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Early Detection of Melanoma Skin Cancer Using Classifiers

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Abstract: Melanoma spreads through metastasis, and therefore it has been proved to be very fatal. A system to prevent this type of skin cancer is being awaited and is highly in-demand. It is important to highlight that excess exposure to radiations from the sun gradually erode melanin in the skin. Moreover, such radiations penetrate into the skin thereby destroying the melanocytes cells. Melanomas are asymmetrical and have irregular borders, notched edges, and color variations, so analyzing the shape, color, and texture of the skin lesion is important for melanoma early detection and prevention. In this work, the components of a portable real-time noninvasive skin lesion analysis system to assist in the melanoma prevention and early detection are proposed. The first component is a real-time alert to help users to prevent skin burn caused by sunlight; a novel equation to compute the time for skin to burn is thereby introduced. The second component is an automated image analysis including image acquisition, hair detection and exclusion, lesion segmentation, feature extraction, and classification. The framework has been developed in a smart-phone application. The experimental results show that the proposed system is efficient, achieving high classification accuracies.

Keywords: Image Segmentation, Skin Cancer, Melanoma.

I. INTRODUCTION

Melanoma is the most frequent type of skin cancer and its incidence has been rapidly increasing over the last few decades. Nevertheless, it is also the most treatable kind of skin cancer, if diagnosed at an early stage. The clinical diagnosis of melanoma is commonly based on the ABCD rule, an analysis of four parameters (asymmetry, border irregularity, color and dimension), or the 7-points checklist which is a scoring method for a set of different characteristics depending on color, shape, and texture. 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. 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 artifacts 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 categorized 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 artifacts must be removed from dermoscopic image. 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 equalization based technique can be used for contrast enhancement. Histogram equalization 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. Dermoscopy is a non-invasive diagnosis technique for the in vivo observation of pigmented skin lesions used in dermatology. Dermoscopic images have great potential in the early diagnosis of malignant melanoma, but their interpretation is time consuming and subjective, even for trained dermatologists. Therefore, there is currently a great interest in the development of computer-aided diagnosis systems that can assist the clinical evaluation of dermatologists.

The standard approach in automatic dermoscopic image analysis has usually three stages:

○ Image segmentation
○ Feature extraction and feature selection
○ Lesion classification

The segmentation stage is one of the most important since it affects the accuracy of the subsequent steps. However, segmentation is difficult because of the great variety of lesion shapes, sizes, and colors along with different skin types and textures. In addition, some lesions have irregular boundaries and in some cases there is a smooth transition between the lesion and the skin. Other difficulties are related to the presence of dark hair covering the lesions and the existence of specular reflections. Some of these difficulties are illustrated. To address this problem, several algorithms have been proposed. They can be broadly classified as thresholding, edge based or region-based methods. An example of thresholding can be found in, where a fusion of global thresholding, adaptive thresholding, and clustering is used. Thresholding methods achieve good results when there is good contrast between the lesion and the skin, thus the corresponding image histogram is bimodal, but usually fails when the modes from the two regions overlap. Edge-based approaches were used in where the segmentation is based on the zero-crossings of the Laplacian-of Gaussian and in several active contour methods like the gradient vector flow (GVF) used in and the geodesic active contour model (GAC) and the geodesic edge tracing described. Edge-based approaches perform poorly when the boundaries are not well defined, for instance when the transition between skin and lesion is smooth. In these situations, the edges have gaps and the contour may leak through them. Another difficulty is the presence of spurious edge points that do not belong to the lesion boundary. They are the result of artifacts such as hair, specular reflections or even irregularities in the skin texture and they may stop the contour preventing it to converge to the lesion boundary. Region-based approaches have also been used. Some examples include the multistage region growing described in , the modified fuzzy c-means algorithm which is orientation sensitive proposed in , the morphological flooding used in , a multi resolution Markov random field algorithm and statistical region merging. Region-based approaches have difficulties when the lesion or the skin region are textured or have different colors present, which leads to over segmentation. However, melanoma has been considered as one of the most hazardous types in the sense that it is deadly, and its prevalence has slowly increased with time. Melanoma is a condition or a disorder that affects the melanocyte cells thereby impeding the synthesis of melanin [1]. A skin that has inadequate melanin is exposed to the risk of sunburns as well as harmful ultra-violet rays from the sun [2]. Researchers claim that the disease requires early intervention in order to be able to identify exact symptoms that will make it easy for the clinicians and dermatologists to prevent it. This disorder has been proven to be unpredictable. It is characterized by development of lesions in the skin [3] that vary in shape, size, color and texture. Researchers have suggested that the use of non-invasive methods in diagnosing melanoma requires extensive training unlike the use of naked eye. In other words, for a clinician to be able to analyze and interpret features and patterns derived from dermoscopic images, they must undergo through extensive training [6]. This explains why there is a wide gap between trained and untrained clinicians. Clinicians are often discouraged to use the naked eye as it has previously led to wrong diagnoses of melanoma.

In fact, scholars encourage them to embrace routinely the use of portable automated real-time systems since they are deemed to be very effective in prevention and early detection of melanoma. This paper proposes the components of a novel portable (smart phone-based) noninvasive, real-time system to assist in the skin cancer prevention and early detection. A system to prevent this type of skin cancer is being awaited and is highly in-demand [4], as more new cases of melanoma are being diagnosed in each year. In this system we have two major components. The first component is a real-time alert to help users to prevent skin burn caused by sunlight; a novel equation to compute the time for skin to burn is thereby introduced. The second component is an automated image analysis which contains image acquisition, hair detection and exclusion, lesion segmentation, feature extraction, and classification, where the user will be able to capture the images of skin moles and our image processing module will classify under which category the moles fall into; benign, atypical, or melanoma. An alert will be provided to the user to seek medical help if the mole belongs to the atypical or melanoma category.

II. EXISTING METHOD

In existing system, the system approached a real time image analysis system to aid in the malignant melanoma prevention and early detection. The existing system presented an image recognition technique, where the user will be able to capture skin images of different mole types. The system will analyze and process the images and alert the user at real-time to seek medical help urgently. The existing work introduced convenient steps for automating the process of melanoma prevention and detection. Experimental results on a PH2 Dermoscopy research database images confirms the efficiency of our system. However the novelty of our system lies in the fact that we further improved the efficiency of the system by implementing an advanced image-processing framework to detect suspicious areas and help with skin cancer prevention. The existing system's goal was to demonstrate how smart phones could turn into powerful and intelligent machines and help large populations without expertise in low-resource settings. Several algorithms have been proposed. They can be broadly classified as thresholding, edge-based or region-based methods. An example of thresholding can be found, where a fusion of global thresholding, adaptive thresholding, and clustering is used. Thresholding methods achieve good results when there is good contrast between the lesion and the skin, thus the corresponding image histogram is bimodal, but usually fails when the modes from the two regions overlap. Edge-based approaches were used where the segmentation is based on the zero-crossings of the Laplacian-of Gaussian and in several active contour methods like the gradient vector flow (GVF) used and the geodesic active contour model (GAC) and the geodesic edge tracing described.

Edge-based approaches perform poorly when the boundaries are not well defined, for instance when the transition between skin and lesion is smooth. In these situations, the edges have gaps and the contour may leak through them. Another difficulty is the presence of spurious edge points that do not belong to the lesion boundary. They are the result of artifacts such as hair, specular reflections or even irregularities in the skin texture and they may stop the contour preventing it to converge to the lesion boundary. Region-based approaches have also been used. Some examples include the multi-scale region growing described the modified fuzzy c-means algorithm which is orientation sensitive proposed, the morphological flooding used, a multi resolution Markov random field algorithm and statistical region merging. Region-based approaches have difficulties when the lesion or the skin region are textured or have different colors present, which leads to over segmentation. While several individual techniques have been proposed for the segmentation of lesions in dermoscopic images, only one previous study compared the performance of different techniques. In that study, six different techniques were evaluated; adaptive thresholding, fuzzy c-means, spherical coordinate transform (SCT)/center split, principal components transform (PCT)/median cut, split and merge, and multi resolution segmentation. No edge-based techniques we retested and only one metric was used to evaluate the methods. An existing system 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, the system 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.

DRAWBACKS:

- It is not considered a real-time system.
- The details of the lesion will not be clearly visible.
- Capturing the images in different light environments will be another challenge.
- The size of the captured lesions will vary based on the distance between the camera and the skin.

III. PROPOSED SYSTEM

In proposed system, this paper proposes the components of a novel portable (smart phone-based) noninvasive, real-time system to assist in the skin cancer prevention and early detection. A system to prevent this type of skin cancer is being awaited and is highly in-demand. The proposed system has two major components flow chart as shown in Figure.1. The first component is a real-time alert to help users to prevent skin burn caused by sunlight; a novel equation to compute the time for skin to burn is there by introduced. The second component is an automated image analysis which contains image acquisition, hair detection and exclusion, lesion segmentation, feature extraction, and classification, where the user will be able to capture the images of skin moles and our image processing module will classify under which category the moles fall into; being, a typical, or melanoma. An alert will be provided to the user to seek medical help if the mole belongs to the atypical or melanoma category. The proposed system uses PH2 Dermoscopy image database from Pedro Hispano Hospital for the development and testing purposes as shown in Figure.2. The image database contains a total of 200 Dermoscopy images of lesions, including benign, atypical, and melanoma cases. To help the users avoid skin burn caused by sun exposure, and hence, to prevent skin cancer, our system would calculate the time for skin to burn and the system will deliver a real time alert to the user to avoid the sunlight and seek shade to prevent developing skin cancer. The system created a model by deriving an equation to calculate the time for skin to burn namely, Time to Skin Burn (TTSB). This model is derived based on the information of burn frequency level and UV index level. The proposed TTSB model can be validated by crosschecking the calculated TTSB values 2 with the information provided by the National Weather Service Forecast, where the TTSB values are calculated using our model based on the UV index, skin type, environment variable and SPF level. The calculated TTSB fall in the range of the data provided by the National Weather Service. To the best of our knowledge, this is the first model proposed that calculates the time-to-skin-burn based on the given UV index, skin type, environmental parameters and SPF, only take into account only UV index and skin type. The system is important in the sense that it allows the users to detect melanoma at early stages which in turn increases the chance of cure significantly. The system introduces an image processing technique to detect and exclude hair from the Dermoscopy images as an essential. The result is a clean hair mask which can be used to segment and remove the hair in the image, preparing it for further segmentation and analysis.

ADVANTAGES:

- This novel framework is able to classify the Dermoscopy images into benign, atypical and melanoma with high accuracy.
- The system would calculate the time for skin to burn and the system will deliver a real time alert to the user to avoid the sunlight and seek shade to prevent developing skin cancer.
- This is the first model proposed that calculates the time-to-skin-burn based on the given UV index, skin type, environmental parameters and SPF, unlike that only take into account only UV index and skin type.

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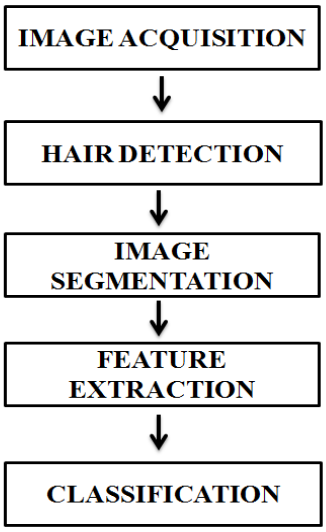

Figure.1 Flowchart for Proposed Method

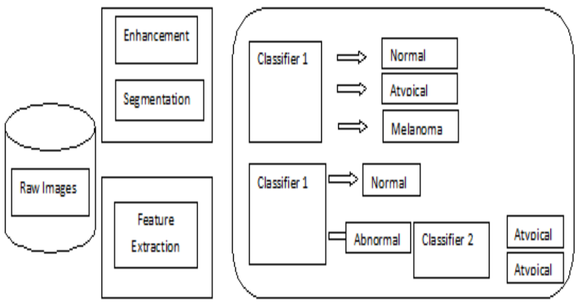

Figure.2 Architecture for Proposed Method

IV. MODULES

A. Image acquisition
B. Hair detection and exclusion
C. Image segmentation
D. Feature extraction
E. Classification
F. Performance analysis

A. Image Acquisition: The first stage of our automated skin lesion analysis system is image acquisition. This stage is essential for the rest of the system; hence, if the image is not acquired satisfactorily, then the remaining components of the system may not be achievable, or the results will not be reasonable, even with the aid of some form of image enhancement. In order to capture high quality images, the iPhone 5S camera is used, equipped with 8 megapixels and 1.5 pixels.

B. Hair Detection and Exclusion: This section introduces an image processing technique to detect and exclude hair from the Dermoscopy images as an essential step also seen. The result is a clean hair mask which can be used to segment and remove the hair in the image, preparing it for further segmentation and analysis. To accomplish this task, a set of 84 directional filters are used. These filters are constructed by subtracting a directional Gaussian from an isotropic filter.

C. Image Segmentation: Pigmented skin lesion segmentation to separate the lesion from the background is an essential process before starting with the feature extraction in order to classify the three different types of lesion. The disk structure element is created to preserve the circular nature of the lesion. The radius is specified as 11 pixels so that the large gaps can be filled. Then, the disk structure element is used to perform a morphological closing operation on the image.

D. Feature Extraction: In this study, five different feature sets are calculated. These are 2-D Fast Fourier Transform (4 parameters), 2-D Discrete Cosine Transform (4 parameters), Complexity Feature Set (3 parameters), Color Feature Set (64 parameters) and Pigment Network Feature Set (5 parameters). In addition to the five feature sets, the following four features are also calculated: Lesion Shape Feature, Lesion Orientation Feature, Lesion Margin Feature and Lesion Intensity Pattern Feature.

E. Classification: In this framework, three types of classifiers are proposed, i.e. one level classifier (classifier A) and two-level classifiers (classifier B and C).The first stage of this framework is to perform image processing to detect and exclude the hair, after that the ROI of the skin lesion is segmented. Then, the image features are extracted. Next, the extracted features are fed to the classifiers.

F. Performance Analysis: The dermoscopic images were obtained under the same conditions using a magnification of 20×. This image database contains of a total of 200 dermoscopic images of lesions, including 80 benign moles, 80 atypical and 40 melanomas. They are 8-bit RGB color images with a resolution of 768×560 pixels. Because the database is anonymous and is used for training purposes, no IRB approval was required for this study.

V. IMAGE SEGMENTATION ALGORITHM

As the premise of feature extraction and pattern recognition, image segmentation is one of the fundamental approaches of digital image processing. This paper enumerates and reviews main image segmentation algorithms, then presents basic evaluation methods for them, finally discusses the prospect of image segmentation. Some valuable characteristics of image segmentation come out after a large number of comparative experiments. In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image

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segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

VI. SIMULATION RESULTS

First step in this method is taking the input image as shown in figure.3. Then this image is applied through a filter, where the hair is removed from the image. Both input and filtered image is shown in figure.4. After filtration, image segmentation is applied to separate the lesion from the background is an essential process before starting with the feature extraction which is shown in figure.5. Then the image is segmented by using morphological segmentation technique. The figure.6 shows the output of morphological segmentation. After segmentation features are extracted.
Then Lesion shape feature, Lesion orientation feature, Lesion margin feature and Lesion intensity pattern feature as shown in figure.7.

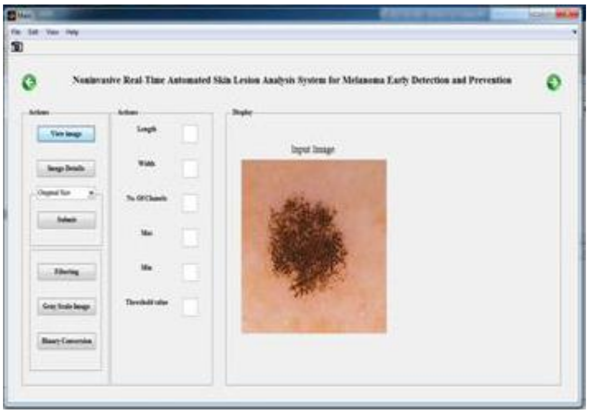

Figure.3 Input Image

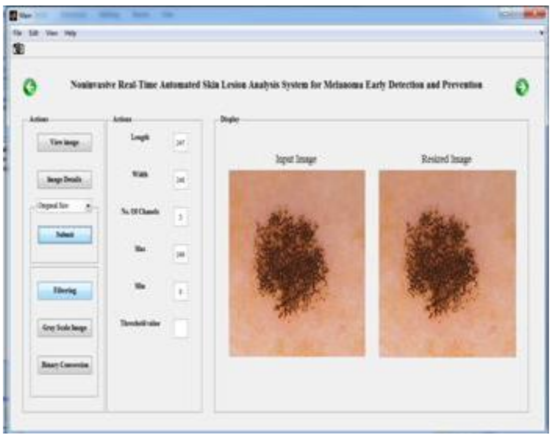

Figure.4 Filter Image

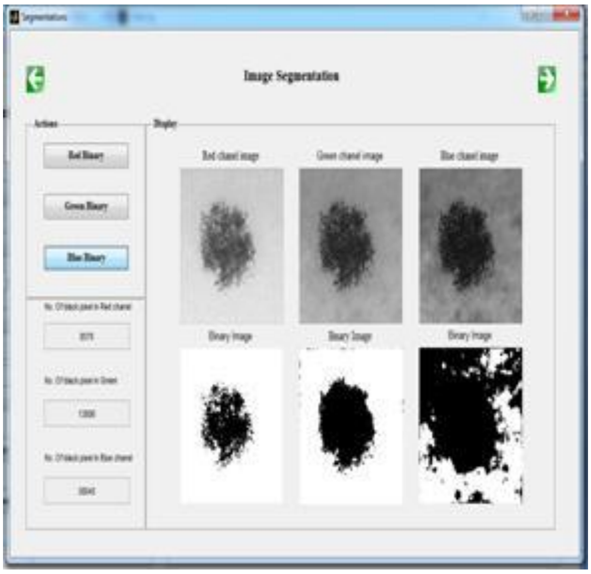

Figure.5 Image Segmentation

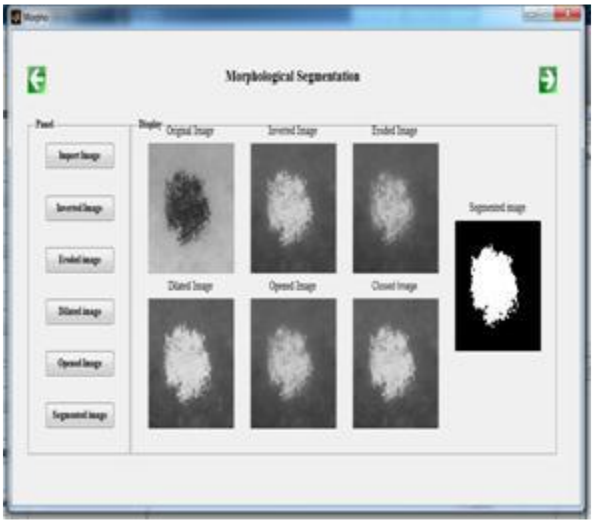

Figure.6 Morphological segmentation of input Image

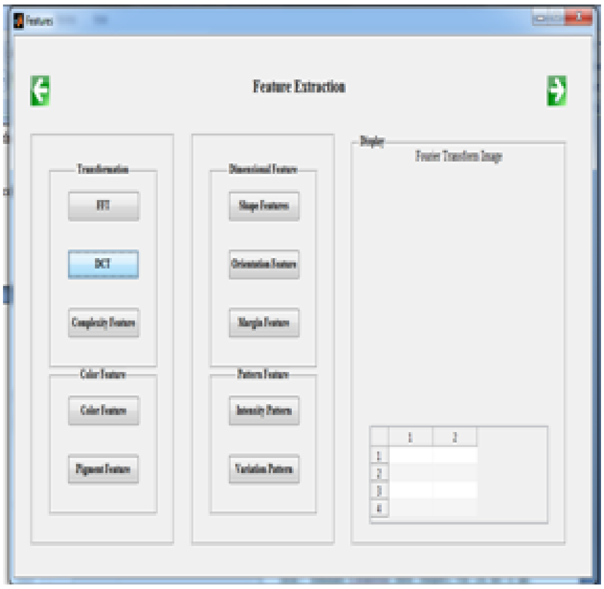

Figure.7 Feature Extraction

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Figure.8 Image Classification

In this framework, three types of classifiers are used to classify the image, one level classifier (classifier A) and two-level classifiers (classifier B and C) as shown in Figure.8.

VII. CONCLUSION

In this paper, the proposed system has two components. The first component is a real-time alert to help the users to prevent skin burn caused by sunlight. a novel equation to compute the time-to-skin-burn was introduced in this component. The second component is an automated image analysis module where the user will be able to capture the images of skin moles and this image processing module classifies under which category the moles fall into; benign, atypical, or melanoma. An alert will be provided to the user to seek medical help if the mole belongs to the atypical or melanoma category. The proposed automated image analysis process included image acquisition, hair detection and exclusion, lesion segmentation, feature extraction, and classification. The proposed system used a state of the art for the dermoscopy image acquisition, which ensures capturing sharp dermoscopy images with a fixed distance to the skin and consistent picture quality. The image processing technique is introduced to detect and exclude the hair from the dermoscopy images, preparing it for further segmentation and analysis, resulting in satisfactory classification results. This system proposes an automated segmentation algorithm and novel features. It is able to classify the dermoscopy images into benign, atypical and melanoma with high accuracy.

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BIOGRAPHIES

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