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Digitally Segmentation of Hair-Particles from Dermoscopic Images

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Abstract:- Melanoma is the most dangerous form of skin cancer, develops when unrepaired damage happens to skin cells known as melanocytes. The skin cells rapidly multiply and forms tumors, called as malignant tumors. The main goal of our paper is hair removal from clinical dermoscopic images. It is the initial preprocessing stage for the skin melanoma diagnostics. In dermoscopy image analysis while analyzing the disease the main obstructs will be the hair objects. These hairs will hide the region of interest (ROI) from being detected. There are many computer-aided techniques to assist dermatologists. In this paper, we propose an algorithm which removes hairs without altering the lesion area. The algorithm uses image processing technique for detection and removal of hair from the dermoscopy images. First, hair is excluded from lesion; later image is reconstructed by considering the nearest 8 edge pixels. The algorithm is tested on PH2 database. We have used MATLAB for implementing our algorithm.

Keywords:- *Melanoma, Skin Cancer, Dermoscopy, lesions;*

I. INTRODUCTION

Nowadays skin cancer is most common type of cancer, usually develops in epidermis layer of skin. This happens in all people regardless of gender, age, or race. These incidence of skin cancers increases every year. There are three main types of skin cancers viz, melanoma, basal cell carcinoma (BCC), and Squamous cell carcinoma (SCC). Malignant melanoma is the most dangerous type of skin cancer and is increasing in the world. It is estimated that 161,790 new cases of melanoma, 74,680 noninvasive and 87,110 invasive, will be diagnosed in the U.S. in 2017 [2]. Invasive melanoma is projected to be the fifth most common cancer for men (52,170 cases) and the sixth most common cancer for women (34,940 cases) in 2017 [2]. Sometimes melanoma is also called as malignant melanoma and cutaneous melanoma. Melanoma affects melanocyte cells thus increasing the synthesis of melanin. Melanoma often looks like moles, sometimes it even develops from moles. Melanoma is often diagnosed from lesions through its Asymmetry, Border, Color, Diameter structure and Evolution of lesion over time. This is called as ABCDE method. It can occur anywhere on skin, but if left undetected can spread to other parts of body. Early diagnosis of melanoma increases the chances of cure.

Since 1997, image processing techniques are used for analysis of melanocytic lesions, with the goal of developing computer-aided detection (CAD) system equipped with digital dermoscopy device for the recognition of atypical melanocytic lesions. This helps in clinical diagnosis and even the practitioners for prognosis of melanoma and for accurate diagnosis of disease. Dermoscopy tool is used for the diagnosis of skin cancer. Dermoscopy identifies the morphological features viz, air bubbles, pigment networks, streaks, and blotches [3]. Once the disease is identified, surgery is done to remove the lesion. This requires the accurate diagnoses of disease. Image processing is an important part of dermoscopy. It helps in diagnoses of benign, atypical, melanoma and determines the probability of melanoma. The proposed method uses the dermoscopy images from PH2 Dermoscopy image database from Pedro Hispano Hospital.

Melanoma is asymmetrical, have notched edges and irregular borders, the early detection of melanoma increases the survival rates. Figure 1 shows the two skin melanoma images with hairs. For analysis of dermoscopic images, first the preprocessing has to be done to extract the region of interest (ROI). The morphological features for classifying the melanoma, benign are based on the ROI, the parameters indicating the porosity or directionality.

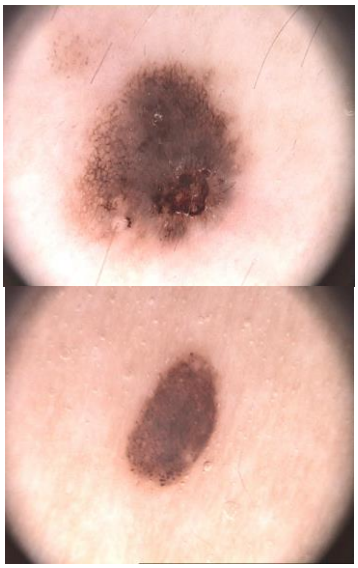

Fig 1:- Melanoma images with hairs

If hair exists on skin, it will clearly appear in the dermoscopy images. The presence of hair is an obstruct for analysis of lesion for both in case of automated analysis of digital image and analysis by dermatologists. In automated analysis, this presence of hair can alter the measurements of pigment network feature set, color, texture, shape, and size.

Several solutions exists, the obvious solution could be shaving. But this leads to bleeding or alter in the skin tissues disrupting the analysis to greater extent than with hair. An alternative solution could be inpainting. This operation is to replace the hair pixels with the underlying skin. The other method could be hair-removal with liner interpolation techniques.

II. MOTIVATION

Melanoma is the dangerous type of skin cancer. It is developed from the malignant transformation of melanocytes. Its survival rates when compared to non-melanoma skin cancer types are low. An automated system to diagnose this type of disease is very much required and is very much in demand since more new cases of skin cancer is increasing each year.

Following are the estimations of the American Cancer Society for melanoma in the United States for the year 2014[4]:

- Approximately 76,100 new melanomas are to be diagnosed (about 43,890 in men and 32,210 in women) [4].
- Approximately 9,710 fatalities are expected as a result of melanoma (about 6,470 men and 3,240 women) [4].

III. RELATED WORK

DULLRAZOR, a software approach for hair removal [5] presented a method for removing the dark thick hairs from image using a pre-processing program called DullRazor. The algorithm has three main steps: 1) Finding the dark hairs. 2) Replacement of hair pixels with the nearby non-hair pixels. 3) Finally smoothing of result. The images are of 512 * 486 pixels in size, with spatial resolution of 0.033 mm * 0.025 mm. Initially for locating the dark hairs, the grayscale morphological closing operation is applied to all the three color bands separately this smoothes out the low intensity values. In the next step, replacement operation is done to the binary mask obtained in initial step. Finally in the last step adaptive median filter is applied to smooth out border lines. The drawback with this software method is excessive loss of fine detail in the image.

Feature-Preserving Hair Removal [6] described hair-restoration algorithm which preserves the skin lesion features such as texture and color and segments both light and dark hairs from the dermoscopy image. The algorithm has three major steps: the rough hairs, both dark and light hairs are segmented using the first derivative of Gaussian (MF-FDOG), refinement of hairs by edge-based techniques and repairing of hair-occluded information using the fast marching inpainting method. All these stages are integrated into single method. Diagnostic accuracy (DA) and texture-quality measure metrics are used to evaluate the performance of the system. The algorithm is tested for 100 dermoscopy images, which obtained the values of DA: 93.3% and TQM: 90%. This method can be easily integrated into the CAD system.

Segmentation of light and dark hair [7] a hybrid approach concentrates to identify both dark and light hair in dermoscopic images. In this method first, using universal matched filtering kernel the hair is amplified generating strong responses for both dark and light hairs. Then by applying local entropy threshold on response, raw binary hair mask is generated. Then by using model checker hair mask is refined and verified. This model checker is combination of morphological operations and mathematical techniques. The final result is clean hair mask which is used for further segmentation and analysis process. This application yields good results for thick hairs. This method has capability of segmenting both dark as well as light hair of constant width, without any prior knowledge of hair color. This algorithm has limitations in case of hairs with many intersections and fine hairs.

E-Shaver: An improved DullRazor [8] presented an improved method for digitally removing dark and light-colored hairs. E-Shaver first find the orientation of hairs using Randon transform. Then Prewitt filters are used for filtering the image. By thresholding and averaging, the non-hair structures and noise are removed from the image. This method has advantage of removing bubbles from the dermoscopy image. In this method showed that the combination of filters, vertical and horizontal filters can be used depending upon the hairs. Then masking is done and for region filling, each hair pixel is averaged with its neighboring pixels.

VirtualShave: An automated hair removal [9] for digital dermatoscopic images describes about the novel tool, VirtualShave for removing of hairs from dermatoscopic images. In this method first, using the top-hat filter the hairs are identified then to this morphological post processing is done. Then by inpainting technique the hairs are replaced with the neighboring non-hair skin pixel values. The performance is compared with dermatologists doing this hair removal process manually. The result is almost indentical

Hair Segmentation and Removal: A Robust method for removal of hairs [10] from skin lesions uses computer-aided diagnostic systems. The system removes artifacts such as hair, which are the main obstacles for segmentation of lesion from dermoscopic images. This paper also tested the DullRazor software using about 20 dermoscopic images. Using DullRazor software is not able fine tune the hairs from dermoscope images and also there is excessive loss of data in the images. The proposed method in this paper uses conventional filters to boost the curvilinear structures. The paper uses the region growing algorithms for the complicated hair intersection patterns. The comparison result with the DullRazor software gives about the hair detection rate by 58%.

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IV. METHODOLOGY

Figure 2 shows the block diagram of the proposed method. The proposed algorithm is tested with PH2 dermoscopy image database. The images are acquired using the dermoscope. The proposed algorithm has 5 major steps: First, Image Acquisition, Pre-processing of dermoscope image, Segmentation, Feature Extraction, Classification using the SVM classifier.

A. Image Acquisition

The first stage is image acquisition which is essential for the rest of the stages, hair detection and exclusion, segmentation, feature extraction and classification; hence images have to be acquired satisfactorily. The iPhone camera is used for capturing of images to which dermoscope is attached. The dermoscope provides quality images of skin lesion. It provides auto-focus ability with magnification of 20x.

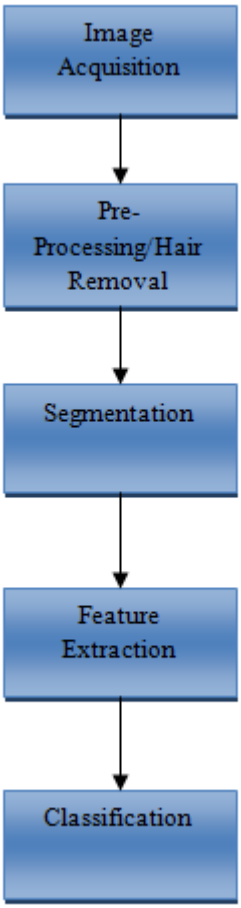


Fig 2:- Block diagram of proposed method

Examples of images captured using dermoscope are shown in Figure 3. Figure 3(a) shows dermoscope image with lesion in center, Figure 3(b) shows image contamination with hairs and Figure 3(c) shows few hairs in lesion. Some air bubbles are also seen in Figure 3(b) and (c).

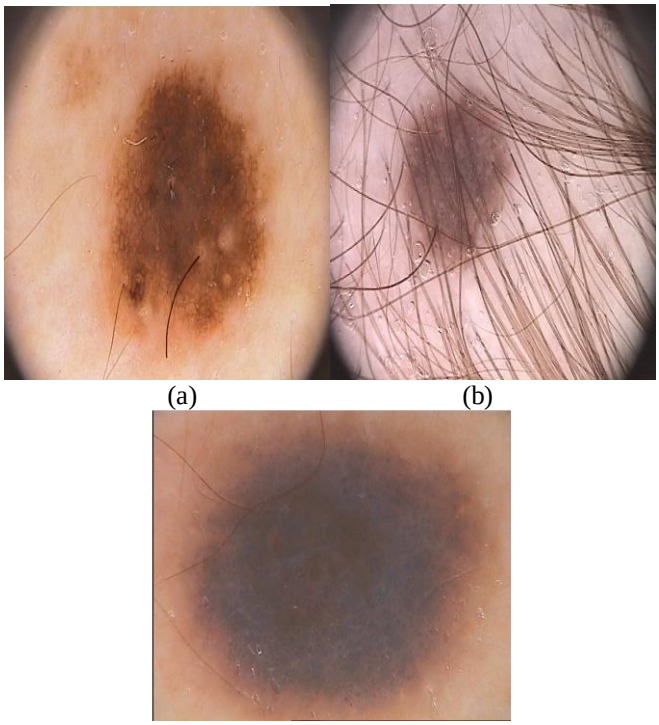


Figure 3(a), 3(b), 3(c): Dermoscopic Images
Figure 3:- Dermoscopic Images captured using dermoscope

Figure 4 shows the block diagram of Hair removal method. The proposed algorithm has 3 major steps: First, detecting the hair pixels from lesion and segmenting it from lesion, replacing the detected hair pixels with the nearest edge pixels in 8 directions and finally smoothing.

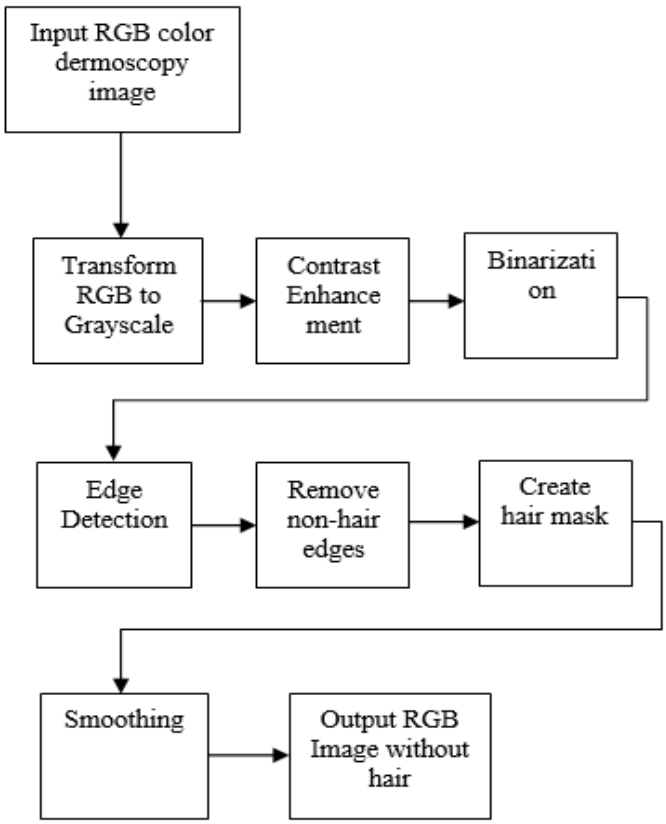


Fig 4:- Block diagram of proposed method

B. Detection of Hair Pixels

The algorithm includes the converting of RGB image into grayscale image using the formula:

$$X=0.299R+0.587G+0.114B \quad (1)$$

Next sharpening of image is done using the median filter thus enhancing the contrast. To locate the dark hairs, morphological closing operation is applied that smoothes out the low intensity values. The thick dark hair pixels appear as troughs, are smoothed out along the structure element direction. Now for finding edges canny edge detector is used. Now the binary hair mask is obtained by subtracting the original RGB image by obtained grayscale closing image. Thus getting separated lesion area and hair area.

C. Replacing of Hair Pixels

In this step, the replacing of pixel value in original image is done with the non-hair pixel values. To reconstruct the image, the nearest edge pixels in 8 directions are considered. The binary hair mask obtained in previous step is considered. In 8 directions, up, down, left, right and along the 4 diagonals the operation is performed until reach the non-hair region.

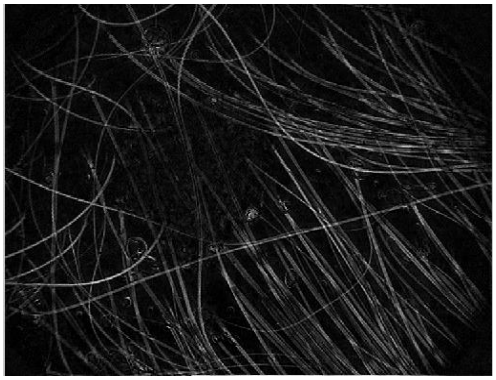
D. Smoothing using Median Filter

The Smoothing is done to smooth out thin lines which are usually formed at the border locations. By averaging the remaining background of non-hair edges are removed. This smoothing is done to obtain better picture after hair removal process.

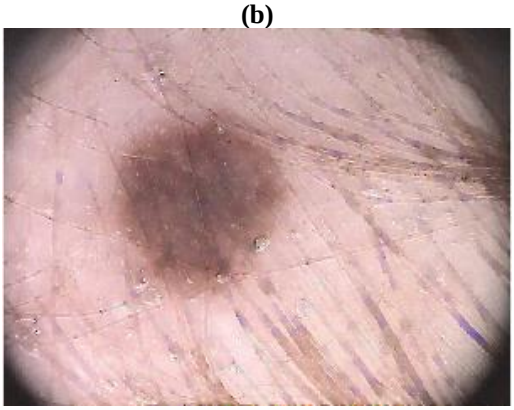
V. RESULTS AND ANALYSIS

Using the proposed method the hair pixels value can be reconstructed using non-hair pixel values. But some traces of hair sometimes visible with careful examination. These traces of hair removal could be removed but with chances of loss fine details in image. Our proposed method does not alter the details in dermoscope image leading to next stage of image analysis. Figure 4 shows the snapshot of all the steps involved in proposed method. Figure 5(a) shows the original image, Figure 5(b) is the hair mask for the particular dermoscope image and Figure 5(c) image obtained after hair removal process.

(a)



(b)

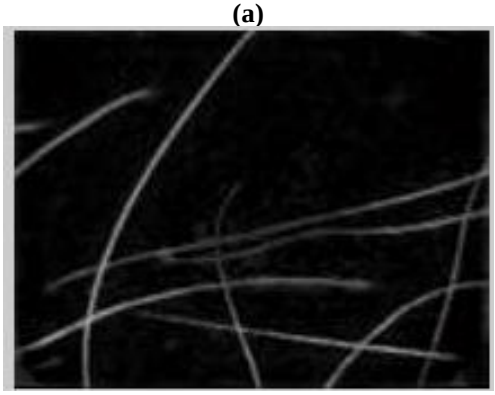


(c)

Fig 5(a): Original Image. 5(b): Hair Mask. 5(c): Output Image

Figure 6 shows the snapshot of all the steps involved in proposed method. Figure 6(a) shows the original image, Figure 6(b) is the hair mask for the particular dermoscope image and Figure 6(c) image obtained after hair removal process.

(a)



(b)

(c)

Fig 6(a): Original Image. 6(b): Hair Mask. 6(c): Output Image

VI. CONCLUSION AND FUTURE ENHANCEMENT

In this paper only the hair removal process is addressed for the dermoscope images of PH2 dermoscopy image database using morphological operations. The proposed method tells that hair replacement can be effectively done using region filling. The validation of effectiveness is done by cross-checking the images produced with the naturally hairless skin that is almost identical. The method can be enhanced in interpolation method used in replacement of hair pixels.

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