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SKIN LESION CLASSIFICATION USING LOW LEVEL INTUITIVE FEATURES(LLIFs)

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ABSTRACT

This paper explains a new method for classifying the skin lesion as the benign or malignant melanoma. These lesion images are captured using standard consumer grade cameras and our new method can also be used by the non specialist in the telemedicine. Each images undergoes a sequence of steps namely (1) Preprocessing where the illumination effects in the images are reduced (2) the lesion part of the image is segmented, (3) feature extraction where the various quantitative features are generated using the segmented lesion image, (4) classification which provide an estimation of whether the lesion is benign or otherwise malignant melanoma. This new method was tested on two publicly available databases of skin lesion images where the classification accuracy is 96.71% which is better than the accuracy of other comparable methods that are available in the literature.

KEYWORDS: Malignant melanoma, feature extraction, skin lesion, consumer grade cameras, classification.

1. INTRODUCTION

Skin lesion can occur anywhere in various parts of the body which may occur on soft tissue or on bone matters though it is most frequently found in mouth, skin and brain. Lesions can be classified based on their features [1]. The skin lesion is caused by tumour means then it is either benign or melanoma.



Figure 1. Difference between the benign and the malignant melanoma which is represented in the image.

The features of lesion include the shape, size, space and so on. Based on these features the skin lesion can be classified. Skin lesions are caused mainly by any process that damages the tissues [1]. Skin lesion includes macule where the skin color is different from the normal skin, nodules where the size of the nodule is greater than 0.5cm in diameter but less than 2cm, tumour is one of the skin lesion whose size is greater than 2cm. Tumour is the general term that can be used to represent the mass, benign, melanoma and sometimes the large nodules [2]. Basically skin lesion are of three different types like primary, secondary and special skin lesions.

Melanoma is the dangerous form of skin cancer. Melanoma is considered as one kind of skin

cancer which is developed from the melanocytes. The main cause for the occurrence of melanoma is UV exposure in those with the low levels of skin pigments. About 25% developed from moles, a history of affected family members and so on[3]. Melanoma can be diagnosed by biopsy and surgery. Melanoma can be prevented by avoiding UV light and also by the use of sunscreen. In 2012 it occurred in 232,000 people globally. Melanoma occurs more commonly in men than in women's [3].

The melanoma skin cancer was diagnosed in the year of 2015 is totally 12,960 where 7,640 for men's whereas it is 5,320 for women's. The number of deaths occurred due to melanoma in the year of 2015 was 1,675 where number of death is 1,160 for men's women's is 515[4]. In the year of 2016 the occurrence of melanoma was increased to 76,380 combining both sexes in the American cancer society. The risk of getting melanoma is about 2.4% (1 in 40) for whites, whereas for black it is 0.1% (1 in 1000) and for Hispanics it is 0.5% (1 in 200)[5].

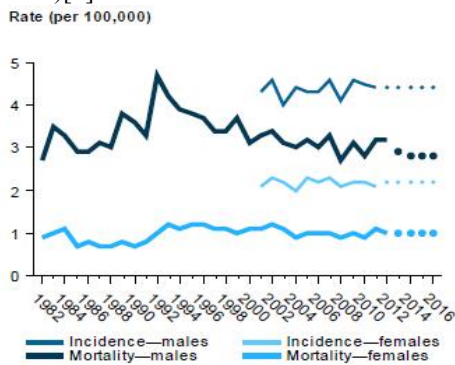


Figure 2. Statistics of melanoma till the year 2016.

Early diagnosis of the skin lesion has been studied using telemedicine techniques. The teledermatology consultation brings various advantages like easier access to health care centres and also includes faster clinical results. When comparing with the face to face diagnosis and remote diagnosis, the teledermatology is very effective and reliable [6]. Dermatology often uses the dermatoscope to analyse each lesion in order to distinguish between benign or malignant melanoma.

This paper explains a new preprocessing method using consumer grade cameras images and a new technology to reduce the illumination effect in the image and the analysis of melanoma can be done easily by the non specialist also In our experiments we collected 206 images of skin lesion that are obtained using standard consumer grade camera. These images are obtained from the two online public databases.

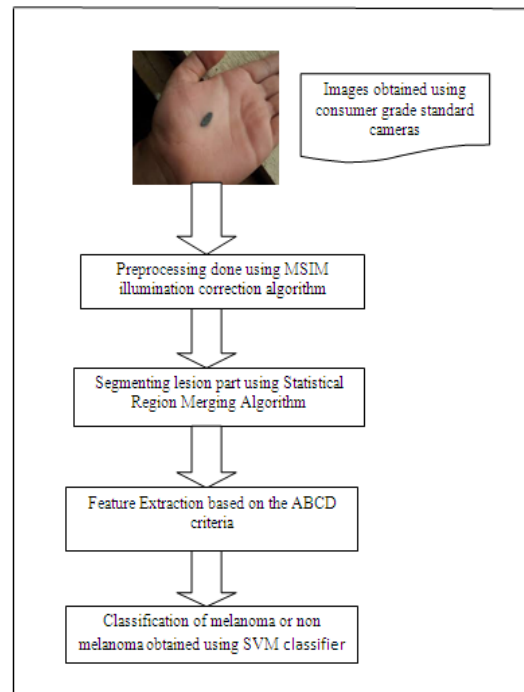


Figure 2. The overall system architecture which describe the steps in this paper in more precise manner.

Each one of these images undergoes a sequence of steps namely (1) Preprocessing, where the illumination effects in the images are reduced, by a new illumination correction algorithm is discussed in the section 2; (2) Segmentation where the Statistical Region Merging (SRM) algorithm is proposed to differentiate between lesion and healthy part of the skin which is discussed in the section 3. (3) Feature Extraction, where the lesion containing new features in the 3 channel representation is described in the section 4. (4) Lesion classification (using SVM classifier), These sequence of steps are done to reduce the number of false negative while classifying the melanoma or non melanoma where the classification accuracy is 94.54% are described in section 5, whereas in section 6 experimental results are discussed.

2. PREPROCESSING

As discussed before, an input image captured using standard consumer grade camera may be affected by illumination effect means if it is used directly in the segmentation step means there may arise confusion in segmenting the lesion part from the healthy skin. So the illumination effect is reduced in the input image before segmenting an image. The multistage illumination modelling (MSIM) algorithm to correct the illumination changes in the skin lesion photographs which are captured using standard consumer grade cameras [7]. The MSIM algorithm has three stages whereas in the First stage based on the Monte Carlo sampling the non parametric modelling approach an illumination map is estimated. In the second

stage, the final estimated illumination map is found using the parametric approach whereas an illumination effect is reduced [7].

3. SKIN LESION SEGMENTATION

The lesion part of the image was manually segmented to provide a better segmentation. The performance of feature extraction which is different from automatic segmentations accuracy [8]. We provide the images rotation and scale invariant by performing the above mentioned preprocessing step that is prior to the feature extraction.

4. FEATURE EXTRACTION

We extract a set of features to differentiate between benign and malignant skin lesion. Based on the ABCD rule the local characteristics from the lesion area were calculated [9]. The ABCD rule has four main criteria, namely asymmetry, border, color and diameter. This ABCD rule was mainly used by the dermatology for the purpose of detection of melanoma.

The feature that is based on the asymmetry characteristics is that to quantify the shape of the lesion, where the asymmetry of the lesion is parallel to the principal axis of the lesion. The shape of the lesion has the major axis L1 having the longest diameter is passing through the centre, whereas the minor axis of the lesion L2 is orthogonal to L1 and also passing through the centre of the lesion [9]. The features are

F1: Solidity – ratio between lesion area (LA) and its convex hull area [10]

F2: Extent – ratio between lesion area (LA) and its bounding box area [10]

F3: Equivalent Diameter - $4LA/L1\pi$

F4: Circularity - $4LA/L1p$, where p is the perimeter of the lesion

F5: ratio between the principal axes (L2/L1) [10, 11]

F6: ratio between the sides of the lesion bounding box [10]

F7: ratio between the perimeter of the lesion (p) and the area of the lesion (LA) [12]

F8: ratio between differences of area in each side of the major axis L1 i.e. $(b1 - b2)/LA$

F9: as same as F8, but it uses the minor axis L2.

F10: In the major axis L1, finding the ratio of $B1/B2$

F11: as same as F10, by using the shorter axis L2.

There are some features based on the lesion boundary characteristics which are mentioned below. The sharpness of the boundary is determined by taking the magnitude of the gradient |gd| at each pixel in the image by using the sobel

operator. Instead of using the pixels at the lesion rim we used the pixels at the extended rim [10]. The lesions that are having boundary can be easily characterised. The lesions having the irregular border, we have the following features.

F12 – F14: In the skin lesion extended rim [10] the average gradient magnitude of the pixel is taken in each of the three I_n channels.

F15 – F17: In the skin lesion extended rim [10] the variance of the gradient magnitude of the pixel is taken in each of the three I_n channels.

The rim of the lesion irregularity can be characterised by the ABCD rule by diving rim into 8 symmetric regions $R=1 \dots 8$ [13]. For each channel I_n , the average gradient magnitudes of the extended rim pixel $U_{R,i}(R = 1, \dots, 8)$ can be calculated. Hence we calculate other 6 features.

F18 – F20: In each of the three I_n channels, an average of the 8 $U_{R,i}$ values are calculated.

F21 – F23: In each of the three I_n channels, the variance of the 8 $U_{R,i}$ values are calculated.

There are some features which are used for characterization of the lesion color variation, whereas the main goal is to quantify the lesion color variation. The features are

F24 – F27: In the color variation channel I_{c3} channel, the maximum, minimum, mean and variance of the pixels inside the skin lesion segment can be calculated.

F28 – F39: In each of the three original I_c channels, the maximum (F28 – F30), minimum (F31 – F33), mean (F34 – F36) and the variance (F37 – F39) of the pixel intensities inside the skin lesion segment can be calculated.

F40 – F42: Considering only the pixels inside the skin lesion segment, the ratios between mean values of three original I_c channels, whereas the mean (I_{c1})/ mean (I_{c2}), mean (I_{c1})/ mean (I_{c3}) and mean (I_{c2})/ mean(I_{c3}) can be calculated.

Lesions containing more of the white, red, blue gray, light and dark browns and black hues are more likely to be malignant. Given a pixel in the segmented lesion, we can calculate the nearest reference color by using the Euclidean distance of the pixel in the original I_c channels. Finally the additional features F43 – F48 are calculated by taking the ratio between the typical hue counters normalized to the lesion area (LA) [14].

There are some features used for characterization of the lesion differential structures which are referred to the vascular structures and sub macroscopic morphology that can be visible only in dermoscopic images. There are the 4 texture features (F49 – F52) found using

macroscopic images, namely maximum, minimum, mean and variance of intensities of the pixels inside the skin lesion segment in the I_n is calculated [14].

5. LESSION CLASSIFICATION

To classify whether the given lesion is benign or malignant melanoma we use the SVM classifier. SVM is a supervised learning given a set of training examples, where each marked for belonging to one or two categories i.e. the benign (non melanoma) or malignant melanoma. SVM classifier is used because it is easy to use and often has good generalization performance. To give special importance to the degree of linear separability of the data in the feature space rather than the performance of the complex classifier the linear kernel is used [15]. LIBSVM has been used for our experiments [16], the LIBSVM is an integrated software that is used for support vector machine classification. LIBSVM is the one which supports multi class classification, provides a simple interface where users can interact with their own programs. With the help of LIBSVM the parameters are optimized in order to find the accurate SVM hyper plane.

6. EXPERIMENTAL RESULTS

This section presents experimental results with two datasets of 100 images of skin lesion, which were obtained using standard consumer-grade cameras. These images were extracted from the online public databases such as Dermatology Information System and DermQuest. Of these 100 images, 50 are melanomas, and 50 are not melanoma. Each image contains a single lesion that occurs at the center of the image and the healthy part of the skin is expected in the four corners [17].

- a) **Experimental Setup:-**An input image which contain the lesion at the center was given as the input to the first module preprocessing.
- i. **Preprocessing:-** The Multistage Illumination Modeling (MSIM) [7] i.e. the skin illumination correction algorithm is mainly used in this module in order to reduce the illumination effects in the input image. Then the image is segmented using the Statistical Region Merging (SRM) algorithm in order to get the over segment of the particular input lesion image.


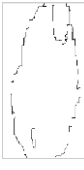
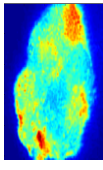
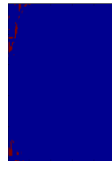



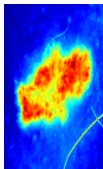
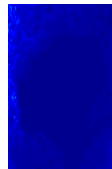



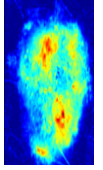
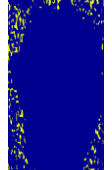
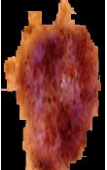
Input Image	SRM used in the MSIM algm	Illuminati on map obtained using MSIM algm	Reflecta nce map obtained using MSIM algm	Segmented image after applying preprocess ing
				
				
				

Table1 : containing an input image, the SRM algorithm has been used for segmentation in the steps of MSIM algorithm, using MSIM algorithm an illumination and reflectance map of an input image is obtained and finally the lesion part of image is segmented.

- ii. **Segmentation :-** An image that is used for the detection of melanoma was captured using standard digital cameras. The lesion part of the image is usually occurs at the center part of the image. The lesion part of the image is segmented in order to extract the features. The segmented lesion part of the image is represented in the table.
- iii. **Feature Extraction:-** Followed by the illumination correction, the proposed system LLIFs presented in Section 4 were extracted which uses the ABCD criteria using standard camera images of pigmented skin lesions.

S_L —set of 52 LLFs describing ABCD [14].

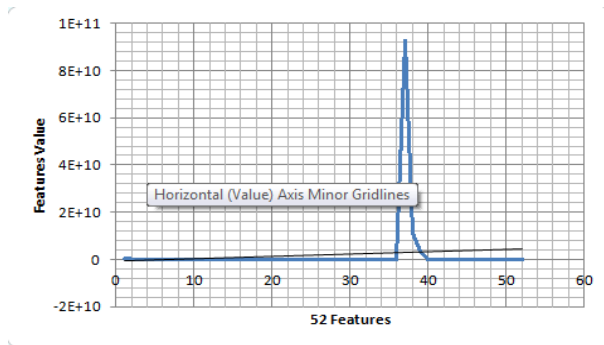


Fig 3: 52 LLIFs features are extracted based on the ABCD criteria. The above graph represents the occurrence of melanoma and the feature having the highest value.

iv. **Classification:-** In this module the SVM classifier is used in order to classify whether there is an occurrence of malignant melanoma or benign (non melanoma) by using the images captured using standard cameras. The support vectors are the data points that are close to the hyper plane. The support vectors are the data points that are most difficult to classify. The support vector machines finds an optimal solution. The experimental results while classifying the malignant melanoma or benign is represented in diagram given below.

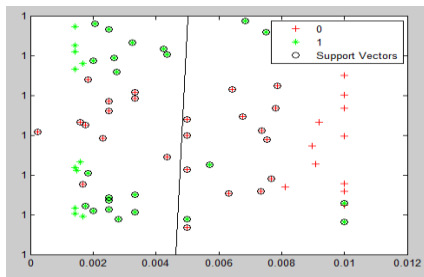


Fig 4 : The support vector is the one which is near to the hyper plane margin, the red and green colour which is used to classify the occurrence of melanoma and non melanoma.

The confusion matrix is the table that is often used to describe the performance of the classification model on a set of test data for which the true values are known. The confusion matrix is the one that is used to calculate the precision, recall, sensitivity and accuracy of a particular image in the database in order to classify whether the given image contains malignant melanoma or benign (non melanoma).

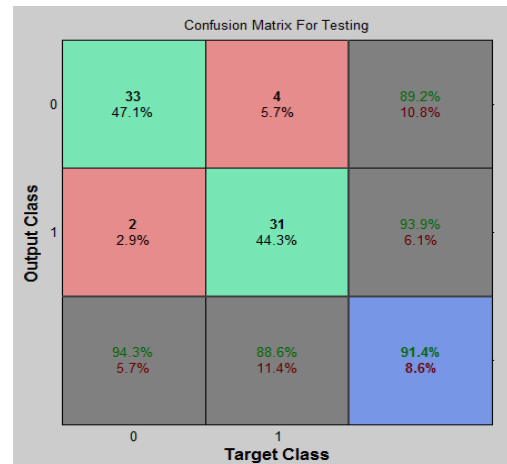


Fig 5: The confusion matrix obtained while testing a particular image, where the database are trained using 70 images from which the precision, accuracy, recall and sensitivity of an image can be calculated.

7. CONCLUSION

This paper presented a new method for classifying benign or malignant melanoma. It is assumed that the lesion part of the image occurs at the center part and the healthy part of the skin is placed in the four connected graph, where the image is captured using standard digital camera.

In this paper, new technique to reduce the illumination effect and analysis of skin images were proposed such as (1) MSIM skin illumination correction algorithm is used in order to reduce the illumination effect and the segmentation is done to segment the lesion part of the skin. (2) 52 LLIFs features has been extracted to facilitate the lesion rim detection, (3) the SVM classifier is used to classify the lesion pigment as the malignant melanoma or benign.

The experimental results that our proposed approach can achieve better classification results than the comparable methods discussed in the literature. The classification accuracy of our proposed method is 96.71% [14] by using some images in the dataset.

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