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Artefact Removal and Contrast Enhancement for Dermoscopic Images Using Image Processing Techniques

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Abstract: Dermoscopy technique is widely used for image acquisition in diagnosis of skin cancer. Artefacts such as air bubbles, ruler markings and hair which are covering skin affect the segmentation process. To improve the accuracy of segmentation, it is necessary to remove these artefacts. Also, it is possible that low contrast of dermoscopic image can give poor results of segmentation. So contrast of dermoscopic image has to be increased. This paper shows results of artefact removal and contrast enhancement for dermoscopic images using different image processing techniques.

Keywords: Dermoscopy, Image Processing, Contrast Enhancement, Skin lesion diagnosis

I. INTRODUCTION

Melanoma, a type of skin cancer must be diagnosed at an early stage. Early diagnosis makes treatment effective and life of patient can be saved.[6] Dermoscopy has become important technique in early diagnosis of melanoma. In this technique, oil is applied on skin surface where lesion is present and polarized light is made incident on skin. Then image is acquired with digital camera attached to dermatoscope. This process reveals the morphological structures which are present in deeper layer of skin.

When image acquisition is done using dermatoscope, some artefacts are introduced in image. The hair which is present on skin can be segmented as lesion because of dark pixels being classified as lesion against lighter pixels which will be categorised as skin. So it is necessary to remove these hair pixels from acquired image. In some of the cases, dermatoscope is provided with ruler markings for measurement of diameter of lesion. So these markings will be there in acquired image. The air bubbles and black frame in image can affect the accuracy of segmentation process and further diagnosis of skin cancer. So these artefacts must be removed from dermoscopic image.[1]

In some of the cases, contrast between skin and lesion can be very poor. It is needed to increase the contrast between skin and lesion. Histogram equalisation based technique can be used for contrast enhancement. Histogram equalisation gives good results for dermoscopic images. This involves remapping in gray levels to produce uniform distribution in input image. Improved contrast between the lesion and skin improves the accuracy of further diagnosis steps.

This paper is organised as follows: Section II discusses the different image processing techniques used for removing various artefacts in dermoscopic image. Section III gives details of contrast enhancement techniques used for dermoscopic image enhancement. In section IV, results are provided. Contrast enhancement results are also provided in this section. Then paper is concluded with discussion in section V.

II. METHODOLOGY

Various image processing techniques which are useful for artefact removal in dermoscopic images are discussed.

A. Colour space conversion and removal of ruler markings

Before the dermoscopic images can be used for the segmentation step, one of the preprocessing steps is needed i.e. black frame and ruler marking removal. For a fast and efficient black frame removal step, Euclidian distance between each object's and the image's centers has been computed. The minimum distance corresponds to the lesion area. So pixels corresponding to black frame are removed. For this luminance plane of image proves to be useful. So RGB image is first processed to the perceptual uniformity CIE L^*u^*v color space. The L^*u^*v color space attempts perceptual uniformity. And then luminance plane is separated. It was previously also used for segmentation of skin lesions. So we have first separated R, G and B planes of RGB image and then converted it to L*u*v color space followed by separation of luminance plane.[2]

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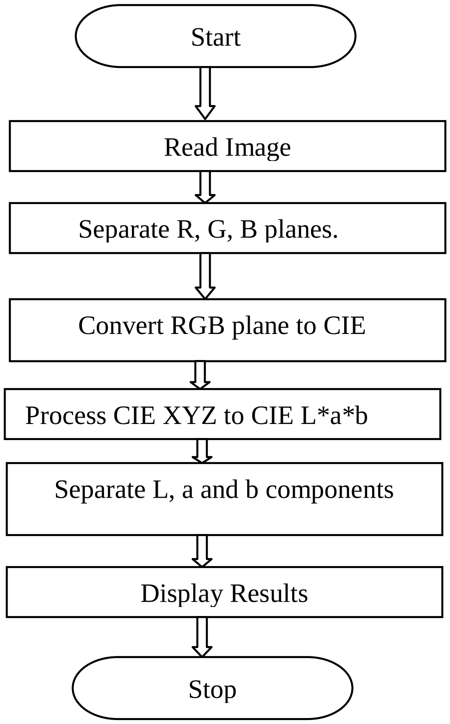
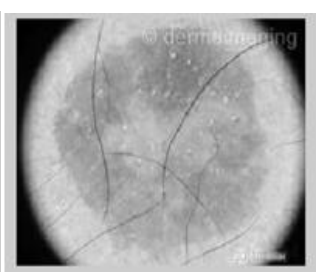


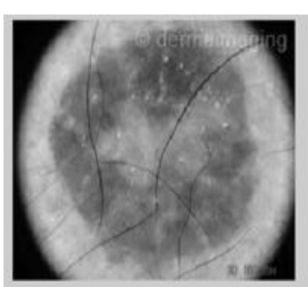
Flowchart for RGB to L*a*b conversion

Then the ruler markings in dermoscopic image are removed by a morphological closing operation.
Results are shown in figure (1) and figure (2) respectively.

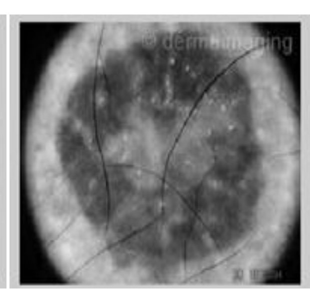
(a)



(b)



(c)



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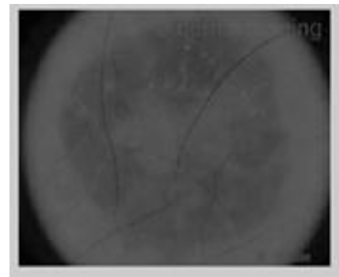
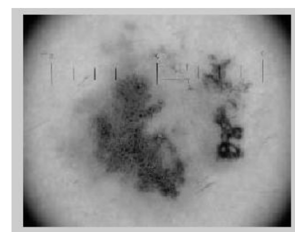


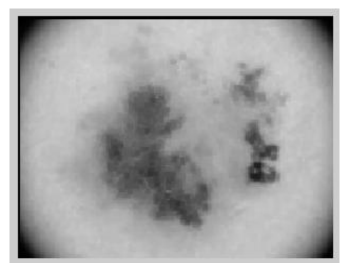
(e)

Figure 1: a) Original image (RGB) b) R plane c) G plane d) B plane e) Luminance plane separated from L*u*v color space

(a)



(b)



(c)

Figure 2: a) Dermoscopic image with rulers markings) b) Gray scale image c) Ruler markings removed from image using closing operaration

B. Hair Removal

The artifacts removal step in dermoscopic images mainly focuses on hair removal. The most interfering factor that degrades the image quality is hair pixels.

Most dermoscopic images have hair covering lesion. These segments of hair which are darker than lesion as well as skin, can lead to wrong segmentation results. So hair removal step is very important. A number of methods have been developed for hair removal on dermoscopic images. Some of them use mathematical morphology methods [11], Flemming [10] has applied curvilinear structure detection with different parameters; Zhou [4] have enhanced Flemming method by introducing an inpainting based method approach. DullRazor software performs dark thick hair removal.

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In this paper, two removal hair approaches are studied and implemented.[11] First method is based on a simple morphological closing operation with a disk-shaped structural element. Based on the assumption that hair segments are thin structures, a simple morphological technique is applied; next, a hair mask is retained by using a global automatically threshold over the image intensity information. Each hair pixel from the resulted mask is replaced by an average mean of the neighbor's pixels. This method has the advantage of being fast. Using a global and a rough thresholding approach can lead to unsatisfying results. As the replacing mask hair pixel is based only on the mean value of the pixel from the neighborhood, this can generate an unwanted blur on the result images. Moreover, in many cases, we deal with thick hair strands cases that will lead to darker progressive traces (the calculated mean of a new replaced pixel of a thick hair is too small); another issue related to this method is the segmentation approach (global thresholding function), based on the assumption that hair strands are darker than skin or lesion, is that it can remove important features misinterpreted as artifacts.

The second approach for hair removal is using the Top Hat Transform combined with a bicubic interpolation approach. First of all, the hair mask is extracted using a Top Hat Transform and, for each hair pixel resulted in a mask, a bicubic interpolation is applied in order to fill in the hair position gaps. This method is stronger and more effective than the first method, as it is not depend on the automatic threshold value and the thickness of hair strands. The Black Top-Hat Transform preserves structures having the size smaller than that of the structuring element and being darker than the background. The hair mask, obtained using the Top Hat Transformation, properly retains the hair strands, even if there are also other occluding structures. It also removes the background while preserving the hair strands, regardless of the nature of the neighbor areas.

A bicubic interpolation fills the gaps resulted after obtaining the hair mask, by using the whole image information without any neighboring spatial dependency. The background smoothening can be done using simple median filtering operation.

III. CONTRAST ENHANCEMENT FOR DERMOSCOPIC IMAGE

Because of air bubbles and non uniform lighting conditions during image acquisition step, dermoscopic image can have non-uniform background as well as low contrast. To reduce the effect of above factors, several enhancement techniques can be used in to improve the low contrast of the image and for removing artifacts.[8] To improve the low contrast between the lesion and the skin, contrast limited adaptive histogram equalization has been used. It is a technique used to improve the local contrast of an Image instead of improving contrast of whole image. This technique has the advantage of using local information instead of using the entire image; this improves each local areas. Enhancement has advantage that lesion will be highlighted against lighter skin. So lesion will be identified easily.

IV. RESULTS

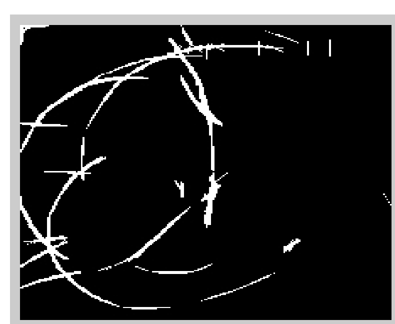
(a)

(b)

(c)

Figure 3: Hair removal results. a) Original image b) Hair mask obtained using morphological closing c) the final result after hair removal

(a)



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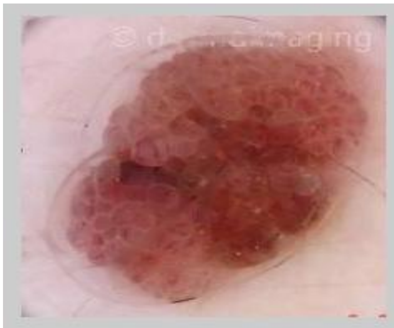
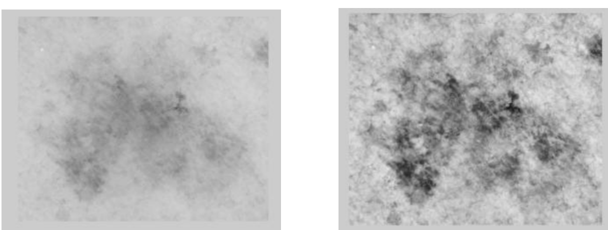
(b)



(c)

Figure 4: Hair removal results. a) Original image; b) Top- Hat transform applied on a); c) the final result after the interpolation and a simple smoothening step.



(a) (b)

Figure 5: a) Low contrast original image b) Contrast enhanced image

V. CONCLUSIONS

This paper presents hair removal and contrast enhancement results which are useful for early diagnosis of melanoma. It contains common pre-processing operation such as contrast enhancement on dermoscopic images. A contrast limited adaptive histogram equalization (CLAHE) approach is applied. It improves the contrast between skin and lesion. Also two hair removal methods based on morphological closing and top hat transformation combined with bicubic interpolation has been studied and implemented. One part is dedicated to contrast improvement between lesion and skin area in original image. Due to the low contrast images, this preprocessing step is needed before segmentation step. Another part is focused on removing hair in the image that could lead to wrong segmentation in a further step. The preprocessing step eliminates other artifacts also, such as ruler's markings. The smoothing of background can be obtained by applying simple smoothing filtering operation. Future scope includes segmentation and classification of skin lesions. The database of images including wide variety of cases that is difficult to diagnose are to be tested under this methods.

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