Study on Skin Lesion Classification Systems and Dermoscopic Feature Analysis for Melanoma

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Abstract

Skin Cancer had been identified as a very commonly occurring kind of cancer which if not diagnosed on time ,leads to the death of the patient. This scenario emphasizes the need for CAD methods for the early detection of melanoma.This paper focuses on reviewing the various different CAD methods that are presently in use and also provides information on various filters used, segmentation techniques ,features selected and also different classifiers used.

Keywords: Skin Cancer,Image Processing,ABCDAnalysis,Features,CAD, SupervisedLearning, SVM, ANN

Introduction

Skin protects the body against heat, sunlight, injury and infection. It also helps control the body temperature, stores water and fat. In recent years, there has been a significant increase in the amount of cases diagnosed for skin cancer. This trend had been visibly noticed primarily across regions dominant with lower melanin in the skin. The increase in skin cancer can also be attributed to the significant change in the climatic conditions across the globe. Delayed diagnosis is very severe and can result in severe consequences leading to fatalities. Early diagnosis can help decelerate the overall progression of cancer and might also help cure completely. This however is purely dependent on the time of detection. Skin cancer is broadly classified to melanoma and non-melanoma. The non-melanoma is further classified to squamous and basal. Of these, melanoma is the most widely occurring and life-threatening form of skin cancer. A recent study has indicated that 75% of the 12190 skin cancer fatalities in US, are due to melanoma. The non-melanoma based cancer can be easily cured if treated early.

A medical practitioner uses Dermascope to detect the various types of skin cancer. This is more like a magnifier through which the physician can examine the lesion. On suspicion of the type of skin tone, the physician recommends a biopsy to confirm the findings. Biopsy is a painful procedure as it involved removal of a section of the lesion for detailed diagnosis. The success of the diagnosis by an experienced physician is about 75-84%.

Recent advancements in the field of Image Processing and Data Science[29] have helped

automated diagnosis of many skin cancer related defects.Image processing is the transformation of an image, which is a 2-dimemtional signal, f(x,y) (where x and y represent the amplitude and intensity of the image) through data processing. For processing, the image is converted to digital form using sampling and quantization. The different steps in image processing are, image acquisition, enhancement, segmentation, feature extraction and pattern recognition. An extension of the application of image processing in the field of medical sciences is called medical image processing[23,24,30]. This involves use of image processing techniques to create visual representations of the interior of a body for clinical analysis. The use of medical image processing[refer 27,28] to assist doctors in diagnosis of diseases is called Computer Aided Diagnosis.

With advancements in the field of image processing , detection of the abnormalities in the skin has been automated to enable early detection and treatment. The CAD[23] system for skin cancer related diseases falls under the Supervised Learning techniques. This technique refers to methods that enable creation of a correlation with different features and labelled outcomes. The subset of Supervised Learning techniques are summarized in Figure 1. The Classifier mainly used in melanoma detection is the Linear Classifier.

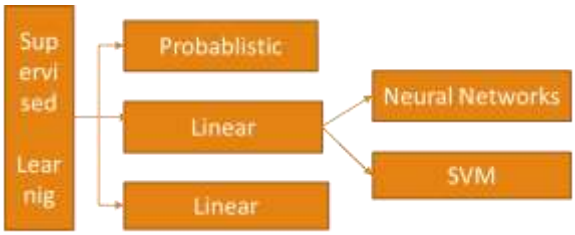

Figure 1. Subsets of Supervised Learning

Figure 2.Block Diagram of the CAD System Using Image Processing

The main objective of this paper is to summarize the various CAD[Refer 22,24,25] techniques adopted for early detection of skin cancer. Different feature selections that have been used and classification techniques for identification of the skin cancer are discussed.

Literature Review

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the

build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.

Some techniques which are used in digital image processing include:

- Anisotropic diffusion
- Hidden Markov models
- Image editing
- Image restoration
- Independent component analysis
- Linear filtering
- Neural networks
- Partial differential equations
- Pixelation
- Principal components analysis
- Self-organizing maps
- Wavelets

Image editing refers to the processes of altering images, whether they are digital photographs, traditional photo-chemical photographs, or illustrations.Retouching refers to the editing of analog images with various tools like airbrush and illustrations with any traditional art medium. Various editing programs are also used to render or create computer art from scratch.

Linear filters process time-varying input signals to produce output signals, subject to the constraint of linearity. This results from systems composed solely of components (or digital algorithms) classified as having a linear response. Most filters implemented in analog electronics, in digital signal processing, or in mechanical systems are classified as causal, time invariant, and linear signal processing filters.

A wavelet is a wave-like oscillation with an amplitude that begins at zero, increases, and then decreases back to zero. It can typically be visualized as a "brief oscillation" like one recorded by a seismograph or heart monitor.

In the field of machine learning, the goal of statistical classification is to use an object's characteristics to identify which class (or group) it belongs to. A linear classifier achieves this by making a classification decision based on the value of a linear combination of the characteristics. An object's characteristics are also known as feature values and are typically presented to the machine in a vector called a feature vector. Such classifiers work well for practical problems such as document classification, and more generally for problems with many variables (features), reaching accuracy levels comparable to non-linear classifiers while taking less time to train and use. Few of the most popular linear classifiers are SVM and Neural networks.

Artificial neural networks (ANNs) or connectionist systems are computing systems inspired by the biological neural networks that constitute the brain. Such systems learn tasks by considering examples, generally without task-specific programming.

In machine learning, support vector machines{Refer 33,34,35] (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM [Refer 23,24,25]training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible.

P.Jayapalet. Al[6] proposes a system using hybrid spatial feature representation and radial basis type network classifier to classify melanoma skin lesion. In order to classify a given image automatically and to decide the stage of abnormality, pnn classifier with rbf is used. Here in this system, the color features from HSV space and the discriminate texture features such as gradient, contrast, kurtosis and skewness are extracted. This melanoma diagnostic system is a two-stage process which involves training and classification. The artificial neural network radial basis type is used as the classifier.

EktaSinghalet. Al[11] has proposed a system in which automatic skin cancer classification is done. The relationship of skin cancer image across the neural network are studied with different type of preprocessing. Image preprocessing is used for noise removal. In this system, the images are segmented using thresholding and feature extraction is done using multilevel 2D wavelet decomposition. The different features extracted are, mean, maximum, minimum, median, standard deviation and variance. The back propagation neural network and radical basis neural network are used for classification. The proposed method gives 92% with BPNN and 88% accuracy with rbfnn.

Shanti Rathoreet. Al[14], in her paper considers the problem of poor contrast and lack of color calibration which are often encountered when analyzing dermoscopy images.Images taken using different devices under different lighting, will leads to different image colors of the same lesion. Accurate border detection is difficult for images with low contrast. The author presents an effective approach through a preprocessing step that enhances color information and image contrast. The enhancement sage is combined with two different enhancement algorithms, where one technique relies on analysis of image background by iterative measurement of non-lesion images. While other techniques utilizecooperative neural network for edge detection.The different features extracted are area, perimeter and color variations. The ABCD rule is used for feature extraction, where A-Asymmetry, B-Border, C-Color and D-Diameter.

Nadia Smaoui[2] et. alproposes a system based on the combination of segmentation method and

analytical method and aims at improving the methodologies to develop an interface that helps dermatologists during the diagnostic phase. In the first step, a sequence of preprocessing is done inorder to remove noise and unwanted disturbances from the image followed by it, is an automatic segmentation approach which locates the skin lesion. The next step is the feature extraction stage where texture and color features are extracted using the ABCD feature extraction. The segmentation process used is region growing which is based on automatic selection of seed pixel and the threshold which ensures best results and helps to avoid and overlap between healthy skin and the lesion.

RuksarFatima[3] et al, proposes a system that uses multi parameter extraction and classification system (MMMMM) which helps in the early detection of skin cancer melanoma. The MMMMM system defines a skin lesion as a set of extracted parameters of features. 21 Parameters are extracted using six phase approaches using dermoscopic images. The first phase deals with extraction of symmetry of the skin lesion, the color spreading factor and the lesion boundary parameter. Second phase is the feature extraction phase where color and physical feature are extracted. The area, perimeter and eccentricity are the physical features extracted from the skin lesion. The 3D projected depth parameter is obtained in the third phase. The fourth phase color parameters of red, green and blue channels in terms of mean and variance are obtained. In the fifth phase, the smoothening filter is used on mean and variance of the red channel and green channel. The last phase discusses the extraction of hue, saturation and value channel parameters.

Dr. S.Gopinathan[4] et. al, proposes a technique for detecting melanoma through OTSU thresholding that segments the lesion from the entire image and boundary tracing algorithm which is used for further segmentation. In the preprocessing stage, the image is preprocessed inorder to remove hair and noise. The featuresthat are extracted from the lesion are geometrical features like area, perimeter, minor axis length and major axis length. In the next step, the stolz[Refer 31,32] algorithm, is used for classification. The results of this method shows best performance of detecting cancer along with stages like benignsuspicious, highly suspicious or just a mole.

Md.AmranHossenBhuiyan[5] et al, proposes aautomatic image analysis method to identify skin cancer at an early stage without performing skin biopsies. In the first step, preprocessing of the image is done to remove the noise followed by segmentation which is done by three methods namely

- Otsu’s method
- Gradient Vector Flow (GVF)
- Color Based Image Segmentation Using K-mean Clustering.

The feature extraction is based on the ABCD rule of dermatoscopywhich represents the asymmetry, border structure, color variation, and

dermatoscopical structure. The diagnosis of skin cancer cells is based on the diameter of the lesions where lesions >6mm may be considered as melanoma.

Ebtihal Al Mansoura[7] et al proposes an intelligent automated method for identification of skin lesions using machine learning techniques. Firstly, the images are segmented by converting color images to greyscale, applying fuzzy C means, fuzzy entropy and morphology based optical mask selection, adaptive contour method, based on optimal mask to segment skin lesions and refinement of segmentation using morphology operations. The two types of features used are color and texture. Local binary pattern and grey scale co-occurrence matrix are the texture features that have been extracted. The features are robust owing to scale invariant property of LPB and rotation invariant property of GLCM. Combing features improves accuracy of classification results Hence, a fused hybrid texture local and color as global features has been proposed to classify the melanoma and non-melanoma.

NayanaBanjan[9] et al, implements an image processing technique for detection of melanoma using matlab. The input to the system will be the skin lesion image. In the preprocessing stage, the RGB images are converted to greyscale images and noise is removed. Segmentation is done by Otsu thresholding. Feature extraction is done using the ABCD method that includes parameters like Asymmetry, Border Irregularity, Color and Diameter. Total Dermatoscopy score is then calculated. Classification is done using Stolz algorithm technique. The TDS determines the presence of skin cancer by classifying it as Benign suspicious or Highly suspicious.

Pauline J.Sheeba[8] et al proposes a novel technique in which classification is done using two classifiers and then compared. The input to the system is dermoscopic images .In the preprocessing stage, noise removal is done using a sober filter followed by which edge detection is done using the Canny method. The segmentation is done by using watershed method and then the features are extracted using the ABCD method. Following this is the classification in which the TDS which is the Total Dermoscopic Value is calculated and and if this value >1, then the lesion is termed as malignant and benign otherwise. In the second technique, the PCA is used for classification and we get a classification accuracy of 92%.

Yogendra Kumar Jain et al[15] has proposed a method that focuses on a skin cancer screening system that can be used even by non-experts.The input to the CAD system is the dermoscopic images.The edges of the input images are detected using contour tracing algorithm.The output of the edge detection becomes input to the Discrete Wavelet Transform and then the images are decomposed and approximation coefficients are produced.The Probabilistic Network and the K-means clustering algorithm is used as classifiers and a classification accuracy of 95% is obtained by the

neural network classifier versus 92% obtained by using the clustering classifier.

JeyaRamya et al[10], proposes a system in which in the preprocessing stage, adaptive histogram equalization techniques and wiener filter is used. A novel method was proposed for the segmentation and classification of skin lesions. The segmentation is achieved by active contour segmentation. Features are extracted and decimated into first order, second order and higher order features. Texture features like entrophy, correlation, homogeneity and energy features are extracted using GLCM and classification is done using an SVM classifier. The accuracy obtained for a dataset of around 20 images is 95%.

Abbas et al[13] proposes a robust approach for automatic skin cancer detection as malignant melanoma is lethal and is very difficult to identify in the last stages. The author proposes a methodology to reduce the probability of false positives in the diagnosis of melanoma.The dataset is initially preprocessed using K-Clustering algorithm.The rate of reorganization is increased by the removal of all the irrelevant texture.The features are then extracted from the preprocessed data.The classification results show that this method improves the classification accuracy of about 94.4% by using Complete local binary pattern in the place of RGB color model with a modified dataset.

Shivanjiet. Al[21] proposes a system to detect melanoma in which the input image which is the lesion image needs to be preprocessed as the image may have been taken from various lighting conditions. Hence preprocessing is done by which image resizing, contrast and brightness adjustments are done. This is done by a image processing technique called Gamma correction. Next is the segmentation using automatic thresholding and masking operations in RGB layers is done. The automatic thresholding method proposed by Otsu is applied to each layer. Then the binary mask for each layer are obtained and combined together to get the final lesion mask. During further segmentation, edge detection is applied. Segmentation is done as it is the main prerequisite of extracting features so that the lesion is separated from the normal skin. The main features extracted here are geometric features like area, perimeter, greatest diameter, circulatory index and irregularity index. Next the classification is done.

Observations:

- ❖ Feature selection from skin images.
- ❖ Classification done by various classification algorithmns.
- ❖ Classifier should be trained using features to classify abnormal or normal.
- ❖ Performance Measures computed on testing set to evaluate outcome of proposed method

Conclusion:

In this paper, we have reviewed various computer aided diagnosis for detection of melanoma skin cancer. CAD is more useful for areas where rural

experts in the field of cancer may not be available. Since tool is more user friendly and robust for image acquired in any condition, it can serve the purpose of automatic diagnosis of skin cancer.

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