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A Review on Skin Lesion Classification Techniques

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***Abstract*— In real world, image processing plays a great role in medical fields. Such application can be used for diagnosis of various diseases. In recent years a large amount of death rates are reported due to cancer. From those cases most predominant type of cancer was skin cancer. Approximately half of Australians are suffered from skin cancer at each second. Skin cancer can be completely cured when diagnosed at early stages. Diagnosing skin cancer through biopsy is a time consuming, lots of man power are needed and it is a painful process. As the technology has been improved in recent years, various image processing techniques have been developed to detect the skin cancer automatically. Through this paper various techniques are reviewed which are used for classifying the lesion in skin as benign and malignant.**

Keywords*— Skin Cancer; Support Vector Machine; Bayesian Classifier; Total Dermoscopy Score; k-Nearest Neighbors; Artificial Neural Network.

I. INTRODUCTION

Now a days a large amount of people are suffering from Cancers. Cancer can occur on different part of the body such as brain, lungs, skin, thyroid etc. The World Health Organization estimates that skin cancer accounts for one third of all the diagnosed cancers worldwide [1]. The conventional method for detecting skin cancer was Biopsy. Recent advancement in medical field and more precisely the involvement of information technology in the medical field introduces a new diagnosis mechanism called Medical Image Processing [2]. The image are acquired for classification is by using a powerful instrument called dermatoscope. Dermatoscopy which is also known as Dermoscopy or Epiluminescence Light Microscopy (ELM), is the examination of skin lesions with a dermatoscope [3]. Dermoscopy images, provides better quality images of lesion.

Fig 1: Image of digital dermatoscope

The images are captured with the instrument by placing an oil immersion between the skin and the optic. Some complex and pigmented structures occurred on skin may not be visible using the naked eye, but with the help of ELM instrument those invisible structures can be made visible and images can be captured easily. Nowadays the doctors depends on ELM to improve analysis of lesions in skin.

(a) Dermatoscopy (b) Dermatoscopic image

The entire paper is organised as follows: Section I gives the introduction, section II describes overview of skin cancer, the description of various techniques are described in section III and in section IV the conclusion of the paper, followed by the references.

II. SKIN CANCER

The largest organ of body is skin. The skin consists of three layers: epidermis, dermis and hypodermis [4]. The Melanocytes are present in the layer called epidermis. The melanocyte are responsible for protecting human from radiation. Melanin which is present in melanocyte cell gives the pigmentation for skin.

The skin cancer is occurred due to the abnormal growth or transformation of cells. Metastasis is the process of spreading the malignant tumours to other parts of body through blood. There are three types of cancer: Basal-cell carcinoma (BCC), Squamous cell carcinoma (SCC) and Melanoma [5].

The Basal-Cell Carcinoma is a type of cancer commonly seen in the head, shoulders due to the effect of radiation. The bleeding are found at the center of lesion and appears as scaly spots. The Squamous Cell Carcinoma is caused due to abnormal growth of squamous cell in epidermis. SCC looks like scaly red patches, open sores, warts and they may crust or bleed. It is commonly seen to occur in neck, balding scalp, lips [6]. Melanoma is dangerous form of skin cancer. It is

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seen in brown, red color. Melanoma is caused mainly by intense, occasional UV exposure, especially in those who are genetically predisposed to disease. If Melanoma is recognized and treated early it is always curable [6].

Features of malignant lesion are:

- Irregular borders.
- While dividing the lesion into two half, they does not seems to look similar - asymmetry.
- Different mixtures of colors are seen.
- Diameter of lesion is larger than 1/4 inch.

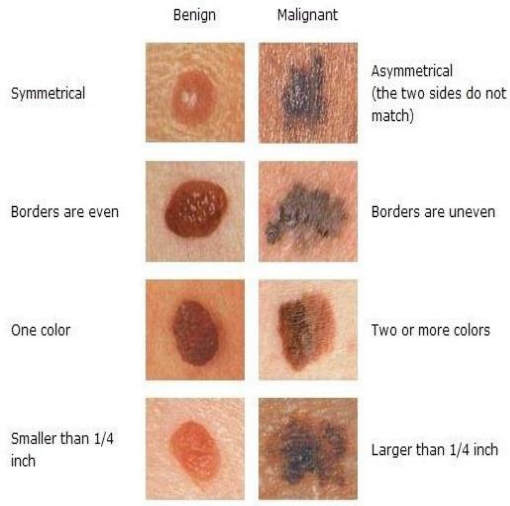

Fig. 2. Difference between benign and malignant lesion

Causes of skin cancer:

- Ultraviolet exposure: The UVA and UVB rays from sun are dangerous to skin and leads to cancer. The people living in Australia, Florida have high chance for skin cancer.
- Actions of chemicals: Chemicals such as arsenic and hydrocarbon in oils, tars causes cancer.
- Sun lamps.
- Tanning beds [7].
- Subjected to radiation treatment.

Types of people with greatest risk are [7]:

- Fair skinned people: More chance to occur skin cancer as melanin prevents as melanin prevents skin cancer by absorbing UV rays.
- People who spent their majority of time in outside.
- Heredity plays major role.
- People with age more than 40 years.
- Weakened immune system: People who are subjected to organ transplantation, infected with HIV.
- Light coloured hair, blue or green eyes.
- People suffering from genetic disorders like albinism.

III. LITERATURE SURVEY

A. Support Vector Machine (SVM)

In [8] the dermoscopy images were pre-processed using three methods such as gray-scale conversion, noise removal using median filter and contrast enhancement. A gray-scale images provides brightness information. This images have the intensity value between 0 and 255, where 0 represents black and 255 represents white. Median filter is a nonlinear filter which helps to remove the noise, thin hairs. Contrast enhancement was done for increasing the quality of the image. A maximum entropy thresholding method was used to segment the ROI from subjected images. The object was segmented with the help of maximum entropy applied to the histogram of the gray-scale image. Texture features was extracted using GLCM method. The output from GLCM was feed as the input to SVM for classifying into cancerous and noncancerous classes.

In [9] author proposes SVM for classifying the melanoma. In pre-processing step median filter was used to remove noise and small hairs. Then this pre-processed images were segmented using K-means model. K-means helps to cluster the lesion image into two classes. Region division was performed before extracting the features. Result obtained from the region division were two lesion region such as inner lesion region and outer lesion region. color, texture, border features were extracted from the inner lesion region and diffusion region. The irrelevant and redundant features were eliminated using principle component analysis (PCA). Finally a SVM classifier was build to classify the lesion as benign and malignant.

A new method was proposed for the detection of skin cancer in [10] that includes four stages such as pre-processing, segmentation, feature extraction and classification [10]. In pre-processing stage the input was subjected to noise filtering with the aid of median filter and the resultant output was subjected to histogram equalisation. Histogram equalisation was used for enhancing the contrast of the image. Otsu's thresholding method was used to segment the input image into foreground and background region. From ROI the features such as mean, variance and standard deviation are extracted and feed into different classifiers such as SVM, k-Nearest Neighbors, boosted tree and decision tree. Finally experimentally proved that SVM is better than others with accuracy 93%.

Hiam et al in [11] performs classification of lesion object by using SVM. First, the images were subjected to pre-processing such as applying filters, enhancing contrast of images. A Median filter was used for smoothing the images. The image may not be homogenous hence contrast enhancement was done. Segmentation was done through the following steps such as, at the first step Otsu's thresholding method was done, hence segmented images were obtained. On the next step the unfilled portions were filled with image filling method followed by morphological opening operation. And at last results obtained from morphological operation were converted into gray-scale image and histogram equalisation was applied. On next step features such as color,

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texture and border were extracted and Principal Component Analysis (PCA) method was used for dimensionality reduction. SVM with radial basis function was proposed for classification.

In [12] the classification was done on skin lesion using three different classifier such as SVM, CART, C4.5. The first step done was some pre-processing steps such as filtering and enhancement. The Gaussian filter was used for smoothing the image. Image enhancement method was used for enhancing the quality of the images. K-mean clustering method was suggested for segmenting the object from the background. The features needed for the classification was done using GLCM method. This method provides information such as contrast, correlation, cluster prominence, cluster shade. This features were the feed to the three different classifier such as SVM, CART, C4.5 and proved that SVM is better than the other two with accuracy of 94.3%.

B. Bayesian Classifier

In [13] directional filter was used for pre-processing for removing hairs from the image. The unfilled regions were filled using the maximum pixel value among the eight adjacent pixel. Active contour based segmentation was applied to segment the subjected image. The features from input image were extracted which were needed for the correct classification. The features were extracted using colour correlogram and segmentation was based on fractal texture analysis (SFTA) method. The colour correlogram was used for finding the colour correlation among the pixels. The fractal dimension gives the information about the complexity and structure of the boundaries. The Bayesian classifier was proposed for classification of lesion into benign and melanoma with the help of colour correlogram and SFTA feature vectors. The system were successfully tested with the dermoscopic dataset and the experimental results showed that the combination of colour correlogram and texture analysis are used so that better results was obtained.

C. Recognition by Neuro Fuzzy System

Authors in [14] made use of different steps for classification of skin lesion. The noise was removed from the input image with the help of median filter and mean shift clustering technique was used for segmentation of the pre-processed image. The advantage of the mean shift clustering technique was there is no need for prior knowledge of the number of clusters. The color features such as mean, variance and skewness were extracted from RGB and HSV color space. The GLCM method was used to obtain global statistical texture features. An adaptive neuro fuzzy inference system was used for the classification, which was the combination of ANN and fuzzy inference system

Messadi M et al [15] proposed an adaptive neuro fuzzy inference system for the classification of lesion. This adaptive neuro fuzzy inference system helped to identify the correct fuzzy rules. A dull razor technique was used method for removing the artifacts. An unsupervised system was used for segmentation and segmented image was subjected to ABCD method which calculates four features such as Asymmetry (A), Border (B), Color (C) and Diversity (D) [15]. Finally the adaptive neuro fuzzy inference system was used for the classification.

D. k-Nearest Neighbors Classifier(k-NN)

In [16] proposed a median filter to remove the noise from the image. Hence the small structures, air bubbles, hairs were removed. The color features were extracted from the RGB color space and texture features were extracted with the help of the method called GCM (Generalized Co-occurrence Matrix). At last a k-NN classifier was used for classification. The texture features such as energy, contrast and entropy were extracted which is useful for classification. Finally the lesion was classified with the help of a k-NN classifier.

In [17] proposed a method that focus on color and texture feature extraction. GCM (generalized co-occurrence matrices) method was used to extract the texture features. The mean and standard deviation were the features obtained from color features. Feature selection was done to identify the most important features for the better result and resultant features were feed to the k-NN classifier system for classification of lesion.

E. Total Dermoscopy Score(TDS)

In [18] introduced a new method for detection of skin cancer. The paper starts with pre-processing the image. The images were converted to YUV color space and Ostu's thresholding was used to segment the lesion from skin. Morphological operations were suggested to fill the small holes.

Four parameters are identified for classification, they are:

- Asymmetry: Dividing the image into two halves does not produce symmetry. If asymmetry along two axis score 2 is given, similarly along a single axis score 1 is given else 0 score.
- Border: Edges are irregular, blurred.
- Color: Different shades of colors are seen. In the case of existing color, the score is incremented by 1.
- Diameter: Larger than 6mm.

Based on this four parameters Total Dermoscopy Score was calculated as: TDS = [(A score * 1.3) + (B score * 0.1) + (C score * 0.5) + (D score * 0.5)], if TDS value is less than 5.9 then benign lesion else melanoma [18].

F. Classification using Artifical Neural Network

Wiem Abbes and Dorra Sellamin in [19] proposed an artificial neural network for classification. At pre-processing stage a nonlinear filter called median filter was used to remove noise. The advantage is that it can preserve edge details. The segmentation was performed using thresholding method. The high level features such as border, asymmetry, color and texture features were extracted and given as input to ANN for training and testing

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In [20] the dermoscopic images were pre-processed using median filter to filter out the noise and bubbles from images. Threshold based segmentation was proposed to segment the image into two regions. The output from segmentation will be binary image. The thresholding method always produce a binary image. 2D wavelet transform was used for feature extraction. These features were feed towards the multilayer neural network with back propagation for better classification.

Deepti Sharma et al [21] developed a system to automatically detect the skin cancer. Image processing techniques were used to smooth the images and then segmentation was proposed to separate the lesion from skin. This was achieved by using statistical region merging algorithm (SRM). The SRM is an algorithm that evaluates the values in a regional space and by using the merging criteria they group these values together, hence segmentation is achieved. The features need for the classification were extracted using 2D wavelets transform. In this method Bior wavelets at two steps of decomposition were performed and at each step it provides the information about the portion. This features were feed to back propagation neural network (BPP) and an auto associative network (AANN) for comparison. Experimentally proved that accuracy of BNN was 91 % compared to AANN.

A new method for diagnosis of skin cancer was described in [22]. The input image set which contained dermoscopic images were subjected to pre-processing for removing thin hairs, noise, air bubbles. Nonlinear filter named median filter was suggested for doing pre-processing. On next stage the pre-processed image was subjected to segmentation. The segmentation helps to maintain the lesion region while removes the background region. For segmentation an easy method called threshold segmentation was used. The input to this method can be color and gray-scale image. But the output will be always a binary image. The working of this segmentation was in such a way that it scans the image, pixel by pixel and based on the value the pixel is either characterized as background or object. For getting correct classification results there were a need for features. Here Gray Level Co-occurrence Matrix (GLCM) was suggested for extracting the texture feature. The information such as contrast, Correlation, Energy, Mean etc. can be obtained by the GLCM. Artificial Neural Network (ANN) based classifier was used for classifying the lesion given as input. The classification is done based on the features extracted. For training a Back propagation (BPN) Algorithm was used.

IV. CONCLUSIoN

In this study, we have gone through the basic concepts of skin cancer and reviewed various non-invasive techniques on dermoscopic images, for classifying the lesion into benign and malignant. Based on the survey we could understand that classification of a lesion into benign and malignant requires various stages such as pre-processing, segmentation, feature extraction and classification. Through this survey we have moved through different methods in the image processing for classification such as SVM, Bayesian classifier, Neuro fuzzy system, k-NN and ANN. Based on the knowledge obtained from the above discussion my M.Tech project is proposed.

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