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MELANOMA DETECTION USING DEEP LEARNING AND ABCD RULE

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ABSTRACT

Catching cancer early often allows for more treatment options. This paper proposes a systematic method for the early detection of melanoma skin cancer, which is considered to be one of the perilous diseases that facilely spread across the body. Early detection of melanoma through precise techniques can reduce the mortality rate. This paper gives two methods for the detection of the melanoma for the same input images. The proposed method different stages include classifier for detection such as benign or malignant. The boundary identification is applied with Otsu's method and implemented into the system with the help of MATLAB tool. The proposed method detects whether the lesion is in benign stage or malignant stage. The outcome of this project will provide a precise result against the subsisting system.

KEYWORDS: Detection, Melanoma, Skin cancer, Lesion, Deep learning, Stages.

I. INTRODUCTION

Skin cancer is the most dangerous type of cancer. It is the uncontrolled increase or growth of skin cells. It occurs mainly due to ultraviolet radiations from the sunlight or tanning beds. It's often caused by the genetic defects which results in skin cells to multiply rapidly and form hazardous tumors. Fair skinned individuals and the persons with blue ocular perceivers and red hair are sensitive to this disease. The quandary is more in the areas near the equator or areas of higher elevation where sunlight exposure is more. The people who have the history of a skin cancer have a chance of 20% for the development of second skin cancer. According to the study of American cancer society, rates of melanoma have been increasing for last thirty years. The recent studies show that one person dies of melanoma every hour (every 54 minutes). Melanoma can be classified as two such as malignant melanoma and benign melanoma. The most hazardous form of melanoma is malignant melanoma. Benign melanoma can identified earlier and can be remedied facilely.

Mainly skin cancer can be classified into three types such as Basal cell carcinomia, Melanoma and Squamous cell carcinomia. The squamous cell carcinomia and basal cell carcinomia are called as non-melanoma cancers. These cancer cells always respond to the treatment given and remotely spread to other skin cells. Melanoma is the most hazardous form of skin cancer. It often appears as skin to moles and some develop from moles. If melanoma is detected and treated early, it is always curable. If it is not detected in the commencement stage, it will infect the neighbor cells. This cancer can spread to other body parts. So it is very consequential to detect melanoma in its early stage.. In 2017, an estimated 87,110 incipient cases of invasive melanoma diagnosed in the U.S. and 9,730 people will die of melanoma. Melanomas can develop anywhere on the skin. Early detection is one of the paramount things that could preserve life.

II. RELATED WORKS

Skin The ABCD rule based method for detection of melanoma is an important method used for detection. The preprocessing stage is done with gabor filter. Geodesic active contour method is used for segmentation. ABCD rule based calculation for feature extraction and final classification is based on the TDS algorithm [1].The comparison between two types of method used for automated melanoma recognition system. The first method

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shows combinations of texture and color features are used for detection of the melanoma. Texture feature such as Local Binary Patterns (LPB) and color feature such as standard HSV histograms are used. The next method used will be a combination of deep learning and support vector machine algorithms for the detection of melanoma. Combination of deep learning features with hand crafted features will be a good solution for the melanoma detection [2]. The comparison of different types of methods used for segmentation stage and classification stage are explained [3]. The convolutional neural network based method is used for identifying the melanoma. Even though it has high performance with the utilizing deep learning, the method misclassifies some benign moles [4].
The detection of malignant melanoma lesions in dermoscopic images is by applying automatic diagnostic tools. This can decrease the deadlines from melanoma. Also, based on dermoscopic images characterize a fully-automated algorithm for the skin lesion. The proposed way is highly definite when discussing with benign skin lesions, while the efficiency is reduced when malignant melanoma images are distributed. This distinct action turns to study geometrical and color features derived from the output of this method for separating malignant melanoma images, and attain better results [5].From all the existing distribution algorithms, border extraction algorithm calculates the performance by correlate with others. Automatic border extraction is one of the challenging demands in cancer images. Differentiating a digital image into more than one part is called Segmentation. In a case of malignant melanoma detection, segmentation is considered as the first step such as distributing the image into multiple parts or regions. Segmentation is considered as the difficult effort in image processing. To take out the stain of the damaged lesion from the healthy skin, segmentation is mainly used [6].Deep learning based method is used for the segmentation stage which has very high accuracy rate [7].

III. PROPOSED METHOD

The block diagram of the proposed method is shown in the Fig. 1.Here we are using two methods for detection of melanoma from the same input images. The first method is deep learning based method and the second one is ABCD rule based method. These are explained in the following sub sections.

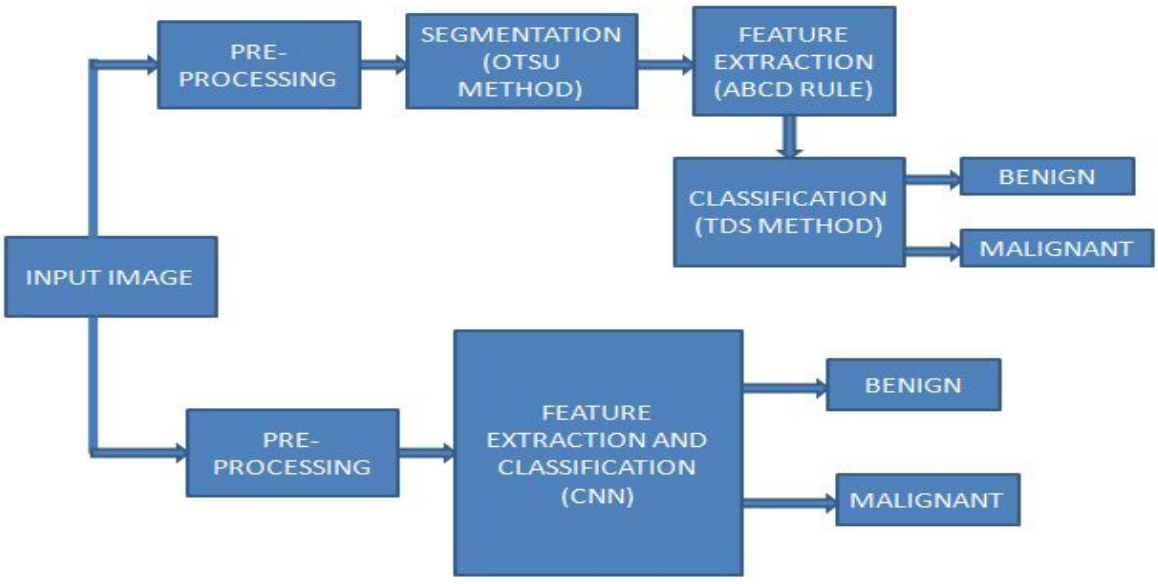

Fig1: Block Diagram

Deep learning based detection:
In this method, convolutional neural network is used for the detection and classification from the input images.

Pre-processing
Pre-processing is used to smooth the input image. This stage will remove the un-wanted artifacts, noises and light reflection from the input image. The image resizing, cropping is completed during this stage.

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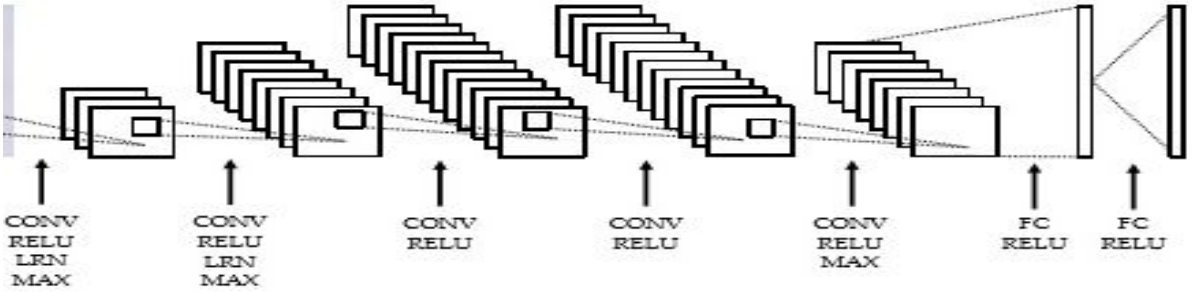
Fig.2: CNN architecture

Feature Extraction and Classification

Last stage of the proposed method is feature extraction. This stage will collect all the features and parameters of



the skin lesion. This features are further required for the classification stage to detect accurately. Here deep learning based architecture is used for learning about the different parameters. The CNN architecture is used having five convolutional layers and three fully connected layers. Each convolutional layer is followed by an activation layer called rectified linear output (RELU).There is another layer called local response normalization which follows the first two convolutional layers. The proposed CNN architecture has maxpooling layers after first two convolutional layers and after the fifth convolutional layer. The CNN architecture is shown in Fig. 2. The last and final stage of melanoma detection is classification. For this purpose, adding a final classificaton layer into CNN as a last layer. This classifier layer will classify the lesions as bengin and malignant. The classification is done with the features collected by the CNN. Mainly two type's inputs are given to CNN such as train set and test set. However increase in the number of images will result in the accuracy of the proposed system.

ABCD rule based detection:

Here first the image is pre-processed followed by segmentation. The feature extraction is done with ABCD rule. Finally the TDS score will give the classified output.

Pre-processing

The input image is resized at first. The input image is shown in Fig.3.Then the rgb image is converted into grayscale image. It is shown in Fig.4. Then using median filter small noises are filtered out. Image smoothening is done with the help of Gaussian filter. The final image is shown in the Fig.5.

Fig. 3: Input image

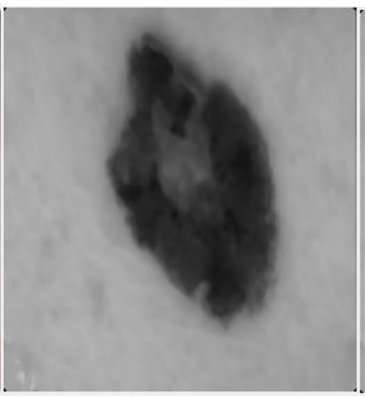


Fig. 4: Gray scale

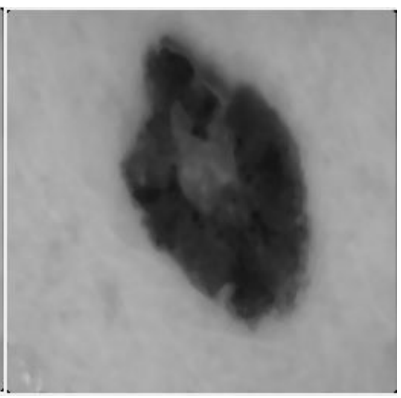


Fig.5: Smoothened image

Segmentation

Image segmentation is the one of important step in image analysis, since it affects the accuracy of the entire system. The lesion with irregular shape is tough to identify the boundary. Hence different algorithms are present. In our proposed method image is segmented using Otsu's segmentation method. This method is fully

unsupervised type method ie, no need of user for changing parameters. The output of segmentation stage with the boundary is shown in Fig.6.

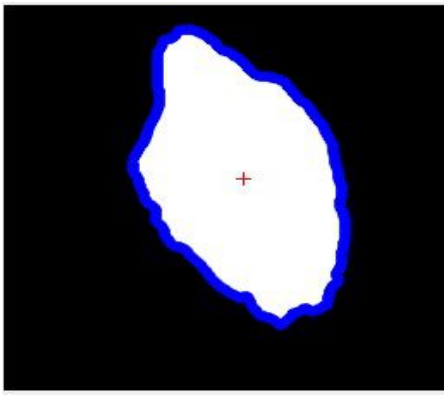


Fig6: Contour

Feature Extraction

ABCD rule based is used for feature extraction. The feature A indicates Asymmetry, B indicates Border, C indicates Colour and D indicates Different structures.

1) Asymmetry

To find the asymmetry first we need to find out the horizontal and vertical axes and centroid is plotted. The asymmetry need to be completed with the following three types of asymmetry.

- Colour asymmetry: The image is subdivided into blocks of size 20*20 pixels. Next image is converted into L*a*b system. Now euclidean distance is calculated between two pixels in the opposite blocks. The equation 1 used for the calculating the Euclidean distance. The JND (Just Noticable Distance) value is used as threshold to differentiate the colors. We take the threshold value as 6.If JND value is less than six, then the block pair is said to be color symmetric. The result is checked along horizontal and vertical axis. Finally if along any axis, the number of blocks which are color symmetric is greater than color asymmetrical blocks , the image is said to be color symmetric.
  $\Delta E=$ (1)
- Brightness asymmetry: The brightness asymmetry is measured with the difference between the average luminance values between two opposite halves. The threshold value is set to 3% of the average luminance value. For one axis, if the asymmetry value is less than threshold the image is said to be brightness symmetric.
- Shape asymmetry: The value is calculated by the difference between the lesion areas above and below the axis. The threshold value is taken as 2% of the total area. For one axis, if the asymmetry value is less than threshold, the image is said to be shape asymmetric.

2) Border

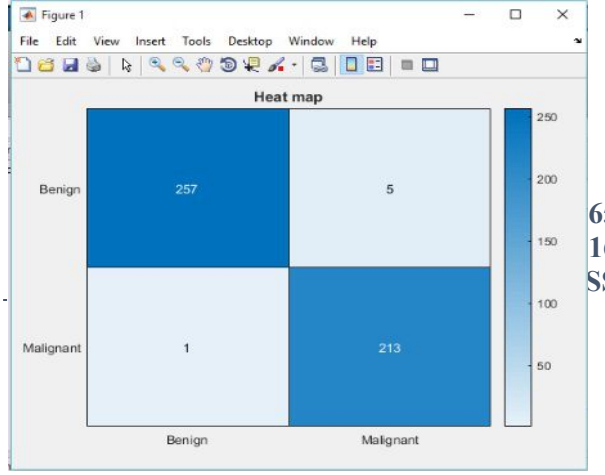
Here the image is subdivided into eight slices. Then sub-contour of each slice is obtained using bounding box function. For each sub-contour score is calculated. For an irregular sub contour score is given as one. The final score is taken between zero to eight.

3) Colour

According to the ABCD rule, six suspicious colours (white, black, red, light-brown, dark-brown and blue-grey) are likely to be melanomas. Then normalized Euclidean distances between each pixel of the lesion and six suspicious colours are calculated. Threshold value is set to 0.4.If the distance is less than threshold value, then the pixel is belongs to the given colour. If the number of pixels belonging to the colour exceeds by 5% of the total number of the pixel, then colour suspicious for melanoma occurs.

4) Different structure

- Pigment network: The lesion is divided into sub-blocks of size 20*20.Pigment network is identified using L and E masks.
- Blue-white veil: The blue-white veil is detected using chromaticity coordinates F3 and F10.
- Geometrical Properties: There are four lesion shape features are measured. They are Fractional dimension, asymmetry index, circularity and elasticity.



Classification

The classification is used to classify whether the lesion as benign stage or malignant stage. Here Total Dermoscopic Score (TDS) method is used for classification. If the score is low (TDS<4.5) then it is benign and if the score is high (TDS>5.45), then it is malignant. The equation used for TDS calculation is shown below.

TDS=A*1.3+B*0.1+C*0.5+D*0.5 (2)

IV. RESULTS AND DISCUSSION

The output of the convolutional neural network can be shown in the confusion matrix. The confusion matrix is displayed as heatmap. The three parameters such as specificity, sensitivity and accuracy can be calculated from the confusion matrix. The training accuracy plot of cnn is shown in the below Fig.7and the confusion matrix is shown in the Fig.8.

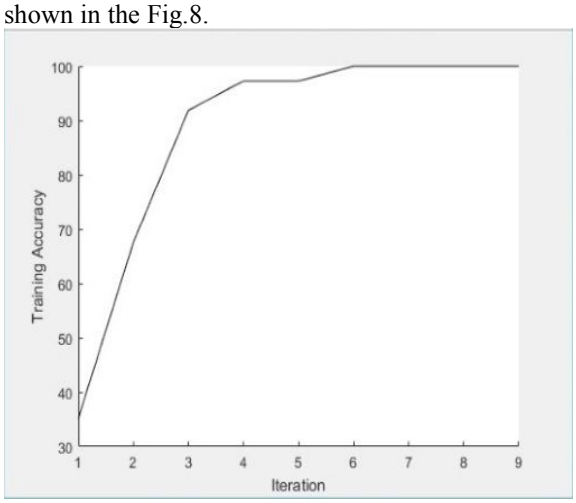


Fig.7: Analysis of CNN

Fig.8: Confusion Matrix

The training accuracy of the cnn increases with the increase in the number of iterations. The method requires NVDIA system with 2 GB GPU and MATLAB 2017a. From the Fig.8 the following three parameters are calculated using the equations given below.

Specificity= (3)

Sensitivity= (4)

Sensitivity= (5)

The table.1 below shows the comparison of parameters of two methods. Deep learning based method shows high accuracy compared to the ABCD rule. But both of the method misclassified some lesions. By increasing the number of training images the accuracy of the CNN can be increased.

Table 1. Comparison table for two methods

Name	Accuracy(%)	Specificity(%)	Sensitivity(%)
Deep Learning based method	98.7	98.0	99.5
ABCD rule based method	96.75	96.0	97.5

V. CONCLUSION

In this paper, we present deep learning based system to identify the melanoma. In this proposed method, image processing methods are used along with deep learning technique to distinguish malignant melanoma from the benign skin lesions. It proposed ABCD based method, pre-processing stage to diminish noise (bubbles and thin hair). The segmentation stage is based on Otsu's method which detects the contour or boundary. ABCD rule is used in feature extraction and TDS score will classify the lesions. The proposed second method is deep learning based method, which comprises of feature extraction stage based on CNN architecture. CNN will classify the

properly as benign and malignant. Both methods are highly accurate ones. These methods are very much applicable to the dermatologist in detecting melanoma at its early stage.

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