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Automatically Detection of Skin Cancer by Classification of Neural Network

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***Abstract*— Skin cancers are the most common form of cancers found in humans. The persistent raise of this cancer in the worldwide, the high medical cost and death rate have prioritized the early diagnosis of this cancer. The different components in an automated diagnosis of skin cancer include: an automatically skin cancer classification system is developed and the relationship of skin cancer image across different type of neural network are studied with different types of preprocessing. The collected images are feed into the system, and across different image processing procedure to enhance the image properties. Statistical region merging (SRM) algorithm is based on region growing and merging. Then the normal skin is removed from the skin affected area and the cancer cell is left in the image. Useful information can be extracted from these images and pass to the classification system for training and testing. Two neural networks are used as classifier, Back-propagation neural network (BNN) and Auto-associative neural network (AANN). Recognition accuracy of the 3- layers back-propagation neural network classifier is 91% and auto-associative neural network is 82.6% in the image database that include dermoscopy photo and digital photo. The analysis of work based on MATLAB.**

***Index Terms*—Skin Cancer, Neural Network, Image Detection, Image Processing, Statistical region merging (SRM)**

I. INTRODUCTION

Cancer is one of the biggest threats to human beings and is the second leading cause of death the entire world human [1]. According to the statistical data from WHO(World Health Organization) [2], cancer caused about 7.6 million people death worldwide in 2008, and it is predicted that the number of deaths caused by cancer is being increased and the number will possibly increase to 13.1 million in 2030 [2]. Based on related research, cancer will become the leading death in next 20 years [3]. There are three types of skin cancer: Basal cell cancer and squamous cell cancer are called non-melanoma skin cancer while melanoma is on melanocytes cells, Basal cell cancer and squamous cell cancer are common but less dangerous. Melanoma is not common as non-melanoma skin cancers, however, it is more likely to spread and become fatal [4]. Although skin cancer is a threat to human life, fortunately even melanoma can be cured if it is detected early. According to research, the curable rate will be more than 90% high if cancer can be diagnosed in its early stages while the curable rate will be less than 50% in its late stage [5]. Thus, the detection of skin cancer in its early stage has attracted the attention from different fields [6]. With respect to the raises in statistical foundation of skin cancer, the importance of its early detection has been considered as a vital issue and the computer based diagnosis is an important tool for this purpose.

Currently the diagnosis of skin cancer is done mainly by a human, who is called dermatologist. During diagnosis, dermatologist exams the skin carefully by his eyes or using a device called dermascope. The skin cancer malignant melanoma can be recovered if diagnosed and treat it in early stages. Therefore early diagnosing is a crucial issue for patients. However, only experienced doctor is able to classify the skin cancer from other skin diseases. Thus the computer based skin cancer detection is necessary to provide recommendation for non-specialized user. The development of this diagnosis system over 20 years, the accuracy of diagnosis is around 73% to 98%. The variations of diagnosis are sufficiency large and there are lacks of detail of the test methods. In this work, a developing an automatically skin cancer detection system to classify the cancer images into either benign or malignant melanoma is presented and discussed through using different approaches. The images in the databases used are contained both digital photo and dermoscopy images. Dermoscopy, also calls Dermatoscopy or Epiluminescence light microscopy (ELM). It was first announced on 1987, it is a kind of imaging technique uses to exanimate lesions with a dermatoscope. The process is done by placing an oil immersion between the skin and the optics. The lighting can magnify the skin that improve on reveal most of the pigmented structure, different color shades that is not visible to naked eye; and allows direct viewing and analysis of the epidermis (the outer layer of the skin) and papillary dermis (the deep vascular inner layer of the skin). Physician uses this technique for diagnosis of skin cancer more efficiency. The historical researches have proved that ELM can improve the diagnostic accuracy by 5 – 30% compare to traditional imaging [7]. Furthermore, ELM has evolution and digitalize that can be used to classification with computer. It given several advantages in diagnosing like considering small suspicious lesion and objective evaluation of parameters: geometry, color and texture; and storage of image and comparable for future development [8]. ELM may improve the accuracy of clinical diagnosing but it requires the experienced dermatology physician to exanimate the image. This thesis works on compare different approach with their performance and accuracy.

II. RELATED WORK

One of the best approaches to overcome aforementioned challenges in automating medical imaging diagnosis is to simplify the objective of the analysis and to exploit some kind of hypothetical information about the imaged structures. The images can then be classified using their morphological, color, fractal, and texture properties. Laws, 1980 in his work transformed digital images to identify regions of interest and provided an input dataset for segmentation and features detection operation.

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Malignant melanoma currently accounts for a third of most frequent type of skin cancer and 79% of skin cancer death. The incidence of malignant melanoma in fair-skinned patients has increased histrionically in most parts of the world over the past few decades (Rubegni et al., 2002; Stanganelli et al., 2005; Dobrescu et al., 2010). In Europe, it's been reported that malignant melanoma incidence is increasing by 5% every year and it is responsible for 91% of skin cancer death (Sboner et al., 2001; Ali & Deserno, 2012). In a bid to improving early detection, a number of diagnostic checklists and rules have been proposed such as Seven Point Checklist (Healsmith et al., 1994), and ABCDE: **A**symmetry, **B**order, **C**olor, **D**iameter, **E**volution checklist (Fitzpatrick et al., 1998). These rules and checklists specify visual features associated with malignant lesion symptoms.

Gilmore et al., 2009 used lacunarity (a measure of transitional invariance of an object used in quantifying aspects of patterns that exhibit scale-dependent changes in structure) to provide a promising method for automated assessment of melanocytic nevi and melanoma. The fuzzy-based histogram analysis technique used by Stanley et al., 2003 provided a possibility for automated skin lesion discrimination in dermatology clinical images. Rubegni et al, 2002 developed an automated process using artificial neural network methods based on mathematical analysis of pigmented skin lesions to avoid the problem of qualitative interpretation made by the use of ELM by Dermatologist. Kreutz et al., 2000 presented a combination of artificial neural network approach with texture analysis using digital image processing and mixture-of-experts to attempt automation of skin cancer diagnosis. Ganster et al., 2001 developed a system that provided for automated computerized analysis of images obtained from ELM to enhance the early recognition of malignant melanoma. Sheha et al. 2012 used Grey-Level Co-occurrence Matrix (GLCM) and Multilayer perceptron classifier (MLP) for automatic Detection of Melanoma Skin Cancer using Texture Analysis. One core challenge however with many of aforementioned approaches is their inability to integrate well with ubiquitous devices such as mobile telephony, now largely accessible to underserved areas (Mobithink, 2012).

In this paper, a developing an automatically skin cancer detection system to classify the cancer images into either benign or malignant melanoma is presented and discussed through using different approaches. The images in the databases used are contained both digital photo and dermoscopy images.

III. Automatic Skin Cancer Detection System

Most of the systems consist of following procedures: image pre-processing to removes the noise and fine hair; Post-processing: to enhance the shape of image; Segmentation: to removes the healthy skin from the image and find the region of interest, usually the cancer cell, remains in the image; Feature extraction extracts the useful information or image properties from the segmented images.

A. Pre-processing

The first step in expert systems used for skin inspection involves the acquisition of the tissue digital image for skin cancer detection. The skin cancer images usually contain fine hairs, noise and air bubbles. These feature that is not part of the cancer cell and would reduce the accuracy of the border detection or segmentation. The first step to do is apply some image processing techniques to the images. Thus pre-processing used to referring to remove the unwanted features on the skin and post-processing referring to enhancement to the shape of image.

Figure.1 True image identification of skin cancer

B. Segmentation process

In this stage, the enhanced skin image is segmented to separate the tumour from the background (skin). Segmentation removes the healthy skin from the image and finds the region of interest. Usually the cancer cells remains in the image after segmentation. Segmentation used here is Threshold Segmentation. Thresholding provides an easy and convenient way to perform the segmentation on the basis of the different intensities or colors in the foreground and background regions of an image. The input to a thresholding operation is typically a grayscale or color image. After segmentation, the output is a binary image. Segmentation is accomplished by scanning the whole image pixel by pixel and labelling each pixel as object or background according to its binarized gray level.

Figure.2 Segmented image

Segmentation algorithms are based on one of two basic properties of intensity values discontinuity and similarity. First category is to partition an image based on abrupt changes in intensity, such as edges in an image. Second category is based on partitioning an image into regions that are similar according to predefined criteria. Histogram Threshold approach falls under this category.

In this work, threshold and statistical region merging (SRM) are implemented and compare their accuracy with neural network classifier.

C. Feature extraction and Selection

At this stage, the important features of image data are extracted from the segmented image. By extracting features, the image data is narrow down to a set of features which can distinguish between Malignant and Benign melanoma. The extracted features should be both representatives of samples and detailed enough to be classified. 2D wavelet transform is used for the feature extraction. In this system, 2-D wavelet packet is used and the enhanced image in gray scaled as an input. Bior wavelets at two steps of decomposition are used. At each step of decomposition, the wavelet of primary image is divided into an approximate and three detailed images which show the basic information and vertical, horizontal and diagonal details, respectively.

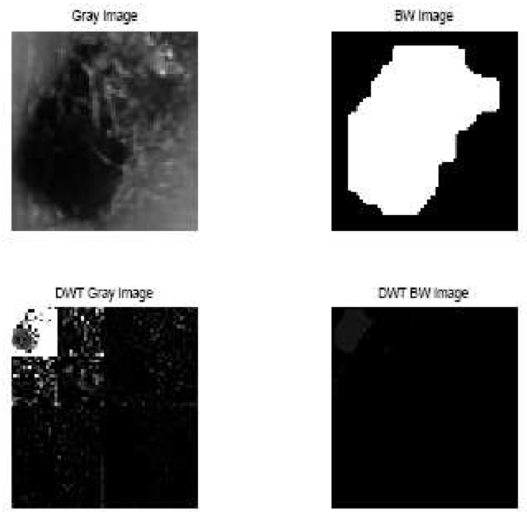

Figure.3 Image composition wavelets

D. Artificial Neural Network Classifier

Artificial neural network (ANN) architectures have been recognized for a number of years as a powerful technology for solving real-world image processing problems. The primary purpose of this special issue is to demonstrate some recent success in solving image processing problems and hopefully to motivate other image processing researchers to utilize this technology to solve their real-world problems.

A classifier is a category of unified modeling language (UML) elements that has some features such as attributes or methods in common. Classifier is used for classifying Malignant Melanoma from other skin diseases. Based on the computational simplicity Artificial Neural Network (ANN) based classifier is used. In this proposed system, a feed forward multilayer network is used.

Back-propagation neural network is one of the most common neural network structures, as it is simple and effective.Back propagation (BPN) Algorithm is used for training. There must be input layer, at least one hidden layer and output layer. The hidden and output layer nodes adjust the weights value depending on the error in classification.

Auto-associative neural network is a network made of equal size of the input layer and the output layer, and smaller size in hidden layer.

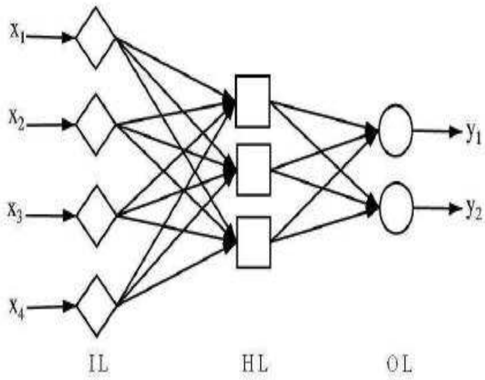

Figure.4 Artificial Neural Network

IV. Result And Discussion

Two neural networks are used as classifier, Back-propagation neural network (BNN) and Auto-associative neural network (AANN). We obtained training image with simulation of MATLAB. These obtained training images to compare at different layer.

Table 1 show as a best result with highest overall accuracy is 90.2%. The best BNN is three hidden layer with 40, 25 and 10 neurons for each hidden layer. The accuracy is increase with number of neuron in hidden layer. However, number of hidden layer cannot improve the result but it could reduce the probability of over-fitting.

Table 1

No of Layer	No of Neuron	Training (%)	Testing (%)	Validation (%)	Total (%)
1	10	82.6	55.5	63.9	74.5
1	20	99.6	60.6	66.5	85.3
1	30	100.0	52.8	77.2	88.6
1	40	98.7	51.1	77.6	87.7
2	10,5	80.5	47.3	56.8	69.7
2	20,10	97.9	52.0	73.6	86.3
2	30,20	99.8	55.3	69.2	86.4
2	40,20	99.9	51.9	77.5	88.3
3	10,8,6	94.0	60.8	69.8	84.3
3	20,12.8	97.6	62.9	76.8	87.9
3	30,20,10	99.2	62.2	72.4	88.6
3	40,25,10	99.4	61.3	80.3	90.2

The best AANN testing result found is 20 neurons in the first and third layer with overall accuracy 81.5% as table 5.2 illustrated. Unlike BNN, ANN provides a stable classification result in different number of neuron. However, when the layer 1 and layer 3 have different size of neuron, the classifier result has a significant low accuracy diagnosing result.

Table 2

Layer 1 to 4	Training	Validation	Testing	Total
10 4 10 4	86.8	59.3	69.4	77.9
10 5 10 4	83.2	56.4	68.8	73.5
20 4 20 4	89.1	58.6	68.9	79.1
20 10 20 10	91.4	61.5	68.6	81.3
30 4 30 4	89.9	59.3	73.0	80.4
30 10 30 4	88.5	55.4	64.2	76.9
40 4 40 4	89.2	63.3	68.5	79.8
40 20 40 4	89.5	54.1	63.3	77.4
40 10 30 4	41.4	39.8	39.4	40.4

V. Conclusion

A Computer based early skin cancer detection system is proposed in this paper. It proves to be a better diagnosis method than the conventional Bioscopy method. The diagnosing methodology uses 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. The unique features of the segmented images were extracted using 2-D Wavelet Transform. Based on the features, the images were classified as Cancerous and Non-cancerous. This methodology has got good accuracy also. By varying the Image processing techniques and Classifiers, the accuracy can be improved for this system.

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