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Leaf Disease Diagnosis using Online and Batch Backpropagation neural network

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***Abstract*—**Productivity of the crops is affected due to diseases. Traditional disease diagnosis system is very time consuming in which pathologist carried out experimentation in the laboratory. Hence it is needed to produce the system which diagnosis the disease accurately and fast with the help of the technology. Identifying disease of crops in its early stage is a major challenge in front of researchers. Many machine learning algorithms and image processing techniques are applied to efficiently identify the disease based on the symptoms that appeared on the leaves. In this paper, the infected leaf is segmented using the Kmeans clustering algorithm and further the 12 texture features are extracted from the segmented image. The backpropagation (BP) algorithm is used for identifying the disease. Here two versions of the backpropagation i.e. online BP and batch BP are used. The Pomegranate infected leaf image database is used for the experimentation purpose. It is observed that online BP performance is better as compared to the batch BP.

***Keywords*—**Leaf disease, Agriculture,Backpropagation neural network

I. INTRODUCTION

Agriculture is the prime and important occupation in India, which is facing problems of the low productivity. Precision agriculture is the field in which the latest advanced technologies such as remote sensing, computer vision, image processing and machine learning are used to improve the productivity. When the plants are infected with disease, its symptoms are physically appeared on its leaves. The leaf disease diagnosis system uses these symptoms and detects accurately the disease of plant in early stage, using machine learning and image processing algorithms. Hence, the measures can be taken at proper time to diagnosis the disease. Leaf disease diagnosis system consists of the 5 steps: Image Acquisition, Image Preprocessing, Image Segmentation, Feature Extraction, Image classification. In Image acquisition step, the infected and healthy leaf images are aquired either by camera or spectrometer. Digital camera will capture color image which is RGB visible band reflections, whereas spectrometer captures the other electromagnetic spectrum band reflections (i.e. Hyperspectral imaginging) which helps in identifying disease at its early stage. In [1], S. Sankaran has given detailed review of plant disease diagnosis where they discussed about difference between colour and hyperspectral imaging. Sometimes these images are either not clear or contain the unwanted signal i.e. noise. In image preprocessing, the images are enhanced using some image enhancement techniques such as contrast stretching or histogram equalization. The noise is removed from the image using different filtering mechanisms. Once the image is preprocessed, the segment of the infected part of image is extracted and used for further processing. This process is known as the segmentation. The most important step of the leaf disease diagnosis system is the feature extraction technique used in the system. The success of this system is majorly dependent on the features, that are extracted from the infected images. Color, texture and shape features are extracted from the infected image. These features are further given as an input to the classifier which identifies the disease. There are many classifiers such as Support Vector Machine, Backpropagation neural network, K Nearest Neighborhood and Naïve bays algorithm, which can be used in leaf disease diagnosis system. Backpropagation algorithm predicts disease accurately. In this article, the online and batch backpropagation algorithms are used for leaf disease classsification. Kmean algorithm is used here for the segmentation. Total 12 texture features are extracted from the Gray Level Cooccurance Matrix (GLCM). It is observed that online BP performance is better than the batch BP.

The paper is organized as follows, Section I contains the introduction of leaf disease diagnosis system, Section II contains the related work carried out on segmentation,

feature extraction, and classification techniques, used in leaf disease diagnosis system. Section III contains the methodology used here for leaf disease diagnosis system using backpropagation neural network algorithm. Section IV describes the comparative result analysis of the online and Batch BP used in disease detection. Section V concludes the research work with future scope.

II. RELATED WORK

The leaf disease diagnosis system consists of three main research domains as shown in figure 1.

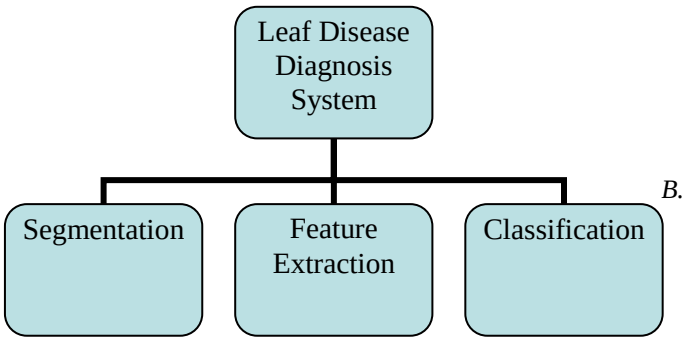

Figure 1. Research Domains in Leaf Disease Diagnosis System

Hence the literature survey is carried out in these three domains.

A. Segmentation in Leaf Disease Diagnosis System

In [2] V. Singh and A. Mishra proposed the new segmentation technique using genetic algorithm for leaf disease detection. In [3] S. Vijayalakshmi given comparative analysis of different segmentation techniques used for plant disease detection system. Bashish et. al. [4] has used Kmeans clustering for the segmentation purpose in leaf disease detection system. They claimed that kmeans clustering gives prominent result and used with ANN classifier, which gives 93% accuracy. M. Islam et. al [5] has used plant village dataset of potato crop. Instead of using Otsu's auto threshold method, authors have invented threshold using Colour Thrsholder app in Matlab. Once these thresholds are identified for each channel, the infected part is segmented from the image. They have used SVM for classification and claimed 95% accuracy. In [6] V Gulhane and A Gujar have performed segmentation of cotton leaves using self-organizing map and genetic algorithm. Gabor Wavelet is used on segmented image to extract the colour features prominently. For classification purpose they used SVM algorithm.

B. Feature Extraction

In [7] Yang-Cheng Zangh et al proposed fuzzy feature selection approach using fuzzy curves and surface to select features from infected cotton leaves. In [8] SP Mohanty et al used deep learning for disease classification. They used plant village dataset. Convolutional neural network is used for feature extraction purpose. In [9] P Balamurugan et. al used the Distance feature using line moving algorithm along with Histogram of Gradient (HOG) features. MF Kazeroun et. al [10] used SIFT features for leaf species recognition. JK Patil et. al [11] applied colour features for detecting tomato disease. In [12] S Arivazhagan et. al applied texture features for recohnizing healthy and unhealthy leaf image. In [13] Q Yao et. al combines shape and colour features for leaf disease detection.

C. Classification

The extracted features are applied further to the classifier for leaf disease detection. There are various classifiers such as Artificial Neural Network, SVM, KNN and Naïve Bays classifiers used for plant leaf disease diagnosis system. [4], [8], [9], [14] and [17] used ANN for the classification of disease. [5] and [15] used SVM for classifying colour and hyper spectral image data respectively. In [16] SD Bauer et al used RGB and multispectral dataset of sugar beet leaves. They used KNN and adaptive Bays method for the classification. In [17], Priyanka PT and SA Angadi classified normal and affected fruits images using neural network approach. In [18], A patil et al discussed different image processing techniques used in leaf disease detection. In [19], G patil discussed the digital image processing field used in plant disease diagnosis.

It is observed from the literature survey that plant disease diagnosis system uses image processing, neural network, fuzzy logic, genetic algorithm, SVM, KNN and deep learning.

III. METHODOLOGY

In this paper, the leaf disease diagnosis system is implemented using backpropagation neural network. Here the performance of the online and batch backpropagation neural network algorithm is compared after applying them on leaf disease diagnosis system. The leaf image dataset of 73 images is used for the classification. There are 5 classes present in the dataset. They are 1) Alternaria Alternata (20 images) 2) Anthracnose (23 images) 3) Bacterial Blight (6 images) 4) Cercospora Leaf Spot (9 images) and 5) Healthy Leaves (15 images). Sample image of each class in dataset is displayed in figure 2.

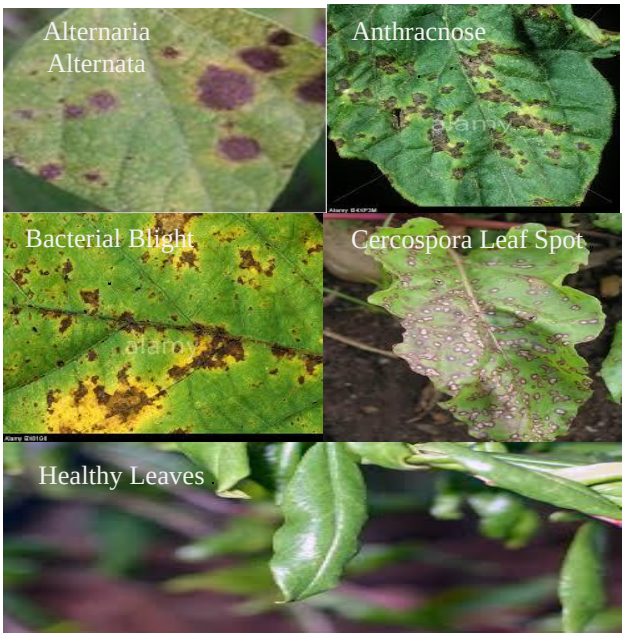

Figure 2. Sample Leaf Disease dataset used for experimentation

The flowchart in figure 3 describes the model implemented here.

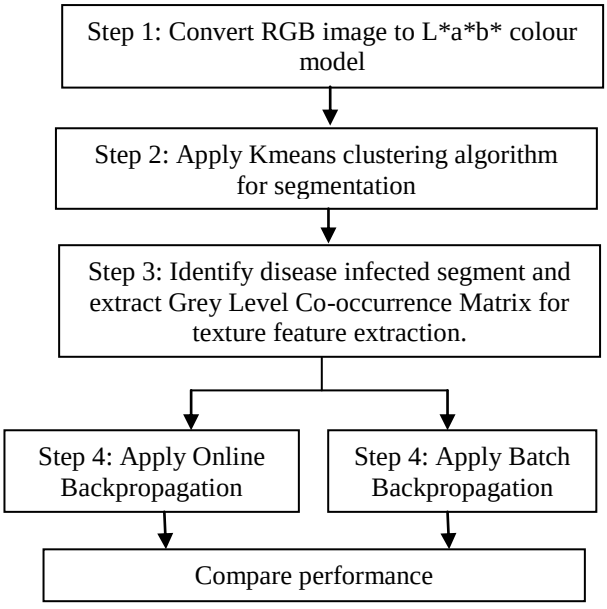

Figure 3. Leaf Disease Diagnosis System using Online and Batch BP

As shown in figure 3, the kmeans algorithm is used for segmentation purpose. Total 12 texture features are extracted from Grey Level Co-occurrence Matrix (GLCM). They are Contrast, Correlation, Energy, Homogeneity, Mean, Standard Deviation, Entropy, RMS, Variance, Smoothness, Kurtosis and Skew. Here the online and batch version of the backpropagation neural network is used for classification purpose. In next section, the working of the backpropagation algorithm is explained.

A. Backpropagation Neural Network

Backpropagation neural network is the famous supervised classifier. The input given to the backpropagation is the labelled data. The neural network, used in this model has three layers: Input, Hidden and Output layer. As shown in figure 4, the extracted features of each input image are given as input to the input layer neurons, which do not contain any activation function. The input and hidden layers are connected with weighted synaptic links. Similarly the hidden and output layers are also connected with each other by weighted synaptic links. The link with input -1 is termed as bias. The weighted sum is calculated by using each incoming weighted synaptic link of the neuron which is also termed as a net. The net is further given as input to the hidden layer neurons, on which activation function is applied to generate the output.

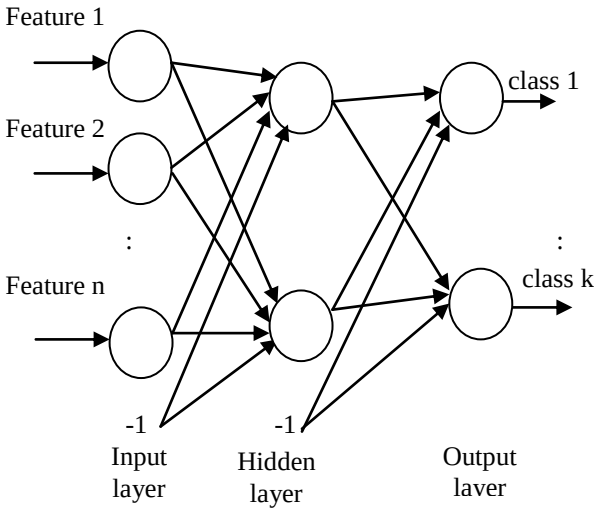

Figure 4. Feedforward neural network architecture used for leaf disease diagnosis system

The output of the hidden layer neuron is inputted to the output layer neurons and similar process is repeated to generate the output of the output layer neurons. The final output is compared with its desired output and if there is mismatch between them, then the /synaptic weights are changed to reduce this gap. As the error is backpropagated back to find the amount by which weights are updated, the algorithm is named as error backpropagation.

The backpropagation algorithm is divided into two types:

1) *Online Backpropagation*: In online BP, the weights are updated immediately after applying each image.

2) *Batch or offline Backpropagation*: In batch BP the weights are updated after applying all images in training set.

In figure 4, the value of n used here is 12 and value of k is 5 as we have extracted total 12 features from each image and

classified it into 5 different classes. In this experimentation the 10 neurons are used in hidden layer.

IV. RESULTS AND DISCUSSION

In this paper, the online and batch BP is applied for leaf disease diagnosis system. As BP performance is dependent on the initial weights chosen, online and batch BP algorithm is run for 10 times with different initial weights parameter. The 10 fold validation is used here to avoid over fitting problem. Two performance parameters are used in each trial, for evaluation purpose: a) Maximum accuracy achieved in 10 fold validation and b) Average accuracy of the 10 fold validation. Figure 5 and 6 shows the graph plotted of maximum accuracy and average accuracy of each trial, when applied online and batch BP respectively.

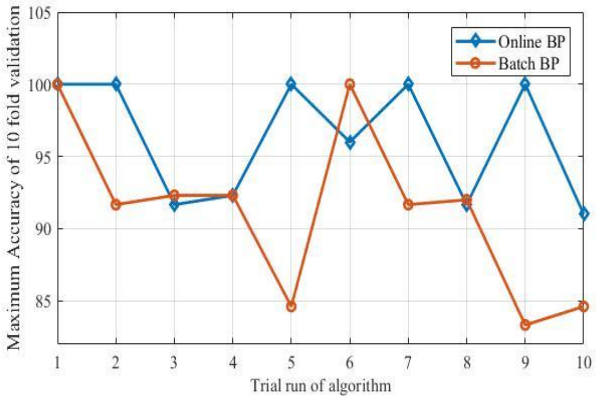

Figure 5. Comparision of maximum accuracy in 10 fold validation of online and batch BP, when run 10 times with different initial weights.

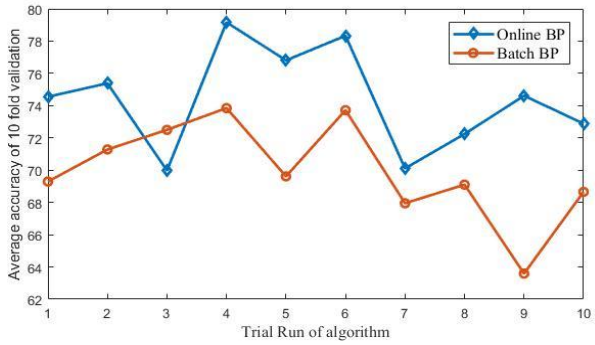

Figure 6. Comparision of average accuracy of 10 fold validation of online and batch BP, when run 10 times with different initial weights.

Here it is observed that online BP performs better as compared to the batch BP.

V. CONCLUSION AND FUTURE SCOPE

The backpropagation algorithm is well proven for classification purpose. In this paper two versions of the backpropagation i.e. online and batch BP are applied for leaf disease diagnosis system. It is observed that the performance of the online BP is better as compared to the batch BP. Here the dataset used is small in size. The performance can be verified on large amount of dataset available on plantvillage website.

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