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Automatic Skin Lesion Detection Using DWT Thresholding based Otsu Segmentation Method

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Abstract

Skin is exposed to outer environment thus the disease and infection occurs more to skin. Skin cancer is one of the dangerous diseases and the deadliest form is melanoma. There is a need for computerized system to detect skin lesions and evaluate a patient's risk of melanoma. Segmentation not only plays an important role but also a challenging task in skin lesion detection due to low contrast between lesion and the surrounding skin, the irregular and fuzzy lesion borders and various imaging acquisition conditions. Therefore, an automatic skin lesion segmentation system is proposed in this paper. In segmentation process Discrete Wavelet Transform (DWT) thresholding based on Otsu method is applied to extract lesion areas.The performance of the proposed system is tested on the ISBI 2016: Skin Lesion Analysis Towards Melanoma Detection challenge website and the result is very appreciable and promising accuracy in segmentation process.

1. Introduction

Malignant melanoma is the most frequent type of skin cancer and its incidence has been rapidly increasing over the last few decades. Thus, there has been an increasing interest in computer-aided systems for the clinical diagnosis of melanoma as an assistance. The clinical diagnosis of melanoma is commonly based on the ABCD rule, an analysis of four parameter (asymmetry, border irregularity, color and dimension) which is a scoring method for a set of different characteristic depending on color, shape and texture. The lesion segmentation step is fundamental in order to increase the effectiveness of the subsequent steps, since it strongly affects the results of the whole pipeline. Indeed, an accurate segmentation allows for deriving border structure information, such as the asymmetry and the irregularity of the lesion area, which are essential for a correct presumptive diagnosis. However, the great variety of lesion shapes, size and colors, the different skin types and textures, as well as the possible presence of hair and irregular border and low contrast between lesion and surrounding skin make segmentation a hard task (three examples of typical challenges are shown in Figure. 1).

(a) (b) (c)

Figure 1. Difficulties in Lesion Segmentation on dermoscopic images (a) Presence of hair (b) irregular border (c) low contrast between lesion and surrounding skin .

Detection of skin lesion using automatic computerized analysis of skin images is an active research area recently as this provide help in early diagnosis of skin cancer [1]. An essential step in the computer-aided clinical diagnosis of skin lesions is the automatic segmentation of the lesions from skin mages. The segmentation is very challenging due to factors such as illumination variations, irregular structural and color variations, the presence of hair, as well as the existence of multiple lesions in the skin [4].

To address these factors, several methods have been proposed and a popular class of approaches to skin lesion segmentation is thresholding [3], which has been shown to be effective for situations where the lesions have consistent characteristics and the surrounding skin regions are homogeneous in nature, as well handling situations characterized by multiple regions. However, such approaches face difficulties in situations characterized by structural, illumination, and color variations, where no clear threshold can be found that separates the lesion regions from the surrounding skin regions, and resulting in poor segmentation accuracy.

In this paper, DWT thresholding based Otsu segmentation approach is proposed to segment the regions corresponding to skin lesions from the skin images. The proposed method is robust to noise and artifacts, multiple lesion regions, structural variations, illumination and color variations, and weak boundary separation between skin lesions and surrounding skin, which are the key challenges to skin lesion segmentation.

This paper is organized as follows. First, the related works that have been proposed by other researchers are described in Section 2. Second, the general steps of skin lesion diagnosis are described in Section 3. The proposed system is detail explained in Section 4. The experimental results using real images of various types of dermatological lesions are presented in Section 5. Finally, conclusions are drawn and future work is discussed in Section 6.

2. Related Work

Automatic skin lesion segmentationis a challenging task due to the low contrast between lesion and the surrounding skin, the irregular and fuzzy lesion borders, the existence of various artifacts, and various imaging acquisition conditions. Therefore, many researchers have developed various computer algorithms to conquer this challenge. These algorithms can be broadly classified as clustering, thresholding, region merging and splitting, active contour models and supervised learning.

Yading Yuan, Ming Chao, and Yeh-Chi Lo presented a fully automatic skin lesion segmentation by leveraging a 19-layer deep convolutional neural networks (CNNs). Furthermore, they designed a novel loss function based on Jaccard distance to eliminate the need of sample re-weighting, a typical procedure when using cross entropy as the loss function for image segmentation due to the strong imbalance between the number of foreground and background pixels. They evaluated the effectiveness, efficiency, as well as the generalization capability of their proposed framework on two publicly available databases: ISBI 2016 PH2 database [7].

Support Vector Machine (SVM) approach was used for skin lesion classification in [8]. For that, the user will have to upload an image of skin disease. The image of skin disease was taken and it must be subjected to various preprocessing for noise eliminating and enhancement of the image. And the feature of the image was extracted by using GLCM algorithm and segmented by using support vector machine. And finally fuzzy classification was used to detect the skin cancer. The proposed system had higher segmentation accuracy compared to existing system.

AlMansour, Jaffarb and Shahad proposed the solution of the un-clarity of images problem in [9] by using the active contour method, but active contour has a major drawback of seed selection where it should start to process segmentation. In their proposed system, fuzzy entropy based morphological processing method had been used to find out automatic seed point for active contour. The proposed methodology was tested on standard dataset DermIS and both quantitative as well as qualitative measures was used to check the reliability of the proposed method that shows promising results.

The proposed system [10] provided an improved automated skin lesion segmentation method for dermoscopic images. There were several stages for this method and these included the pre-processing steps such as resizing the images and eliminating noise. Hair was removed and reflective light was reduced using morphological operations and a median filter. The single green channel was rescaled into new intensities, as it provided the highest segmentation accuracy. The threshold value was calculated to separate the skin lesion region from healthy skin. Morphological operations were implemented to merge the small lesion areas around the bigger lesion areas with similar features and trace the boundary of the melanoma.

The research paper [11] presented an automated diagnosis system based on the ABCD rule used in clinical diagnosis in order to discriminate benign from malignant skin lesions. First, to reduce the influence of small structures, a preprocessing step based on morphological and fast marching schemes was used. In the second step, an unsupervised approach for lesion segmentation was proposed and iterative thresholding was applied to initialize level set automatically. As the detection of an automated border is an important step for the correctness of subsequent phases in the computerized melanoma recognition systems, they compared its accuracy with growcut and mean shift algorithms, and discussed how these results may influence in the following steps: the feature extraction and the final lesion classification. Relying on visual diagnosis four features: Asymmetry (A), Border (B), Color (C) and Diversity (D) were computed and used to construct a classification module based on artificial neural network for the recognition of malignant melanoma.

A new method of dermoscopic images segmentation was introduced in [12]. The preprocess was the filtering operation to dermoscopy image to remove most of difficulties facing the efficient segmentations, like a variety of lesion shapes, sizes, color, changes due to different skin types and textures and presence of hairs. Segmentation based mainly on histogram thresholding. The proposed method evaluated by using Hammoude Distance (HM) and the True Detection Rate (TDR). Also the proposed method is compared with other skin lesions segmentation methods such as Otsu, adaptive thresholding and fuzzy Cmeans.

3. Skin Lesion Diagnosis

The computer-aided diagnosis of skin lesion consists of these general steps – image acquisition, pre-processing, segmentation, post processing (optional), feature extraction, and classification [2]. First of all, a digital dermoscopic image have to be acquired which has to be pre-processed to produce better result and to get faster processing time. After that, segmentation is needed to perform which is very significant step in skin lesion diagnosis as accuracy in skin lesion border detection affects the later successive phases. For automatic skin lesion segmentation, DWT thresholding based on Otsu method is used in this proposed system. If required, post processing is done to improve the segmented image. After segmentation is performed, features are extracted from the segmented lesion area and this is used for classifying the given input as whether the lesion is in benign phase or malignant phase.

4. Proposed System

An automatic skin lesion segmentation approach is proposed in this work that can be used for computer-aided diagnosis of melanoma. Firstly, the skin lesion images are acquired from the ISBI 2016 dataset.

Then, images are preprocessed. This is fundamental step in all image processing techniques to produce better result and to get faster processing time. Although, there are many image preprocessing techniques currently used in image processing, only few image preprocessing need to carry out in this procedure. For this process resizing and double Precision is done.

(a). Resizing

The faster image loading time, controllable image size and better search space can be obtained by resizing the training images before carry out other image.So, we have to resized all training images into *[240 320]* in size.

(b). Double Precision

Sometimes operations on images are easier when the images are represented in floating point. The conversion from integer class to double precision is to switch the numbers to floating point and then divide by the maximum allowed for the class, such as double(ImageData)/255, so that 0 still corresponds to 0.0 and 255 corresponds to 1.0.

After the images have been preprocessed, these are converted into grayscale images using Principal Component Analysis (PCA). Visually important image features often disappear when color images are converted to grayscale. PCA reduces such losses by attempting to preserve the salient features of the color image.The RGB image is converted to grayscale image. Converting a color image to grayscale is a dimensionality reduction problem. PCA can be employed to compute an ellipsoid in color space that is a least-squares best fit for the cloud of points formed by all the image color values. Color values in the image can then be projected on a luminance axis defined by the primary axis of this ellipsoid. The effectiveness of PCA depended upon the color space but in most cases it can be maintained the proportionality between perceived color difference and perceived luminance difference and ignored spatial arrangement of pixels and give a result of aesthetic and perceptually salient grayscale images. The advantage of using PCA is to extract important visual information.

Then, the converted grayscale images are used in morphological processing. The field of mathematical morphology contributes a wide range of operators to image processing. These operators are particular useful for common usage include noise removal and image enhancement. .Morphological closing is applied to the grayscale image to enlarge the boundaries of foreground regions and to remove the small holes in an image, with a disk-shaped structuring element with appropriate diameter. (We used the value 2 for diameter.).

The next step is to find the thresholds from the morphological images using Discrete Wavelet Transform (DWT). It is a suitable tool for any type of segmentation or classification. In this system Level-1 2-D wavelet decomposition is performed to the resultant image and search for the thresholds that minimizes the intra-class variance (the variance *within the two classes, black and white regions) in*

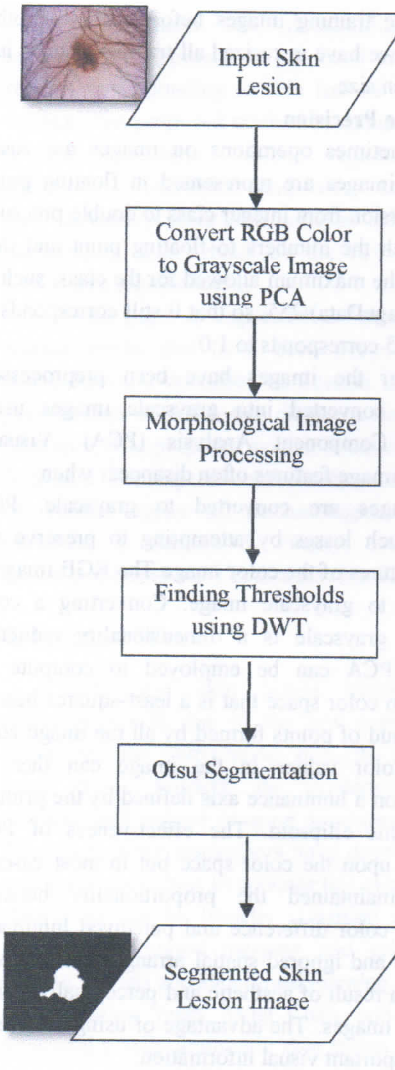


Figure 2. System Flow Diagram

each component of the decomposed image. Then calculating new threshold(gray-level) from sum of the four Otsu thresholds and dividing by 2.

Then Reconstruct the image by applying inverse wavelet transform and quantized the reconstructed image with the calculated Otsu threshold to reduce the amount of grayscale information and to convert it to binary(black and white) image. In this approach, the gray-level(threshold) value of each pixel is calculated from the average value of approximate and detail components of wavelet transform. So that, the binarization results are greatly improved the experimental results, especially for those images including hair lines and color plates.

The canny edge detector is used iteratively to find the edges in the binary image. We set the value 2 for the counter of iteration. The Process of Canny edge detection algorithm can be broken down to 5 different steps:

1. Apply Gaussian filter to smooth the image in order to remove the noise.
2. Find the intensity gradients of the image.
3. Apply non-maximum suppression to get rid of spurious response to edge detection.
4. Apply double threshold to determine potential edges.
5. Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

Morphological operations such as clear border, filling holes are done as post-processing. Finally lesion is detected.

The system flow diagram of an automatic skin lesion segmentation system is shown in Figure2.The resulted images that are generated from each segmentation step of the proposed system are shown in Figure 3.(a), (c), (d), (e), (f).

5. Experimental Results

We evaluated the proposed method on the ISBI 2016 skin lesion challenge dataset. The most common skin lesion segmentation evalution, metrics were used for comparison including dice similarity

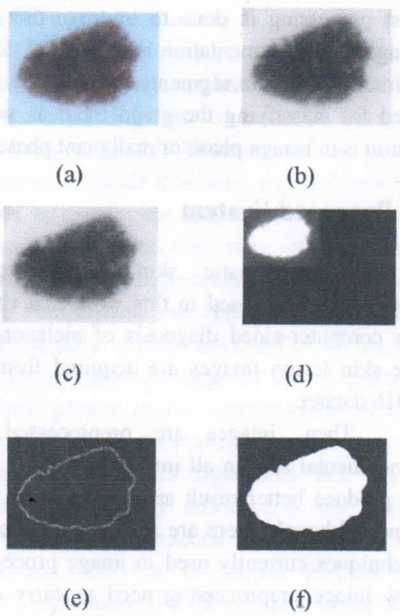


Figure 3. (a) Original Image (b)RGB to Gray (c)Morphological closing (d) After using DWT (e) After using Canny Edge (f) Segmented Image

coefficient equation(1)-measure the overlap between the ground truth and the algorithm produced result.

DSC= 2TP/2TP+FP+FN (1)

Where TP= true positive, FP= false positive andFN=false negative

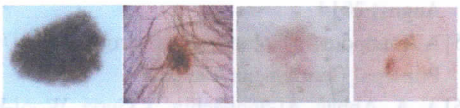
dice=2*nnz(segImage&TruthImage)/(nnz(segImage)+nnz(gTruthImage))*100 (2)

totalDice =totalDice + dice(3)

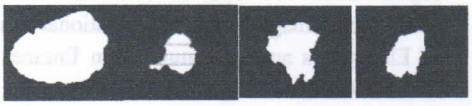
In equation(2)nnz means number of nonzero elements in matrix, segImage and TruthImage represent the obtained segmentation and the ground truth.segIm and grndTruth to be of the same size. After apply equation (2) the similarity of each image.

totalDice =totalDice / no: of image (4)

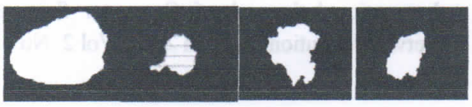
After apply equation (4), the overall segmentation accuracy rate with 95.18% is obtained. About 600 images were used to get that result. Output of DWT thresholding based Otsu method is implemented using Matlab. The segmented skin lesion image and the overall segmentation accuracy rate are shown in figure (4) and (5).



(a)



(b)



(c)

Fig 4.(a) original image, (b) Final Result after Complete Segmentation. (c) ground truth

6. Conclusion and Future Work

The proposed method generates the segmented skin lesion images with high accuracy. The final output given by the system will help the dermatologist to detect the lesion and its type, accordingly with his knowledge he will examine the

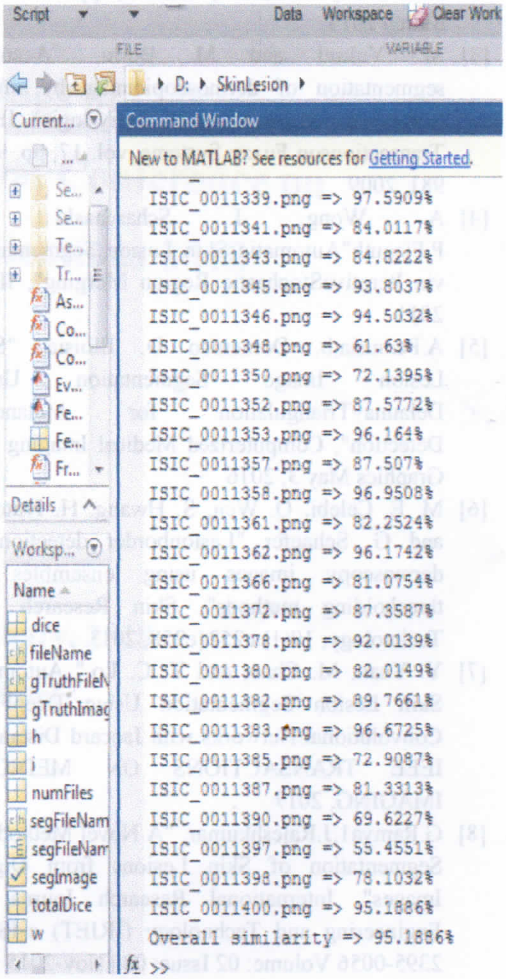


Figure 5. Overall Segmentation Accuracy

patient to draw a final conclusion whether it can be operated or not or any other ways to cure it for e.g. using medicines or ointments, etc. As future work, these segmented skin lesion images are used to extract lesion features. Then, the system will detect and classify lesion images into benign or melanoma using convolutional neural network.

References

[1] M. E. Celebi, W. V. Stoecker, and R. H. Moss. "Advances in skincancer image analysis", Computerized Medical Imaging andGraphics, 35(2):83–84, 2011.

[2] B. Baral, S. Gonnade and T.Verma, "ImageSegmentation and Various Segmentation Techniques – A Review",International Journal of Soft Computing and Engineering (IJSCE)ISSN:

2231-2307, Volume-4, Issue-1, pp. 134-139, March 2014.

[3] M. Yuksel and M. Borlu, "Accurate segmentation of dermoscopicimagesby image thresholding based on type-2 fuzzy logic", IEEE Transactionson Fuzzy Systems, vol. 17, pp. 976-981, 2009.

[4] A. Wong, J. Scharcanski and P.Fieguth"Automatic Skin Lesion Segmentation via IterativeStochastic Region Merging", IEEE 2011

[5] A.Pennisia,b, Domenico D. Bloisia, "Skin Lesion Image Segmentation Using DelaunayTriangulation for Melanoma Detection", Computerized Medical Imaging and Graphics May 3, 2016

[6] M. E. Celebi, Q. Wen, S. Hwang, H. Iyatomi, and G. Schaefer "Lesionborder detection in dermoscopy images using ensembles of thresholding methods", Skin Research and Technology, 19(1):e252{e258, 2013

[7] Y. Yuan, M. Chao, and Y. C. Lo," Automatic Skin Lesion Segmentation Using DeepFully Convolutional Networks with Jaccard Distance", IEEE TRANSACTIONS ON MEDICAL IMAGING, 2017

[8] G.Ramya1,J.Rajeshkumar, "A Novel Method for Segmentation of Skin Lesions from Digital Images", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 02 Issue: 08 | Nov-2015

[9] E.AlMansour, M. ArfanJaffar, S. AlMansour,"Fuzzy Contour based Automatic Segmentation of Skin Lesions in DermoscopicImages",IJCSNS International Journal of Computer Science and Network Security, VOL.17 No.1, January 2017

[10] A. Ahmed, Al-abayechia, X.Guoa, "Automatic skin lesion segmentation with optimal colourchannel from dermoscopic images", Jun 2014

[11] M. MESSADI, H. CHERIFI and A. BESSAI, "Segmentation and ABCD rule extraction for skin tumors classification", Journal of Convergence Information Technology(JCIT)Volume9, Number2, March 2014

[12] N.Khdhair, E.Abbadi and A. H.Miry,"Automatic Segmentation of Skin Lesions using Histogram Thresholding", Journal of Computer Science 10 (4): 632-639, 2014ISSN: 1549-3636

[13] S. and N.Razmjooy, "A Novel Method for Skin Lesion Segmentation", International Journal of Information, Security and System Management, 2015, Vol.4, No.2, pp. 458-466

[14] J. M. John, S. S. Samuel, N. M. John, "Segmentation of Skin Lesions from DigitalImages using Texture Distinctiveness withNeural Network", International Journal of Advanced Research in Computer and Communication EngineeringVol. 3, Issue 8, August 2014

[15] A.Abadpour, "Color Image Processing Using Principal Component Analysis"

[16] A. A. Abbas, Al-abayechia, X.Guoa, Wooi-Haw Tana, Hamid A. Jalab,"Automatic skin lesion segmentation with optimal colourchannel from dermoscopicimages",SSRG International Journal of Electronics and Communication Engineering Volume 4 Issue 4 – April 2017

[17] Khan, Noufal, "Wavelet Based Automic Lesion Detection using Improved OSTU Method", International Journal of Computer Science & Network Solutions, March 2014, Vol 2. No 3