Skin Cancer Detection Using Image Processing

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Abstract— There is need to develop the software which allow expert dermatologists for diagnosis the skin cancer.The objective of our project is to detect skin cancer using image processing technique. It collects dermoscopic images of skin, processes the images, and Displays the result. Our project provides new approach for Skin Cancer detection and analysis from given demoscopic image of patient's cancer affected area, which can be used to automate the diagnosis and theoretic treatment of skin cancer. The proposed scheme is using Wavelet Transformation for image, de-noising and Histogram Analysis whereas ABCD rule with good diagnostic accuracy is used in diagnostic system as a base and finally Fuzzy Inference System for Final decision of skin type based on the pixel color severity for final decision of Benign or Malignant Skin Cancer.

Keywords: dermoscopic images, malignant, benign, image processing, Fuzzy Inference System, Wavelet.

I. INTRODUCTION

Skin cancer is the uncontrolled growth of abnormal skin cells. It occurs when unrepaired DNA damage to skin cells (most often caused by ultraviolet radiation from sunshine) triggers mutations, or genetic defects, that lead the skin cells to multiply rapidly and form malignant tumors. Skin cancer is a major public health problem in the light skinned population.The three most common types are: Melanoma skin cancer: Melanoma begins in melanocytes (pigment cells). Most melanocytes are in the skin. Melanoma can occur on any skin surface. In men, it's often found on the skin on the head, on the neck, or between the shoulders and the hips. In women, it's often found on the skin on the lower legs or between the shoulders and the hips. Melanoma is rare in people with dark skin. When it does develop in people with dark skin, it's usually found under the fingernails, under the toenails, on the palms of the hands, or on the soles of the feet. Basal cell skin cancer: Basal cell skin cancer begins in the basal cell layer of the skin. It usually occurs in places that have been in the sun. For example, the face is the most common place to find basal cell skin cancer. In people with fair skin, basal cell skin cancer is the most common type of skin cancer. Squamous cell skin cancer: Squamous cell skin cancer begins in squamous cells. In people with dark skin, squamous cell skin cancer is the most common type of skin cancer, and it's usually found in places that are not in the sun, such as the legs or feet. However, in people with fair skin, squamous cell skin cancer usually occurs on parts of the skin that have been in the sun, such as the head, face, ears, and neck. [1]

Fig 1: Types of skin cancer

Skin cancer is considered the most deadly form of skin cancer and is caused by the development of malignant tumor. Skin cancer greatly affects quality of life, and it can be disfiguring or even deadly. The single most promising strategy to cut acutely the mortality rate from skin cancer is early detection. Attempts to improve the diagnostic accuracy of skin cancer have spurred the development of innovative in-vivo imaging modalities, including total body photography, dermoscopy, automated diagnostic system and reflectance co focal microscopy. The use of computer technology in medical decision support is now widespread. Recent work has shown that skin cancer recognition from images is possible via supervised techniques that can be used to classify the normal/abnormal images. Despite efforts to address skin cancer risk factors, such as inadequate sun protection and intentional tanning behaviors, skin cancer rates, including rates of melanoma, have continued to increase worldwide. Dermatologists have been trying different methods to aid in the detection of the rapid growing skin cancer threat. For the benefit of human race, there is a need of Diagnosis of skin cancer at an early stage and lots of researchers already working in that direction by means of hardware and software development using different techniques. In this regards, we are suppose to use images of cancer affected skin of patients frequently. So the basic aim of this project is, to identify and develop a framework to analyze and assess the risk of skin cancer using dermatological photographs taken with a standard Consumer-grade camera. We are planning to develop a simple, efficient and automatic skin cancer, detection and diagnosis system with the use of commonly available software for non experts/clinicians/doctors.

Traditional method of skin cancer detection is Skin biopsy. It is a biopsy technique in which a skin lesion is removed to be sent to a pathologist to render a microscopic diagnosis. It is usually done under local anesthetic in a physicians's office, and results are often available in 4 to 10 days. It is commonly performed by dermatologists.

This project will try to recognize whether the given dermoscopic image of skin sample is cancerous or not. It presents a new approach for skin cancer detection and analysis from given dermoscopic image of patient's cancer affected area, which can be used to automate the diagnosis and theoretic treatment of skin cancer. The proposed scheme is using Wavelet Transformation for image, de-noising and Histogram Analysis whereas ABCD rule with good diagnostic accuracy is used in diagnostic system as a base and finally Fuzzy Inference System for final decision of skin type based on the pixel color severity for final decision of benign or malignant skin canc**er.**

II. LITERATURE SURVEY

A cancer diagnosis is nearly always made by an expert looking at cell or tissue samples under a microscope. The procedure that takes a sample for this testing is called a biopsy.

2.1 Existing Systems

2.1.1 MelaFind: MelaFind is another noninvasive instrument that can assist in early diagnosis of melanoma by providing physicians with a recommendation for whether a suspicious lesion should be biopsied. It uses light of multiple wavelengths to capture images of suspicious skin lesions and compares the data against a database of melanomas and benign lesions. Electro-Optical Sciences, the company behind the development of MelaFind, has a binding Protocol Agreement with the FDA.

2.1.2 Siascopy **:**Siascopy or spectrophotometric intracutaneous analysis system is yet another imaging process that may allow the physician to tell the difference between benign moles and melanoma. Like Melafind, it employs multiple wavelength illumination of clinical and dermoscopic images, but requires physician interpretation, while Melafind provides diagnosis in a completely automated system.

2.2.3 Dermatoscopy: It is the examination of skin lesions with adermatoscope. This traditionally consists of a magnifier (typically x10), a non-polarised light source, a transparent plate and a liquid medium between the instrument and the skin, and allows inspection of skin lesions unobstructed by skin surface reflections. Modern dermatoscopes dispense with the use of liquid medium and instead use polarised light to cancel out skin surface reflections. When the images or video clips are digitally captured or processed, the instrument can be referred to as a "digital epiluminescence dermatoscope

2.2 Detection Algorithms

Several different algorithms for skin cancer diagnosis are used to differentiate malignant from benign skin lesions. They are

2.2.1 Pattern Analysis: Historically pattern recognition has been used to differentiate benign from malignant neoplasm by clinicians. It was described by Pehamberger, H. [7]. Pattern analysis techniques have been widely applied to analysis and recognition of cancer, evaluation of the effectiveness of treatment and prediction of the development of cancer. This method is used to identify specific patterns, which may be global (reticular, globular, cobblestone, homogeneous, starburst, parallel, multi-component, nonspecific, network, dots/globules/moles, streaks, blue-whitish veil, regression structures, hypo pigmentation, blotches, vascular structures) and color (Homogeneous blue pigmentation, Patch of pigment, Blue- Gray points, Blue-White Veil) can be present in melanocytic tumors. The location and distribution of shapes and colors can often create different visual patterns that are characteristic of certain lesions.

2.2.2 ABCD rule: It is one of the easiest guides to the most common signs of melanoma. In 1985, recognizing the need to educate physicians and the public to recognize melanoma in its early clinical presentation, group from New York University [6] devised the ABCD acronym (Asymmetry, Border irregularity, Color variegation, Diameter). Stolz, W. [8] established this diagnosis scheme for dermoscopic images known as the ABCD rule of dermoscopy. Asymmetry is one half of the tumour does not match the other half. Border Irregularity is the unevenness of images. Color intensity change in the lesioned region is irregular. Malignant melanoma is having a diameter greater than 6mm.

2.2.3 7-Point Checklist: This method has seven criteria that assess the chromatic characteristics and t shape and/or texture of the lesion as described by Argenziano, G. [9]. This includes 3 major and 4 minor criteria. The major criterion includes change in size, shape and color. They are atypical pigment network, blue whitish veil, and atypical vascular pattern. The minor criteria includes sensory change, diameter of 7mm or greater and the presence of inflammation, crusting or bleeding. They are irregular streaks, irregular pigmentation, irregular dots/globules, irregular blotches and regression structures. The acquired image of the melanocytic skin lesion is analyzed in order to evidence the presence of these standard criteria; finally, a classified as malignant or nevus. Due to complex nature of criterion, as compared with ABCD criteria, the Glasgow checklist has been less widely ad**opted.**

2.2.4 CASH: To differentiate benign with that of malignant melanocytic lesions, appearance of color(C), architectural order (A), symmetry of pattern (S) and homogeneity (H) are important considerations [10]. Benign melanocytic lesions have few colors, architectural order, symmetry of pattern or homogeneity whereas malignant melanoma has many colors, architectural disorders, asymmetry of pattern and heterogeneity.

Table 1: Comparison of Diagnostic Accuracy of Dermoscopy Algorithm

Sr.	Diagnostic Algorithm	Diagnostic Accuracy
1	Pattern Analysis [12]	**71%**
2	ABCD [12]	**80%**
3	7-point checklist [12]	**58%**
4	CASH [12]	**-**
5	Menzies [12]	**81%**

2.2.5 Menzies Method: This method is used to identify negative features (symmetry of pattern, presence of a single color) and positive features (blue-white veil, multiple brown dots, pseudo pods, radial streaming, scar-like depigmentation, peripheral black dots/globules, multiple (five to six) colors, multiple blue/gray dots, broaden network). This method is considerably complex and explained by Menzies, S. W. [11].

III. BASIC CONCEPTS

Skin is divided into three layers, viz. epidermis (outer layer), dermis (middle layer) and hypodermis/sub cutis (deepest layer) as shown in Fig.1. The epidermis mainly consists of keratinocytes. It also contains melanocytes, cells responsible for our skin pigmentation, which provides natural protection against sun's rays. They are evenly distributed in the skin along the basal layer at the dermo-epidermal junction. Melanin is the major pigmentation factor for human skin color variation. Below the epidermis is the dermis layer, it contains special cells which repair our skin. The hypodermis is deepest layer mainly made from fat and manages feeding, excreting and heat exchange. Fat manages the insulation and sweat glands from this layer controls heat exchange of human body [2].

Cancer can be defines as a diseases in which there is uncontrollable growth of cells aggressively, invasively and meta statically. Cancer can be classified based on tissues from which the cancerous cell originates. Skin cancer is by far the most common of all cancer and it usually begins with skin lesions. So based on the nature of these skin lesions, skin cancer can be majorly divided into melanoma and non melanoma.

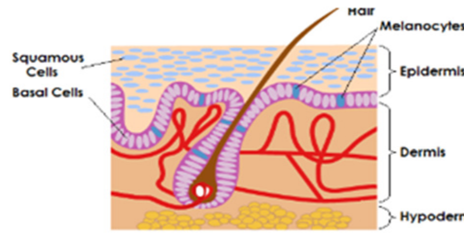

Fig 2: Illustration of details of human skin

The malignant non-melanoma lesions are further divided into basal cell carcinoma (BCC) and squamous cell carcinoma (SCC).BCC is the most common type of skin cancer. It originates from the basal keratinocytes of the epidermis. The most common example of such cancer is a pink, pearly papule or plaque all sun -exposed skin. BCC can occur in fair complexion, chronic sun exposure and ionizing radiation.
BCC can be seen on the human face, particularly the nose.BCC tends to grow slowly. Proper lighting is most important in detecting BCC at their earliest stages.SCC is second most common type, arises from the epidermal keratinocytes. The common example of SCC represents a scaly papule, plaque or nodule on sun-exposed skin. In addition to BCC, SCC can occur because of cigarette smoking. The skin of the head and neck are the most common location for SCC.Malignant melanoma, the third most common and the leading cause of death is the second type of skin cancer. Although Melanoma can occur in many organs, the most common form, cutaneous melanoma arises from the melanocytes that are found in basal layer of the epidermis, hair follicles, sebaceous glands and other adnexal structure.

The Features differentiate cancerous images from non cancerous images is:
(A) Asymmetry -one half does not match the other. Symmetry or asymmetry in zero, one, or two orthogonal axes is considered. Also color, texture, and shape must be taken into account.

(B) Border irregularity -the edges are ragger, notched or blurred. The lesion is divided into eight radial pieces which are then labeled as showing a sharp cut-off with the surrounding skin or not.

(C) Color -the pigmentation is not uniform. The presence of up to six known colors must be detected white, red, light brown, dark brown, slate blue, and black.

(D) Diameter -the width is greater than 6mm. Differential structures with at least five patterns are relevant for specific types of lesions.

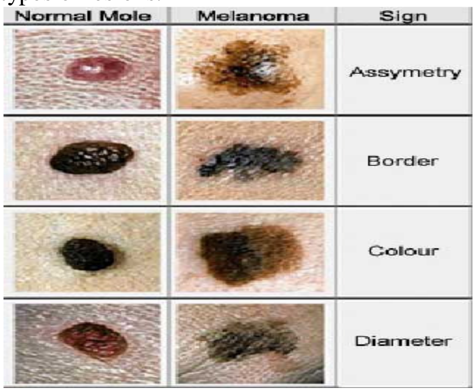

Fig 3: ABCD rule

IV. SYSTEM DESIGN

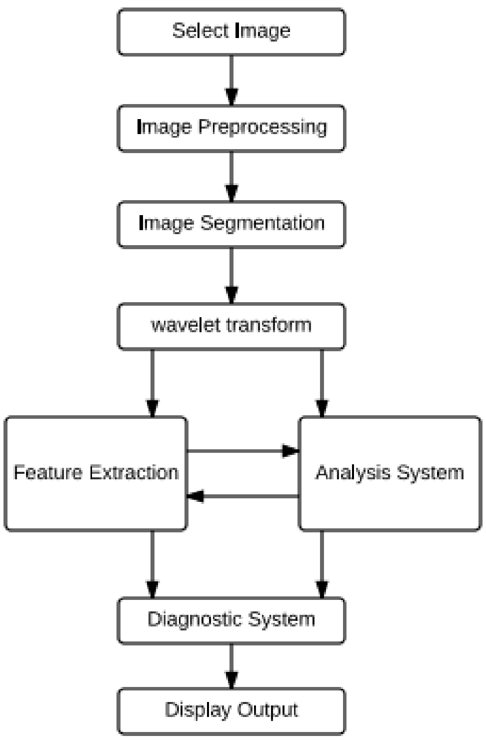

Fig 4: Proposed Scheme of Skin Cancer Detection

4.1 Image pre-processing:

Image pre-processing makes an acquired-prepared image suitable for a particular application. It basically involves improvement or enhancement of image, which includes noise removal, edge highlighting, sharpening, deblurring, brightening, change in image contrast, masking, hair removal, cropping or resizing. The pre-processing step removes the undesirable parts, enhances the image, corrects the image skew and removes noise from the image. In order to detect the border of melanomas, there are numerous techniques (please refer Fig. 5) intended for edge detection. One of the most applicable is the Canny Edge Detection, which firstly smoothes the image to eliminate noise. It then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is no at its maximum (no maximum suppression). The remaining pixels that have not been suppresses are treated by two thresholds and if the magnitude is below the first threshold, it is set to zero. If the magnitude is above the high threshold, it is made an edge. And if the magnitude is between the two thresholds, then it is set to zero.

4.2. Image Segmentation:

It is a process of image partitioning into multiple segments or regions or structures of interest, so that the contents of each region have similar characteristics. It is a process of extracting and representing information from the image to group pixels together with region of similarity. Changing the image representation into a meaningful andeasy-to analyze one is the primary aim of segmentation. In a given image, it assigns a label to each pixel, such that pixels with same labels share common visual characteristics. It makes an image processing tasks easier for analysis. Image segmentation is used to locate objects and boundaries in improved images. Image segmentation results in a set of regions that collectively cover the entire image or set of extracted from the images. Images are scanned from top-left to bottom-right and from bottom-right to top-left. During each scan, unique labels are assigned to each detected regional minima. A segmentation method is usually designed taking into the properties of a particular class of images.

A three-step segmentation method using the properties of skin cancer images is as follows:

1) Pre-processing - A color image is transformed into an intensity image in such a way that the intensity at a pixel shows the color distance of that pixel with the color of the background. The color of the background is taken to be the median color of pixels in small windows in the four corners of the image.

2) Initial segmentation - A threshold value is determined from the average intensity of high gradient pixels in the obtained intensity image. This threshold value is used to decide approximate lesion boundaries.

3) Region refinement - A region boundary is refined using edge information in the image. This involves initializing closed elastic curve at the approximate boundary, and shrinking and expanding it to fit to the edges in its neighborhood.

4.3 *Feature Extraction:*

Feature extraction is a sub-division of improved image into constituent parts or isolation of some aspects of an image for identifying or interpreting meaningful object forms, which includes finding lines, circles or specific shapes and identifying pimples, white heads or black heads, etc. The segmented image is further used to extract features such as texture, color and shape. Some of important properties or descriptors) of the texture are coarseness, smoothness, regularity, of the color are light rate, medium rate, dark rate, while the common shape descriptors are length, breadth, aspect ratio, area, location, parameter, compactness, et*c*.

4.4 Analysis System:

Image analysis techniques involve the measurement of extracted image features. Measurement of image features for diagnosis of melanoma requires that first, the lesions be detected and localized in an image. It is essential that lesion boundaries are determined accurately so that measurements, e.g. maximum diameter, asymmetry, irregularity of the boundary, and color characteristics can be accurately computed.

4.5 Wavelet Transform:

Wavelet analysis is used for decomposing the skin lesion image and utilizing wavelet coefficients for its characterization. Wavelets are an extension Fourier analysis. Wavelets are a mathematical tool for hierarchically decomposing functions in the frequency domain by preserving the spatial domain. This property can be exploited to segment objects in noisy images based on their frequency response in various frequency bands, separating them from the background and from other objects. The major advantage of using wavelets is that they can be used for analyzing functions various scales. It stores versions of an image at various resolutions, which is very similar how the human eye works. In practical applications for various medical imaging systems, features of interest and noise properties have significantly different characteristics. These properties can be efficiently and separately characterized with the techniques of Wavelet Decomposition. The steps required to compress an image using Wavelet transform are as follows:

i. Digitize the source image into a signal which is a string of numbers.

ii. Decompose the signal into sequence of wavelet coefficient w.

iii. Use threshold to modify wavelet coefficient w1 to another coefficient w2.

Wavelet packets provide more flexibility on partitioning the spatial-frequency domain, and therefore improve the separation of noise and signal into different sub-bands in an approximated sense (this is referred to the near diagonalization of signal and noise).

4.6 Diagnosis System:

Skin Health Diagnosis is a process of identifying a skin texture or problem by its signs, symptoms. Diagnosis system is a system that can be used to analyze any problem by answering some questions that lead to a solution to the problem. When melanomas occur, they usually arise from pigmented nevi (moles) that are large (diameter > 6mm), asymmetric, with irregular borders and coloration. Bleeding, itching and a mass under skin are other signs of cancerous change. The method we will be using here is ABCD rule.

The Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. In the Fuzzy Inference System, skin color as input variable is fuzzified by applying membership function to it. We divide color of skin as Light Red, Medium Red and Dark Red as linguistic variable. Similarly output variable are based on the fuzzy-based Madmani, having status as healthy skin, rash skin, cancer skin. The mapping then provides a basis from which decisions can be made. The process of fuzzy inference all of the pieces that are described in Membership function's logical operations and If-then rules.

The rules are set in human language as given below:

i. If "skin color" (input variable) is Light Red then Decision (output variable) Healthy skin.

ii. If "skin color" (input variable) is Medium Red then decision (output variable) is Rash skin.

iii. If "skin color" (input variable) is Dark Red then decision (output variable) is Cancer skin

A classification problem deals with associating a given input pattern with one of the distinct classes. Patterns are specified by a number of features (representing some measurements made on the objects that are being classified) so it is natural to think of them as d-dimensional vectors, where d is the number of different features.

V. CONCLUSION

Skin cancer detection software identifies and recognizes skin cancer symptoms and diagnoses melanoma in early stages. With the proper image input using different Digital Image Processing steps, doctors can get very good help from such diagnostic systems. We are proposing to use ABCD rule as its diagnostic accuracy has been reported to be 80%. A combination of both ABCD rules and wavelet coefficients has been shown to improve the image feature classification accuracy by 60%. At the end, we proposes algorithm with relevant processing mathematics for proper, efficient detection of skin cancer. We hope that the proposed algorithm will help doctors. This system will save doctor's time and also can be used for regular monitoring skin cancer development in patients. Early diagnosis is more than 90%curable.

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