Sundeep.P.S, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 10, Issue 6, (Series-V) June 2020, pp. 32-38

RESEARCH ARTICLE OPEN ACCESS

Expert System for Diagnosis of Skin lesion using Android Application with Tensor Flow API

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ABSTRACT
Melanoma is one of the most unpredictable and difficult environments to diagnose due to its complexity. It becomes important to identify these diseases at their initial stage to control it from spreading. Traditional approaches for early detection of melanoma by dermatologist to manually measure a skin lesion using the ABCDE (Asymmetry, Border-irregularity, Color variation, Diameter, Evolution) conditions before confirmation can be done through biopsy or pathologist. The main objective of the project is to identify various skin ROI (Region of Interest) at their initial stage whether its melanoma or non-melanoma to treat it very easily. In this project authors proposed an early detection of skin melanoma using Android application and image processing technique by android Studio software and openCV library in Tenser Flow object Detection using API. To evaluate the detection performance, the detection process has been achieved using two different datasets on a real-time mobile application of Android camera, and Tensor Flow Object Detection Application Program Interface (API). Experimental results reach 96.3% of detection accuracy for Benign and 89.2% accuracy for malignant dataset. The experiments have been executed on windows 7 with Google Colab, OS configuration with API level 23. The result and discussion is more reliable when the lesion of skin cancer images are geographically distinct.

Keywords - : Melanoma, Skin lesion, openCV library, Tensor Flow object detection using API, Android.

Date of Submission: 01-06-2020 Date of Acceptance: 16-06-2020

I. INTRODUCTION

Skin cancer is the most common form of cancer, with more than 3. Million cases affecting more than two million people each year, according to the skin cancer foundation. Early detection of skin cancer leads to 5-year survival rate for patients in the US. The survival rate drops to 63% if the disease reaches the lymph nodes and 20% if it spreads to distant organs [1]. Skin cancer organize a lesser but important quantity of patients with cancer. Even though the presence of eumelanin in dark skin is protective against the growth of skin cancer, it is gradually being diagnosed in the Indian population [4]. There are two main types of skin cancer: melanoma and non-melanoma.

The most common non-melanoma tumors are basal cell carcinoma and squamous cell carcinoma. In India, skin cancers constitute about 1-2% of all diagnosed cancers. Basal cell carcinoma is the commonest form of skin cancer worldwide [14, 7], but various studies from India have consistently reported SCC as the most prevalent skin malignancy.

Figure 1: Types of skin cancer

In primary skin cancer, diagnosed is usually by a visual examination. If a suspicious spot is found, the area, size, shape, color and texture, as well as any bleeding or scaling. Lymph nodes to see whether they are enlarged. The two most common types of tests used in diagnosing skin cancer are biopsies and imaging tests. Primary stage detection of melanoma needs computer aided detection, in order to assist dermatology, produce the right diagnosis and treatment.

Generally, dermatology use biopsy method for examination to diagnosis presence of skin cancer. Skin biopsies at early stage are necessary to identify Melanoma. Biopsy is a procedure to removal or scrapping off the skin. Then this skin samples are undergone various laboratory test. Thus, this process is time consuming and painful. It may cause rise of medical costs for doing skin biopsies unnecessary. Nowadays, medical field depends more on computer-aided diagnosis [15,16,17,18]. This is the great option to distinguish melanoma without increasing the number of biopsies. Computer-aided diagnosis tool will help to increase the diagnosis accuracy as well as the speed, by applying Image Processing techniques. Therefore, automatic diagnosis tool is necessary for dermatologist.

1.1 Contribution:

In this journal, we propose an Android Application for melanoma using ABCDE Rule based on mobile device. The detection using an Android camera to take lesion image and process it too. The Accuracy of weighted score yields under the total dermoscopic score or TDS basics. Basically Diagnosed tool is able to extract various features of skin lesion such as color, types of dots, pigmentation, size of mole, deficiency details, multiple lesion details, area which is selected for cropping etc. However input to the diagnoses tools are skin lesion images only. After analysis of the various skin lesion which is given as an input, lesion are classified under the category of Melanoma or non-melanoma. The basics steps in processing skin lesion image for diagnosis of melanoma are pre-processing, image segmentation, feature extraction and classification of skin lesion. In the following section we discuss detailed each step and methods involved in skin cancer diagnosis.

II. ABCDE RULE FOR MELANOMA

The lesion identification of various skin area based on basics skin cancer features. The proposed work is based on the feature extraction of ABCD rules include Asymmetric, Border thickness, Color of the mole, Diameter of the mole and Evolution of the symptom. Back propagation neural network is used as classifier. Melanoma is the most dangerous skin cancer. Reduction of the cost rather than ordinary system and spend less time to detect cancer. In this frame work, an automated melanoma prescreening system is proposed to diagnose melanoma skin cancer using modified TDLS algorithm and Support Vector Machine (SVM) [3] is used for classification. Segmentation of skin lesion from the surrounding skin in the dermoscopic images by using Neural Network segmentation algorithm. Different segmentation techniques were applied to the dermoscopic images to segment the skin lesions and evaluated with 3 different metrics, namely sensitivity, accuracy and border error.

Segmentation [6] performance shows that Neural Network based lesion segmentation has high sensitivity, accuracy and less border error. For better performance in the classification step, in addition to the smartphone, a computer was also used. This application is user-friendly and the calculated Accuracy, Sensitivity, and Specificity are 95%, 98%, and 92.19% on average, respectively. It should be noted that these results are more reliable when the lesions are geometrically distinct [10].A simple algorithm is used to detect the skin cancer.

Detecting melanoma using ABCD rule which is including in the methods of dermoscopic and using STOLZ Algorithm to given weight in detection. The result of this application shown value TDS and classification hypothesis suspected melanoma or normal mole from cameras smartphone used [2]. Another method extends the ABCD rule to incorporate the evolution of the lesion (E parameter) by adding the patient's description of lesion change (e.g., enlargement, elevation, and color change) [13, 9]. Although the ABCDE rule has been validated in clinical practice, no randomized clinical trials have shown that there is an improvement in the early detection of melanoma [13].

In addition, image acquisition methods have also been developed to differentiate the amount of light absorbed, transmitted, or backscattered by the melanin content of the lesion. A technique for early detection skin cancer problem is proposed. The diagnosing methodology use Digital Image Processing Techniques and Artificial Neural Networks for the classification of Malignant Melanoma from other skin diseases. Dermoscopic images were collected and they are processed by various Image processing techniques. The cancerous region is separated from healthy skin by the method of segmentation. There are several problems like accuracy in the existing works. In this frame work are used to get better accuracy than others.

III. METHODOLOGY

The environment will build by using the Android camera, OpenCV tensor Flow API and, ABCDE Rule. Fig 2 show the basis steps to diagnoses the skin cancer.

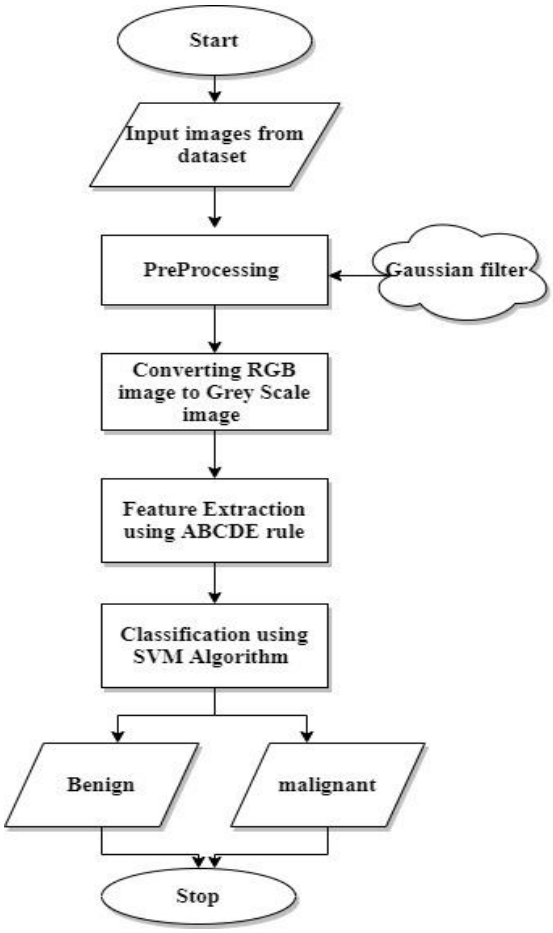

Figure 2: Skin Cancer diagnosis basic steps using Image processing in Android application using Tensor Flow API.

Android camera is an important communication device for this system to upload various skin lesion image from dataset. Preprocessing to make lesion only ROI (Region of Interest) from the skin lesion. The largest active contours it finds major spot on the image and removes the small spot. So only lesion will be processed. The result from the largest spot can be automatically crop only lesion skin so remove the entire area not used on the lesion. The main feature is ABCDE rule which is Asymmetry (A), Border (B), Color(C), and Diameter (D), Evolution (E). This part is important to determine the suspected melanoma.

1.1 Image database:

The accuracy of the proposed system is based on the skin lesion images from international skin imaging collaboration ("ISIC Archives", 2016).Specially ISIC 2016 dataset consists of 900 images with ground truth segmentation. The database is generated by collecting images with known category (Benign/Melanoma). These websites are specified for melanoma skin cancer.

1.2 Preprocessing:

Preprocessing is the basic step in medical image processing to improve the quality of the digital image. Initially, the quality of skin images had to be enhance by filtered to remove unwanted hairs, air bubbles, ebony frames and reduce noises. This noises may cause inaccuracies in classification process [8]. Fig 3 shows remove of unwanted hair using morphological methods, curvilinear structure detection, dull razor software, etc. This is to avoid misclassification.

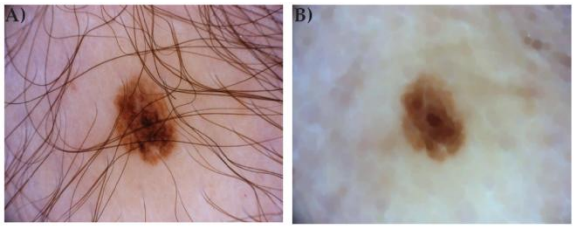

Figure 3: (A) Original skin lesion image from ISIC dataset. (B) Preprocessing image after the hair removal From ISIC16 dataset.

Gaussian filter is used to apply smooth our images more and make it easier to process. The equation of the Gaussian filter for two dimension is:

$$G(x, y) = \frac{1}{2\pi\sigma^{2e}} \frac{x2+y2}{2\sigma^2} \quad (1)$$

Where x is the distance from the origin in the horizontal axis, y is the distance from the origin in the vertical axis and σ is the standard deviation (sigma) of the Gaussian distribution. In proposed algorithm, the Gaussian function is applied to 15 x 15 pixels with sigma set of three pixels. The Gaussian filter sets each pixel to the weighted average of its neighbors, with the central pixels receiving more weight than the outermost pixels. Giving more weight to the central pixels result in gentler smoothing g than a normal weighted average. The resulting image blur removes small objects but preserve boundaries and edges.

1.3 Image Thresholding:

The pre-processing image is then color thresholding to remove all skin-like pixels. Thresholding is the process where pixels within a specific range of hue and saturation values are labeled as "not-skin", and the intersection of these two not-skin pixels masks in found. The hue and saturation (HS) color channels are instead of the RGB color channels due to inherently large variance of pixel intensity of the lesion in the RGB channels.

$$Mean = sum\,(A(i,j))/(r * c) \quad (2)$$

$$Standard\ Deviation\ SD = \sqrt{variance} \quad (3)$$

The median and standard deviation of the entire set are then computed. The median is used instead of the mean because using the median ensures that any outlier lesion pixels sampled do not affected the range of intensities calculated, so non-skin pixels mistakenly sampled do not affect the computation. The trained threshold values are then validated on the remaining 50 images in the training data. The accuracy measure is taken after connected component analysis and based on whether the correct object has been identified as the lesion. [4].

1.4 Feature Extraction using ABCDE rule:

In proposed system feature extraction is completely depend upon "ABCDE rule". Once the skin lesion infected area is identified the feature of skin has to be extracted. These features are classified as whether the lesion is melanoma or normal skin infection. Internal features are obtain by some attributes Gray Level Co-Occurrence Matrix (GLCM) [5] which the parameters like instance correlation, energy, homogeneity, mean, entropy, distribution, standard deviation. Etc. ABCD rule-based detection in 1985, to identify melanoma in the premature stages, the group from New York University designed the ABCD approach (asymmetry, Border, color variegated, diameter > 6mm). It is the easiest technique utilized for the detection of skin cancer.

i. **Asymmetry-** During this process, ABC checks the symmetry of lesion. If the value is 0 means lesion is symmetric, if the value is 2, the lesion is asymmetric and considered as cancerous.
ii. **Border Irregularity-** The border of the lesson is checked. Most of the edges of the cancerous lesion are ragged, gaps or blurred in such cases the values are lies between 0 -8.
iii. **Color:** The cancerous lesions appear in a number of colors such as white, red, light brown, dark brown, slate blue and black with value ranges from 0 – 6.

Colour	RGB Values
White	[197 188 217]
Black	[41 31 30]
Red	[118 21 17]
Light-brown	[163 82 16]
Dark-brown	[135 44 05]
Blue-gray	[113 108 139]

Figure 4: various melanoma colors

iv. **Diameter-** The diameter of cancerous lesions is more than 6mm and the values range from 0 to 5.

1.5 Classification:

Once the features have been obtained, we have had to choose what classifier to use. There are several well-known classifiers as Instance based classifiers, support vector machine (SVM), Discriminant analysis, Convention Neutral Network (CNN), Decision Tress, Logistic Regression, Ensemble Classifiers, Bayesian Network and other Classifiers. Classifier is used to classifying malignant melanoma or benign melanoma.

Today Deep learning is very popular in the modern era. Deep learning is one of the best techniques for image classification. Based on the texture features we are training the dataset for classification. Here first we are giving Extracted feature to the neural network for checking performance of image classification then we are using CNN (Convolutional Neural Network) it is one of the deep learning techniques for classification, Dermoscopic images classification is done in two categories Melanoma and Non-Melanoma, it is done by using automated extracted features by CNN images.

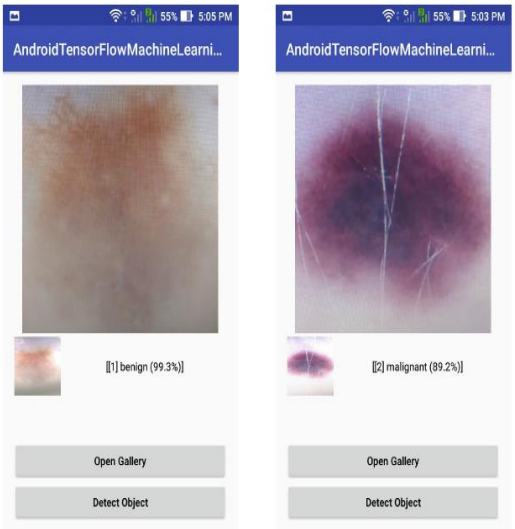

Figure 5: classification result using CNN (Melanoma Cancer)

In this step, we are passing Preprocess Images to the CNN classification. In this system, we have used resent 50 pre-trained convolution layer for training new dermoscopic images. DAG Network properties of the pre-trained network indicate, nnet.cnn.layer.Layer Layers with 192X2 connections.

IV. RESULT AND DISCUSSIONS

After obtaining the values the four criteria, the Total Dermoscopy Score is calculated based on

the following formula where each one of the presented with weighting factor.

Criteria	Score	Weight factor
1. Asymmetry(A)	0-2	1,3
2. Border(B)	0-8	0.1
3.Color(C)	1-6	0.5
4.Diameter	1-6	0.5

Table 1: Table weight each criteria on ABCD rule

Each criteria calculated using Total Dermoscopic Score (TDS).4

TDS = A * 1.3 + B * 0.1 + C *0.5 + D * 0.5 (4)

For final diagnosis result, classification is done using TDS table

Total Dermoscopic Score (TDS)	Classification
<4,75	Benign Melanocyte lesion
4,75-5,45	Suspicious lesion
5,45	Highly lesion suspicious for melanoma

Table 2: Final classification table of TDS

For this experiment we used android phone with Samsung Tab S (8 MP). The testing using a digital clinical image medical dataset from PH2 - A dermoscopic image database for research and benchmarking and International Society for Digital Imaging of the Skin with histologic diagnosis. There are 40 images for testing with detail 20 images benign and 20 melanoma. We compare from taking a picture from printed picture each android.

4.1. Testing benign dataset:

S.No	Image Name	Final Value that's satisfied TDS Score in Samsung Android Phone	Status of the skin lesion based on TDS value.
1.	*Image_1*	*4.56*	*TRUE*
2.	*Image_2*	*3.59*	*TRUE*
3.	*Image_3*	*5.69*	*TRUE*
4.	*Image_4*	*5.66*	*TRUE*
5.	*Image_5*	*3.81*	*TRUE*
6.	*Image_6*	*4.58*	*TRUE*
7.	*Image_7*	*4.12*	*TRUE*
8.	*Image_8*	*3.83*	*TRUE*
9.	*Image_9*	*5.65*	*TRUE*
10.	*Image_10*	*3.84*	*TRUE*
11.	*Image_11*	*4.7*	*TRUE*
12.	*Image_12*	*3.8*	*TRUE*
13.	*Image_13*	*5.58*	*TRUE*
14.	*Image_14*	*5.69*	*TRUE*
15.	*Image_15*	*5.58*	*TRUE*
16.	*Image_16*	*2.93*	*TRUE*
17.	*Image_17*	*3.73*	*TRUE*
18.	*Image_18*	*3.89*	*TRUE*
19.	*Image_19*	*3.89*	*TRUE*
20.	*Image_20*	*5.16*	*TRUE*

Table 3: Result compare with benign skin lesion dataset

4.2. Testing malignant dataset:

S.No	Image Name	Final Value that's satisfied TDS Score in Samsung Android Phone	Status of the skin lesion based on TDS value.
1.	*Image_1*	*5.68*	*TRUE*
2.	*Image_2*	*4.03*	*FALSE*
3.	*Image_3*	*6.29*	*TRUE*
4.	*Image_4*	*7.29*	*TRUE*
5.	*Image_5*	*4.19*	*TRUE*
6.	*Image_6*	*6.45*	*TRUE*
7.	*Image_7*	*5.89*	*TRUE*
8.	*Image_8*	*4.01*	*FALSE*
9.	*Image_9*	*4.93*	*TRUE*
10.	*Image_10*	*5.44*	*TRUE*
11.	*Image_11*	*4.96*	*TRUE*
12.	*Image_12*	*4.84*	*TRUE*
13.	*Image_13*	*5.65*	*TRUE*
14.	*Image_14*	*6.69*	*TRUE*
15.	*Image_15*	*4.87*	*TRUE*
16.	*Image_16*	*3.24*	*FALSE*
17.	*Image_17*	*4.85*	*TRUE*
18.	*Image_18*	*4.45*	*FALSE*
19.	*Image_19*	*5.89*	*FALSE*
20.	*Image_20*	*3.58*	*TRUE*

Table 4: Result compare with melanoma skin lesion dataset

The result from Table 4 given false classification of melanoma for few images. The causes of the error are due to the color in figured too dim and difficult to capture and processed with *OpenCV* too. In the criteria android phones make different result especially on the different crop from range color. By comparing the accuracy of Neural Network tool and convolutional neural network. By using CNN, we are getting accuracy averagely 96.3% for benign cases and 89.2% accuracy for melanoma dermoscopic images.

V. CONCLUSION:

ABCD rule is the *dermoscopy* method can detect melanoma with three classifications. This paper proposed a method to detect melanoma using a mobile device. The image for data test is taken from digital clinical image medical PH Dataset Melanoma and International Society for Digital Imaging of the Skin with histological. With the ABCD rule method. It can detect melanoma cancer from printed image and different accuracy result happens from different sensor image. The high accuracy from an android which using CMOS Image Sensor. Color range from each sensor makes different crop result. The dim color made false classification because dim color difficult to catch the color. The proposed system successfully detects and classifies the skin cancer from images. At the end of the system, you can say that the system achieves its expected expectations. The proposed system test 50 types of images and obtains the result where the overall success rate of the system is 96.30% for benign and 89.2% malignant skin cancer which meet the expectation of the system. In future, this technique can be used in the detection of brain tumor, breast cancer, prostate cancer, lung cancer etc.

In future, the future work will be based on developing algorithm to identify the various skin cancers with its type and to improve the overall efficiency and to reduce the computational time. Take more features in future to get more accuracy and other additional steps.

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ACKNOWLEDGEMENTS

Sundeep PS, Lakshmi Rajan, Karthika Venugopalan is pursuing BTech (CSE) under KTU university in Adi Shankara Institute of Engineering and Technology in Kalady, Kerala. **Asst.Prof. M.Gokilavani** is working as assistant professor in the department of computer science and technology in ASIET, Kerala with 3 years of teaching experience. She is Pursing **PhD in medical image processing**. She published more than **20 papers** in international and Scopus journals and **3 papers in** international conferences. I would like to thanks to our guide to do for the valuable work and to our department staffs.

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