ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 4, March 2017

SEGMENTATION OF LESION IMAGES USING MORPHOLOGICAL OPERATION AND FUZZY LOGIC THRESHOLD

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Abstract— ***Image processing techniques* plays a wider role in many medical imaging applications. In the field of *dermatology, skin cancer can be identified by image processing techniques. Various automations are involved in these techniques. Differentiating lesions from normal skin is an important task in all techniques .The segmentation of pigmented skin lesion images pertaining to malignant melanoma is obtained in a more accurate manner with the help of morphological operation like erosion and dilation, and fuzzy logic threshold technique.***
Keywords – Fuzzy Logic, erosion, dilation Threshold

I. INTRODUCTION

Skin Cancer occurs when normal cells undergo a transformation during which they grow and multiply without normal controls. Skin cancer is a disease in which malignant cells are found in the outer layers of your skin. The most common sign of skin cancer is a change on the skin, such as a growth. Melanoma usually occurs in adults, but it may occasionally be found in children and adolescents. Nearly 75% of the victims die from this disease. Skin cancer is the most common form of human cancer. It is estimated that over 1 million new cases occur annually. The lesion depth becomes thicker than 1-1.5 mm. This Paper describes the image segmentation which plays an important role in the feature extraction, classification.

II. LITERATURE SURVEY

There are a number of approaches for the evaluation of the visual features of the pigmented skin lesions regarding diagnosis. Many different methods have been proposed to segment dermoscopic lesion images based on Laplacian filters hybrid classification algorithms, and soft computing methods. These are semi-automatic and an expert is needed to label the initial set of regions as dermis or epidermis [Kurugol, 2008]. Graph based segmentation is very useful but usually gets stuck in a local minimum if there are noises or tiny blemishes present in the image [Jianbo, 2000]. The Normalized N-cuts usually deal with larger images [Haralick, 1992]. Fuzzy based split and merge method can also be used, but its experimental results are worse than the other methods due to the unsupervised perceptual segmentation approach.[Maeda,2007].

III. STUDY OBJECTIVES

Among the methods discussed, the most straightforward and easiest segmentation is threshold technique. Applying threshold technique with morphological operation (erosion, dilation, region growing) will give more accurate segmentation of lesion images from skin. This paper focused on these techniques

IV. METHODOLOGY

Skin lesion is highly irregular and it is very difficult to fix the border. The choice of the threshold plays a major role in the performance of segmentation procedure. The automatic determination of this threshold has a few limitations due to fuzziness and uncertainty at the border between the lesion and the skin. Hence in this paper fuzzy logic technique is applied to determine the threshold value in order to find out the sharpest border of cancer in spite of its irregularity. In addition, Morphological operations are applied to get accurate segmentation. The important step involved in extracting the lesion image from skin is given below.

1. Acquiring the image.
2. Applying morphological operation such as Erosion and dilation on the gray scale image
3. Computing the histogram for the image.
4. Calculating the threshold value using fuzzy Logic technique.
5. Convert the gray-scale image into a Binary (black and white only) image by replacing the

gray pixels with values equal to or less than the threshold with white pixels and the gray pixels with values greater than the threshold with black pixels.

6. Applying the Morphological operation (region growing) to the resultant binary image.
7. Mapping the binary image into color image.
8. Finding the pathological skin

The details of the aforementioned procedure are given below.

4.1. ACQUISITION OF THE IMAGE

The image is acquired using digital imaging devices such as digital camera joined with a special optical device. Thus acquired nevus images are transferred to a dedicated image processing system, which is, in most cases, a personal computer running dedicated image processing software. Once the image is obtained, it is converted into gray scale image.

4.2 APPLYING THE MORPHOLOGICAL OPERATIONS ON GRAY SCALE IMAGE

4.2.1 ERODING THE IMAGE

Erosion: Erosion of image A by structure element B, AΘB is

defined as

$$A \Theta B = \{ p \mid p + b \in A \ \forall b \in B \} \quad \text{--(1)}$$

Erosion helps to removes the anomalies and reduces the brightness in the image. Erosion operator can be applied on both binary and grayscale images. It uses the replicate functions to shrink or reduce the images. To avoid indeterminate edge values, and to detect the changeover skin, erosion operation is applied on gray images..

4.2.2 DILATING THE ERODED IMAGE

Dilation: Dilation of a image A by structure element B, denoted by

$$A \oplus B = \{ a + b \mid for\, a \in A\, and\, b \in B \} \quad \text{--(2)}$$

Dilation helps to fill the holes and broken area that are separated by spaces. Dilation operator can be applied on both binary and grayscale images. Dilate operation can use the replicate function to expand or increase the eroding image. This will increase the brightness of the image. It will be easy to find the pathological skin from a lesion image.

4.2.3 Computation of Histogram of the Gray scale image

The histogram of a gray-scale image is a plot of dynamic range of gray colors in the image versus the frequency of appearance of the gray colors. From the histogram the number of pixels with a particular gray color is found out[Gonzales,2002].It will help to find the level or frequency of the color.

4.3. CALCULATION OF THRESHOLD USING FUZZY SET

Discussion on some basic idea of fuzzy set is found important prior to the application of the same to get the threshold value.

4.3.1 Fuzzy Set Theory

A fuzzy set is a class of points possessing a continuum of membership grades, where there is no sharp boundary among elements that belong to this class and that do not. It can be expressed by membership *function* or *characteristic function* $\mu_A(X_i)$. This function assigns a membership grade to each element in the set. The grading is in the interval [0, 1]. Let X be the universe of discourse, with a generic element denoted by x_i : $X = \{x_1, x_2, \ldots, x_m\}$. A fuzzy set A in X is formally defined as

$$A = \{ (x_i, \mu_A(X_i)) \},\ x_i \in X \quad (3)$$

Where A is characterized by the function $\mu_A(.)$. This function associates with each point xi ∈ X with a membership grade $\mu_A(X_i) \in [0, 1]$. In this work, the S-function is used for modeling the characteristic function. Such a function is defined as

$$\mu_{As}(x) = S(X : a, b, c)$$

S-function (sigmoid function):

$$= \begin{cases} 0, & x \le a \\ 2\{(x-a)/(c-a)\}^2, & a \le x \le b \\ 1 - 2\{(x-c)/(c-a)\}^2, & b \le x \le c \\ 1, & x \ge c. \end{cases} \quad (4)$$

The function can be controlled by the parameters a and c, b denotes the crossover point, which is given by b=(a+c)/2 with $\mu_{As}(b)=0.5$; the bandwidth of the function is defined as Δb= b – a = c - a

4.3.2. Proposed Algorithm

The thresholding algorithm is based on the concept of similarities between gray levels. Hence in order to implement this algorithm, the following are assumed.

i) There exists a significant contrast between the objects and background;
ii) The gray level is the universe of discourse, a one-dimensional set, denoted by **X**.
The main aim is to threshold the gray-level histogram. This can be achieved by splitting the image histogram into two crisp subsets namely, object subset **O** and background subset **F**. The splitting is done with the help of the measures of fuzziness. Now, based on the assumption, two linguistic variables {object, background} are defined. They are modeled by two fuzzy subsets of X denoted by **B** and **W**, respectively. The fuzzy subsets **B** and **W** are associated with the histogram intervals $[x_{min},x_j]$ and $[x_r, x_{max}]$, respectively, where x_j and x_r are the final and initial gray-level limits for these subsets, and x_{min} and x_{max} are the lowest and highest gray levels of the image, respectively. It is known that the gray levels in each of these subsets have the intuitive property of belonging with certainty to the final subsets object **(O)** or background **(F)**. So $B \subset O$ and $W \subset F$ or *vice-versa*. The subsets are located at the beginning and the end regions of the histogram. With these subsets, a seed for starting the similarity measure process is found. Also, a fuzzy region placed between **B** and W is defined. Then, to obtain the segmented version of the gray-level image, each gray level of the fuzzy region is classified as being object or background. The classification procedure is as follows. Each of the seed subsets **B** and W are added with a gray level x_i picked from the *fuzzy region*. Then, by measuring the IF's of the subsets **B** U $\{x_i\}$ and **W** U $\{x_i\}$, x_i is assigned to the subset with lower IF (maximum similarity). Finally, applying this procedure for all gray levels of the *fuzzy region*, the region can be classified into o*bject* or *background* subsets.

Instead of using the S with fixed bandwidth (Δb), the parameters of S were used as follows.[Orlando J.Tobias,2002].

$$b = \frac{\sum_{i=p}^{q} x_i h(x_i)}{\sum_{i=p}^{q} h(x_i)} \qquad (5)$$

$$c = b + \max\{|b-(x_i)_{\max}|, |b-(x_i)_{\min}|\}, \quad p \le i \le q \qquad (6)$$

$$a = 2b - c \qquad (7)$$

Where $h(x_i)$ denotes the image histogram and x_p and x_q are the limits of the subset under consideration. The quantities $(x_i)_{max}$ and - $(x_i)_{min}$ represent the maximum and minimum gray levels in the current set for which
$h((x_i)_{max}) \neq 0$ and $h((x_i)_{min}) \neq 0$

(iii) Measures of Fuzziness

By using the IF introduced by Kaufmann [Kaufmann, 1975], it is found that the set A is compact when compared with its nearest ordinary set $\underline{A}$. The characteristic function of the later is given by

$$\mu_{\underline{A}}(X_i) = \begin{cases} 0, & if \quad \mu_A(X_i) < 0.5 \\ 1, & if \quad \mu_A(X_i) > 0.5 \end{cases} \qquad (8)$$

In Kaufmann's definition, this index is obtained by measuring the distance between A and A.
Such an index is defined as

$$\psi_k(A) = \frac{2}{n^{1/k}} d_k(A, \underline{A}) \qquad (9)$$

Where dk(A, A) is a measure of distance, and n is the Number of elements in A. Such a distance is computed according to

$$d_k(A, \underline{A}) = \frac{2}{(n)^{1/k}} \left(\sum_{i=1}^{n} (\mu_A(x_i) - \mu_{\underline{A}}(x_i))^k \right)^{1/k} \qquad (10)$$

In this paper fuzzy logic can be useful to find the threshold value. In the way of region grow the image edges should find out. In the segmentation of image we find out the lesion image from a normal skin.

4.4 REFINEMENT OF BINARY IMAGE USING MORPHOLOGICAL OPERATION (REGION GROWING)

Once the threshold value is identified it is converted into binary image. In the binary image if more than two regions are found then it is grouped with the help of region growing morphological operation. With an appropriate disc structure element, an erosion operation removes the boundary pixels the use of a radius element. Applying erosion operations successively strips off the image object in layers and finally erases the entire object. So the binary image now contains only skin and lesion image.

V SEGMENTATION OF LESION IMAGE FROM THE COLOR IMAGE

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Available online at www.ijartet.com

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Vol. 4, Special Issue 4, March 2017

Then the pixels are classified using the information from the binary nevus image. Using this classification the color nevus image is segmented into two namely *nevus* and *skin*. The segmentation of cancer is done on the image shown below. Digital video microscopy improves diagnostic accuracy for melanoma [Seidenair, 1998, Seidenair, 1995, Stoecker,1995]. This image is obtained from a digital dermoscope camera of high resolution.

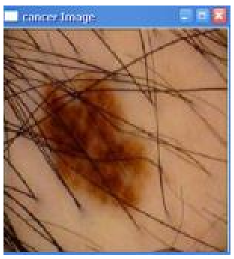

Figure 5.1 Cancer Skin Image with Hair

From the above figure red channel , green channel and blue channel are extracted using the REFORM operation. Once the individual channels (red, green blue) are extracted from the RGB image, morphological closing operation as shown in equation (1) is applied on the image to remove the hair. Morphological closing operation uses the structure element shown in figure 52. The result image is given below.

Figure 5.2 after Morphological Operation

After applying the morphological operation the cancer image without hair is shown in figure 5.3.

The corresponding histogram for the above diagram is shown below.

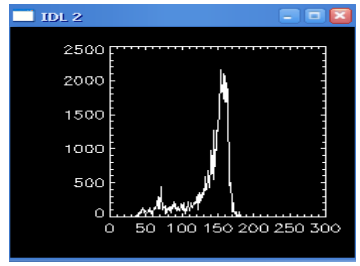

Figure 5.3 Histogram of Gray Scale Skin Image

Once the image is converted into gray scale, threshold value is calculated using fuzzy logic for segmentation.

Using the threshold value gray scale image is converted in to binary image in which white pixels shows the border of nevus images

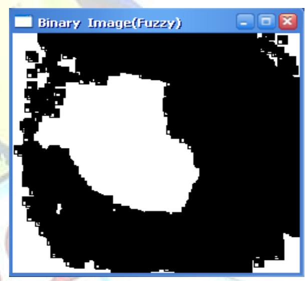

Figure5.4 Binary Image-using fuzzy logic

To give more clarity to the binary image morphological operations are applied. Lesion border is obtained by subtracting lesion image with eroded image.

The resultant image is shown below.

Figure 5.5 Border of lesion image

The binary image after applying morphological operation is

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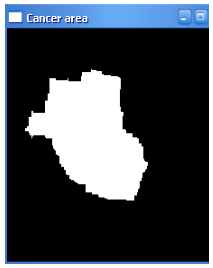

Figure 5.6 Resultant Binary Images

The color nevus image for the corresponding binary image is Shown in figure 5.7

Figure 5.7 skin and caner area

The proposed method can more effective because it can sharply detect the lesion skin from a normal skin.

VI.CONCLUSION

This Paper focused on segmentation of skin cancer from skin using fuzzy logic and morphological method. As the border of the lesion is clearly found out using this method, repetition of this image processing on the images taken at various intervals will reveal the growth of the lesion and hence it is more effective to reduce mortality from malignant melanomas. The powers of these systems depend on the input features.

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