11	0.95	0.93	0.95
I3	2.19	2.92	3.85	2.05	2.78	2.76	0.93	0.88	0.92
I4	6.99	7.01	7.68	5.32	6.76	6.79	0.99	0.91	0.96
I5	2.16	2.19	2.95	1.95	1.92	1.98	0.91	0.86	0.88

VII. CONCLUSION

In this paper, Different range filters are used and tested on different dermatology medical images. These types of images give a texture behavior and serve the physicians to detect the infected regions. We segment various anatomical structures of different dermatology medical imaging modalities using texture filtering. The range filtering is exploited for medical image texture segmentation. Results show the efficiency, simplicity and robustness of medical image texture segmentation.

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