Competitive Analysis for the Detection of Melanomas in Dermoscopy Images

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***Abstract*—Melanoma is type of skin cancer which is less common but deadliest in nature. If it is recognized and treated early, then it is mostly curable else it can cause most deaths. The main aim is to determine melanocytic and non melanocytic skin lesions from dermoscopic images and then differentiate between benign melanocytic lesion and melanoma. In this paper, we are reviewing the two methods used to detect the melanoma using dermoscopy images. First one uses global features and second uses the local features. Then, the best among two is determined.**

Keywords— ABCD rule colo; dermoscopy; images; melanoma; skin lesions; texture.

I. INTRODUCTION

This is the most dangerous form of skin cancer. The cancerous growth is developed when unrepaired DNA damage to skin cells and mostly it is caused by ultraviolet radiation from sunshine and also because of genetic defects. It is caused by sunburns caused by UV radiations. Melanoma looks same as moles, and may be developed from moles. The color of melanomas may be black, brown, skin-colored, pink, red, purple, blue or white. But probability color of black or brown is more.

If melanoma is recognized and treated early, it is almost always curable, but if it is not, the cancer can advance and spread to other parts of the body, where it becomes hard to treat and can be fatal. While it is not common of the skin cancers but it causes the most deaths [1].

Usually, Melanoma gets metastasized very fast. Hence, the physicians should detect and diagnose melanoma in its earliest stage as the probability of already metastasized is less and increases the chances of survival.

Dermoscopy is a technique mainly used by physicians to diagnose skin lesions or to detect melanomas. Dermoscopy is a noninvasive method that allows the in vivo evaluation of colors and microstructures of the epidermis. Dermoscopy can amplify the lesions from 6 to 100 times. By this it is easy to recognize that are not visible by naked eye. This can be used to diagnose the lesions using medical diagnostic algorithms. The identification of specific diagnostic patterns related to the distribution of colors and dermoscopy structures can better suggest a malignant or pigmented skin lesion that is not harmful. The use of this technique provides a valuable aid in diagnosing pigmented skin lesions. Because of the complexity involved, this methodology is reserved for experienced clinicians. [2]

There are two systems for the automatic classification of melanocytic skin lesions [3]. First one uses global methods to classify skin lesions. It first does the segmentation of lesion using an automatic segmentation method. Then, a set of color and texture features from the ABCD rule is extracted and used to train a classifier to perform binary classification as melanoma or melanocytic skin lesion which is not harmful. The classifier will classify melanoma from non melanoma lesions.

The second system uses local features. BoF approach [4-7] is used on dermoscopy images. First lesion is segmented using an automatic segmentation method. Then, set of keypoints is selected from lesion region. Each keypoint is characterized by a vector of local features (color and texture features). The number of keypoints and local features varies from image to image, so it cannot be directly given to a classifier. Hence, all local features associated with all the training images are gathered and used to compute a smaller set of prototypes denoted as visual words. Then, the local features of each dermoscopy image are assigned to the nearest visual word, and a histogram for that is computed. The histogram counts the number of times each visual word was selected. A statistical classifier is then trained to identify melanoma lesions from non melanoma ones.

Dermoscopy images of skin lesions are examined and differentiate between pigmented skin lesions and non pigmented skin lesions. Pigmented skin lesion are checked to determine whether it is melanocytic or non melanocytic skin lesion. If it is non melanocytic skin lesion, then it is non melanoma. But, if it is melanocytic skin lesion then distinguish whether benign i.e not harmful in effect and melanoma. If it is benign, then it is non melanoma. If result is melanoma, then physician should diagnose in early stage itself, else it can cause death.

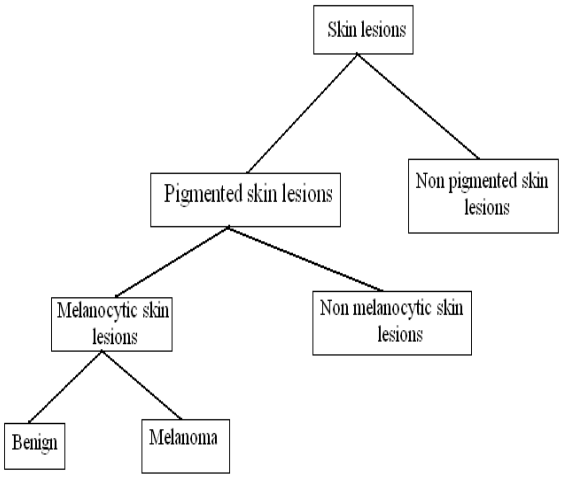

Figure. 1. Classification of skin lesions

II. MEDICAL DIAGNOSIS ALGORITHMS

Several medical diagnostic algorithms are

- The ABCD rule[8,9]
- Menzies method[10,11]
- Seven-point checklist[11,12]

These algorithms identify the skin lesion as melanocytic or non melanocytic. Melanoma is a melanocytic. Then they differentiate between melanocytic lesion which is not harmful and melanoma using different approaches.

A. The ABCD Rule

ABCD stands for asymmetry, border, color and differential structure. For calculating the ABCD score the criteria have to be assessed semi quantitatively. Total dermatoscopy score (TDS) is calculated by summation of each of the criteria that has to be multiplied by a given weight factor. The values of TDS greater than 5.45 are highly skeptical for melanoma; values between 4.8 and 5.45 indicate a skeptical lesion and values less than 4.75 indicate a benign melanocytic lesion or non melanoma [3, 4].

Asymmetry

A dermoscopy image of lesion is bisected in two 90° axes. The maximum score is 2 and minimum score is 0. If there is asymmetry on 1 axis with respect to color and structure then the score is 1. If both axes show asymmetry then score is 2. If there is no asymmetry or it's symmetric to both axes then the score is 0. The weight factor of asymmetry is 1.3.

Border

The lesions are divided into eight sub parts. The maximum score is 8 and minimum score is 0. If there is a sharp, abrupt cut-off of pigment pattern at the periphery within one eighth has a score 1. A gradual, indistinct cut-off within one eighth has a score of 0. The weight factor of border is very low i.e. 0.1.

Color

There are six different colors. They are white, red, light-brown, dark-brown, blue-gray, and black. The maximum score is 6 and minimum score is 1. If all 6 colors are present then score will be 6. The number of colors in skin lesion gives the score of color. The weight factor of color is 0.5.

Differential structure

There are five structural features for evaluation of differential structures. They are pigment network, structure less, streaks, dots, and globules. The maximum score is 5 and minimum score is 1. If pigment network is present then score for that is 1 else its 0. If lesion is structure less then score is 1 else 0. Same way for other structural features streaks, dots and globules. Streaks and dots are counted only when more than two are clearly visible. For counting a globule only the presence of one single globule is necessary.

Formula for calculating TDS: [(A score x 1.3) + (B score x 0.1) + (C score x 0.5) + (D score x 0.5)]

B. Menzies Method

Menzies method is used to differentiate the dermoscopic features of benign melanocytic skin lesions from melanoma. It identifies two types of dermoscopic features. They are

- Negative
- Positive

Negative dermoscopic features are symmetrical pattern in terms of structure and have single color.

Positive dermoscopic features are blue-white veil, multiple colors, radial streaming, scar-like pigmentation, pseudopods, multiple blue or grey dots, and multiple brown dots. If positive features are present then there is high probability of melanoma.

C. Seven-point Checklist

Seven-point checklist is method used to differentiate between benign melanocytic lesions and melanoma. This algorithm inspects the skin lesion for the presence of atypical differential structures. The following are dermoscopic features with there respective scores.

1. A typical pigment network (2)
2. Blue-whitish veil (2)
3. Atypical vascular pattern (2)

4. Irregular streaks (1)
5. Irregular dots/globules (1)
6. Irregular blotches (1)
7. Regression structures (1)

The scores should be added up. Three or more indicates the high probability of melanoma.

III. RELATED WORK

Many systems for melanoma detection have been proposed. Few systems use the same methods as dermatologists. They detect and extract the dermoscopic features from dermoscopic images. The dermoscopic features include blue – white veil (irregular and structure less areas of merging blue pigmentation with white) [13], multiple skin lesion color, pigment network structure (detect pigment network structures in dermoscopic images, based on the edges of pigment network structures) [14], asymmetric structure less areas (detects automatically by using thresholds in the red and green color planes) [15]. Majority of melanoma detection system use a pattern recognition approach. An Internet-based melanoma screening system, web server is accessible from all over the world and it detects the tumor as melanoma or non melanoma using a neural network classifier [16].

Most of the works use global methods to classify skin lesions [16], [11], [15]. The systems mainly consist of three or four steps. They are lesion segmentation, feature extraction, feature selection, and lesion classification. Lesion classification uses trained classifier. These systems are usually inspired in the ABCD rule [8]. The dermoscopic features that are extracted from dermoscopic images produce scores. The dermoscopic features are mainly shape, color and texture.

Different authors used different set of dermoscopic features and classifiers and obtained different results. Shape, color and texture features were used and achieved a *SE* = 96% and a *SP* = 93%. kNN (k-Nearest Neighbor) classifier was used [17].

Local methods have been proposed to classify skin lesion. There are algorithms for lesion classification that uses the bag-of-features (BoF) approach. Skin lesion is represented by a histogram of code words that are identified from a training data set. Naive Bayes Classifier is used for classification. The performance obtained is 82.21% on a dataset of 100 skin lesion images [18].The relative color histogram analysis technique is used to evaluate skin lesion discrimination based on color feature calculations in different regions of the skin lesion in dermoscopy images. The histogram analysis technique is examined for varying training set sizes from the set of 113 malignant melanomas and 113 benign dysplastic nevi images.

There are three types of features shape, color, and texture which are relevant for the automatic detection of melanomas. Based on color feature calculations in different regions of the skin lesion in dermoscopy images, color histogram analysis technique is used to evaluate skin lesion discrimination. This technique is examined for varying training set sizes from the set of 113 malignant melanomas and 113 benign dysplastic nevi images [19]. Color distribution in the RGB color space was used to distinguish between melanomas and benign [19 - 20].

Most previous works describe the skin lesion of dermoscopic images using global features, but it has been proved that local features perform better in several image analysis problems.

IV. SYSTEM OVERVIEW

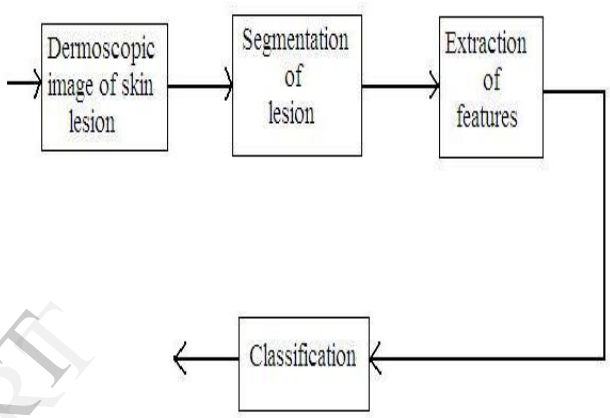

Figure 2: Melanoma detection system using global features

In this paper, two systems described for automatic classification of melanocytic skin lesion.

The first system uses global methods to classify skin lesions from dermoscopy image and differentiate between melanoma and non melanoma skin lesions. The system takes the dermoscopic image of skin lesion as input. The lesion is segmented using an automatic segmentation method. Then, a set of features from the ABCD rule is extracted and used to train a classifier to perform binary classification as *melanoma* or *benign*. It describes the dermoscopy image by a set of global features and uses a classifier to discriminate melanomas from non melanoma lesions [see Figure. 2]. This system uses a training set of images that are labeled by expert the classifier uses to detect the melanoma lesions.

The second system uses local features. This system uses a Bag of Features approach [see Figure. 3] [5 - 6]. In this system, the system takes the dermoscopic image of skin lesion as input. The lesion is segmented using an automatic segmentation method. Select a set of key points from the lesion region of dermoscopic image. Then, each key point is characterized by a vector of local features. This feature vector represents color and texture features in a local patch centered at the key point. As the number of key points and local features varies from image to image, we cannot directly feed a classifier with these data. Instead of that, all local features associated with all the training images are gathered and used

to compute a smaller set of prototypes denoted as *visual words*. Then, the local features of dermoscopy image are assigned to the nearest visual word, and a histogram is computed. The histogram counts the number of times each visual word was selected. A statistical classifier is then trained to discriminate melanoma lesions from non melanoma ones, using the histogram of visual words as input [3].

In both systems, there is one assumption that the dermoscopy image is segmented and that the skin lesion region is separated from healthy skin.

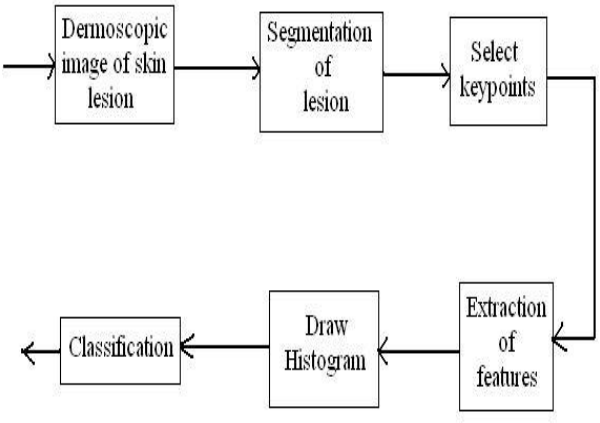

Figure 3: Melanoma detection system using local features

V. CONCLUSION

This paper tries to determine whether global or local method performs best in melanoma detection. Its difficult to say that one is better then the other. Global method is considered best if a skin lesion is homogeneous as it is able to describe the lesion by a set of global features that use all the available information. But skin lesions mostly have differential structures (typical pigment network, blue-whitish veil, typical vascular pattern, irregular streaks, irregular dots/globules, irregular blotches) and colors that are localized and appear in specific regions, these structures may not be determined using global features. Hence, local methods may represent them better.

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