The Melanoma Skin Cancer Detection and Feature Extraction through Image Processing Techniques

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Abstract

We propose a technique for detecting the melanoma skin cancer with the Otsu thresholding that segments the lesion from the entire image. Boundary tracing algorithm has been used for further segmentation. After extracting the features from the lesion, Stolz algorithm has been used for the classification stage. The results obtained are presented in the form of statistical tables and graphs. The experimental result shows that the proposed algorithm makes good for detecting different stages of skin cancer.

Keywords: Skin Cancer, Otsu, Boundary Tracing, Stolz.

1. INTRODUCTION

The skin protects against heat, sunlight, injury, and infection. Skin also helps control body temperature and stores water and fat. Skin cancer is the most common type of cancer. It usually forms in skin that has been exposed to sunlight, but can occur anywhere on the body [2]. The fair complexioned population has been liable for melanoma cancer. If it diagnosed in the early stage it is assurance to be medicable, otherwise it can penetrate into the skin and disperse all other parts of the body [8]. Vigorous exposure of ultraviolet ray to skin is the prominent source of melanoma. Though the detection of melanoma using dermoscopy is higher than unaided observation based detection, its diagnostic accuracy lean on the habitude of the dermatologist. Each year close to 55,000 people suffered from this type of cancer. As compared with other types of cancer, melanoma is quite common to all [1].The automatic diagnosis tool is crucial for medical practitioner. Even when the accomplished dermatologist uses the dermoscopy for diagnosis, the exactness of melanoma recognition is estimated to be about 75-84%. The computer aided diagnostics is supportive to increase the diagnosis accuracy as well as the speed. Computer is not more brilliant than human but it may be able to obtain some information, like color variation, asymmetry, texture features, that may not be readily perceived by human eyes.

In recent years, Image processing techniques have been used to detect melanoma skin cancer by many researchers. Image processing plays a vital role for producing digital images with a good brighten/contrast and detail is a strong requirement in medical field like vision, biomedical image analysis, cancer detection and orthopedics[5]-[11].

Arushi Bhardwaj et al. [4] discussed that the segmentation of skin lesion from the outer skin area either uses manual, semi automatic or fully automatic techniques. For the early diagnosis of melanoma, it is required to be image acquision done on digital images. Harpreet Kaur et al. [6] given a review that an image-processing technique involves treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. A. Bono et al. [9] says that the other studies report the circularity index, as a measure of borders in skin images. Nilkamal.S et al [3] proposed the segmentation method for melanoma detection and it has been given that the goal of segmentation is transforming the image representation into a meaningful one for simplification in image analysis. In this process every pixel is assigned by a label, which will share same visual behaviors. Mangesh Patil et al. [10] discussed about the automation of skin cancer diagnosis could deduct the false positive or false negative in clinical remedy .It has the difficulties of over segmented because of the textured lesion area.

In this paper we propose a technique to detect the melanoma skin cancer and compare with some standard reference values. Our algorithm produced better result. We discuss about an approach to detect the melanoma skin cancer and feature extraction in Section 2. The proposed system context diagram is presented in Section 3. Experimental results are discussed in Section 4. Finally the conclusions are drawn in Section 5.

2. PROPOSED METHOD

We proposed an approach to detect the melanoma skin cancer and feature extraction through various image processing techniques .The input for the system is the skin lesion which is uncertain to be melanoma cancer. The image is pre-processed to ejection of hair and noise etc and contributed a quality image.

The Otsu thresholding and boundary tracing algorithm is used for image segmentation .The segmented image is given to extract the center of the mass by calculating the mean value of the image repeatedly to acquire the center, in order to measure the geometrical features like Area, Perimeter, MinorAxisLength, MajorAxisLength appropriately. The Stolz algorithm is used for feature classification stage, the extracted features that are proceeded in order to assort the image as mole, benign, suspicious, highly suspicious skin lesions [13].

The important steps in a diagnosis of melanoma skin cancer are: image acquision of lesion image, Segmentation of the lesion area from the outer area, Extraction of the feature from the input image. Based on the extraction, the classification has to be done. Feature extraction is the intent of extracting the features from the lesion image in order to characterize the melanoma. But all melanomas do not have all four ABCD features. It is the combination of features (e.g., A+B, A+C, B+C, A+B+C, etc.) that render some lesions most suspicious for early melanoma [3].

2.1. Pre-processing Stage

Image pre-processing includes image resizing, hair removal, brightness etc. The image is given as input, it checks for the lesion image ,if so it proceeds for pre-processing .Usually the input image has noise like hair, so in order to remove such noises, wiener filter is applied. For the case of melanoma skin cancer, the most common type of noise is hair, for this intent wiener filter is used. If the input image is other than the skin lesion image like flowers,Scenery, animals etc then the system rejected the input image.

2.2. Segmentation Stage

In Image Processing various segmentation methods are available. Once the pre-processing has done. The next step is to segment the lesion area from the input image. For this intent the image segmentation has been done. In this paper, the Otsu thresholding and boundary tracing algorithms are used one after another in order of clear segmentation of the lesion area from other part of the image. Once the input image is converted into gray scale image the Otsu thresholding has been done [11].

In Otsu's method the threshold that minimizes the intraclass variance (the variance within the class) is selected by trial and error. Within class variance is defined as a weighted sum of variances of the two classes. Otsu shows that minimizing the intra-class variance is the same as maximizing inter-class variance (between class variance) [7].

The class probability ω1 (t) is computed from the histogram as t. Similarly, you can compute ω2 (t) and μ2 on the right-hand side of the histogram for bins greater than t [7]-[14]. Then the segmented image is used for boundary tracing algorithm for further segmentation. Finally the clear segmentation of lesion area has done.

2.3. Feature Extraction

The feature extraction of the image includes the geometrical features like Area, Perimeter, MinorAxisLength and MajorAxisLength.

Area (A): Number of pixels of the lesion.
Perimeter (P): Number of edge pixels.

Major Axis Length or Greatest Diameter (GD):

The length of the line passing through lesion centroid and connecting the two farthest boundary points. The output of (x_c, y_c) is given by the relation (1).

$$(x_c, y_c) = \left(\frac{\sum_{i=1}^{n} x_i}{n}, \frac{\sum_{i=1}^{n} y_i}{n} \right) \qquad (1)$$

Where n is the number of pixels inside the lesion, and (x_i, y_i) is the coordinates of the ith lesion pixel.
Vandana jagtap et al. [1] discussed about the relation (1) for finding the output of (x_c, y_c).

Minor Axis Length or Shortest Diameter (SD):
The length of the line passing through lesion blob centroid and connecting the two nearest boundary points.

Asymmetry:
The mathematical formula which is used to determine the asymmetry value is given by the relation (2)

$$Asymmetry = (\Delta p / p) * 10 \qquad (2)$$

Where, ΔP = Pixel difference, P =Total Pixel count of lesion
Arushi Bhardwaj et al. [4] discussed about the relation (2) for calculating the asymmetry value.

Border:
The mathematical formula which is used to determine the border irregularity is given by the relation (3)

$$B = [(perimeter)^2 / 4\pi A] \qquad (3)$$

Where, A= Area of the lesion, π = 22/7

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Arushi Bhardwaj et al. [4] discussed about the relation (3) for calculating the border irregularity.

Color:
The color of the skin lesion differs over the various shades of brown, black, red, white or blue. The value of one is assigned on the presence of each color in the lesion image [3].

Diameter:
The diameter of the output image is greater than 6 mm then it is classified as melanoma, then a score of 5 is assigned for diameter [3].

2.4. Proposed Algorithm

2.4.1 Algorithm -1

BEGIN PRE_PROCESS ()
Step 1: Initialization
     Input: Image (X)
Step 2: Check_If: Image (X) = Skin_Lesion
     Then
     Convert RGBtoGrayScale
     Else
     Image (X): Invalid
Step 3: Goto Filtering ()
END PRE_PROCESS ()

BEGIN FILTERING ()
Step 1: Input: NoiseAddedImage (X)
     Noise: Gaussian
     Filter: Wiener
END FILTERING ()

BEGIN FIRST_SEGMENT ()
Step 1: Input: Filtered_Image (X)
Step 2: Threshold: Minimize_intraclassvariance
     $\sigma^2 w (t) = \omega 1 (t) \sigma^2 1 (t) + \omega 2 (t) \sigma^2 2 (t)$
Step 3: Weights ωi are the probabilities of the two classes
     Threshold: t and $\sigma 2$
     $\sigma^2_b (t) = \sigma^2 - \sigma^2 w (t)$
     $= \omega 1 (t) \omega 2 (t) [\mu 1 (t) - \mu 2 (t)]$
Step 4: Compute histogram as t from $\omega 1 (t)$
Step 5: Compute class mean $\mu_1 (t)$
     $\mu_1 (t) = [\Sigma^t_0 p (i) x (i)] / \omega 1$
Step 6: x (i) is the center of the ith histogram bin
Step 7: Similarly, we compute $\omega 2 (t)$
Step 8: Compute $\mu 2$ on the right-hand side of the histogram for > t.

END FIRST_SEGMENT ()

BEGIN SECOND_SEGMENT ()
Step 1: Input: FIRST_SEGMENT_IMAGE (X)

Step 2: Assign S=size (FIRST_SEGMENT_IMAGE (X))
Step 3: For row = round (dim (1)/2);
     For col=1: S (2)
     If (FIRST_SEGMENT_IMAGE (X)) (row, col),
     Break;
     End
     End
Step4: Contour = bwtraceboundary ((FIRST_SEGMENT_IMAGE (X)), [row, col], 'W')
Step 5: Plot the Contour value for extract boundary.
END SECOND_SEGMENT ()

2.4.2 Algorithm -2
BEGIN CENTRE_MASS ()
Step 1: Input: SEGMENTEDIMAGE(X)
Step 2: Assign n=size (SEGMENTEDIMAGE(X))
Step 3: Compute   M=zeros (dim (1), dim (2));
     ii=0;
     End
     While ii<nn(1)
     ii=ii+1;
     M (contour (ii, 1), contour (ii, 2)) =1;
     End
Step 4: Fill the holes in M, Assign the value to M2
Step 5: Assign the dimension for the variable x axis as
     x= [1: dim (2)]
Step 6: Assign the dimension for the variable y axis as
     y= [1: dim (1)]
Step 7: Fill the x and y axis as
     a=ones (dim (1), 1)*x;
     b=ones (dim (2), 1)*y;
Step 8: Multiply the values for x and y coordinates as
     Co_ordx=a.*M2;
     Co_ordy=b.*M2;
Step 9: Calculate the xmean value and ymean value.
END CENTRE_MASS ()

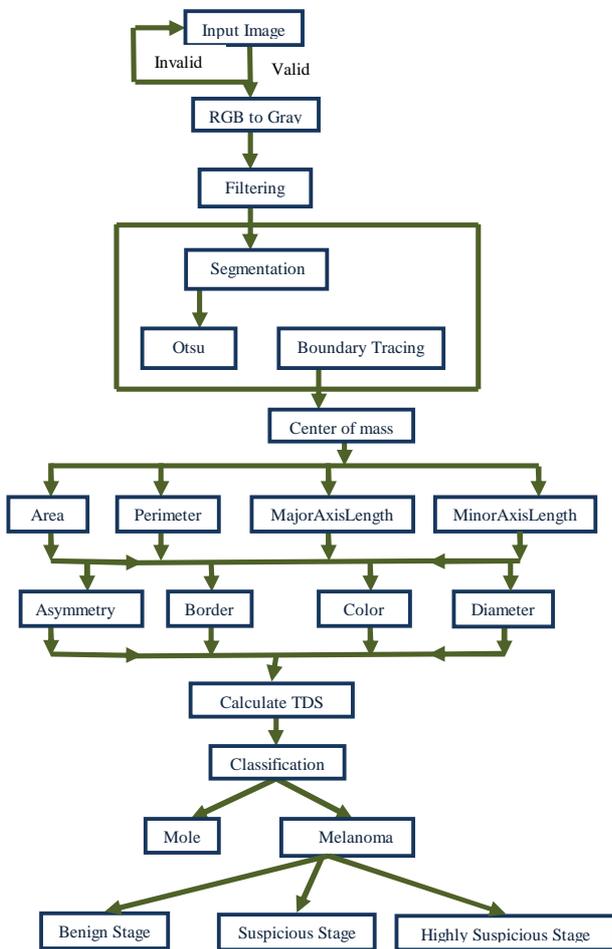## 3. BLOCK DIAGRAM OF THE PROPOSED SYSTEM

Figure 1 Block Diagram of the Proposed System

4. EXPERIMENTAL RESULTS

To measure the performance of the proposed system, we have tested various skin cancer images. We have added Gaussian Noise with standard deviation $\sigma = 5$ to the input image [12]. Then we have applied the proposed method for noise removal using wiener filter and we have done two stages of segmentation. First method is Otsu segmentation method that minimizes the IntraClass variance. The results are reported in figure 2 to figure 10 for melanoma cancer images.

We have used MatlabR2009a software for our experiments. We have used Stolz Algorithm, which is called the ABCD Rule which leads to the diagnosis of image acquision. The feature extraction methodology of ABCD-rule dermascopy is used because of its effectiveness and accuracy of detecting the melanoma skin cancer. For the classification methodology Total dermascopy score is used in order to assort whether the lesion is cancerous or not.

For the asymmetry evaluation, the lesion is bisected by two perpendicular axes positioned to produce the lowest possible asymmetry Score, Similarly the border , color and the diameter value has been detected. The Total dermoscopic Score is used in classification stage, which will be compared with TDS value, the classification has been done.
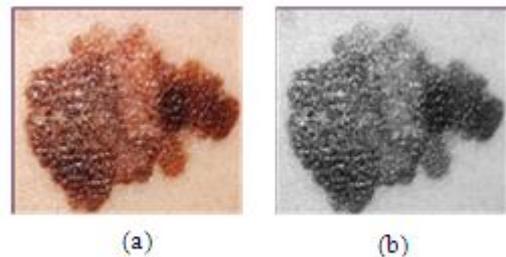

Figure 2 (a) Original Image;   (b) RGB to Grayscale Image, In the fig 2(a) the original image which is the input image for the system, (b) The RGB Image is converted into Grayscale Image.
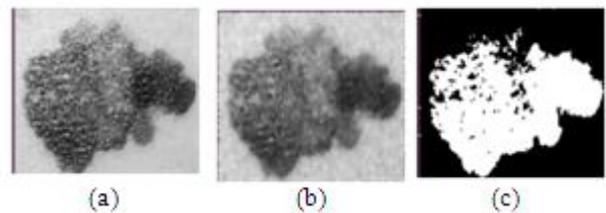

Figure 3 (a) Grayscale Image; (b) Enhancement of Grayscale Image using Wiener Filter; (c) Otsu Segmented Image In the fig 3 (a) The Grayscale Image which is converted from RGB Image , (b) Enhanced by removing the noises from the Grayscale Image using Wiener Filter ,(c) Segmented Image of skin lesion using Otsu Segmentation.
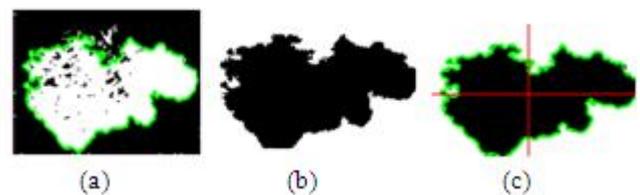

Figure 4 (a) Boundary Tracing Image; (b) Segmented Image; (c) Center of Mass
In the fig 4 (a) Tracing the boundary of the Otsu segmented image (b) Segmented Image of skin lesion using Boundary Tracing Segmentation applied on Otsu Segmented Image for further clear segmentation (c) Mean value has been calculated for finding the center of mass by drawing perpendicular axes.
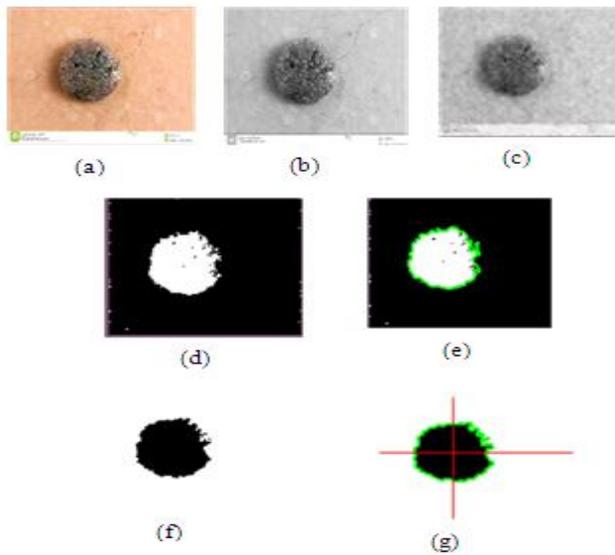
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Figure 5 (a) Original Image; (b) RGB to Grayscale Image; (c) Enhanced by removing the noises from the Grayscale Image using Wiener Filter; (d) Otsu Segmented Image; (e) Boundary Tracing Image; (f) Segmented Image using Boundary tracing segmentation; (g) Center of Mass

Figure 6 (a) Original Image with Hair Noise; (b) RGB to Grayscale Image; (c) Enhanced by removing the noises from the Grayscale Image using Wiener Filter; (d) Otsu Segmented Image; (e) Boundary Tracing Image; (f) Segmented Image using Boundary tracing segmentation; (g) Center of Mass
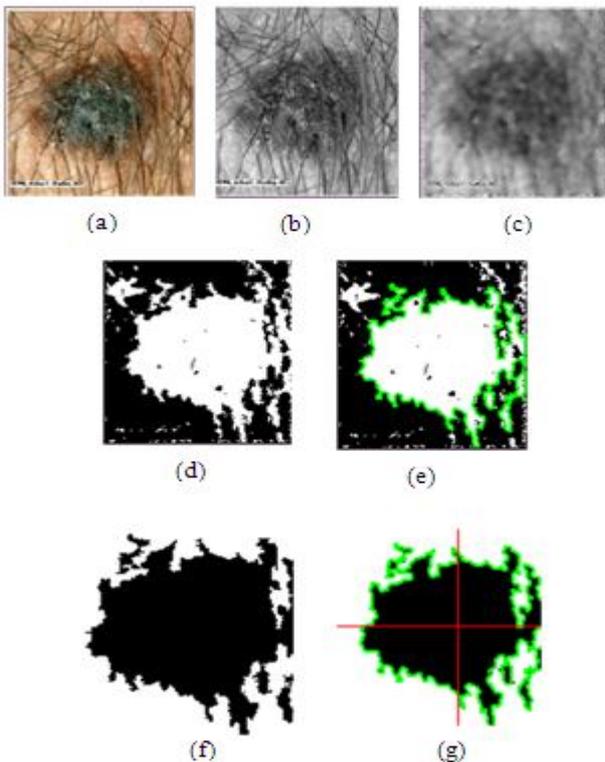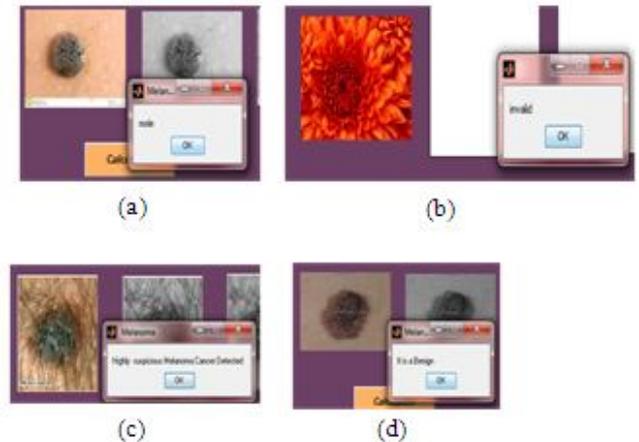

Figure 7 (a) Mole with Message box ;(b) Invalid Image with

Message box;(c) Highly Suspicious melanoma detected with Message box (c) Benign Stage has been detected.

Table 1: Criterion for Stolz algorithm

Criterion	Score	Weight Factor
ASYMMETRY	0-2	*1.3
BORDER	0-8	*0.1
COLOR	1-6	*0.5
DIAMETER	1-5	*0.5

Table 2: Total Dermascopic Score and its Interpretation [Reference TDS Value]

Total Dermascopy Score	Interpretation
<4.75	Benign Lesion
4.8 – 5.45	Suspicious Lesion
>5.45	Highly Suspicious Lesion

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

Arushi Bhardwaj et al. [4] discussed about the relation (4) for calculating the total Dermascopic score

Table 3: Proposed Value for extracting the geometrical features of various skin lesion images.

Class	Area	Perimeter	MinorAxisLength	MajorAxisLength
Benign	13165	914	233.1586	362.0305
Benign	13296	914	233.578	362.24
Suspicious	2621	444	139.9528	143.0818
Highly Suspicious	12156	1778.455	223.3833	312.9766
Benign	2621	444	139.9528	143.0818
Mole	6437	906	236.0629	318.4639
Highly Suspicious	11253	823	311.0356	421.0897
Suspicious	4986	812	215.8963	258.369
Mole	8963	896	115.789	247.456

Table 4: Proposed Value for Total Dermascopic Score and its classification for various skin lesion images.

| Area	Perimeter	Minor axis length	Major axis length	Asymmetry	Border	Color	Diameter	Proposed TDS value	Class
13165	914	233.1586	362.0305	1.6114	0.17659	3	5	3.306	Benign
6437	906	236.0629	318.4639	1.273	0.20556	0	1	0.686	Mole
2621	444	139.9528	143.0818	2.0894	0.01110	3	4	5.023	Suspicious
12156	1778.455	223.3833	312.9766	4.2208	0.29875	1	1	6.517	HighlySuspicious
2621	444	139.9528	143.0818	2.0894	0.01110	2	4	3.181	Benign
13296	914	233.578	362.24	2.6374	0.17597	1	1	4.446	Benign
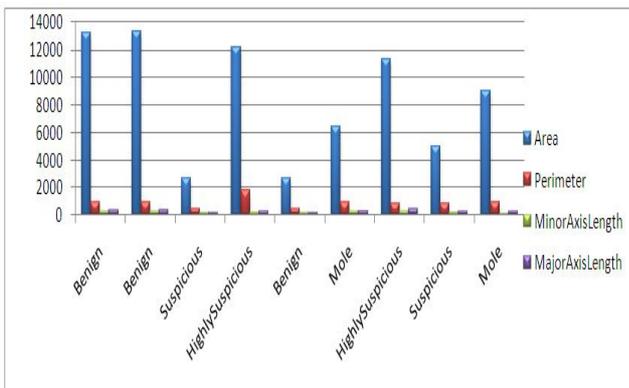
Figure 8. Distribution graph for the geometrical features of various skin lesion images
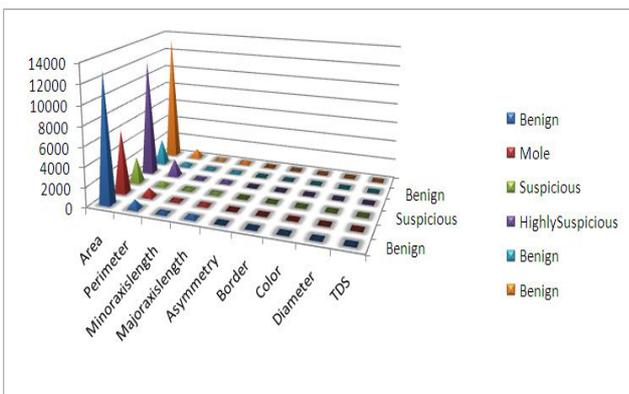

Figure 9. Distribution graph for Total Dermascopic Score value and its classification for various skin lesion images

5. CONCLUSION

We have presented the melanoma skin cancer detection and feature extraction through Otsu thresholding and boundary tracing algorithm. It combined together to segmented the lesion range. The experimental result shows the best performance of detecting and assorting the cancer image along with the stages of benign, suspicious, highly suspicious or it's just a mole. This approach gives better result than the other system for melanoma skin cancer detection.

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