Proceedings

of

2018 Joint International Conference on Science, Technology and Innovation, Mandalay with Japan University & Company Research Group cooperated by IEEE

October 5th, 2018

Mandalay Technological University

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IEEE

2018 Joint International Conference on Science, Technology and Innovation, Mandalay with Japan University & Company Research Group cooperated by IEEE.

September 26, 2018

Dear Ohn Mar Lwin,

Congratulations on the select of your paper entitled "**Segmentation and classification of skin cancer from skin lesions**" has been accepted for a presentation at the 2018 Joint International Conference on Science, Technology and Innovation in Mandalay.

The conference venue located at the Mandalay Technological University (MTU), Patheingyi, Mandalay, Myanmar. The date of the Conference is October 5, 2018. We look forward to your presentation at the Conference.

Sincerely yours,

Dr. Shoshi Inoue
Chairperson of the paper review committee
Professor
Hokkaido University of Education, Japan

Dr. Phyoe Wai Htun
Professor and Head, IRs Department,
Mandalay Technological University,
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Segmentation and Classification of Skin Cancer from Skin Lesions

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ABSTRACT

During the last years, computer vision-based diagnosis systems have been widely used in several hospitals and dermatology clinics, aming at the early detection of malignant melanoma, which is among the most frequent types of skin cancer. In this work, we present an automatic diagnosis system based on the ABCD rule used in clinical diagnosis in order to discriminate benign from malignant skin lesions. First- an unsupervised approach for lesion segmentation is proposed. As the detection of an automated border is an important step for the correctness of subsequent phases: the feature exaction and the final lesion classification. Relying on visual diagnosis four features; Asymmetry(A), Border(B), Color(C) and Diameter(D) are computed and used to classify the image as Normal skin and malignant melanoma. This framework has been tested on the ISBI 2016:Skin Lesion Analysis Towards Melanoma Detection Challenge Website.

KEYWORDS: *melanoma, segmentation, skin lesion image, dermoscopy.*

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. 1and the melanoma and benign are shown in figure. 2).

(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

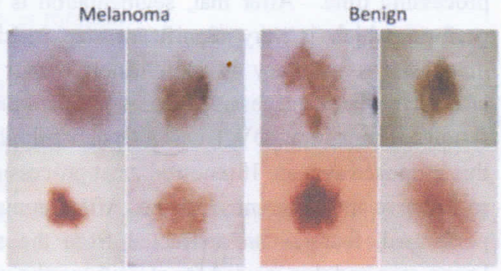


Figure2. Melanoma and Benign

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, we present an automatic diagnosis system based on the ABCD rule used in clinical diagnosis in order to discriminate benign from malignant skin lesions.

This paper is organized as follows. First, the general steps of skin lesion diagnosis are described in Section 2. The segmentation process is detail explained in Section 3. Feature Extraction for Skin Lesion Discrimination are presented in Section 4. TDS calculation is presented in section5. Finally, conclusions are drawn in Section 6.

2. 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 based 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.

3. Segmentation

Image segmentation is the process of object separation. The purpose of segmentation is to distinguish a range of pixels having nearby values. Thresholding is the key process for image segmentation. Thresholding can be of two types-Bi-level and multi-level. In bi-level thresholding, two values are assigned_ one below the threshold level and the other above it. In multi-level thresholding, different values are assigned between different ranges of threshold levels. Wavelet transform of an image gives four components of the image approximation, horizontal, vertical and diagonal. Following has to be done to implement the proposed methodology.

Step 1: 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-square 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 gives a result of aesthetic and perceptually salient gray scale images.

Step 2: Morphological closing is applied to the gray scale 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.).

Step3: 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 each component of the decomposed image. Then calculating new threshold(gray-level) from sum of the four Otsu thresholds and dividing by 2.

Step 4: Reconstructed 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.

Step 5:
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:

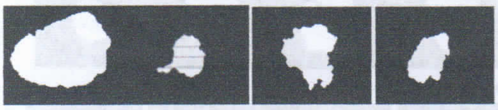
1. Apply Gaussian filter to smooth the image in order to remove the noise.
2. Find the intensity gradients of the image.
3. Apply non-maximum suppression to get rid of spurious response to edge detection.
4. Apply double threshold to determine potential edges.

5. Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

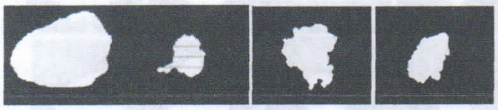
Step 6: Morphological operations such as clear border, filling holes are done as post-processing. Finally lesion is detected.

The resulted images that are generated from each segmentation step of the proposed system are shown in Figure 2. (a), (b), (c).

(a)



(b)



(c)

Fig 3.(a) original image, (b) Final Result after Complete Segmentation. (c) ground truth

4. Feature Extraction for Skin Lesion

This step aims to design a set of robust parameters that accurately describe each lesion and this in order to ensure that melanoma and benign lesions can be distinguished. We mimic the ABCD rule used by physicians in order to distinguish between different tumors.

4.1 Asymmetry index

Asymmetry (A) is one of the more important parameters used *in differentiating malignant tumorsfrom* benign lesions. An asymmetry index based on the principal axes of the lesion, was proposed by Stoecker. In this method, an asymmetry index is calculated from the smallest difference between the image area of the lesion and the image of the lesion reflected from the principal axis (Fig. 4).According to dermatologists, four axes are sufficient to determine the rate of symmetry (vertical,horizontal and two diagonal axes). To calculate this parameter, we determine the symmetry rotation of tumor through a 180° angle from first axe and second axe. Let A(x, y) be the initial surface, and B(x, y)the surface we obtained after symmetry rotation. The ratio between the intersection of A(x, y) surface sand B(x, y) surfaces and their merging quantifies the recovery rate of the two surfaces, and therefore the degree of symmetry. The calculation of this index is illustrated in Fig. 4(c), where the region in blue refers to the intersection of the surfaces and the external line defines their merging. The more the index approaches 1, the more the lesion will be considered as symmetrical.

$$IS = A \cap B / A \cup B \qquad (1)$$

(a) (b) (c)

Figure 4(a). Principal axis illustration. (b)and (c) Example of a mask overlaid on its symmetrical (180° center rotation)

4.2 Border irregularity

In order to calculate border irregularity, there are different measures such as: compactness index and fractal dimension.

4.2.1 Index compactness and fractal dimension

Compact Index can be determined by using the following equation:

$$C = p^2/4\pi a \qquad (2)$$

Where p and a represent the perimeter and area of the lesion respectively.

Fractal Dimension: Fractal set is provided by the"box counting" method.

4.3 Color (C)

Regarding the color evaluation ,six shades are taken in consideration: black, white, red, light-brown, dark-brown, blue-gray.

4.4 Diameter (D)

The average diameter for the lesion can be determined by using the equation.

$$D = (4A/\pi)^{1/2} \qquad (3)$$

Where A is the lesion's area, the diameter should be less than 6mm for benign lesion. Malignant growth more than 6mm in diameter.

5. TDS Calculation

To calculate Total Dermoscopy Score TDS following formula is used

$$TDS = 1.3A + 0.1B + 0.5C + 0.5D \qquad (4)$$

According to the value of (TDS) we classify all images.

TDS of this lesion is greater than 5.45 hence the lesion is malignant melanoma.

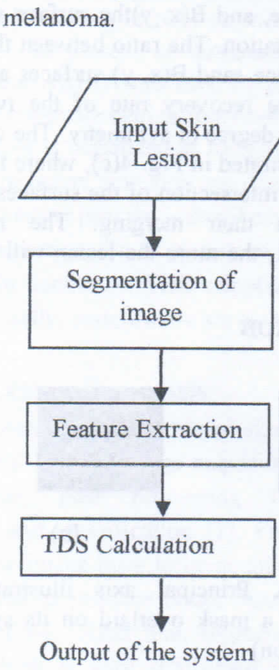


Figure 5. System Flow Diagram

5. Experimental Results

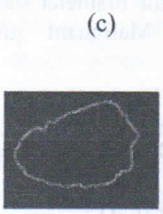
To test the performance of proposed system we used about 500 images. We compared the segmented images resulted by proposed method with ground truth images in ISBI 2016: Skin Lesion Analysis Towards Melanoma Detection Challenge Website.

(a)

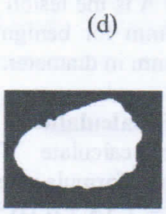
(b)

(c)

(d)

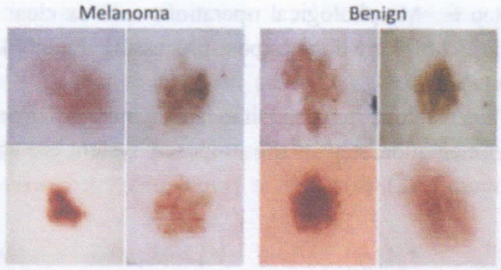


(e)

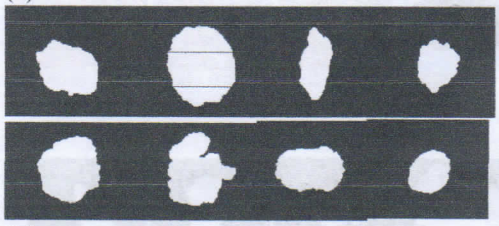


(f)

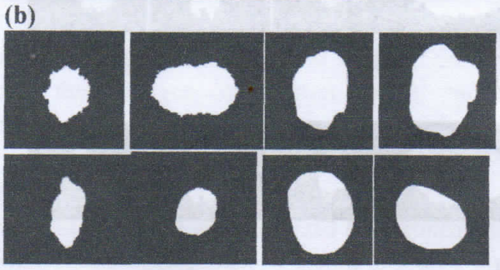
Figure 6: (a) Original Image (b)RGB to Gray (c)Morphological closing (d) After using DWT (e) After using Canny Edge (f) Segmented Image



(a)



(b)



(c)

Fig 7.(a) original image, (b) Final Result after Complete Segmentation. (c) ground truth

After the segmentation process we compute the TDS for each image. According to the value of TDS we classified all images.

(a)The lesion is benign

A	B	C	D	TDS
0.09,	0.55011,	2 ,	3.8356	2.9230

(b)The lesion is malignant

A	B	C	D	TDS
2	0.37465	3	7.3126	7.7540

Figure 8: Values of(A,B,C,D and TDS) for benign and malignant lesion sample.

6. CONCLUSIONS

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 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.

ACKNOWLEDMENT

The author is grateful to international skin image Collaboration(ISCI), the organizers of 2016 International Symposium on Biomedical Imaging (ISBI 2016) challenge of "Skin lesion analysis towards melanoma detection". We also thank the anonymous reviewers whose comments and suggestions helped improved this manuscript.

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