A Technical Survey on Early Detection of Melanoma

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Abstract -- The incidence of melanoma has been increasing faster than that of any other cancer. Early detection of skin cancer has the potential to reduce mortality and morbidity. With the advancement of technology, Skin cancer is detected at an initial period. Earlier detection and therapy also lead to less morbidity and decreased cost of therapy. Therefore, a significant savings in healthcare cost can be realized if melanoma can be detected in an earlier, more easily treatable phase. The diagnosing methodology uses Image processing techniques and Classification methods to distinguish from Melanoma (Skin Cancer) and Benign (non-cancerous).

Keywords -- Skin Cancer, Artificial Neural Network, Segmentation, Wavelet Transform, ABCD Rule, Classification, Feature Extraction Melanoma, Skin Lesion.

I. INTRODUCTION

Cancer is a disease of the cells, which are the body's basic building blocks. Normally cells grow and multiply in an orderly way, but sometimes something goes wrong with this process and cells grow in an uncontrolled way. This uncontrolled growth may result in abnormal blood cells or may develop into a lump called a tumor (refer Fig 1).

A tumor can be benign (not cancer) or malignant (cancer). A benign tumor does not spread to other parts of the body. Whereas a malignant tumor is made up of cancer cells, which grow out of control and are able to spread. Cancer (malignant) cells are found in the outer layers of our skin. Skin, like all other body tissues, is made up of cells. It has two main layers called the epidermis and the dermis (refer fig No.2).

The epidermis is the top, outer layer of the skin. It contains three different kinds of cells:
- cells – flat cells that are packed tightly to make up the top layer.
- Basal cells – tall cells that make up the lower layer.
- Melanocytes – cells that produce a dark pigment called melanin, the substance that gives skin its color.

Fig 1.uncontrolled growth of blood cells
Keratinocyte cancers (Basal and Squamous cell skin cancers) and Melanomas are two main types of skin cancers. Basal and squamous cell skin cancers are the most common cancers of the skin. They develop from cells called keratinocytes, the most common cells in the skin. Both basal cell and squamous cell cancers are found mainly on parts of the body exposed to the sun, such as the head and neck, and their occurrence is related to the amount of sun exposure a person has had. Whereas Melanomas is the least common skin cancer but it is the most serious because it can grow quickly. They develop from cell called Melanocyte. If melanoma isn't treated it may spread to the deeper layer of skin (dermis) where cancer cells can escape to other parts of the body. Melanomas can occur anywhere on the body. Melanocytes can also form benign (non-cancerous) growths called moles. Melanoma typically initially grows horizontally within the epidermis (melanoma in situ). In time, it then penetrates into the dermis and spreads to other parts of the body. The percentage of survival depends on the depth of penetration of Melanoma (refer Fig No. 3).

In 2010, 68,130 newly diagnosed cases of invasive melanoma and 46,770 cases of in situ melanoma are expected. At current rates, the lifetime risk of an American developing invasive melanoma is approximately 1 in 58 (Fig. 4).

There are many methods to diagnose non-melanoma skin cancer (NMSC) such as physical and clinical examination, biopsy, molecular markers, ultra sonography, Doppler, optical coherence tomography, dermoscopy, spectroscopy, fluorescence imaging, confocal microscopy, positron emission tomography, computed tomography, magnetic resonance imaging, terahertz imaging, and electrical impedance. All these methods have different accuracy rates, sensitivity and specificity in diagnosing NMSC.

The standard method to evaluate a skin growth to rule out melanoma is by biopsy followed by histopathological examination. Over the last two
decades, a tremendous amount of research work has been conducted for automated skin cancer diagnosis. This is partly because automated skin cancer diagnosis holds great promise for large-scale use in the advanced skin cancer treatment and partly because automated skin cancer diagnosis is not a straightforward task, with a number of challenges to be overcome. The challenge lies in identifying the lesions that have the highest probability for being melanoma. Such lesions should be biopsied, and their histopathology appropriately evaluated at the earliest possible time in their development. Laboratory sampling often causes the inflammation or even spread of lesion. So, there has always been lack of less dangerous and time-consuming methods. Computer based diagnosis can improve the speed of skin cancer diagnosis which works according to the disease symptoms.

II. OVERVIEW
In this paper, there is an Explanations of process flow of detection of skin cancer Melanoma. The skin cancer diagnosis consists of three main computational steps: Image processing, feature extraction, and classification. An overview of these three steps is given in Fig.5 . The aim of the Image processing step is to acquire the image, eliminate the background noise and improve the image quality for the purpose of determining the focal areas in the image. This step also comprises nucleus/cell segmentation in the case of extracting cellular-level information. The preprocessing becomes the most important yet difficult step for a successful feature extraction and diagnosis. After preprocessing the image, features are extracted for further accuracy of classification of lesion. ABCD feature is the important information based on morphology analysis of image dermatoscopic lesion. ABCD feature is Asymmetry, Border Irregularity, Color Variation and Diameter features. The melanoma lesions usually have morphology characteristics such as asymmetrical characteristic, irregular edge of the lesion, different color composition, and a large diameter. Feature extraction focuses on quantifying the properties of skin lesions for a single skin lesion the morphological, textural, fractal, color, pigmentation and/or intensity-based features can be extracted. The aim of the classification step is to distinguish benignity and malignancy.

1. Image Processing Technology:
   a. Image Acquisition
   b. Preprocessing & post Processing
   c. Image Segmentation
2. Feature Extraction
3. Classifier Method
   a. Artificial Neural network
   b. k-nearest neighborhood
   c. fuzzy systems
   d. linear discriminate functions
   e. decision trees algorithm

III. IMAGE PROCESSING TECHNOLOGY
(a) Image Acquisition: The first step in an image analysis system intended for characterization of skin lesions involves the acquisition of the tissue digital image. Probably the most important problem, which has to be resolved concerning the design and implementation of the acquisition system, is its ability to capture reliable and reproducible images. The reproducibility is considered essential for image analysis classification and for the comparison of sequential images during follow-up studies. However, the acquisition of reproducible images is quite challenging due to equipment and environmental constraints, such as image resolution, image noise, illumination, skin reflectivity and pose uncertainty. There are two devices that have caught the attention of those knowing the risks, MelaFind using multispectral imaging and Verisante Technology's Aura using rapid Raman spectroscopy.

MelaFind is the first FDA approved computer aided device for melanoma detection. According to the development team, MelaFind is a novel multispectral digital dermoscope, with expert system" software that performs the image processing sequence automatically end-to-end, leading to differentiation between early melanoma and benign a typical neoplasms. This digital dermoscope captures image data both in the visible and in the infrared (a spectrum that lies outside the eye's sensitivity). Image acquisition is done under computer control to ensure standardization. Next, the digital dermoscope uses the image data to uncover new features that can only be obtained with computer assistance. MelaFind is a new early-stage melanoma detector with a 98% of detection rate.

Verisante Aura utilizes Raman spectroscopy, a powerful analytical method that uses a laser to probe molecular vibrations and provide very specific, fingerprint-like spectral patterns for identification of
the biochemical composition of tissue. In Raman spectroscopy, near-infrared laser light changes the vibrational state of the bonds within molecules, which in turn causes a shift in the light that is scattered back to a sensor. The magnitude of that shift reveals what molecules are in the sample and at what concentration. Aura can operate at 99% diagnostic sensitivity for differentiating malignant and premalignant skin lesions from benign ones, and reduce the number of unnecessary biopsies by 50%–100%.

Epiluminescence Microscopy (ELM), also known as dermatoscopy, is a noninvasive technique for improving the early detection of skin cancer. In dermatoscopy, a set of polarized light filters or oil immersion render selected epidermal layers transparent and macro lenses magnify small features not visible to the naked eye. Dermatoscopy is frequently combined with digital imaging technology and a large body of research is devoted to developing computerized processing techniques operating on the digital images produced. A systematic review of the diagnostic accuracy of dermoscopy in detecting melanoma reported that this technique has the sensitivity and specificity of clinical diagnosis of melanoma from 71% to 90%.

(b) Image Preprocessing & Post-processing: Once a magnified image of a skin lesion is captured it is passed to a preprocessor. Usually the image consists of noises in the form of hairs, bubbles etc. These noises cause inaccuracy in classification. In the preprocessing step, the border detection procedure namely, color space transformation, contrast enhancement, and artifact removal, treated as follow:

i) Color space transformation: Dermoscopy images are commonly acquired using a digital camera with a dermoscope attachment. Due to the computational simplicity and convenience of scalar (single channel) processing, the resulting RGB (red-green-blue) color image is often converted to a scalar image using one of the following methods:

- Retaining only the blue channel (lesions are often more prominent in this channel).
- Applying the luminance transformation, i.e. Luminance = 0.299Red+0.587Green+0.114Blue:

Fig 6. a) Dermoscopic images with many occluding hairs b) the results after undergoing preprocessing & post-processing

- Applying the Karhunen-Loeve (KL) transformation and retaining the channel with the highest variance.

ii) Contrast Enhancement: Delgado et al. proposed contrast enhancement method, based on independent histogram pursuit (IHP). This algorithm linearly transforms the original RGB image to a de-correlated color space in which the lesion and the background skin are maximally separated. Border detection is then performed on these contrast-enhanced images using a simple clustering algorithm.

iii) Artifact removal: Dermoscopy images often contain artifacts such as such as black frames, ink markings, rulers, air bubbles, as well as intrinsic cutaneous features that can affect border detection such as blood vessels, hairs, and skin lines. These artifacts and extraneous elements complicate the border detection procedure, which results in loss of accuracy as well as an increase in computational time. The most straightforward way to remove these artifacts is to smooth the image using a general purpose filter such as the Gaussian(GF), median(MF), or anisotropic diffusion filters(ADF). Post-processing is done to enhance the shape and edges of image. In addition, contrast enhancement can sharpen the image border and improve the accuracy for segmentation.

(c) Segmentation: Segmentation removes the healthy skin from the image and finds the region of interest. Usually the cancer cells remain in the image after segmentation. Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). 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. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region are 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. The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale or colour image into a binary image. After segmentation, the output is a binary image. Segmentation is accomplished by scanning the whole image pixel by pixel and labelling each pixel as object or background according to its binarized gray level.

![Filtered image](image1.png) ![Segmented image](image2.png)

Fig. 7 Segmentation

IV. FEATURE EXTRACTION

The important features of image data are extracted from the segmented image. ABCD feature is the important information based on morphology analysis of image dermatoscopic lesion. ABCD feature is Asymmetry, Border Irregularity, Color Variation and Diameter features. To diagnose whether it is a cancerous or non-cancerous, the segmented image has to undergo by any one of the following feature extraction method. 2D wavelets transform hybrid discrete wavelet Transform, Discrete Wavelet Fourier Transform. There are also other methods to extract textural features. The Features extracted using the wavelet transform are: Mean, Standard deviation, Mean Absolute Deviation, L1Norm, L2 Norm. The Obtained Features were given as inputs to a classifier.

V. CLASSIFIER

Classifier is used for classifying Malignant Melanoma from Benign. Artificial Neural network(ANN), k-nearest neighborhood(K-NN), logistic regression, fuzzy systems, decision tree linear discriminate analysis are the different classifier to distinguish the malignant structures from their counterparts. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning Phase. The feed-forward neural network was the first and arguably simplest type of artificial neural network devised.

One of the most straightforward instance-based learning algorithms is the nearest neighbor algorithm. K-NN is based on the principle that the instances within a dataset will generally exist in close proximity to other instances that have similar Properties. If the instances are tagged with a classification label, then the value of the label of an unclassified instance can be determined by observing the class of its nearest neighbors. The k-NN locates the k nearest instances to the query instance and determines its class by identifying the single most frequent class label.

VI. CAUSES OF SKIN CANCER

The main cause of all types of skin cancers is exposure to ultraviolet (UV) radiation from the sun or another source, such as a solarium tanning machine. Sunlight is the main source of UV rays, which can damage the genes in your skin cells. Tanning lamps and beds are also sources of UV radiation. People with high levels of exposure to light from these sources are at greater risk for skin cancer. Ultraviolet radiation has 3 wavelength ranges:

- **UVA** rays cause cells to age and can cause some damage to cells' DNA. They are linked to long-term skin damage such as wrinkles, but are also thought to play a role in some skin cancers.
- **UVB** rays can cause direct damage to the DNA, and are the main rays that cause sunburns. They are also thought to cause most skin cancers.
- **UVC** rays don’t get through our atmosphere and therefore are not present in sunlight. They are not normally a cause of skin cancer.

The good news is that we can do a lot to protect our self and our family from skin cancer, or to catch it early enough so that it can be treated effectively.

**VII. CONCLUSION**

According to the survey the early diagnosis of skin cancer is of severe importance for the outcome of the therapeutic procedure and the basis for reducing mortality rates. Usual systems undergo a variety of methods for the image acquisition and preprocessing, and feature definition and extraction, as well as lesion classification from the extracted features. Melafind using multispectral imaging and Verisante Technology's Aura using rapid Raman spectroscopy are the new scanners adopted in this paper.

**REFERENCES**


