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VARIOUS METHODS AND POSSIBILITIES OF MEDICAL DIAGNOSTIC CRITERIA IN DERMATOLOGY SECTION

Dr. R. Jayaprakash, Assistant Professor, Department of Computer Technology, NGM College, Pollachi. jayaprakash@ngmc.org

Abstract
Healthcare systems provide personalized services in wide spread domains to help patients in fitting themselves into their normal activities of life. Skin disease is one of the most important serious challenges in the medical field. Since most of the time is wasted in diagnosing the disease. Classification is one of the most important decision-making techniques in many real-world problems. The main objective is to classify the data as skin lesions or healthy skin layers and improve the classification accuracy. Machine learning and deep learning for diagnosis of skin disease, is about learning structures from the skin disease dataset which is provided. Machine learning in recent years have been the evolving, reliable and supporting tool in medical domain.

Keywords:
Diagnosis, Processing, Sensory, Classifier, Disease.

Introduction

This research is focused on the prediction of several common skin disease types of patients based on their personal and clinical information using machine learning classifiers. In this chapter, summarization of the works proposed by various researches in the past decade is done. It is useful to identify the limitations in the works which are proposed in the area of skin disease diagnosis-based machine learning classifiers. The problem in diagnosis of skin disease is a dynamic area in the research field.

During the years, there are several studies has been done on skin disease classification using image processing and machine learning techniques. Before conducting this study a survey was carried to gather the available data on skin disease diagnosis using a machine learning approach. The data were summarized in three categories, that is multi-class, binary and other types of classification studies; to know the current scenario of the technology usage in skin disease diagnosis. This chapter reviews certain aspects of skin lesion having medical orientation. It also provides general information about skin structure and skin abnormalities associated with dermatology, along with some more information about the diagnostic methods used by medical experts. This review not only presents the important work done and published, but also plans to provide general details and ideas on skin lesion issues and attempts to elaborate its medical viewpoints. The limitations of these studies were listed at the end along with the solutions to overcome the same.

Anatomy of Skin

Skin is the longest organ in the human body and provides a cover around the body. It protects from heat, sunshine, injury and infection. Skin also helps to manage the warmth of the body and consists of water, fat, vitamins and minerals of various types. As shown in Figure 2.1, there are two main types of human skin. One is non-hairy (smooth) skin found on the palms and soles, it can be found on the surface as the ridges and sulci, with distinctive patterns for each of them commonly called as dermatoglyphics. It is distinguished by a thick epidermis, which divides them into multiple well-marked layers, as well as a compact stratum corneum, the existence of embodied sensory organs in the dermis, and the lack of hair follicles and sebaceous glands. The second type is hair-bearing skin, made up of hair follicles and sebaceous glands, but lack of encapsulated sensory organs. In addition to this, skin types also differ widely between different types of body.

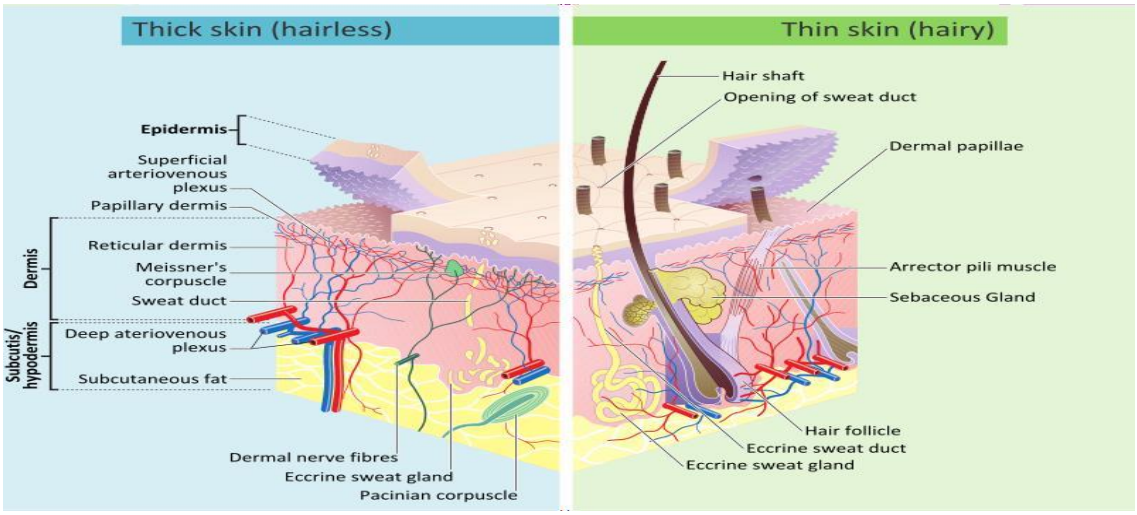

Figure: Human Skin Category

Human skin layers: Skin mainly consists of three primary layers as illustrated in Figure

•The epidermis that provides waterproofing and acts as an infection barrier.

• The dermis that serves as a place for skin appendages including hair.

• Sweat and sebaceous glands refresh the skin surface and hypodermis maintain the thermal control and act as an energy resource

An abnormal lump, bump, ulcer, or colored area and sore on the skin generates skin lesion. In the next section a glimpse of skin lesions and its class is discussed.

Skin lesion

Skin lesions are several types of skin patch which are different from the surrounding area. There is a broad variety of skin lesions that can be categorized in a hierarchical way. Primarily, each lesion is divided according to its source. Malignant lesions such as melanoma build up from melanocytes and the skin cells responsible for the production of a protein pigment called melanin and other class of lesion originated from other types of skin cells, such as the basal or squamous cells. The next step involves the identification of lesion categories, i.e., if it is a malignant neoplasm or benign cells then they define the skin patterns and its pigmentation in related image samples. It can be divided into two groups benign and malignant.

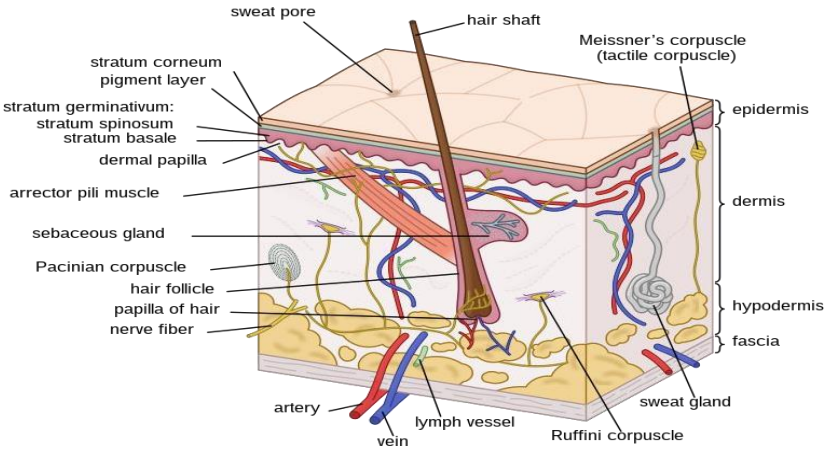

Figure: Layers of Human Skin

There are various sub-groups in each group of samples. Examples, of the these sub-groups or classes in standard data set are pyogenic granuloma (PYO), dermotofibroma (DF) and haemangioma (HAEM) represent benign and another sub-group of lesions or classes are melanoma (ML), squamous cell carcinoma (SCC) and basal cell carcinoma (BCC) represent malignant. Other than that, there is pre-malignant class samples of lesion which can be malignant or benign and difficult to detect, example classes are intraepithelial carcinoma (IEC), actin keratosis (AK), seborrhoeic keratosis (SK). In Figure 2.3 discusses about the sample classes of skin lesion which are available in standard data set of dermofit

except mole(nevi). In India, the most common type of skin cancer are SCC and BCC, due to its slow development, it is considered to be less hazardous than melanoma. The appearances of this cancer class are quite similar to one of the pre-malignant class sample (AK). AK considered to be the source class for SCC and BCC. It grows abnormally to generate a malignant class of skin lesion called as BCC and SCC. On the other side DF, HAEM and ME are vascular lumps or benign forms of skin disorder. Moreover, out of the three cancers, Melanoma is the most severe type and causes majority of deaths related to skin-disease, although it is one of the most common skin cancers

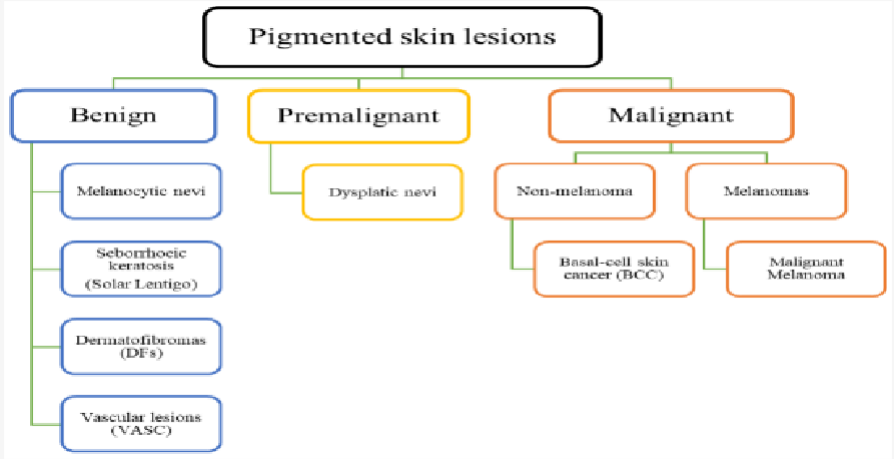

Figure: The pigmented skin lesions at different stages

On the other hand, BCCs and SCCs are less severe but difficult to diagnose as compared to melanoma. Both of cancers (BCC and SCC) have a tendency to expand and effect nearby tissues slowly and severely. Despite the growth rate of SCCs, BCCs are slow but it is quite destructive in behavior. If they are not treated in early stages, could cause severe damages possibly affect other organs of the human body. It is not feasible to simply separate the classes based on the property of skin lesion as color and shape. There are several reasons, including the variation shown in lesion classes. As an example, malignant sample class is having an sample of SCC, BCC and ML. In the next section, various standard procedure of diagnosis is going to be discuss. Although the non-invasive methods are not much accurate, but quite close to the actual facts.

Skin Lesion Image Analysis

The following section reviews two aspects of the related literature, i.e. 1) the diagnosis of skin disease by a dermatologist, 2) computer aided system based skin lesion diagnosis. Common skin diseases are easily diagnosed by observation, but for the severe disorders, there is a need of an efficient diagnostic procedure. In general, dermatologist suggests treatment, according to visual information, some valid questionnaire and based on some empirical criteria of diagnosis. Although, there are few indiscernible ailments which require images of high magnification and histopathological examinations as biopsy such as cancer. In the medical society, a large amount of research focuses on the diagnosis of severe skin diseases by non-invasive approaches. These are based on the characteristics of lesions in medical images,e.g. shape, color, etc. There might be a mapping of skin lesion characteristics with skin lesion images, such as its structure represents the distribution of textures in image space and color variegation in different class of lesion are distributed at various wavelengths of color in medical imaging. This section summarizes the role of image processing in skin lesion screening and the standard medical procedures used to diagnose skin abnormalities.

Imaging Techniques for Skin Lesion

It has been found that there are numerous different imaging techniques used to screen the skin lesions. The least complex perception strategy is photography and this technique gives the picture of skin upper layer. Next subsequent stage is dermoscopy techniques of polarized light camera and it helps to decrease surface impressions and illuminates the image of the epidermis – the second layer of skin. Due to this, it is easier to estimate the structures of lesions such as dots, globules, networks that are the main indicators of skin lesion diagnosis. Dermoscopy is an imaging method that gives a more

straightforward connection between medical science and particular visual attributes and develop a new modality as an epiluminescence microscopy (ELM). This method has opened another way of investigating by clinical examination of morphological markers for pigmented skin lesions. In addition to this, visual perception of the lesion by Ultrasound is another detail modality of diagnosis. Ultrasound imaging is generally used to quantify the profundity of skin lesion and if there are no variations from the normal skin, then there are no distinctions between the two regions. At this point when specialist analyzes lesions and utilizes high recurrence ultrasound (more than 30 MHz) to gauge infiltration profundity so as to make right cut and adopt right medical procedure. However, other modalities are optical coherence tomography (OCT) and confocal laser scanning microscopy (CLSM). Visual review with the bare eyes has a generally low sensibility in identifying early abnormalities as a lesion. In this particular circumstance, a few non-invasive modalities of skin lesion images as dermoscopy. It is all about body photography and other one is the confocal.
Microscopy reflectance (RCM), which are currently being developed to increase diagnostic accuracy by analysis microscopic skin structures. The principle of improvement in this field is the integration for the clinical practice of dermoscopy and computerized photography. Developing advance imaging modalities creates more refined methods of prognosis. Standard dermatology criteria are discussed in the next section.

Medical Diagnostic Criteria in Dermatology

Dermatologists use certain diagnostic criteria to distinguish between various types of lesions. Some of these criteria are related to the set of patterns and colors that are observed in the skin lesion images. The first method was proposed in 1985 by Friedman et al. to diagnose skin lesions is called pattern analysis. This method considers a set of patterns, also called global features, which can be found in each type of skin lesions. A specific pattern is characterized by one or more fundamental skin structures by local features(image descriptors) that can cover parts or the entire lesion. In addition, there are a variety of diagnostic approaches such as ABCD rule, Menzies technique, 3-point and 7-point checklist to evaluate lesion structures and patterns, using non-invasive imaging system. The standard diagnostic rule of skin lesion is ABCD in the domain of dermatological was suggested in 1994 by Stolz et al. Precisely, the following rule used to evaluate the properties of lesion as asymmetrical, border, color and, diameter.
ABCD Rule: They are usually inspired from the four characteristic features of an image used to detect the abnormalities in skin lesion images. The four criteria's are:
Asymmetry Features: Use to assess the degree of asymmetry in terms of shape, color, and texture of lesion.
Shape Features: This feature attempt to describe the lesion shape using attributes such as the area, perimeter and circularity index. The characterization of the lesion's border is associated with shape features, so it is also common to include other features such as the fractal dimension and the index of irregularity.
Color Features: Use to describe the lesion's color properties. In this case, there are different other features such as statistical descriptors (mean, standard deviation, skewedness, entropy, etc.), color histograms, and chromatic differences can be used. Multiple color spaces (e.g., RGB, HSV, L*a*b *) are usually used to extract with other features.
Texture Features: These features are aimed at characterizing skin images structures. Some of the most popular features are the co-occurrence gray level matrix (GLCM) and associated statistics and Gabor filters.

Computer Aided Diagnostic System

The diagnosis of abnormalities in standard skin lesions images is a challenging task. Indeed, even if therapeutic calculations are used, for example, the ABCD criteria and the standard 7- point checklist rules. In every possible case it is difficult to separate lesion class or identify the severe sores of the skin and its types because the inclusion of noise, concealing structures, biological complexity and anisotropy of the imaging system render the automated analysis of dermatological images a difficult

task. Due to this, it reduces the probability of detection and increases the specificity of lesion diagnosis. It also increases the number of histological tests, since this is the standard way of skin lesion diagnosis. In addition to this, different dermatologists may differ in their finding of skin lesion. This is because the assessment of distinctive diagnostic criteria depends on the visual acuity and the opinion of medical expert's. The past downsides inspired to use homogeneous frameworks for abnormality detection in a more precise way.

Feature Extraction

Although, the extraction of features is a vital step but finding an appropriate feature for certain application requires detailed knowledge. A lot of studies have been done in this sector, identifying a wide range of dermatological features that characterize skin lesions and able to classify them accurately. The primary purpose of feature extraction is to quantify the unified signs used by the finite set of pixels for determining the malignancy of a skin lesion or categorizes the lesions class in skin lesion images. In a given image, isolation of features is an important measure for accurate classification.

To perform analogous activity, what dermatologists used to do for classifying the skin lesion images, it is also essential to extract features that characterizes the lesions in a computer aided framework. There are various characteristics that can be used to define skin lesions. These sorts of characteristics can be split into two distinct groups as global and local features used to perform image analysis. The global image features present image as a whole while local feature symbolizes image patches.

However, there is a wide range of dermoscopic images which are characterized the lesions and extraction of these features seems to be difficult task. These features are related to skin distortion, it is also very difficult to analyze the distorted skin caused by bacterial and viral infections of skin in these images. The related features are body location, subject parameters (age), graphics parameters (view angle and illumination effect), image parameters have a major impact on the lesion categorization. All these influential challenges typically increase the overhead in the automatic screening and diagnosis of skin lesion images. There have been various attempts to solve some of the above challenges reported in the literature.

One of the best approach to tackle the above mention challenges is automated feature extraction. It helps to simplify the lesion analysis by image structures and generate important information about the lesion in skin lesion images. The information related to anatomical structures of their typical appearance (shape, size, color,location) or statistical knowledge of their properties, these properties is used to classify the skin lesion images.

Classification Methods

The aim of this stage is to curtail the size of feature vector by eradicating the unimportant and/or redundant features and improve the classification score.

Classification of images depends on selected image features which helps to isolate the image pixels into one of several classes based on specific knowledge of the domain. This could be done by training a model using a set of data and then testing the model using a different set of data that is disconnected from the training set. Typically, the classification results are influenced by the selected descriptors and the strength of the classifier. Automated classification method performance depends equally on the degree of population of the dataset. As reported in the literature on dermatological imaging that follows two main types of classification techniques unsupervised and supervised . They encourage to perform an effective classification by examining the reflection of each pixel and choosing the best signatures to match during skin lesion classification. Several methods of classification for lesion images have been reported in the literature. The Artificial Neural Network (ANN), Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Regression Analysis (RA) and Decision Trees (DT) classifiers are commonly used among these methods. Out of them, ANN consists of an interconnected group of nodes similar to human brain's neurons. Traditionally, neural network models consist of both an adaptive weight adjusted during model training and the ability to use the quantitative characterization of input images.

The accompanying subsections give extra insights and the briefly overview of the state-of-the art about various techniques of lesion border detection, feature extraction and classification that can be used for skin lesion diagnosis. And, the major finding from this review are that most of the research was performed with a homogeneous framework for skin lesion diagnosis, commonly for melanoma only. Although malignant melanoma is a serious class of skin cancer, but other category of cancer prognosis are also required. The other classes of cancers which commonly occur in India are SCC and BCC know as non-melanoma. There is a need for new approaches which is viable to distinguish all other categories such as nevi(moles), tumor, pre-cancer along with cancer class of sample. This also indicates that, many of the systems may fail or may not be able to classify various other classes of non-melanoma skin lesions. In addition to this,the problem of classification for various classes of lesion which belongs to melanoma or non-melanoma was hardly dealt with in the literature. Iyatomi's proposed CAD system which are notable exceptions and differentiate melanocytic and non-melanocytic lesions. Ballerini et al. developed a robust system which can classify the melanoma and non-melanoma class of samples.

Conclusion

We have reviewed that DL has numerous potential applications in the dermatologist's workflow from diagnosis to treatment. DL can improve the dermatologist's practice from diagnosis to personalized medicine. Recent advancements in access to large datasets (e.g., electronic medical records, image databases, omics), faster computing, and cheaper data storage have encouraged DL algorithms' development with human-like intelligence in dermatology. There are many promising opportunities for DL in the dermatologist's practice. The classification of images through CNNs has garnered the most attention for its potential to increase the accessibility of skin cancer screenings and streamline the workflow of dermatologists.

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