International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Special Issue NCTFRD18

# Detection of Cotton Leaf Diseases Using Machine Learning Regression Techniques

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***Abstract*— Cotton is one of the most important commercial crops in India. Every year the production of cotton is decreasing due to the attack of the diseases. Plant diseases are generally caused by pest insects and pathogens and they decrease the productivity in large-scale if they are not controlled within time. This paper presents a system for detection and controlling of diseases on cotton leaf along with soil quality monitoring. The work proposes a Support Vector Machine based regression system for identification and classification of some cotton leaf diseases i.e. Bacterial Blight, Alternaria and Cercospora. Thus, in order to diagnose the cotton leaf diseases accurately, the use of image processing and machine learning techniques can be helpful. After disease detection, the name of a disease with its remedies will be provided to the farmers using an android app. The Android App is also used to display the soil parameters values such as humidity, moisture and temperature along with the water level in a tank. All this leaf disease detection system and sensors for soil quality monitoring are interfaced using Raspberry Pi which makes it independent and cost effective system. The overall classification accuracy of this proposed system is 83.26%.**

***Keywords—Cotton Leaf Disease; Color Transform; Gabor Filter; Median Filter; Color Moment; Support Vector Machine; Raspberry Pi; Android App; Sensors.***

## I. INTRODUCTION

Cotton is one of the most important commercial crops in India and affects India's economy in many ways. Large number of the population depends on Cotton crop either for its cultivation or for the purpose of processing. It is observed that the development in agriculture is deteriorate nowadays due to the attack of diseases. Many farmers detect disease by their previous experience or some of them take help from experts. But the experts usually judge the symptoms of disease with bare eyes. So there is the possibility of an inaccurate diagnosis of diseases having very large similarity in their symptoms. Any error during diagnosis of the disease sometimes may lead to wrong controlling method and an excess use of pesticides. Therefore, it is essential to move towards the new strategies for automatic diagnosis and controlling of disease. A number of varieties of pesticides are available to control disease and increase production but finding the most suitable and effective pesticide to control the disease is difficult and required experts advise which is time-consuming and expensive. The presence of disease on the cotton plant is mainly reflected by symptoms on the leaves. So there is need of an automatic, accurate and less expensive machine vision system for detection of disease from cotton leaf images and to suggest the proper pesticide as a solution. This paper focuses on detection of most commonly occurring diseases on cotton leaves. The disease is detected using SVM based regression algorithm written in python code in Raspberry Pi. In this method, four different sensors that is temperature, moisture, humidity and water sensors are used and interfaced with raspberry pi for soil quality monitoring. Two android app are used; one for displaying soil parameters and other for displaying disease information, for turning external devices such as sprinkler or motor ON/OFF and for handling the movement of the whole system from one place to another to check soil parameters at different places. So this system is useful in large farm for accurate detection of diseases.

## II. COTTON LEAF DISEASES

### *A. Bacterial Blight*

Bacterial blight is bacterial disease mainly caused by the bacteria "Xanthomonas Campestris pv. Malvacearum". The symptoms of Bacterial blight starts as Dark green, water soaked angular spot of 1 to 5 mm on a leaf with red to brown border. At the beginning, these angular leaf spots appear as water-soaked areas which later on changes from dark brown to black color. The spots on the lesion area of leaves may spread over the major veins of leaf and in later petioles and stems get infected and premature fall off of the leaves occur.

### *B. Alternaria*

It is a fungal disease mainly caused by A. Alterneta or Alternaria macrospora . The disease is most severe on the lower part of leaves as compared to the upper part and may get confused with the spots of bacterial leaf blight as the symptoms are nearly similar. At the beginning, brown, gray-brown to tan colored small circular spots appears on leaves and vary from 1-10mm in size which later on become dry, dead with gray centers which crack and fall out.

### *C. Cercospora*

Cercospora is brought about by the Cercospora Gossypina [12]. The tainted leaf has red spot blemishes on the leaves which expand in distance across to around 2 cm. The spots are round or unpredictable in shape with yellowish, purple, dark brown or blackish fringes with white focuses. The rakish leaf spot shows up because of the limitation of the lesion region by fine veins of the leaf. This malady influences more seasoned leaves of develop plants.

 DOI : 10.18231/2454-9150.2018.0808 

## III. System Architecture

The present system is used to detect the disease on cotton leaves along with soil quality monitoring. This system also helps to automatically ON/OFF the relay connected to

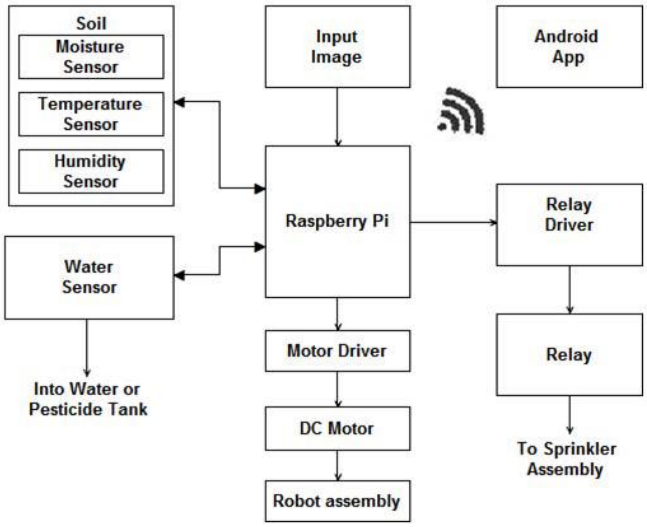


Fig. 2. Block diagram of system for cotton leaf disease detection and Remedy to it.

external devices such as motor, sprinkler assembly according to need with the use of Android App. *Fig. 1*, portrays the block diagram of the system. The present system consists of Raspberry Pi- model B which is the main part of the system used for interfacing purpose. Initially, the input image is selected. According to selected image disease is detected along with its name and remedies by using python and they are displayed on the App. After disease detection farmers take the necessary action i.e turn ON/OFF the sprinkler assembly by using app to spray pesticides or fertilizers by mixing it in water. Farmers can also check the soil condition and water level in the tank with the help of sensor. Four different types of sensors are used for measuring soil condition and level of water or pesticide tank. These sensors include LM 35 temperature sensor, DHT-22 Humidity Sensor, Water sensor and moisture Sensor. All these sensors are interfaced with Raspberry Pi. The motor driver and DC motor are used for the movement of the overall system. The moving system help to monitor soil condition at different places.

## IV. General Approach For Detection And Classification Of Leaf Diseases

### A. Process flow of the Leaf Disease Detection

*Fig.2.* depicts the design flow of cotton leaf disease detection. The disease detection needs to be performed in step wise manner to get high accuracy. The main steps of disease detection are as:

*1) Image Acquisition*
*2) Pre-processing*
*3) Segmentation*
*4) Feature Extraction*
*5) Classification*

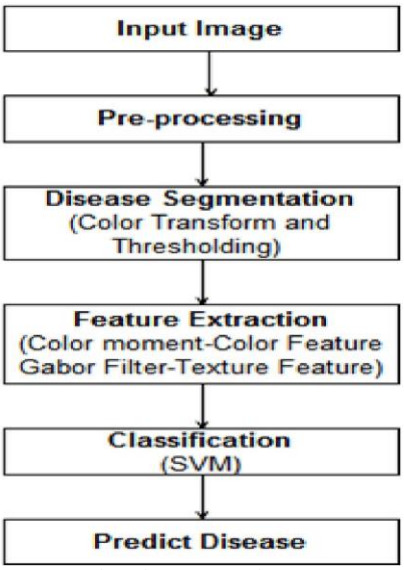


Fig. 3. Design flow for cotton leaf disease detection

*1) Image Acquisition:* Image acquisition is the principal phase which consists capturing of infected leaf images to build a database. The RGB color images of cotton leaves are captured utilizing Nikon digital camera in JPEG format with required resolution which gives great quality pictures for disease detection. The database of 900 pictures are gathered. From database, one image is taken and processed further as shown in Fig. 3. Fig 3(a), shows infected image of cotton leaf.

*2) Pre-processing:* The input image is pre-processed to enhance its quality. The aim of pre-processing is improvement of an image data to suppress unwanted disfiguring and enhance some image features which are important for further processing. The preprocessing methods incorporates image enhancement, color conversion, resizing and filtering of an images. In present system, resizing and median filter is adopted for pre-processing to expel noise and to get good quality image. First, the image is read and then resized into 250×250 pixel and then median filter is applied. *Fig. 3(b),* depicts the image obtained by pre-processing the captured image in fig 3(a).

*3) Segmentation:*

Segmentation is an important step in leaf diseases detection which is used to extract the lesion(infected) region from images. In present system, color transformation and thresholding is used to extract the Region Of Interest (ROI) from the image. First the RGB color format image is transformed to YCbCr color format. After color conversion, Bi-Level thresholding is applied. In bi-level thresholding two threshold range such as upper and lower threshold is set for each of three color plane i.e. Y, Cb, Cr and pixel between these ranges are considered as infected part. After applying bi-level thresholding, we get logical black and white image which is needed to be further processed to extract region of interest (ROI). *Fig. 3(c),* depicts the YCbCr color transformed image while *Fig. (d),* shows logical black and white image.

*4) Color Mapping:* In color mapping, the logical black

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and white image is converted to RGB color format which is a masked image. Then bit wise operation is performed to get the RGB masked image. We are interested only in diseased part so this RGB masked image is converted to grey image. *Fig 3(e),* shows the RGB masked image while *Fig 3(f),* shows the gray image. In this grey image white color shows diseased part which is our Region of Interest (ROI).

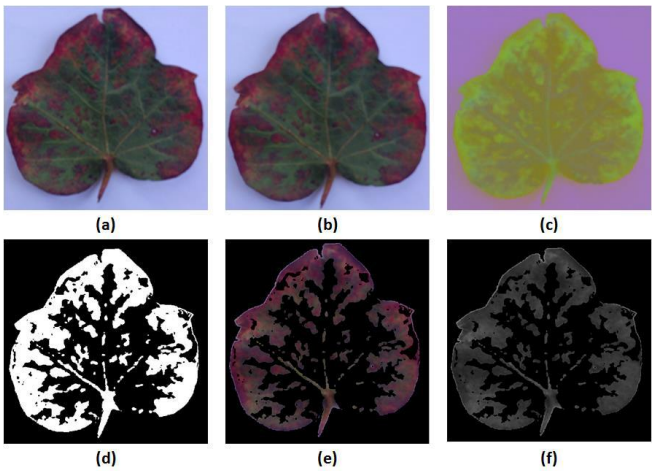


Fig. 3. Experimental results of disease detection steps: (a) RGB input image of infected cotton leaf (b) Pre-processed image (c) YCbCr color transformed image. (d) Logical Black and White image (e) RGB masked image (f) Grey Level Image

*5) Feature Extraction*: Features extraction is the next important step after segmentation to perform. The goal of feature extraction is to extract a set of features representing each character, which increases the recognition rate to the maximum with the minimum number of elements. The diseased area separated by segmentation is the region of interest (ROI) in feature extraction in order to extract different features that are used to diagnose the disease. Total eight color and texture features are extracted in present system using Partial Least Square Regression(PLSR). PLSR finds a few components in order to explain most of the variations in both predictors and responses.

*a)* Color Features: In the present work color moment is used for color feature extraction. In color moment, Mean and standard deviation are embraced. Therefore, an image is characterized by 6 moments as 2 color moment for each 3 color channels (i.e. 3*2=6). Here we define the i-th color channel at j-th image pixel as Pij. Mean and standard deviation can be defined as:

**Moment 1- Mean**: It represents the average color value of the image.

$$\mu_j = \frac{1}{N}\sum_{i=1}^{N} x_{ji} \qquad (1)$$

**Moment 2- Standard Deviation:** Std. Deviation represents the square root of the variance of the distribution

$$\sigma_j = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_{ji} - \mu_j)^2} \qquad (2)$$

*b) Texture features:* In present work, two texture features are extracted using 2D Gabor filter. The Gabor texture feature include mean and std. deviation of the magnitude of Gabor wavelet transform coefficient. Mean gives the average value and std. deviation decides the deviation of data from center of Gaussian filters. In present system, Gabor filter with different parameters such as frequency, angle in 16 orientation with 10 different frequencies is considered.

*6) Classification:* This is the last step of disease detection in which classifier is used to recognize the kind of the leaf disease. Classification deals with matching the given data vectors with one of the trained data of different classes. In machine learning, there are various types of classifier available for classification. In present system SVM based regression technique with non-linear Gaussian kernel is used for classification of the diseases on cotton leaves. The SVM based regression finds the nonlinear relationship between input vectors and response variables by finding the best hyperplane. The best hyperplane is that one which is at maximum distance from test vectors.

## V. Experimental Results

As discussed, the main aim of the present work is to detect the diseases on cotton leaves. The secondary aim is to monitor the soil quality. For disease detection, 900 images of cotton leaves were used. Out of this 629 images are trained and 271 images are used for testing. Table 1 shows the accuracy for individual cotton leaf disease detection. *Fig.4,* shows the implementation of system showing raspberry Pi, Relay and sensors. *Fig.5(a),* shows the result of android app displaying cotton leaf disease name with its remedies. It also shows forward, reverse, left and right movement and stop options along with motor ON/OFF to ON or OFF the relay. *Fig.5(b),* shows the result of android app displaying different sensors reading.

Table 1: Accuracy of Cotton leaf Disease detection

| Name of disease | Correctly Classified (CC) | Incorrectly Classified (IC) | Accuracy of CC |
|---|---|---|---|
| Bacterial Blight | 67 | 11 | 85.89% |
| Alternaria | 55 | 10 | 84.61% |
| Cercospora | 39 | 8 | 82.97% |

The overall accuracy of proposed system for disease detection is 83.26%.

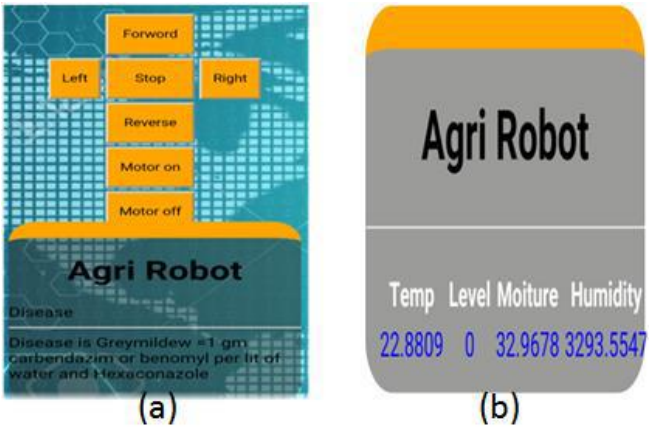


Fig. 5. (a) Android app displaying cotton leaf disease information (b) Android app displaying different sensors reading.

## VI. Conclusion

This paper presents the Support Vector Machine based regression technique for detection of cotton leaf diseases.

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The farmers are suggested to use pesticides as the remedy to control the diseases. The android app is developed to display disease and sensor information along with the ON/OFF of the relay. The app also handles the movement of the whole system from one place to another. So by using present system, the farmers can automatically detect the disease and know the remedies to control that disease. The farmer can move the system from one place to another place to check the soil condition at different locations with the help of sensor and can change soil condition by turning motor ON/OFF with relay. All these processes are done by using android App which saves human hard work in large field area. The use of Raspberry pi makes this system cost effective and independent. The present system gives accuracy of 83.26% for disease detection and proves its effectiveness to the farmers for cotton leaf disease detection and controlling by improving the crop production.

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 DOI : 10.18231/2454-9150.2018.0808 