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The Beneficial Techniques in Preprocessing Step of Skin Cancer Detection System Comparing

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Abstract

Automatic diagnostics of skin cancer is one of the most challenging problems in medical image processing. It helps physicians to decide whether a skin melanoma is benign or malignant. So, determining the more efficient methods of detection to reduce the rate of errors is a vital issue among researchers. Preprocessing is the first stage of detection to improve the quality of images, removing the irrelevant noises and unwanted parts in the background of the skin images. The purpose of this paper is to gather the preprocessing approaches can be used in skin cancer images. This paper provides good starting for researchers in their automatic skin cancer detections.

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1. Introduction

Skin cancer is an increasing cancer in different countries. With this type of cancer, the patient can be survived if it is detected in early stages [1]. So, early detection is the promising strategy to cut the mortality rate of skin cancer [2]. As skin cancer diagnosis can be faced to different human faults and involves some expense and morbidity, researchers are trying to automate this assessment to verify if it is inoffensive or dangerous, and estimate it with a small margin of error less that the human achievements [1]. In such systems, the accuracy of diagnostics is not always acceptable and involves some errors. Therefore, high performance computer aided diagnostic systems help the physicians to avoid misdiagnosis. The common approaches to skin lesion early detection include different steps of Preprocessing, Segmentation, Feature extraction and Classification [1].

Since the output of each step is the input of next step, all steps have an important role to avoid misdiagnosis. Pre-processing as the first stage of computer aided cancer diagnostics has seriously effects on misleading the results [3]. Although the success of such systems critically depends on pre-processing [4], only a few papers until now dealing with preprocessing techniques.

In skin cancer detection, preprocessing step can be divided into image enhancement, image restoration and artefact removal. Each stage includes different techniques which will be discussed in this paper. Furthermore, the selection of

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preprocessing techniques depends on the subsequence methods which have been selected for the automaton system [4]. The Gaussian, mean and median filters [5], and speckle noise filters [6, 7] are as the most popular pre-processing techniques.

The paper is organized as follows. In Section II, we review the total scheme of preprocessing stages. Thereafter in Sections III, VI and V, the different techniques of image enhancement, image restoration and hair removal are discussed respectively, and also the most effective techniques are illustrated according the literature. Section VI is conclusion of the paper.

2. Pre-processing In Skin Cancer Detection Systems

Image pre-processing is an essential step of detection in order to remove noises and enhance the quality of original image. It required to be applied to limit the search of abnormalities in the background influence on the result [8]. The main purpose of this step is to improve the quality of melanoma image by removing unrelated and surplus parts in the back ground of image for further processing. Good selection of preprocessing techniques can greatly improve the accuracy of the system [9]. The total framework of techniques followed in preprocessing stage of medical image processing is illustrated in Fig. 1.

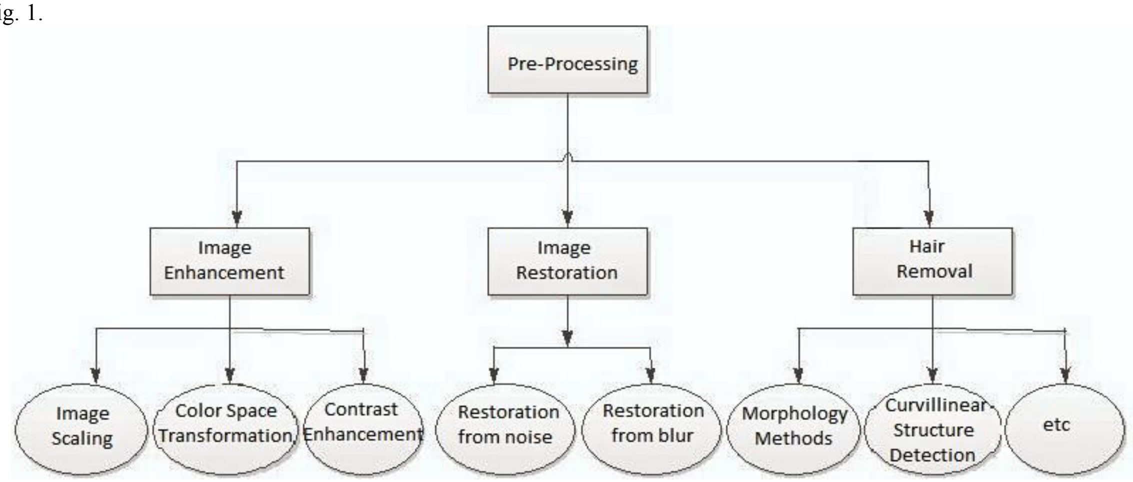


Fig. 1. Total framework of preprocessing in Skin cancer detection systems

The objective of the preprocessing stage can be achieved through three process stages of image enhancement, image restoration and hair removal. Here, the paper explains above techniques clearly for researchers who involves in pre-processing stages of automatic detections.

3. Image Enhancement

Image Enhancement is a crucial procedure to improve the visual appearance of the image; it is defined as provider of the "better" transform representation for further automated steps of detection [10].

Thus, the image enhancement can be categorized in three categories:

3.1. Image Scaling

Image scaling techniques are applied due to the lack of same and standard size of images. Since the skin cancer images may be gathered from different sources and sizes, the first step is to resize the images to have the fixed width pixels but variable size of height [11].

3.2. Color Space Transformation

Since color information plays an inevitable role in skin cancer detection systems, researchers try to extract the more corresponding color of images for further processing. Generally, the common color spaces include RGB, HSV, HSI, CIE-LAB and CIE-XYZ.

RGB is a color space which comprise the red, green, and blue spectral wavelength. The most frequently presentation of colors in image processing is RGB. Since RGB color space has some limitation in high level processing, other color space representations have been developed [12].

HSV and HSI color spaces imitate the human visual perception of color in terms of hue, saturation and intensity which are respectively the average wavelength of the color, the amount of white in the color and the brightness. The next color space is CIE- LAB which has been proposed to provide uniformity. CIE-XYZ is another color space which can produce every color with positive tristimulus values [13].

Since the purpose in images of skin cancer detection systems is to obtain the high level variations between intensities to detect the edges of lesions, it would be optimal to convert the image into gray scale. Since LAB is one of the useful color models which represent every color through three components of luminance, red/green and blue/yellow, it could be beneficial to transform the RGB to LAB using XYZ as an intermediate colorspace. The luminance would present the grayscale skin image [3]. Fig. 2 shows the tristimulus curves of LAB colorspace which have been obtained by data tables of CIE 1964 Supplementary Standard Colorimetric System [14].

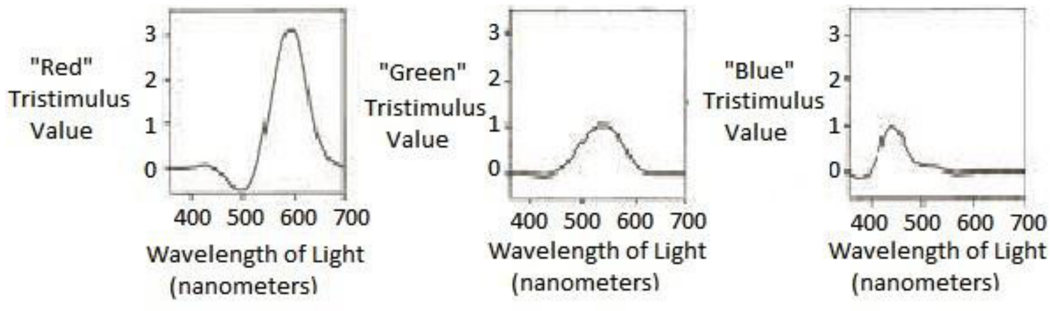


Fig. 2. Tristimulus Curves

3.3. Contrast Enhancement

Contrast enhancement is beneficial step to improve the perception for further processing; it can sharpen the image border and improve the accuracy by accentuating the brightness difference between background and foreground. Contrast enhancement plays a vital role in increasing the quality of an image [15]. The widely practiced methods are classified into "Linear contrast enhancement" and "Non-Linear contrast enhancement" techniques [16]. Linear contrast enhancement mostly used in remotely sensed images.

- Linear contrast enhancement techniques: This type of contrast enhancement refers to contrast stretching techniques. The image can be transformed to higher contrast by remapping or stretching the gray-level values so that histogram spread over the full range [17]. Fig. 3 shows the expand classification of Linear contrast Enhancement methods.

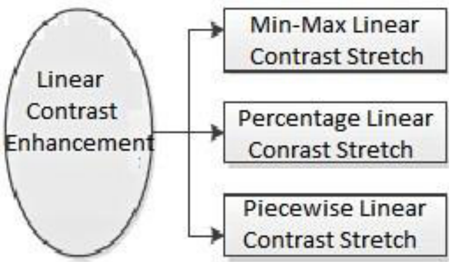


Fig. 3. Linear Contrast Enhancement Methods

- Non- Linear contrast enhancement techniques: This type of contrast enhancement mostly deals with histogram equalizations and algorithms [16]. The most imperfection of such techniques is losing the correct brightness of an object due to the multiple values of output image against each value in an input image [16]. In medical purposes, non-Linear contrast enhancement techniques are commonly used [18]. The different methods of non-Linear contrast enhancement are in fig. 4.

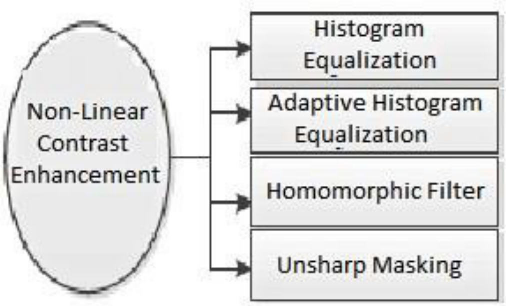
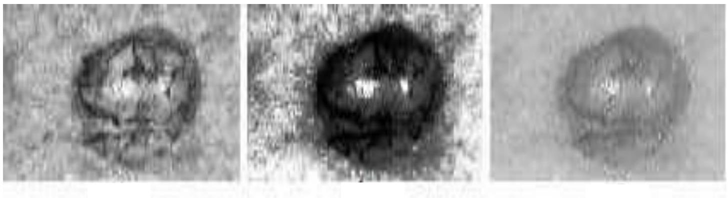


Fig. 4. Non-Linear contrast Enhancement Methods

Since in skin cancer detection systems, local details of melanoma are more essential than global, therefore, the Histogram Equalization (HE), Adaptive histogram equalization (AHE), and Unsharp Masking as three well-known local enhancement methods are more applicable in such diagnostic [11 and 19-23]. Among above contrast enhancement techniques, although the HE can also sharpen the image, it reduces the surrounding detail [24]. Fig. 5 shows the results sample of these three techniques on skin cancer images as the following.



a b c

Fig. 5. a) Adaptive Histogram Equalization b) Histogram Equalization c) Unsharp Masking

4. Image Restoration

Image Restoration is defined as the procedure to recover the degraded image from a blurred and noisy one [25].It can restore the degraded images in different ways. The image degradation can happen by various defects such as imperfection of imaging system, bad focusing, motion and etc. which make an image usually noisy or blur [25]. Since the corrupted images lead to fault detection, hence, it is essential to know about noises present in an image to select the most appropriate denoising algorithm.

The image noises can be divided into four groups of Gaussian, Salt and Pepper, Poisson and Speckle [26].The sample of such noises has been simulated in Matlab as shown in fig. 6.

a b c d e

Fig. 6. a) Image without noise b) Gussian noise c) Poison noise d) Salt and Pepper noise e) Speckle noise

4.1. Restoration from noise

Image denoising is an essential step in preprocessing of an image. It is extremely difficult to apply an effective denising algorithm for different types of noisy images. The essential property of a good image denoising method is to suppress the noise as well as preserving the edges [27].

There are many existing methods for de-noising an image. The basic methods can be classified as Spatial Filtering and Transform Domain Filtering [28]. Spatial filtering such as Mean filters, Median filters, Wiener filter, Lee filter, Anisotropic diffusion filter, Total variation filter and etc. include neighborhood and a predefined operation which change the grey value of each pixel according to the pixel values of square neighborhood centered at that pixel [29].The description of more common spatial filters for removing noises and smoothing the image are in the following [26 and 30-32].

- Mean filters: It works best with Gaussian noise and could be effective for salt and pepper noise. Although this filter reduces the noise, blur the image and reduce sharp edges.
  - – *Arithmetic mean filter:* This is the simplest of mean filter. It can uniform the noise and works well with Gaussian noise.
  - – *Geometric mean filter:* This filter can preserve the detail information of an image better than the arithmetic mean filter
  - – *Harmonic mean filter:* It works well with salt noise, and other types of noise such as Gaussian noise, but doesn't work well with pepper noise.
  - – *Contraharmonic mean filter:* It can preserve the edge and remove noise much better than arithmetic mean filter.
- Adaptive filters: It works best when the noise is constant-power ("white") additive noise like Speckle noise.
  - – *Adaptive local noise reduction filter*: It can be used for random noises.
  - – *Adaptive median filter:* It can preserve the details as smoothing non impulse noise such the traditional median filter is not able to do.
- Order statistics filters
  - – *Median filter:* This filter in comparison with mean filter is less sensitive to the extreme values. Therefore, it can remove the outlier without reducing the sharpness of an image. It is an effective filter for salt and pepper noise.
  - – *Max and min filters:* This filter is useful to find the darkest points of an image.
  - – *Mid-point filter:* This filter is the best for random distributed noises such as speckle noise.
  - – *Gaussian smoothing filter:* This is a useful filter for smoothing and sharpening the image.

The second classification of de-noising methods, Transform Domain Filtering, is based on wavelet transforms. Wavelet transforms is the extended form of Fourier transform which represent the function by wavelets. Wavelets are defined as mathematical functions which analyze data based on scale or resolution [33, 34]. There are different types of Transform Domain Filtering such as VisuShrink, SureShrink, BayesShrink, Neighshrink, OracleShrink, Smoothshrink and LAWML [33, 34].

In medical applications, particularly in skin cancer images, the most common filters applied by researchers to suppress noises in preprocessing step of detection systems are Median filter, Adaptive Median filter, Mean filter and Gaussian smoothing filter [2, 3, 11, 12, 15, 19, 30 and 35-39].

4.2. Restoration from blur

As mentioned earlier, blur is a kind of image degradation which owe to the imperfect formation process of an image. It occurs by bad focusing or motion between original image and camera [40-42]. There exist different techniques for de-blurring such as Lucy- Richardson algorithm technique, Inverse filter, Wiener filter de-blurring technique, and Neural network Approach [40-42]. In medical applications, Wiener filter has been applied as one of the most powerful and common de-blurring technique which also remove the noise as well [43-46].

5. Removing Thick Hairs

Although the thin blood vessels and skin lines will be smoothed using most of restoration filters, the image may include the thick hairs .Thick hairs in automated analysis of small skin lesions are considered as a common impediment which are able to mislead the segmentation process [47]. To remove the thick hairs in skin cancer images, researchers applied other methods such as mathematical morphology methods [48], curvilinear structure detection [49], an inpainting based method approach [50], automated software called DullRazor [51] and Top Hat transform combined with a bicubic interpolation approach [19]. The hair-free images are acquired using the operations.

At the end of preprocessing step of skin cancer detection system, the resulting images are distinguishable from those initial images and almost are ready to feed the segmentation stage.

6. Conclusion

This paper represents the pre-processing techniques require for designing the automatic skin cancer detection system. It has classified the whole process into two sections of Image Enhancement and Image Restoration. In these two processes, all the steps with its beneficial techniques to enhance the skin cancer images and also the useful filters to remove the noise and smoothing the images have been explained. This paper is useful for researchers working on skin cancer detection systems.

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