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Abstract: The multi-disciplinary agri-technologies domain have paved a way to the big data technologies, through Machine learning. Pest management is one of the most important problems facing farmers. A normal human monitoring cannot accurately predict the amount and intense of pests attacked. The issue of plant pests and diseases detection of agriculture has been tackled using the various available Neural Network (NN) techniques to process spectral data. In this manuscript, authors have presented a Back propagation Neural Network (BP-NN) model, which was developed on data of the reflectance spectra (in range of 400 to 900 nm) cashew trees leaves infested with a borer pest attack as well asgood leaves spectra. With the help of BP-NN model the classification accuracy was foundto be 85% which is quite good. However, the accuracy of the model needs to be improved with better trainingalgorithmandlargerdataset.

Keywords: Cashew Stem and Root Borer, Back-Propagation Neural Network (BP-NN), Machine Learning, pest detection, Principal Component Analysis (PCA)

1. Introduction

The agricultural sciences undoubtedly have undergone transformational changes with the usage of Information and Computation Technologies (ICT). The booming domain of machine learning (ML) techniques[1-3] have been applied to the phenotyping of plant stress (biotic and abiotic) throughidentification, classification, quantification, and prediction. One such ML technique that has carved a niche for the biotic stress of the plant disease detection, is Neural Networks (NN). With regards to processing the spectral data, several studies [4] have utilized the NN that use different algorithms through their techniques, structural variety and classifiers.As for disease detection and diagnosis, the combination of NN-spectral approach is commenced as a robust tool.

In this paper, we focus on biotic stress caused by a borer pest to commercial crops of cashews and mangoes. The Cashew Stem and Root Borer (CSRB) *Plocaederusferrugineus*is one such pest, that is evidently known to infest the crucial trunk regions and leads to the gradual death of yielding plantations [5]. The pest is invisible during day-time and causes sporadic type of damage. The pest density of CSRB increases over the years, resulting in significant loss of tree population. Thus, the cashew produce in a given region gets reduced over the years. Upon wide-spread proliferation, there is significant loss in nut yield causing distress to the farmers. The main issue with the detection is that, there is no indication on leaves (as shown in Fig. 1), until the boring of the trunk by the borer turns the treedead.

Fig. 1: photographs of the leaf samples for study categories: healthy condition and infested end.

Even worldwide, there is threat to different other trees like pines from borer pests [6-8].

2. History

As per literatures, the detection of borers based on tracking of the symptoms, have resorted to two main technologies: 1) satellite imagery [9, 10] and 2) Image processing [11-18]. Analogously, some studies have been done to trace the flying pest insects, itself [19, 22].

The works of detection CSRB is being ventured using Embedded Systems (through initial analysis via Spectroscopy of the leaves and bark samples) [20]. Also, an image processing technique to develop an RGB model was employed [21], having target on leaves portion of trees, for the early detection of CSRB, although not fruitful.
The different Neural Network (NN) techniques available are Single-Layer Perceptron (SLP), Multi-Layer Perception (MLP) [35,36], Radial-Basis Function (RBF) networks, Learning Vector Quantization(LVQ), Kohonen's Self-Organising Map(SOM) networks, Convolutional Neural Network (CNN) and Probabilistic Neural Network (PNN). These have been exerted thoroughly as per a review [4], for the specific application of plant diseasedetection.

Another review highlights the significance of using PCA, along with ANN, and enlists myriad related works [32]. It also brings out various pre-processing techniques pertaining to spectral data.

3. Methodology

In order to develop a BB-NN model of MLP type, for detecting the existence of borer infestation in early stage, we have followed the procedure formed around pre-processing of data, PCA and ANN. The executed steps are presented using of a flowchart of Fig.3 and implemented using MATLAB 2019b.

Dataacquisition

On-site data was collected in mid-winters of 2018. Altogether 20 trees were selected, 5 each in category of healthy, and infestations - initial, middle and end. A thorough field survey was conducted to recognize individual category, by noticing of dry, boring dust, which had been burrowed out of the bark surfaces during the tunnelling by borer.

Leaves were picked off from the pointed out trees and secured intoclean, sanitized and labelled zip-locked bag. All bags were placed in a containerof frozen ice-packs so as to deter any effect of temperature rise on the biochemical properties of the leaves, during the day progress while transportation. On arrival at theexperimentation location, all the leaves were expunged any water drops and dust, by using clean cotton before beginning thespectra recording.