Agribot for Detection of Leaf Disease based on Support Vector Machine (LD-SVM) Classifier

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***Abstract*— The twin benefits of ease and efficiency in the automated agriculture usually provide a beneficial solution for today's highly complicated real – time embedded system. While allowing high resource utilisation and executing critical real time tasks such as ploughing, sowing, levelling, irrigation and leaf disease, detection is carried out along with herbicide sprayer with acceptable efficiency. This paper presents an innovative idea towards the design and development of an agricultural robot (Agribot) and leaf disease detection with a mixture of texture and feature extraction using Support vector machine (SVM) classifier. Our first contribution is development of an Agribot. Based on the environmental factors such as temperature, humidity, soil pH and moisture the robot intimates the farmer which crops should be sown to get good yield and the Agribot when placed into the farm does all the agricultural activities in either automatic mode or manual mode. The second contribution is the leaf disease detection in crops. The purpose is to differentiate between the healthy and diseased leaf. The images of leaves are gathered, pre-processed followed by the feature extraction and classified based on SVM classifier.**

Keywords—Agribot, SVM, Sensor nodes, machine learning.

I. INTRODUCTION

Generally, we still use the traditionally methods for all the agricultural activities be it seed selection, tilling, ploughing, sowing, levelling, harvesting and threshing. Although agriculture has been the backbone of our economy and will continue to remain until and unless certain new methodologies are adopted according to the current emerging technologies. As modern agricultural equipment's and technologies are expensive henceforth aren't bearable by the small land holders [1]. But by adopting certain scientific farming methods which are quite feasible and affordable can help the farmers get good yield and good quality of crops which can prevent them from being bankrupt. Due to lack of knowledge or lack of investment for utilizing modern techniques in agriculture sector majority of the farmers are still using primitive methods for farming.

The usage of hand tools for cultivation is predominant in India as the access of the tractors isn't easy for the farmers. In the developing countries such as ours, sustainable improvement in the livelihoods of farmers depends largely on the adoption of improved resource conserving cropping system. Most of the necessary cropping components already exist, the information on the availability and the knowledge of the performance of equipment is lacking in us and the effective communication between the agricultural researchers or engineers and the development department is becoming unsuccessful.

Modern agricultural equipments that feature all the necessary agricultural tools such as plough, seed drawer, a leveler and a pump which allow ease and efficient method of agriculture for the farmers along with low cost. The above facilities must result in good yield of crops and should be accessible to even small land owners.

Differentiating between a healthy leaf and a diseased leaf and what kind of precaution can be taken i.e. which fertilizer or non harmful chemical or homemade techniques can be used to stop the further spreading of the disease.

A. *Designing of an Agribot:*

Recently, a few interesting researches have been done in the agricultural sector that allow optimum resource utilization. Basically, a robot is assembled along with four major sensors required for agricultural purpose i.e. pH, moisture, humidity and temperature sensor. When the robot is placed into the farm and the sensor readings are taken, these readings are sensed and the sent to the farmer's number and also a pre defined data set is fed. So according to the sensor output the data will be crossed matched with the data base and a particular crop suitable for that particular area and temperature which provides good yield will be sent via SMS. Once the farmer decides which crop to be sown then the Agribot is placed into the field and there are two modes of operation of the robot i.e. it works either in manual mode or automatic mode. When working in an automatic mode the robot begins its activity by placing the plough on the ground and seeding in forward direction. On completion of a straight line the robot moves in reverse direction where it levels the soil back and continues the process until the required amount of farm is cultivated. Based on the moisture sensor output the required amount of water is being irrigated in the farm. Manual mode can be accessed either by using a Zigbee module or a Wi- fi module. In case of a Zigbee module, a GUI is created and the robot can be accessed by the conditions using MATLAB software, while by using a Wi- fi module the robot can be communicated by using an application in the cell phone.

B. *Leaf disease detection*

This stage has different stages starting with collection of images to setup a database. Using clustering an segmentations of data is perfomaed [2]. Features are stored and utilized by SVM classfier to identify the disease and make sugeestions.

- **Shape feature extraction:**

Measurement of eccentric and minor axis of the spots on image provides a solidity of image and helps in shape feature extraction of given image.

- **Color Feature Extraction:**

Scaling translation is majorly done by using color feature extraction mean, skewness and kurtosis are usde to represent above features.

- **Multi Support Vector Machine:**

Hyperplane is used for image sepration which is calculated in accordance with decision fucntion. Using weight and threshold values.

Applying it to carious machine learning algorithms like back propogation and feed forward provides a limitation in feature extraction where as the SVM classfier provides better results.

II. SURVEY WORK

Earlier papers that describes about detecting pests mainly like, whiteflies, thrips, aphids etc. By using various approaches [3], different ways of implementing are illustrated and discussed below. Our Proposed work is based on a cognitive visualization system that combines image processing, learning and knowledge-based techniques. They only detect established stage of white fly and count the total of flies on single leaflet. For this process 180 images as test images. including this image, they tested 162 images and each image developing 0 to 5 whitefly pests. They calculate false negative rate (FNR) and false positive rate (FPR) for test images with no whiteflies (class 1), at least one white fly (class 2) and for entire test set. To detect pests in controlled environment like greenhouse extended implementation of the image processing algorithms and techniques were carried out. Three kinds of typical features including size, morphological feature (shape of boundary), and color components were considered and investigated to identify the three kinds of adult insects, whiteflies, aphids and thrips. indorsing the early pest detection in green houses based on video examination. The goal was to define a sustenance system which handles a video camera data. They implemented algorithms for detection of only two bio aggressors name as white flies and aphids [4].

III. METHODOLOGY OF PAPER WORK

From decades thee development of leaf diseases detection is been considered as a serious development which leads to major conclusion:

- Most of methods have been tested are specific to particular purpose, like detection of particular diseases.
- Detection methods are not generalized to many other diseases.
- Change in the environmental conditions such as light, temperature, humidity etc.
- Technical conditions such as angle of capture depth of extraction of features.

Methods if properly applied like neural networks, genetic algorithms and SVM can be very powerful tools. One of the most commonly used methods in leaf feature extraction is based on morphological features of leaf. Some simple geometrical features are feature ratio, rectangularity, convexity, sphericity, form factor etc.

Image caputerd can be transferred automatically after capture and using basic descriptions available we can classify the leaf based on features like Histogram equalization, edge detection, geometry of the leaf, later make use of the MATLAB resource available.

Indeed, there are plentiful advantages of combining MATLAB with the leaf recognition program from the computer. The method of detection and classification is showed by using preprocessed images from the system. Further the texture extraction is also included

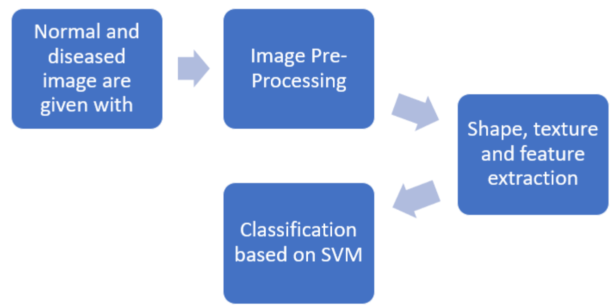


Figure 1 Block diagram of Image processing

Most of the systems designed for agriculture operations such as seeding weeding and fertilizer spraying which are engaged on the system based on camera and machine vision. The vehicle is engaged and operated remotely based on GPS or WiFi module. This module has electronics and mechanical perspective of development and provide a cost-effective solution to various problems based on images captured.

IV. IMPLEMENTATION

The first step in our proposed work is to process the training data. The images of leaf of a plan are captured using a digital camera, to process the data set. After that, the techniques for image preprocessing re applied on the processed data. The features of the image are extracted from the feature selection technique, once the preprocessing is done. These features are then used as the samples for training in the algorithm, which is machine learning based algorithm, called Support Vector Machine Classifier (SVM). Finally, the image is captured, once the training samples are applied in the algorithm. This phase is called the detection phase, where the final captured image detects if, the leaf is infected or not. The proposed detection system model is shown in the figure 2.

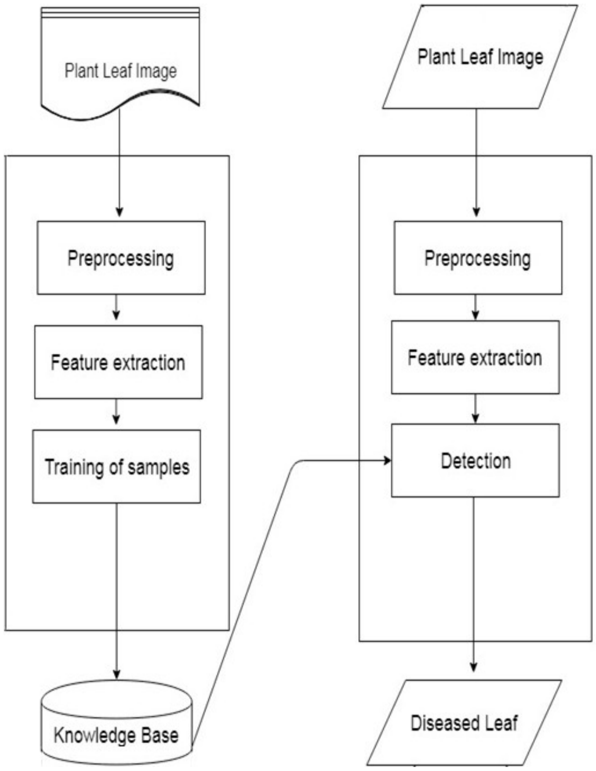


Figure 2: Proposed Detection system model

Certain images of the leaves are captured and then sent to the PC having MATLAB where the images of the leaves are classified as either healthy leaves or diseased leaves using SVM algorithm. The leaf disease detection is done in the following steps:

1. An image is selected from the Data set folder by opening the folder.
2. Creating a grey level cooccurrence matrix (GLCM's).
3. Evaluating 13 different features (Contrast, Correlation, Energy, Homogeneity, Mean, Standard Deviation, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, and IDM).
4. Deriving statistics from GLMS's
5. Putting all the features in the array
6. Training the classifier
7. Classify the leaf based on healthy or unhealthy and in case of unhealthy what kind of disease is it suffering from?

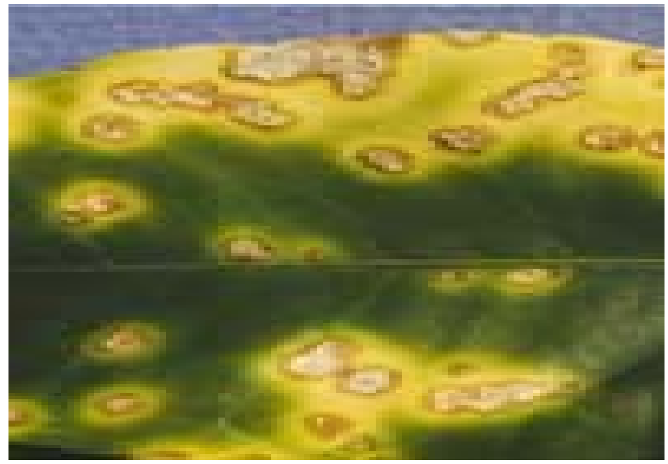


Figure 3: An Unhealthy leaf (Citrus canker)

Figure 4: A Healthy leaf

A) Dataset

In our work, the images were captured and collected from many other sources, one of which included the field farm in Kalaburagi district. The leaf images were collected from three different plant crops, namely, tomato, wheat and cucumber. In the table below, the dataset for three different plants is shown, along with their types of diseases and no. of samples for which detection was performed. Also, the samples for the groups specified for different crops are shown as an image in figure 5.

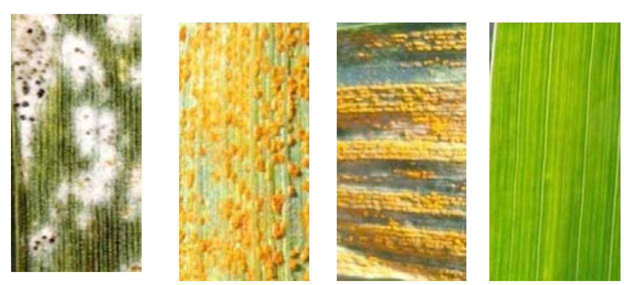


Figure 5: Images of Different Crops

Wheat (healthy) Wheat (stripe rust) Wheat orange (Rust) Wheat Powdery mildew

Table 2: Dataset for diseased leaf

Name of crop	Type of Case	Number of Samples
Wheat	powdery mildew	70
Wheat	orange rust	79
Wheat	stripe rust	70
Wheat	healthy	24
Tomato	Septoria leaf spot	71
Tomato	late blight	73
Tomato	leaf mold	74
Tomato	healthy	60
Cucumber	Downy mildew	80
Cucumber	powdery mildew	86
Cucumber	Mosaic virus	40
Cucumber	healthy	71

B) Preprocessing Image

The steps for detection and the final results are analyzed as described below.

1. Cropping the Image Captured

The image that is captured should be cropped, so that only the necessary information is considered. Only 30% of the image of the infected leaf is considered and the remaining 70% which is the background is removed from the image. This is because the consumption of memory space can be reduced and the processing time by the CPU can be increased. The command imcrop(I) is used in MATLAB which is the tool for interactive cropping. Here, 'I' represents the image that needs to be cropped. We should be careful while the process of cropping as, any important information should not be removed from the captured data. To gain high accuracy, the process of correct cropping is very important.

2. Resize of the size

The images are resized to a fixed size of (300 X 400). The fixed size of the image is used as an imported image, since the less accuracy in feature extraction is occurred when the sizes of images are different.

3. Equalization in fuzzy histogram (EFH)

It contains two main periods. In first period, based on the set theory, the fuzzy histogram is computed. This shows inexactness of grey level values in an improved manner as compared with that of cleaned histogram. In the second stage of period, the fuzzy histogram is classified into sub sections which are equalized independently to preserve the brightness of the image.

C) Extraction of Features

The information of the extracted image is used to differentiate between various situations, where the information of image is converted to reduce the representation set. This is called feature processing or feature extraction.

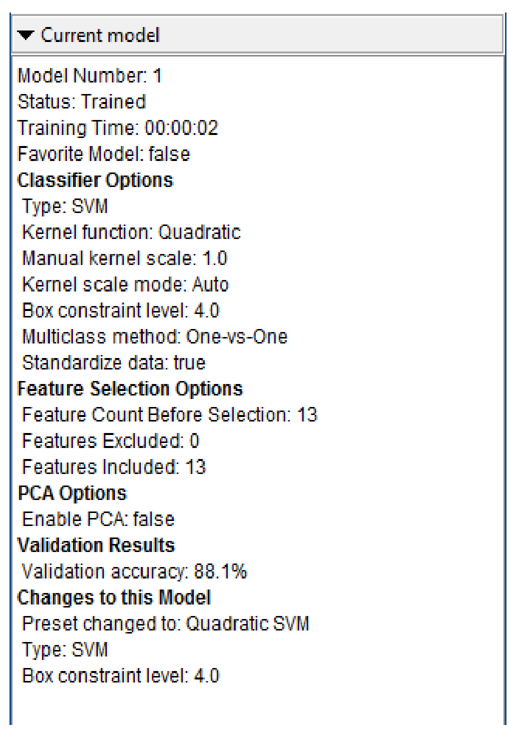
The features like colour and texture is obtained by applying the set of grey level to the value 8 along with the offset as [0,1]. Finally, the output in this phase, includes extracting the features like texture and colour in the excel file. All the extracted features are included such that, later it can be used as the base for knowledge and train the classifier for leaf disease detection.

D) Training and Testing the detection system

The machine learning approach is used for identifying patterns in two stages. First, the training samples are used to train the classifier and the weights are extracted. Then the accuracy of the system is examined with the test samples. Here, the total samples are divided into number of training and testing samples. The total number of samples is divided into 20% testing and 80% training samples. The complete description of the settings made in SVM classifier is shown in the figure 6.

The total data set with 799 images, 80% of the samples were used as input for SVM classifier as training set and remaining 20% of samples used as testing set, as shown in the figure 7. To obtain the best result, the settings "Kernel function: Quadratic, Box Constraint level: 4.0" is followed in the SVM classifier. Using the same ratio, the division of disease samples are used as the diagnosis process for diseased samples.

Figure 6: Setting in SVM classifier



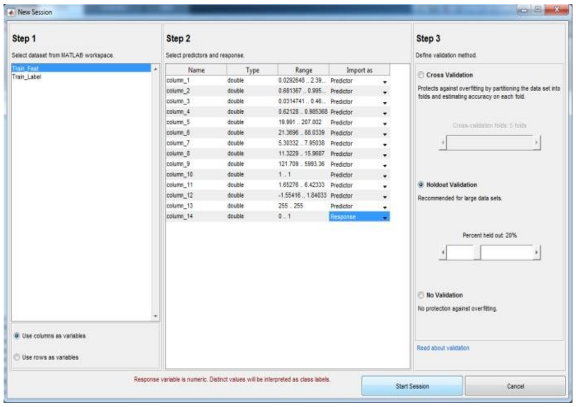


Figure 7: Dataset Classification screenshot

After the completion of the training, the samples are used by the classifier and the accuracy is examined using the confusion matrix. Out of total samples, 20% were used as testing samples, among which, 90.61% were detected accurately as disease case and 77.4% of healthy cases, the average accuracy by the detection system is 88.1%, shown in figure 8 and figure 9. The ratio of Exact True

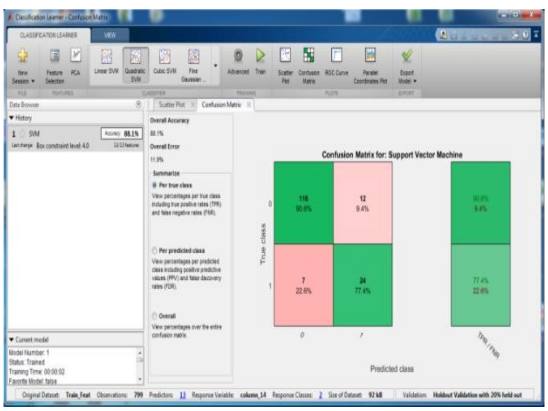


Figure 8: Testing result in SVM disease detection

prediction (ETP) with the total predictions summing up with the false predictions (FP) is the accuracy obtained. Equation 1 is used to calculate the accuracy of the detection system.

Accuracy = ETP/(ETP+FP) *(1)*

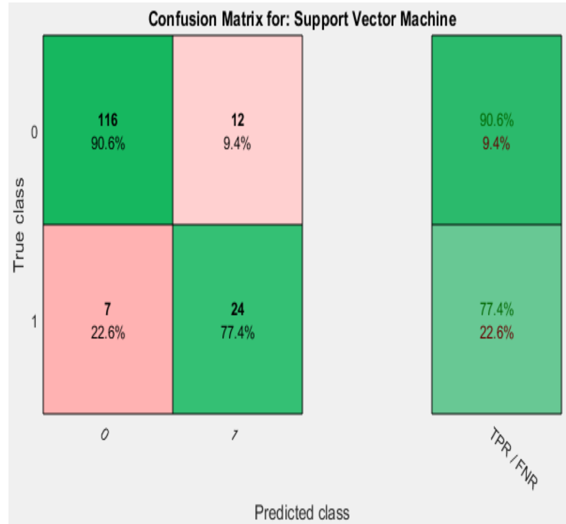


Figure 9: Confusion Matrix of SVM disease Detection

CONCLUSION

This paper presents a novel idea towards the design and development of an agricultural robot (Agribot) and leaf disease detection with a combination of texture and feature extraction using Support vector machine (SVM) classifier. Our first contribution is development of an Agribot. Based on the environmental factors such as temperature, humidity, soil pH and moisture the robot intimates the farmer which crops should be sown to get good yield and the Agribot when placed into the farm does all the agricultural activities in either automatic mode or manual mode. The second contribution is the leaf disease detection in crops. It is concluded that the accuracy of detection increases as the number of training samples increases.

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