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Identification and Classification of Mango Leaf Disease Using Wavelet Transform based Segmentation and Wavelet Neural Network Model

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ABSTRACT

Automatic detection of plant diseases is very ample beneficial as it reduces the workload of farmers. To improve the quality and quantity of crop yield, identification of plant diseases is important in agricultural field. Leaves are considered as the food source for plants and the early and accurate recognition of leaf diseases is very much essential. This research work presents an wavelet transform image segmentation technique for automatic detection and a WNN(Wavelet neural network) based approach presented that classifies leaf diseases in Mango plant species. It is proposed to identify and detect the disease from the mango leaf by taking high resolution images. The plant Village dataset which is consisting of 1130 images of diseased and healthy mango leaves is considered for segmentation and classification. The proposed WNN model achieves an accuracy of 98.93% for identifying the leaf diseases in mango leaves thereby showing the feasibility of its usage in real time applications.

Keywords
Wavelet Transform, Radial Basis function Neural Network, Mango leaf diseases, wavelet neural network

INTRODUCTION

The king fruit "Mango" acquires a great importance in business in agriculture as agriculture is the mother of all cultures. The plant leaf diseases destroying the crops and the farmers are facing losses in crops. Deprived of knowing regarding the diseases affected in the plant, excessive pesticides are applied by farmers for plant disease treatment. So, proper care is required for the advance detection of mango plant leaf disease. Image segmentation, utilized for mango plant leaf disease detection. It is the process of splitting or grouping an image into different parts of the affected areas.. The segmentation process is intelligent, so, we propose wavelet based algorithm for color image segmentation.

The orthodox means of diagnosis of plant disease needs larger amount of pesticide which is time-consuming and challenging, for farmers [1].With the introduction of "Computer Vision (CV), Machine Learning (ML), and Artificial Intelligence (AI)" technologies, "Deep Learning (DL)" has dominated the detection process in agriculture [2,3]. R. Nikam et al. [4] presented a methodology to determine the severity level of mango disease from leaf images. In their work they have used a model dataset of 150 color images and applied disease region segmentation, Sobel and Laplacian filters to detect the severity level. L. Dutta in [5]. Authors have utilized the different morphological & statistical features for feature extraction and Artificial Neural Network (ANN) for classification. Savita N. Ghaiwat et al.,[6] reviewed " ANN, SVM, PNN, SELF ORG MAPS and fuzzy logic" for classification of plant diseases, Sanjay B. et al., utilized Vision-based identification algorithm with masking for classification process[7].Mrunalini R. et al.,[8] proposed "K-means clustering"algorithm to classify the crop diseases. S. Arivazhagan et al.,[9] proposed (2013) classification by utilizing SVM. Kulkarni et al.,[10] proposed ANN classifier, Sabah Bashir et al.,[11] proposed (2012) Texture segmentation and K-means clustering technique to classify various plant diseases. Naikwadi et al.,[12] (2013) proposed detection with color extraction. Sanjay B. Patil et al[13]., utilized thresholding segmentation methods. PiyushChaudhary et al.[14], "Color transform" based approach for calculating dimensions of disease spot. Arti N. Rathod et al.[15], Surveyed different techniques for leaf disease detection. Therefore, Barbedo in [16] identified challenges in the classification of plant diseases. Kaur et al. in [17] proposed computer vision methods for the detection and classification of the plant leaves. To improve the drawback of the automatic classification of plant disease, the wavelet neural network is proposed. The proposed wavelet neural network model employs different layers to smooth images in order to improve the noise-immunity. Therefore, the proposed wavelet neural network is more robust than these algorithms for images corrupted by different types of noise and the proposed model is suitable for good classification results.

The rest of the paper is organized as follows: section-2 presents material and methods which includes research block diagram, proposed WNN model, section -3 presents the graphical results of segmentation and classification, section-4 presents segmentation and classification detailed discussion, section -5 presents the conclusion followed by related references.

2. MATERIAL AND METHOD

2.1 Research flow diagram

The research flow diagram indicates the step by step accomplishment of the research work. Further the block diagram shows the flow of algorithm application for detection and classification of plant disease and presented in Fig.1.

2.1.1 General Objective:

The objective of the research work to identify of mango plant leaf disease using wavelet transform [19] based segmentation and diseases classification using wavelet neural network model.

2.1.2 Specific Objectives:

- Objective to localize the disease infected areas using wavelet transform segmentation technique. It will help the farmers at the rural belt to know in advance the effect of disease.
- Objective to develop a new wavelet based neural network model for classification of mango leaf disease.

2.2 Proposed Wavelet Neural Network Model

The wavelet neural network[18] and presented in **Fig.2** are a new class of networks which have been used for classification of mango diseases. In this research the wavelet function is modified and a new wavelet function has been utilized in hidden node to improve the performance of the neural network.

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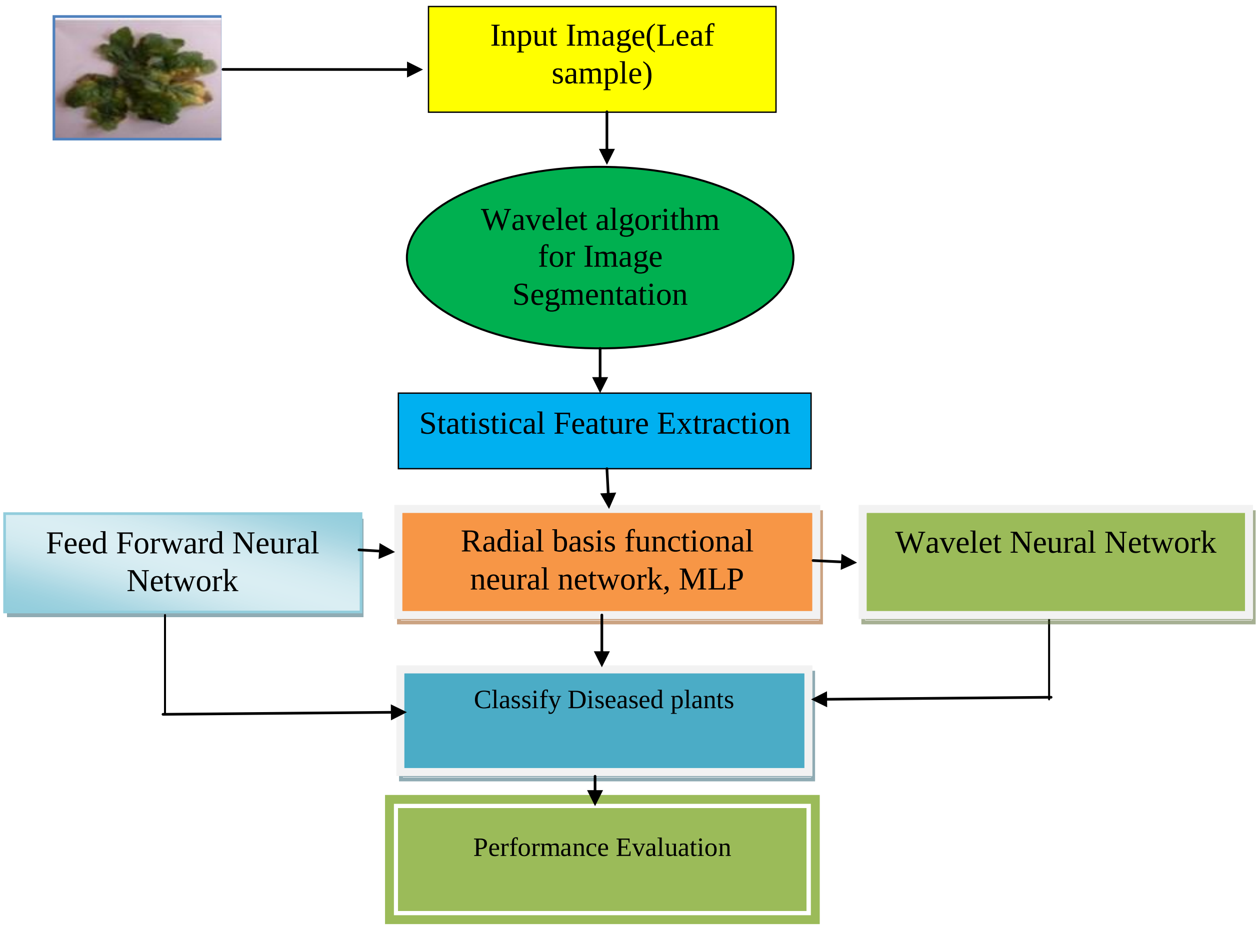

Fig.1 Work flow diagram of research

MLP: Multilayered neural network

In this model the data points $x_1, x_2, \ldots\ldots x_n$ are inputs (features) and $\psi_1, \psi_2 \ldots\ldots \psi_n$ are the wavelet activation function in the hidden units. Where the wavelet function proposed as

$$\psi_n(x) = -x \exp\left(-\frac{x^2}{2}\right)$$

$$y_n = \sum_{i=1}^{N} (w_{i0} + w_{i1}x_1 + \ldots\ldots\ldots\ldots w_{iN}x_N)\psi_n(x) \tag{1}$$

The objective function is to minimize the error and the mean square error is given by

$$MSE(e) = \frac{1}{N}\sum_{n=1}^{N}(d_n - y_n)^2 \tag{2}$$

Where "d" is the desired vector.

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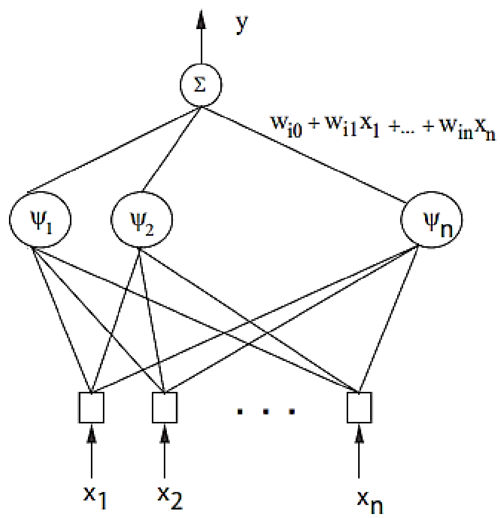

Fig.2 wavelet neural network model

2.3Data Collection

In the proposed work, the Mango leaves dataset [20] repository having leaves of multiple plants are considered for segmentation and classification. A total of 1130 images were taken from the plant Village dataset. Out of these 80% of data has been considered for training and remaining 20% are taken for testing.

2.4 The mango tree diseases

Alternariatenuissima (Kuntze: Pers) Wiltshire[20],the disease appears in the small, circular and brownish spots, which enlarge and become irregular to form big Alternariatenuissima (Kuntze: Pers) Wiltshire. The disease appears in the small, circular and brownish spots, which enlarge and become irregular to form big water-soaked patches. Reddish patches develop on the flesh below the spotted area of fruit.MangoMalformation,Anthracnose is also known as blossom blight, leaf spot, fruit rot and twig blight. This disease is severe both in field and storage. The disease is present all mango area of India The verities neelam and bangalora are highly susceptible to this disease.

Fig.3Image samples (a) Anthracnose (b) Golmich (c) Red Rust

The literature survey shows different classification techniques, segmentation process for leaf disease detection and classification.

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2.5 Feature extraction

The input leaf images will undergo the process of gray image conversion, for computation of disease location detection, and segmentation. A total of seven statistical features are extracted for purpose of classification.

Table -1 Normalized Feature Extraction Table

	Feature values
Correlation	0.6469
Entropy	0.9018
Skewness	0.5785
Mean	0.3425
Kurtosis	0.8422
Energy	0.8335

3. RESULTS

3.1 Segmentation results

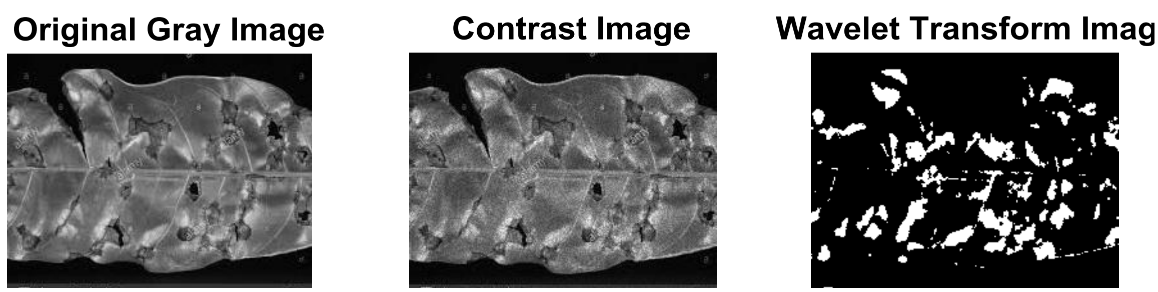

Fig.4(a) Image-1Wavelet transform segmentation

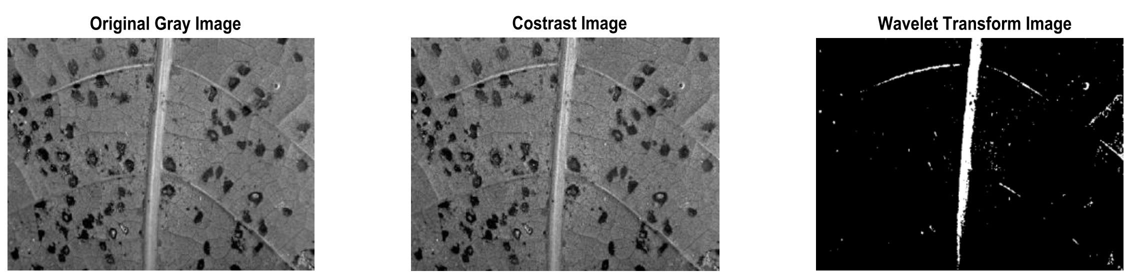

Fig.4(a) Image-2Wavelet transform segmentation

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3.2 Classification Results

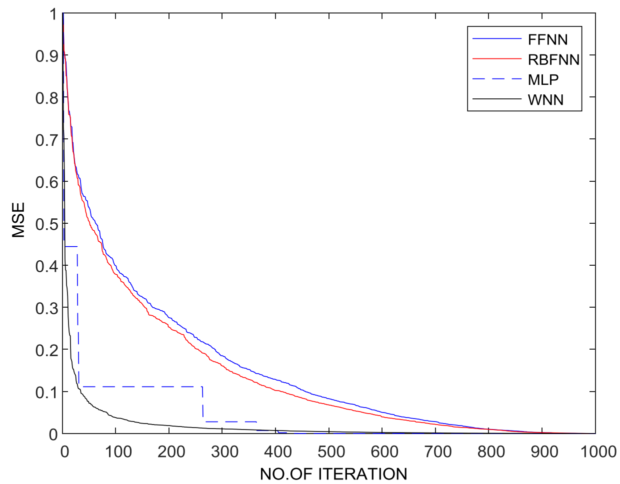

Fig.5 Classification comparison results

Table 2 Classification Accuracy of the models

Model	**No. of data**	**Computational time**	**Classification Accuracy**
RBFNN	1130	27.5487	93.28
FFNN	1200	21. 2548	95.85
MLP	1200	18.2547	97.89
WNN	1200	12.6587	98.93

Table 3 Segmentation Accuracy and Performance Evaluation

Algorithm	**Accuracy in%**	**Computational time**
FCM	**96.31**	**21.54**
WT	**98.87**	**11.27**

WT: Wavelet Transform
FCM: Fuzzy c means

4. DISCUSSION

Fig. 4(a) and Fig.4(b) presents the localization of infected areas of leaf diseases. The wavelet transform segmentation shows prominent identification of diseases. After segmentation the images are under gone for statistical feature extraction and the feature values are presented in Table-1.The segmentation accuracy has been shown in Table-3. The extracted features are fed as input to the proposed wavelet neural network (WNN)model for classification. The features are grouped into batches and applied for classification. It is found from the Fig.5 that, the wavelet neural network outperforms than the Radial basis function neural network [21], multi layered neural network and feed forward neural network. RBFNN,MLP took nearly 850 and 900 iterations to converge. The proposed WNN took nearly 400 iterations for convergence which is lowest in comparison to other models which can be observer visually from Fig.5.

5. CONCLUSION

This research work proposes a novel wavelet neural network by introducing a new wavelet function in the hidden nodes. The WNN is preferred for classification due to faster convergence speed and needs lesser number of hidden nodes in its structure. The leaf images are segmented by wavelet transform and applied for feature extraction. There are seven statistical features are obtained from 1030 images. Further, the features are given as input to the proposed WNN model for classification. It is found the accuracy of classification is 98.93 % which is higher than the other models presented in Table-2. The computational time taken by proposed model is 12.6587 seconds whereas the other models took higher computational time for convergence. The proposed WNN model can also be applied for other medical imaging data bases in future.

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