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COMPUTER AIDED MELANOMA SKIN CANCER DETECTION USING ARTIFICIAL NEURAL NETWORK CLASSIFIER

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ABSTRACT

Skin cancer is the uncontrolled growth of strange skin cells. It occurs when unrepaired DNA damages to skin cells triggers mutations, or genetic defects, that lead the skin cells to multiply readily and form malignant tumors. Image processing is a commonly used method for skin cancer detection from the appearance of affected area on the skin. Artificial Neural Network (ANN) is one of the important branches of Artificial Intelligence, which has been accepted as a brand new technology in computer science for image processing. Neural Networks are currently the area of interest in medicine, particularly in the fields of radiology, urology, cardiology, oncology, etc. Neural Network plays a vital role in an exceedingly call network. In this paper, a computerised method has been developed to make use of Neural Networks in the field of medical image processing. The ultimate aim of this paper is to implement cost-effective emergency support systems, to process the medical images. It has been used to analyse Melanoma parameters Like Asymmetry, Border, Colour, Diameter, (ABCD), etc. which are calculated using MATLAB from skin cancer images intending to developing diagnostic algorithms that might improve triage practices in the emergency department. Using the ABCD rules for the melanoma skin cancer, we use ANN in classification stage with Back Propagation Algorithm. Initially, we train the network with known target values. The network is well trained with 96.9% accuracy, and then the unknown values are tested for the cancer classification. This classification method proves to be more efficient for the skin cancer classification.

I. INTRODUCTION

In recent days, skin cancer is seen as one of the most Hazardous forms of the Cancers identified in Humans. Skin cancer is classified into various types such as Melanoma, Basal and Squamous Cell Carcinoma out of which Melanoma is the most unpredictable.

Melanoma could be a notably deadly variety of skin cancer, and though it justifies solely 4% of all skin cancers, it is chargeable for 75% of all skin cancer deaths. Image processing is one of the widely used methods for skin cancer detection. Dermoscopy could be a non-invasive examination technique supported the cause of incident light beam and oil immersion technique to form potential the visual investigation of surface structures of the skin. The detection of melanoma using dermoscopy is higher than individual observation based detection[3], but its diagnostic accuracy depends on the factor of training the dermatologist.

The diagnosis of melanoma from melanocytic nevi is not clear and easy to identify, especially in the early stage. Thus, automatic diagnosis tool is more effective and essential part of physicians. Even when the dermoscopy for diagnosis is done with the expert dermatologists, the accuracy of melanoma diagnosis is not more than 75-84%[4].

The computer aided diagnostics is more useful to increase the diagnosis accuracy as well as the speed[5]. The computer is not more inventive than human but probably it may be able to extract some information, like colour variation, asymmetry, texture features, more accurately that may not be readily observed by naked human eyes[5]. There have been many proposed systems and algorithms such as the seven-point checklist, ABCD rule, and the Menzies method[2,3] to improve the diagnostics of the melanoma skin cancer.

The key steps in a computer-aided diagnosis of melanoma skin cancer are image acquisition of a skin lesion, segmentation of the skin lesion from skin region, extraction of geometric features of the lesion blob and feature classification. Segmentation or border detection is the course of action of separating the skin lesion of melanoma from the circumferential skin to form the area of interest. Feature extraction is done to extract the geometric features which are accountable for increasing the accuracy; corresponding to those visually detected by dermatologists, that meticulously characterizes a melanoma lesion. Figure 1 shows the medical diagram of a melanoma skin cancer in advanced stage.

Figure1. Medical diagram of a melanoma skin cancer.

The feature extraction methodology of many computerised melanoma detection systems has been largely depending on the conventional clinical diagnostic algorithm of ABCD-rule of dermoscopy due to its effectiveness and simplicity of implementation [14]. The effectiveness of methodology stems from the fact that it incorporates the classic features of a melanoma lesion such as asymmetry, border irregularity, colour and diameter (or differential structures), where surveyable measures can be computed.

Dermoscopy is a diagnostic technique that is used worldwide in the recognition and interpretation of copious skin lesions [4].Other than dermoscopy, a computerised melanoma detection using Artificial Neural Network classification has been adapted which is

efficient than the conventional one and Melanoma detection using Artificial Neural Network is a more effective method compared to other.

II. METHODOLOGY

The proposed methodology for detection of Melanoma Skin Cancer using Image Processing as a key tool is shown in Figure 2. The input for the system is the image of the skin lesion which is speculated to be a melanoma lesion image, which is then pre-processed to upgrade the image quality. The background subtraction and edge detection are used for image segmentation. The segmented image is then given to the feature extraction block, which inheres of region lesion analysis for its classic geometrical features. The geometrical features are advised since they are the most sophisticated features of the skin cancer lesion. The extracted features are moreover given to the feature classification stage which classifies the skin lesion as cancerous or normal by Neural Network.

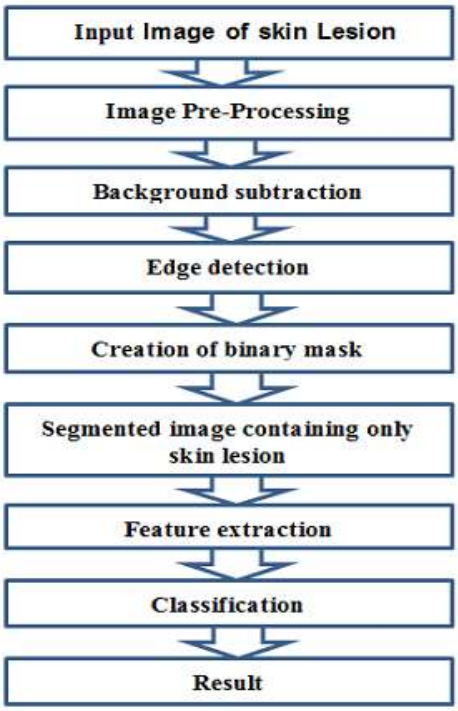

Figure2. The simplified work flow of computer aided melanoma detection using ANN classifier

A. Image Pre-Processing

The image of skin lesion is given to the computer diagnostic system can be captured in any lighting condition or by using any camera. Hence, it needs to pre-process. Here, the pre-processing is the process of image resizing (scaling) and contrast and brightness modification, which is done in furtherance of compensating the non-uniform illumination in the image.

1. Image scaling

Figure3. Resized image

Image scaling is the course of action of resizing a digital image. The size of an image is reduced or enlarged, the pixels that form the image become increasingly visible, making the image appear "soft".

2.RGB to grayscale image

The rgb2gray function converts the true color image RGB to the grayscale intensity image, by eliminating the saturation information.

Figure4. Grayscale image

3. Grayscale to Binary image

Im2bw command converts the grayscale image to a binary image. The output image replaces all pixels in the input image with luminance exceeding the level with the value 1(white) and substitute all other pixels with the value 0 (black). If you do not define the level, then im2bw uses the value 0.5.

Figure5.Binary image

B. Segmentation

Image segmentation is the course of action of segregating an image into multiple parts, which is used to identify objects or other relevant information in digital images.

1. Background subtraction

Background subtraction, also known as blob detection, is an emerging technique in the fields of image processing wherein an image's foreground is extracted for further processing. Typically, an image's regions of interest are objects in its foreground.

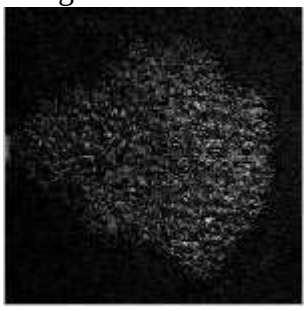

Figure6. Blob detection

2. Edge detection

Edge detection is a significant image processing technique for catching the boundaries of objects within images. It works by detecting discontinuities in brightness.

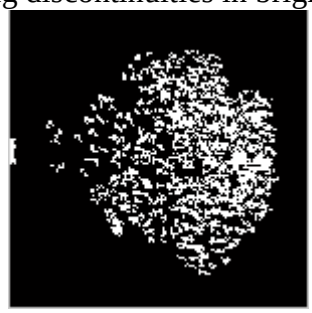

Figure7. Edge detection

3.Masking

Masking involves setting the pixel values in an image to zero, or some other "background" value. It is used to separate the lesion from the skin image. The masked image obtained contains only the skin lesion.

Figure 8. Masked skin lesion

C. Feature Extraction

The foremost features of the Melanoma Skin Lesion are its Geometric Features. Hence, we propose to extract the Geometric Features of the segmented skin lesion. Here, we used some classic geometry features (Area, Perimeter, Greatest Diameter, Circularity Index, Irregularity Index)[11] adopted from the segmented image containing only skin lesion, the image blob of the skin lesion is analysed to extract the geometrical features. The various Features extracted are as follows.

Area (A): Number of pixels of the lesion
Perimeter (P): Number of contour pixel.

Major Axis Length (Ma L): The length of the line passing through lesion centroid and joining the two farthest boundary points.

Minor Axis Length (Mi L): The length of the line passing through lesion blob centroid and joining the two adjacent boundary points.

Circularity Index (CI): It gives the shape uniformity.

$$CI = \frac{4A\pi}{P^2} \quad (1)$$

Irregularity Index A (IrIA):

$$IrIA = \frac{P}{A} \quad (2)$$

Irregularity Index B (IrIB):

$$IrIB = \frac{P}{MaL} \quad (3)$$

Irregularity Index C (IrIC):

$$IrIc = P \times \left(\frac{1}{MiL} - \frac{1}{MaL}\right) \quad (4)$$

Irregularity Index D (IrID):

$$IrID = MaL - MiL \quad (5)$$

D. Classification

Using the ABCD rules for the melanoma skin cancer, we use Artificial Neural Network in the classification stage. The construction of the neural network prevails in three distinctive layers with feed forward architecture [15]. It is the most influential network architecture in use today. The input layer of the neural network is a set of the feature values extracted in the feature extraction stage. The input units (neurons) are entirely coupled to the hidden layer with the hidden units. The hidden units (neurons) are also completely linked to the output layer. The output layer delivers the response of the neural network to the activation pattern implemented to the input layer. The single output from the system denotes whether the input skin contains cancer or not. The information given to a neural network is procreated layer-by-layer from the input layer to output layer through (none) one or more hidden layers.

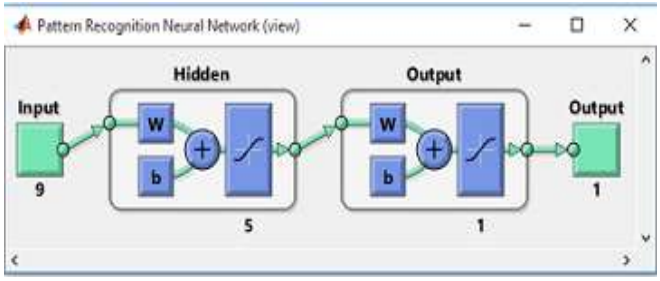

Figure 9. The structure of the ANN.

Once a network has been formulated for a appropriate purpose, that network is capable of being trained. To start this process, the initial weights are chosen randomly. Then, the training, or learning, begins. The ANN has been trained by reporting it to sets of existing data where the outcome is known. Multi-layer networks employ a number of learning techniques, the most paramount are back – propagation algorithm. It is one of the most active approaches to machine learning algorithm developed by David Rummelhart and Robert McLelland (1994)[14]. Informations are progress from the direction of the input layer towards the output layer. A network is trained rather than programmed.

E. Results

Initially, 31 skin cancer patients, skin lesion image has been collected from various hospitals and websites, and these images were pre-processed with the following techniques like image scaling, RGB to grayscale, grayscale to binary image conversion and segmentation processes. Finally, the masked image gets from the pre-processing technique contains only the skin lesion. It gives more than 96% of accuracy. The standard geometric features Area, Perimeter, the Greatest Diameter, the Shortest Diameter, Circularity Index, Irregularity Index, are very useful to classify the melanoma skin cancer more accurately. So that these parameters are extracted from the masked image of the skin

lesion using MATLAB code as shown in Figure 10.

The eradicated features are given as input to the neural network with known results as target values. The neural network is trained with these known target values. We use the Back Propagation algorithm for training the ANN. In the MATLAB platform, we have an ANN training toolbox as shown in Figure 11. The output got from the network is compared with the target values, and the confusion matrix is plotted for target class and output class.

Once the network is trained with the known target values, the unknown images are given as the input to the ANN. The ANN is already trained so that the network produces whether the image is cancerous or not. For cancer condition, the network output is 1 and for normal skin the network output is 0.

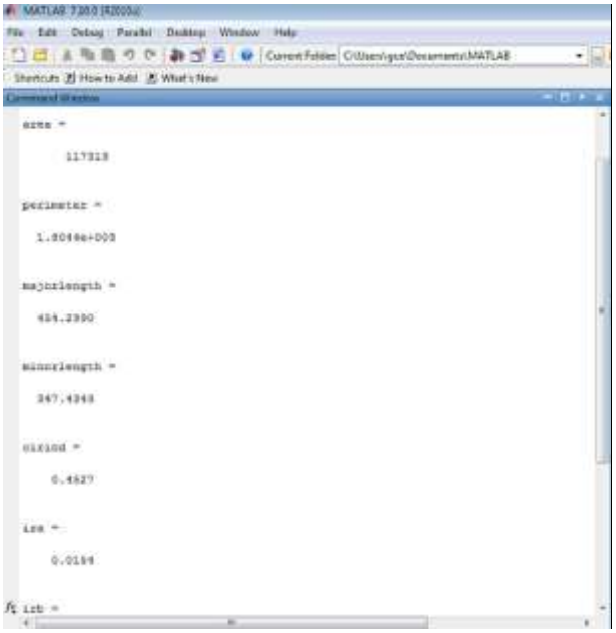

Figure 10. Results of feature extraction

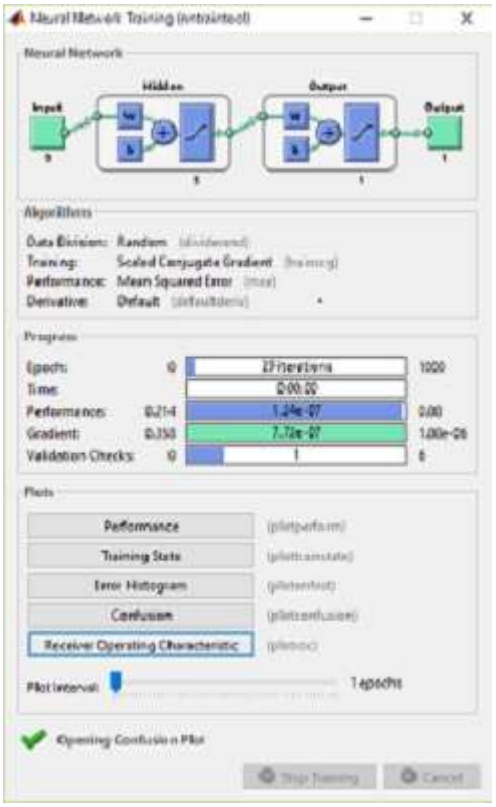

Figure11. ANN training toolbox in MATLAB

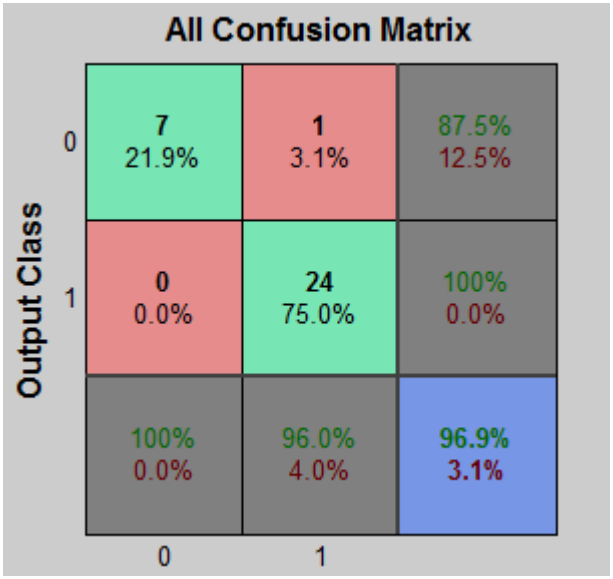

Figure12. Confusion matrix diagram between output class and target class

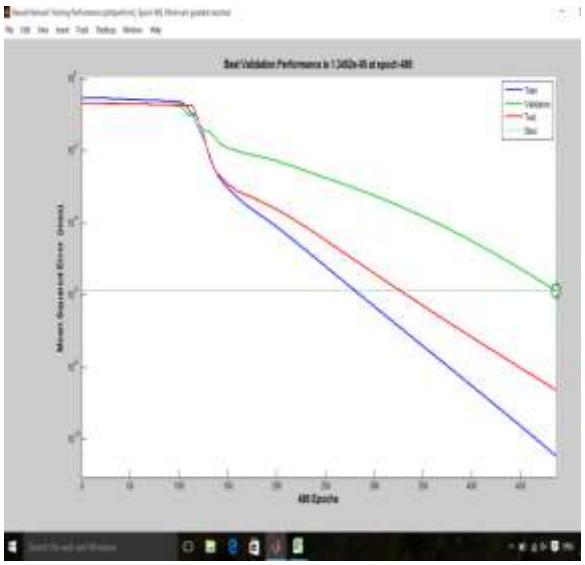

Figure13.The Best validation performance of the ANN for the diagnosis system

Figure 12 shows the confusion matrix which shows that the network is trained with 96.9% accuracy, and Figure 13 shows the best validation performance of the network.

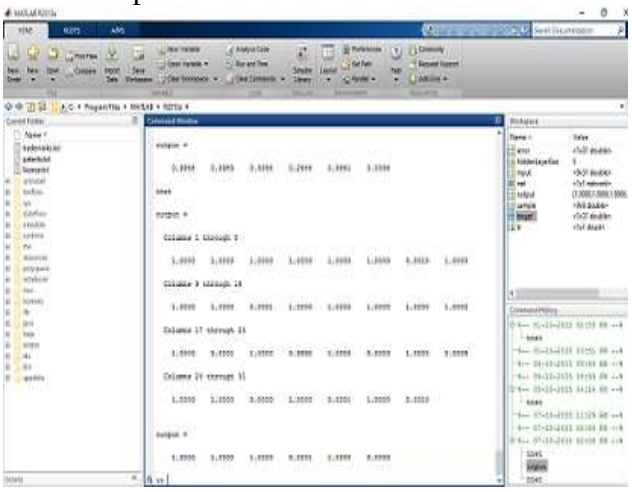

Figure14. Network output for samples

For the unknown input images, the network output is shown in Figure 14.

III. CONCLUSION

In this paper, we have discussed a computer-aided diagnosis system for melanoma skin cancer with Artificial Neural Network as a classifier using Back Propagation Algorithm. The present algorithm is fast, consume only a few seconds of execution time and results are found to be better with the accuracy of 96.9%. It can be concluded from the network results that the suggested system can be capably used by patients and physicians to diagnose the skin cancer more exactly. This tool is useful for the rural areas where the experts in the diagnosis field may not be applicable. Since the tool is made more feasible and robust for images acquired in any conditions, it can deliver the purpose of automatic diagnostics of the Melanoma Skin Cancer. Image processing is a wide area where various classifiers are developed in recent days. In future, we could develop a computer algorithm for skin cancer diagnosis using Support Vector Machine, which is also an emerging technology nowadays.

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