Wavelet Based Decomposition and Neural Network Classification for Melanoma Diagnosis

V. Lalitha, G. Geetha

Assisstant Professor, Faculty of Computing, Sathyabama University, Jeppiaar Nagar, Chennai
Dean, School of Computer Science, Lovely Professional University, Phagwara, India

Abstract— Melanoma is a dangerous type of skin cancer which can be cured if diagnosed early. Finding the difference between melanoma and mole is a complex task.In this paper we have applied canny edge detection algorithm for segmentation and wavelet based decomposition for feature extraction purpose. Then the extracted features are fed as input to neural network for classification and the results are proven to be better in melanoma diagnosis.

Index Terms—melanoma, wavelet based decomposition, neural network

I. Introduction

Melanoma is a skin cancer in which malignant cells become visible on the outer skin layers. It is a fatal type of skin cancer which leads to death of thousands of people every year.[1] It is curable if diagnosed early. But differentiating melanoma with other pigmented skin lesion is a challenging task even for experienced dermatologists. But there are some of the fundamental symptoms of skin cancer, such as: A- Asymmetry, B - Border irregularity, C - Color variation and D - Dermoscopic structures. These symptoms known as ABCD rule [2] help to diagnose melanoma. This works almost correctly for thin melanocytic lesions. The accuracy rate is between 59% to 88% in melanoma identification but a more precise diagnosis is necessary.

A novel method to melanoma diagnosis is based on using canny edge detection algorithm for segmentation and feature extraction by using wavelet transform.

II. Background

There are many transforms available for skin cancer classification.One such method is Fourier transform [3]. But the main shortcoming of Fourier Transform is difficulty in extracting time information. Also it not suitable for images with sharp changes. Hence Windowed Fourier Transform (WFT) came into existence but unfortunately, this transform is difficult to invert, due to its extreme redundancy, and it does not capture short "pulses" accurately, unless a very small window is used[4].

III. Wavelet Transform

To evaluate signals and images, a new multi resolution analytical tool called Wavelet transform was used [5]. They depict an image at each scale and location. Using Wavelet transform helps to detect edges and sharp transitions very efficiently.

IV. Preprocessing

The preprocessing step removes the noise from image and enhances the image. Noise is undesirable parts of the melanoma and benign images. We have preferred the median filter from the different filters available as it is efficient than mean filter. Many algorithms are available for noise removal and based on the data set, devices used to collect image we have to select the right filter.

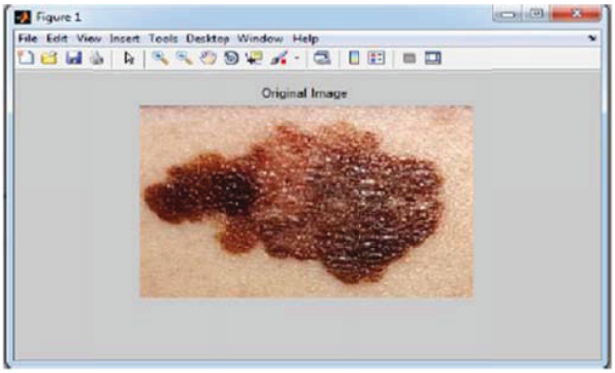


Fig 1 Reading image from dataset

We convert into gray scale image for removing hue and saturation information and preserving luminance.

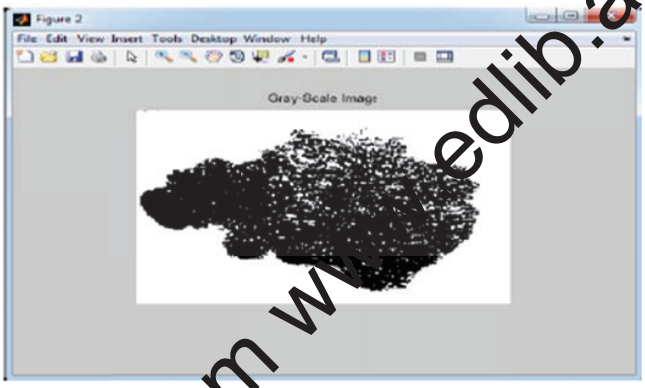


Fig 2 Converting into gray scale image

We have used median filter is for preprocessing. In median filtering, the output pixel's value is calculated by median of the neighboring pixels, and not by mean. For extreme values, the median is less reactive than the mean. Hence it is better than mean in removing these outliers at the same time it maintains the sharpness of the image[6]

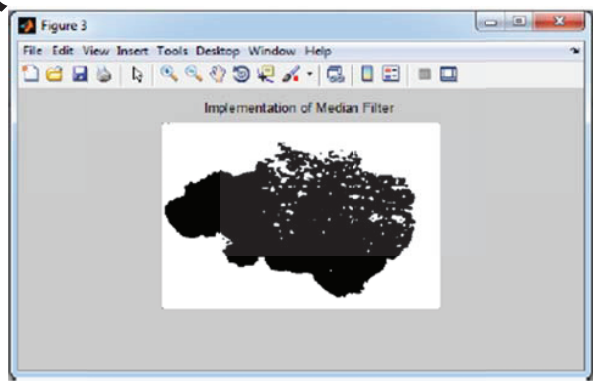


Fig 3 Applying median filter

V. Segmentation

Segmentation is the process of subdividing the image and boundaries are identified. It is an important step as the end result depends on the outcome of this process. The quality depends on the algorithm used [7].Here canny edge detection algorithm is used as it determines the boundaries effectively especially for melanoma images.

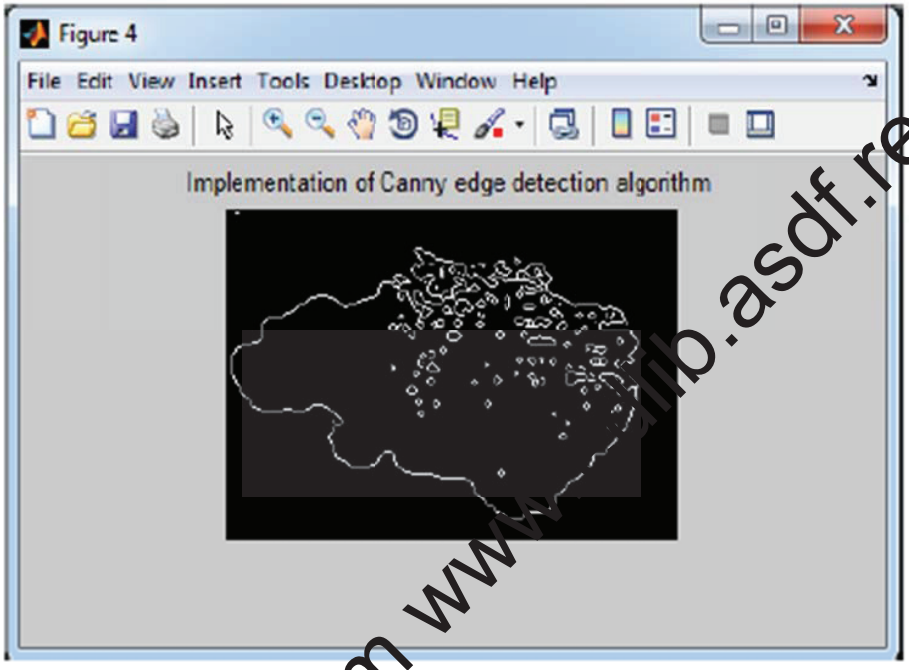


Fig 4. After applying canny edge detection

VI. Feature Extraction

In this stage, the key features of the data are identified and extracted for further processing. This makes the raw data more useful in processing. By extracting features, we narrow down the image data to a set of features which will be input for further processing [8,9].

We have used Biorthogonal wavelets. In this case, instead of having one scaling and wavelet function, two scaling functions are used which may produce two different wavelet functions. Interesting properties can be derived by using two wavelets, one for decomposition and the other for reconstruction instead of the same single one.

There are three steps of decomposition in this wavelet based feature extraction. The results of the second step were more detailed to be used in production of final results. At each step of decomposition, the wavelet of primary image is divided into an approximate that shows basic information and three detailed images that shows the vertical, horizontal and diagonal details, respectively. During next steps, the approximate image is employed instead of the original image and is decomposed into sub images.

The mean and variance of decomposition coefficients of the second step are utilized to produce the features. Each step of decomposition produces coefficients for approximation and details. There are four mean and four variance features.

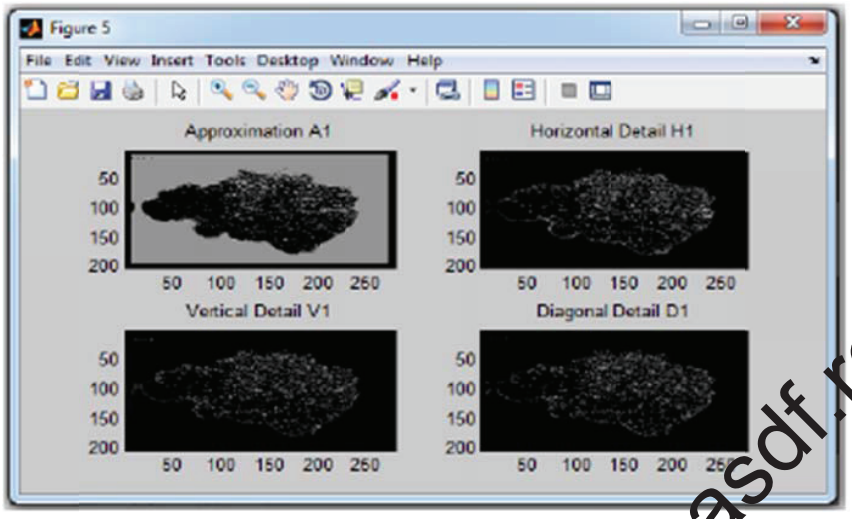


Fig 5. Performing single level wavelet decomposition

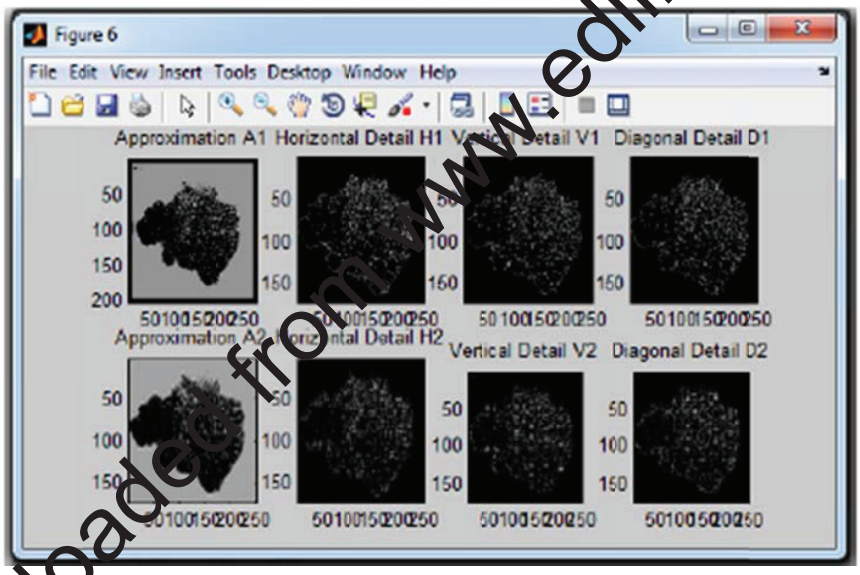


Fig 6 Performing second level wavelet decomposition

VII. Classification

During the neural network stage, images are divided into training, testing and validation data. After the initial round, the network replaces the subdivisions of training and testing, so that the whole data would be considered as the testing subdivision. Finally the network is fed with the validation data and final results are obtained. The neural network is used to classify between melanoma and other skin lesion images. We have used feed forward neural network for classification purpose.

For classification of melanoma and implementing the system Neural network toolbox and Matlab are used.

The simulated results are shown below.

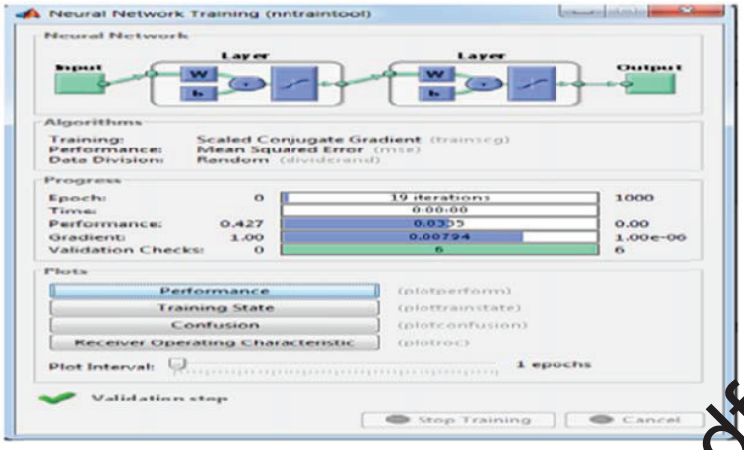


Fig 7. Neural network pattern recognition tool

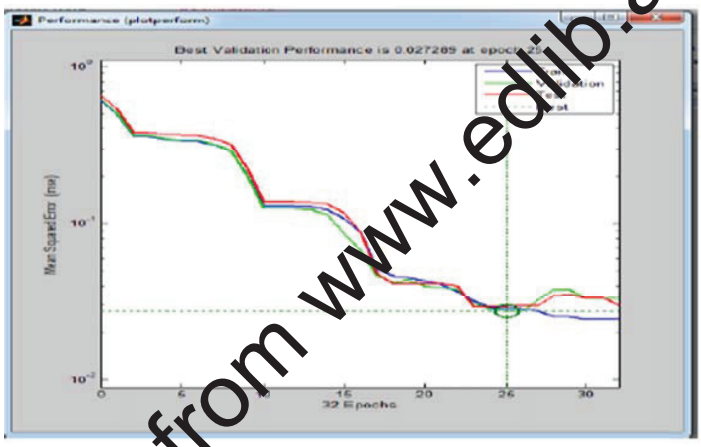


Fig 9. Performance chart

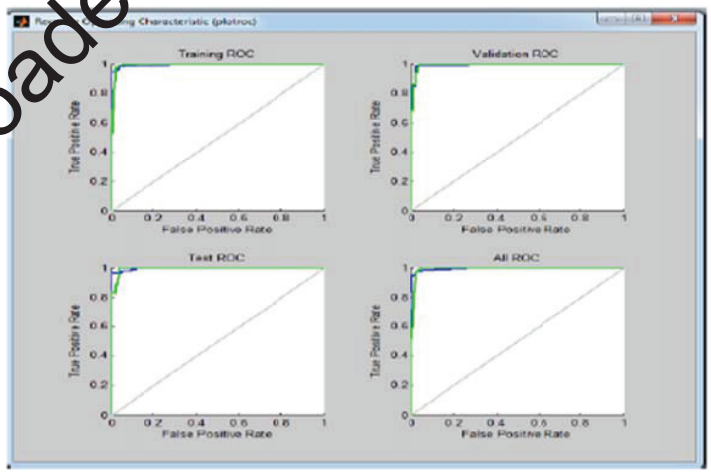
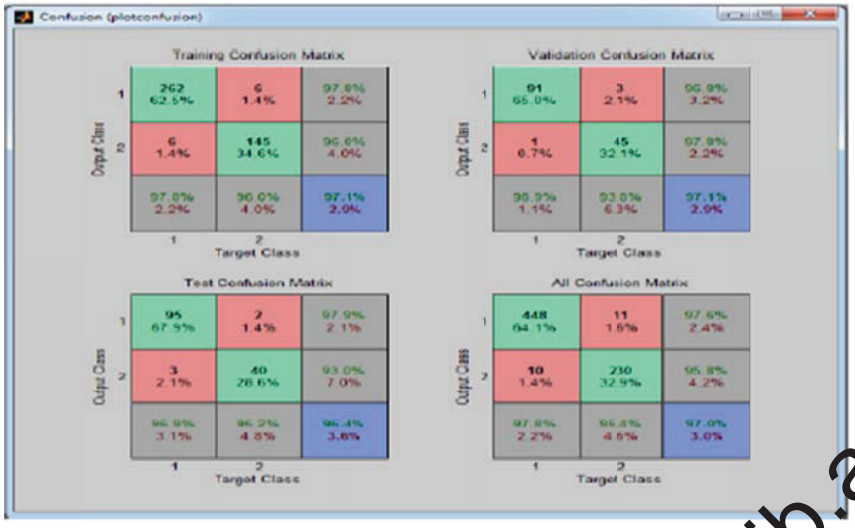


Fig 10. ROC(Reciever Operating Characteristic)

Fig 11. Confusion Matrix



depends on the features extracted by the different wavelet functions.

VIII. Conclusion

Finally the advantage of using wavelet transform for melanoma images is demonstrated effectively by applying it to the classification problem. The steps in this algorithm includes pre processing, segmentation , feature extraction and classification. The ROC and confusion matrix has shown 96% accuracy and the difference of true positive rate and false positive rate

IX. Future Work

In this paper we have employed wavelet transform for melanoma images. But the curvelet transform which is the extension of wavelet transform can be applied for feature extraction to get better results as it deals with curved edges more effectively[11,12]. These curvelets gives location and directional information which are more important for dealing with curved images.

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