# A Hybrid Approach for Plant Leaf Disease Recognition Using Image Processing Techniques

**Abrham Debasu Mengistu, Dagnachew Melesew**

*Abstract*— **Plant leaf disease recognition based on image processing provides quickly, more reliable diagnosis and control of plant diseases. 15 features were extracted (four morphology, five GLCM (gray level co-occurrence matrix) and six color features) were identified from the image of four kinds of plants i.e. maize, mango, banana and avocado. We were used and compare ANN (Artificial neural network) and SOM together with RBF (self organizing map and radial basis function) were used to recognize plant leaf diseases and compared. The experiments were conducted under four scenarios by using feature sets of morphology, texture and color separately, and finally combining the three feature sets. The total number of data sets is 10380. Out of these, 70% were used for training and the remaining 30% were used for testing. In general, the overall result showed that morphology and color features have more discriminating power than texture features and the recognition performance of combination of RBF and SOM is 92.96% and by far better than ANN.**

*Index Terms*— **SOM, RBF, ANN, Plant Diseases**

## I. INTRODUCTION

Plant disease affects plants which occur on the leaves, stems and roots, nowadays plant diseases becomes critical problem and can cause significant reduction in both quality and quantity of agricultural products [1]. The aim of plants is not only to feed population but also an important source of energy in addition to this they can provide a solution to solve the problem of global warming [1]. Diagnosing of plant disease is very important in order to cure and control the spreading of diseases. The method of diagnosing these plant diseases is by using naked eye, in order to identify the diseases in this method experts are involved who have the ability to detect spot on the leaf and the changes in leaf color [2]. There are three types of plant diseases which occur on the leaves part of plants there are 3 types of microorganisms that cause plant leaf diseases these are fungi, virus and bacteria. Fungal leaf spot can be found on plant leaves. Spotted leaves occur when fungal spores in the air find a warm, wet, plant surface to cling to [3]. As soon as that microscopic spore gets comfortable in its new home, sporulation (the fungal method of reproduction) occurs and the tiny brown fungal leaf spot begins to grow. Bacteria are microscopic single-cell organisms that reproduce by dividing in half. This process may occur as often as once every 20 minutes, or it may take several hours. In some of the faster multiplying species, a single bacterium can produce over 47 million descendants in 12 hours. Viruses are immobile and are usually transmitted from one plant to another by a living organism called a vector or carrier. Viruses can also be transmitted by other insects, mites, nematodes, fungi, infected pollen or vegetative propagating material, contact between plants, and infected or contaminated seeds [4].

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## II. RELATED WORK

Some papers are describing the detection of leaf disease using various methods, suggesting the various implementation ways as illustrated and discussed here.

P.Revathi, M.Hemalatha[1] , in this paper the authors consists of two phases to identify the affected part of the disease. the first phase is using edge detection this help the authors to detect the border of the image. The second phase is analysis and classification of diseases is done, using the proposed Homogeneous Pixel Counting Technique for Cotton Diseases Detection (HPCCDD) Algorithm. The goal of this research work is identify the disease affected part of cotton leaf sport by using the image analysis technique [5].

Dheeb Al Bashish,et al, in this research the authors have proposed A Framework for Detection and Classification of Plant leaf and Stem Diseases in which the images at hand are segmented using the KMeans technique, RGB input images are converted into HIS color space this helps the author to know the values of hue intensity and saturation of the given image once the authors knows the values of HIS then the next is calculating color of the given image. The authors used neural network classifier that is based on statistical classification is used for classification [6]. Elham Omrani, et al[4] have proposed Potential of radial basis function-based support vector regression for apple disease detection, detection of leaf diseases has been used [7].

[Prakash M. Mainkar, Shreekant Ghorpade]. [8], in this paper, the authors are providing software solution to automatically detect and classify plant leaf diseases. They are using image processing techniques to classify diseases. They include image processing techniques like, image acquisition, image pre-processing, segmentation, features extraction and neural network based classification.

[Premalatha.V, Valarmathy.S, Sumithra.M.G]. [9], in this paper, the authors have used spatial FCM & PNN (Fuzzy C-Means and Probabilistic neural network) on cotton plant to identify the pest & type of disease in cotton plant. They have used Image acquisition devices to acquire images of plantations at regular intervals. These images are then subjected to pre-processing finally they applied median filtering technique in order to minimize noise. The

pre-processed leaf images are then segmented using Spatial FCM clustering method.

[Nikita Rishi, Jagbir Singh Gill]. [10], in this research, the authors have used different plant diseases based on different techniques these techniques include Otsu method, image compression, image cropping and image denoising including K means clustering to articulate the disease images. Neural networks including back propagation (BP) networks, radial basis function (RBF) neural networks, generalized regression networks (GRNNs) and probabilistic neural networks (PNNs) are also used to diagnose wheat and grape diseases. Cotton leaf diseases and rice plant disease using sobel operator, canny filter and feature extraction are passed down to recognize the disease. Many other diseases like orchid leaf disease, rubber tree leaf disease; apple fruit disease and chili plant disease can also be encountered using other approaches like fuzzy logic, Multi-class Support Vector Machine and Local Binary Pattern. A miniature explication on all the diseases and their detection has been given in this paper. [Jayme Garcia, Arnal Balbedo], in this paper the authors presents a survey on methods that indicates use digital image processing techniques on agriculture to detect, quantify and classify plant diseases from digital images in the visible spectrum. [11]. [Haiguang Wang, Guanlin Li, Zhanhong Ma, Xiaolong Li], in this paper plant disease identification based on image processing could quickly and accurately provide useful information for the prediction and control of plant diseases. They extracted, 21 color features, 4 shape features and 25 texture features were extracted from the images of two kinds wheat diseases (wheat stripe rust and wheat leaf rust) and two kinds of grape diseases (grape downy mildew and grape powdery mildew), principal component analysis (PCA) was performed for reducing dimensions in feature data processing, and then neural networks including backpropagation (BP) networks, radial basis function (RBF) neural networks, generalized regression networks (GRNNs) and probabilistic neural networks (PNNs) were used as the classifiers to identify wheat diseases and grape diseases, respectively. For the two kinds of grape diseases, the optimal recognition results were obtained when GRNNs and PNNs were used as the classifiers after reducing the dimensions of feature data with PCA [12].

## III. Statement of the Problem

Plant diseases are caused by bacteria, fungus or virus. A better understanding of each will help in the diagnosis and thus treat the problem if possible. This method involves lots of efforts, takes long time and also not practical for the large fields. Many times different experts identify the same disease as the different disease.

On the previous researches there is a scope for the design of classifier to detect the type of plant diseases, this provides better and more reliable results for the plants, in line with this, and plant leaf diseases identification is very useful in encouraging good quality in plant diagnosis. There is a need for automated in recognition of plant leaves disease so that the abuses during diagnosis and treatment can be minimized. To this end this study answers the following research question

- To what extent recognition effectiveness is registered for the plant leaves diseases?
- What are the features that distinguish the three types of plant leaf diseases?
- How to develop an automatic plant leaf diseases recognition system based on image processing techniques?

## IV. Methodology

In order to achieve the objectives of the research, literatures on contemporary development of image processing related to plant leaf diseases will be reviewed. From these insight reviews of image processing techniques and tools that were employed on plant leaf diseases recognition and identification that were relevant to this work will be selected. These image processing techniques are selected based on the performance they had on the current related works. The methods and tools that are used in this research work are described in the following sections

## V. Materials and Tool

A digital camera model canon EOS 600d, 8 Mega Pixel, was used to record leaf images. When images were taken, the camera was mounted on a stand which provides easy vertical movement and stable support for the camera. The camera was fixed at a distance of 130mm from the sample table in order to get clear images of coffee beans. To obtain uniform lightning or balanced illumination, an incandescent lamp whose light source was 100W with a rated voltage of 220V was used in all experiments. The lighting system was switched on for about 5 minutes prior to acquiring any images for its stabilization. In-order to reduce the influence of surrounding light, we took the samples in a controlled room. The images were taken at resolution of 1632x1224 pixels

## VI. Implementation Tool

For image processing of plant leaf diseases recognition MATLAB 2013Ra on windows platform is used because of MATLAB is the high-level language and interactive environment used by millions of engineers and scientists worldwide. Therefore, for the purpose of displaying, editing, processing and analyzing and recognizing of plant leaf diseases recognition were used on MATLAB environment.

## VII. Design of Plant Leaf Diseases Recognition

First stage in plan leaf diseases recognition is input image. Plant leaf image in digital format is given as input to the system. The second steps for plan leaf diseases recognition is that preprocessing of image, preprocessing image commonly used removing low frequency background noise, normalize the intensity of the individual particle image, removing reflection and masking portion of image these noises cause errors in classification. The noises are removed by filtering. Filtering method implemented here is the Median Filtering. In feature extraction stage, the features of plan leaf diseases recognition are extracted to feed into the classifiers. The feature should be measurable, highly sensitive, highly correlative, high specificity, high probability of true positive and negative response. The final step of plan leaf diseases recognition is the classification stage. A classifier classifies the given datasets into their corresponding class. In order to train the classifiers, a set of training of leaf diseases image was required, and the class label where it belongs to, 10380 plan

leaf diseases were taken from Amhara agricultural office from the predefined three types of plan leaf diseases i.e. Bacteria, fungi and virus.

The task of recognition occurs in wide range of human activity. The problem of recognition is concerned with the construction of a procedure that will be applied to differentiate items, in which each new item must be assigned to one of a set of predefined classes on the basis of observed attributes or features. Accordingly, image analysis or computer vision is used in the recognition of plant leaf diseases to predefined classes. The predefined classes are the feature or attributes that are computed from plant leaf images. These observed features of plant leaf were used to decide the class or the type of plant diseases. Hence, in this research the main interest is to differentiate the type of plant leaf diseases varieties by using image analysis technique, this is because of in order to maximize the curability of the disease if we identify the type of plant diseases where it belongs to it is very simple to cure and also simple to stop spreading to others.

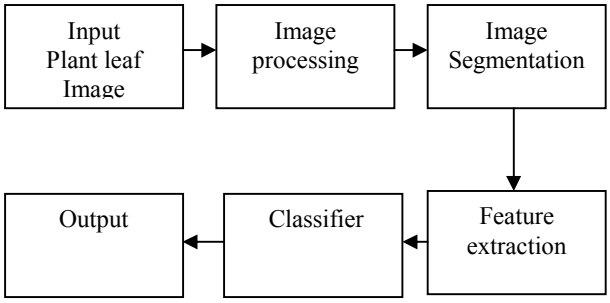
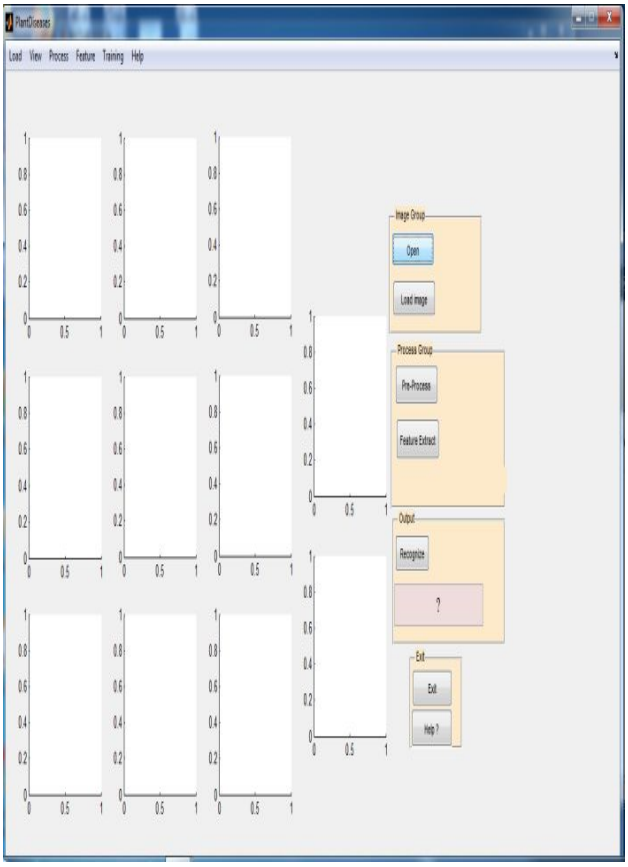



Figure 1: Plant disease recognition block diagram



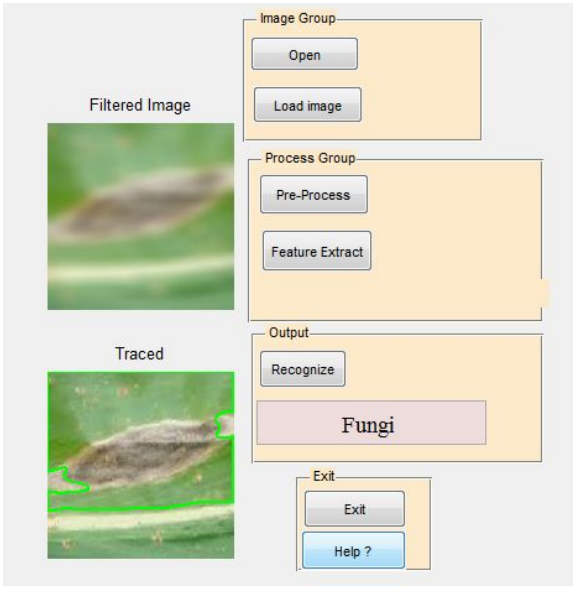



Figure 2: Plant leaf diseases recognition prototype

Feature extraction is the method by which unique features of plant leaf images are extracted. This method reduces the complexity in classification problems. The purpose of feature extraction is to reduce the original data set by measuring certain properties, or features, that distinguish one input pattern from another. We have the following three groups of features:

GLCM (Texture features): GLCM is a powerful tool for image feature extraction by mapping the grey level co-occurrence probabilities based on spatial relations of pixels in different angular directions. Morphological features: Morphology is the geometric property of a given image, in our case it is the size and shape characteristics of plant leaf diseases image.

Color features: Color is one of the features of plant leaf diseases, they have different color variation of each type and color analysis computed by taking.

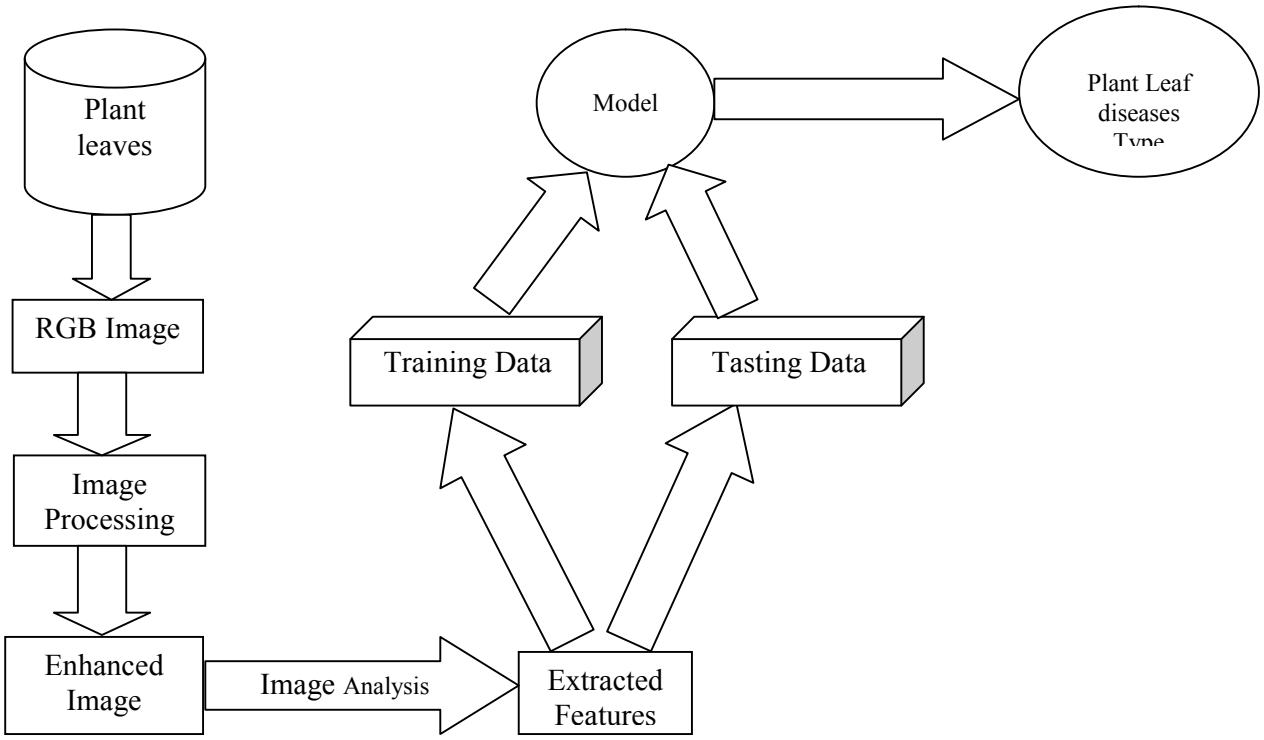



Figure 3: Plant leaf diseases Recognition process model

## VIII. RESULTS

15 extracted features (four morphology, five GLCM and six color features) were identified; hence, the total input features were fifteen we have fifteen input neurons in the input layer. These features were used to classify different plant leaf diseases. experimental scenarios were designed to test the classification performance by taking the extracted features of leaf image The classifications were tested by three different algorithms namely ANN (Artificial Neural Network) and SOM (self organizing map) together with RBF(Radial basis function) in order to get a more accurate result. There are two basic phases of pattern classification: training and testing phases in the training phase, data is repeatedly presented to the classifier, in order to obtain a desired response. In testing phase, the trained system is applied to data that it has never seen to check the performance of the classification. Hence, there is needed to design the classifier by partitioning the total data set into training and testing data set. A combination of RBF and SOM Were used for recognizing plant leaf diseases from the given image, we use RBF for fully controlled environments and SOM for uncontrolled environments. In RBF, all the training data is given to the network for training. Once the network is trained using RBF it is very simple to differentiate the diseases. Then the output of this RBF is taken by SOM for uncontrolled environments this help us to take a minimum iteration for choosing the activation value and also provides a higher rates of convergence.

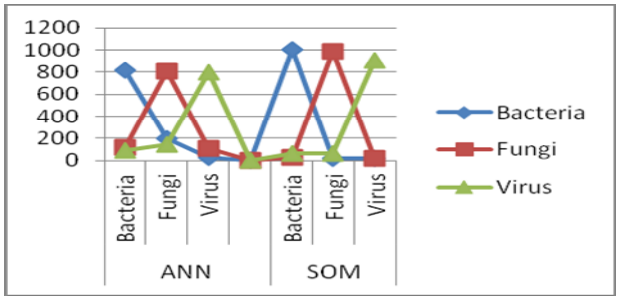



Figure 4: Overall performance of plant leaf diseases recognition

| | ANN | | | | SOM | | |
|---|---|---|---|---|---|---|---|
| | Bacteria | Fungi | Virus | | Bacteria | Fungi | Virus |
| Bacteria | 815 | 198 | 25 | Bacteria | 1002 | 17 | 19 |
| Fungi | 121 | 806 | 111 | Fungi | 29 | 986 | 23 |
| Virus | 91 | 149 | 798 | Virus | 66 | 65 | 907 |
| | Total | 3114 | | Total | 3114 | | |
| | Classified | 2419 | | Classified | 2895 | | |
| | misclassified | 695 | | misclassified | 219 | | |
| | % | 77.68144 | | % | 92.96724 | | |

Table 1: Summary Result of ANN and SOM Classifier Using All Features

As we have presented in detail in the previous section, the experiments were conducted under four scenarios by using feature sets of morphology, texture and color separately, and finally combining the three feature sets. Then, the experiment results were compared; the performance of ANN and SOM together with RBF classification over the three scenarios. The total number of data sets is 10380. Out of these, 70% were used for training and the remaining 30% were used for testing. In general, the overall result showed that morphology and color features have more discriminating power than texture

features and the classification performance of combination of SOM and RBF is by far better than ANN.

| Paper | Features Extraction | Feature Extraction Technique | Classifier | Plant |
|---|---|---|---|---|
| V. A. Gulhane, et al[1] | 1. color<br>2. shape of holes | Unsupervised self organizing feature map. | ANN | Cotton |
| S. Arivazhagan, et al[2] | 1. Color<br>2. Texture | Color-Co-Occurrenc e methodology(CCM). | SVM. | Native plant species |
| Dheeb Al Bashish, et al | 1. Color<br>2. Texture | CCM | ANN | Five diseases which effect on the plants; they are: Early scorch, Cottony mold, Ashen mold, late scorch, tiny whiteness. |
| Elham Omrani, et al | 1. Color<br>2. shape<br>3. Texture | Wavelet transform, SGDM and CCM. | support vector regression (SVR) | Apple |
| Haiguang Wang, et al | 1. Color<br>2. Texture<br>3. Shape | Principal component analysis (PCA) | BPNN, RBFNN, GRNN and PNN | Wheat and grape diseases. |
| Santanu Phadikar, et al | 1. Boundary<br>2. Edge<br>3. Spot | Boundary detection algorithm | ANN | Rice |
| P. Revathi, et al | 1. Edge<br>2. CMYK color<br>3. Texture | Enhanced PSO and GA algorithm. | SVM, BPN, Fuzzy | Cotton |
| Abrham Debasu & Dagnachew Melesew | 1. Color<br>2. Texture<br>3. Shape | PCA +GA | RBF+SOM | Maize, Mango, Banana and Avocado. |

Table 2: Comparison of work

## IX. Conclusion and Future Work

The result of the experimentation showed that the three varieties of plant leaf diseases have been classified more accurately by SOM than using ANN classifier. The image analysis for the recognition of the type of plant leaf diseases can be further investigated. The work can also be seen in depth and researched by the different characteristics of its physical and chemical in connection to image technology. In light with this, the following recommendations are made for further research and improvements. Identification of leaf diseases type by exploring more features, leaf diseases recognition by levels of injuries using image analysis, implementing on mobile to make simplified for experts

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