

Plant Diseases Detection Using Image Processing Techniques

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Abstract—Agriculture is a most important and ancient occupation in India. As economy of India is based on agricultural production, utmost care of food production is necessary. Pests like virus, fungus and bacteria causes infection to plants with loss in quality and quantity production. There is large amount of loss of farmer in production. Hence proper care of plants is necessary for same. This paper presents an overview of using image processing methods to detect various plant diseases. Image processing provides more efficient ways to detect diseases caused by fungus, bacteria or virus on plants. Mere observations by eyes to detect diseases are not accurate. Overdose of pesticides causes harmful chronic diseases on human beings as not washed properly. Excess use also damages plants nutrient quality. It results in huge loss of production to farmer. Hence use of image processing techniques to detect and classify diseases in agricultural applications is helpful.

Index Terms- Image processing; Agrobot; K-means; HSV; ANN; BPNN; CCM; Neural Network; SURF; RBF;SIFT; RDI; GLCM; PCA; SGDM

I. INTRODUCTION

Agriculture is an ancient occupation. It plays an important role in our day to day life. Food is basic need of all human beings. To distribute food among large population needs proper amount of production. In India large number of population lives in rural areas where livelihood of people depends mostly on agriculture. Thus Indian economy mostly depends on agriculture. Hence increasing quality production has become necessary day by day.

Monitoring of plants/crops and their management from early stage is utmost important. It includes various tasks like preparation of soil, seeding, adding manure and fertilizer, irrigation, disease detection, spraying pesticides, harvesting and storage [1]. Amongst these entire tasks spraying proper amount of pesticides has to be taken proper care. Pesticides are used to attract, seduce and destroy pests hence known as crop protection product. Pesticides are prepared by harmful chemicals or sometimes by biological methods to kill pests, weeds or infections on plants.

Large percentage of farmers in India sprays pesticides on cash crops, vegetables or fruit plants. In most cases it has been observed that overdose of pesticides is more than 40% [2]. Hence it causes harm to plant/crops as well as to human

beings. Farmers manually checks diseases and spray pesticides accordingly. Pesticides if sprayed in large amount lead to loss in nutrients which ultimately aims to decrease in quality food production. Due to this, production gets affected by means of both quality and quantity. Also if they are not washed properly causes harmful diseases to human beings like chronic diseases.

One of the most common practices of spraying pesticide is by using sprayer. In conventional agriculture mostly mechanical sprayer or hydraulic sprayers are used. Farmers basically spray manually sometimes in excess amount or in less amount. Further in most of the cases farmers do not use protective clothing. Hence harmful pesticides enter in body either by being inhaled or through skin or eyes. Exposure to pesticides thus causes irritation of nose to most fatal diseases. Hence to avoid all above things and to increase yield by means of quality and quantity it is necessary to detect disease in proper amount and spray pesticides properly. Also farmer has to pay for labors too. They also have to work whole day with much more efforts. Hence need to overcome these drawbacks various techniques have been invented.

Thus it's important to detect diseases on plant/crop properly. When they are infected by diseases, there is change in shape, size and color. These symptoms can be checked manually but not in proper amount. Hence there are various image processing methods that detect diseases on plant leaf and stems. Using image processing techniques proper amount of disease based on color, texture or shape change of plants can be identified. These techniques can be used in Agrobot to detect various diseases.

Next section gives a brief introduction of general block diagram for Agrobot.

II. PLANT DISEASE DETECTION FOR AGROBOT

Today various means are available to increase yield in production and reduce human efforts. Technologies have been vastly developed and spread in all fields including agriculture. One of the inventions is agricultural Robot. Agrobot or agricultural robot or Agribot is an agricultural robot used for performing various agricultural tasks. It performs all sorts of agricultural tasks from seeding to spraying pesticides. This reduces human efforts, increases yield and decreases cost of labor. Due to which one gets healthy food .Thus Agrobot is

boon to farmers and society. Figure.1 shows general block diagram of Agrobot.

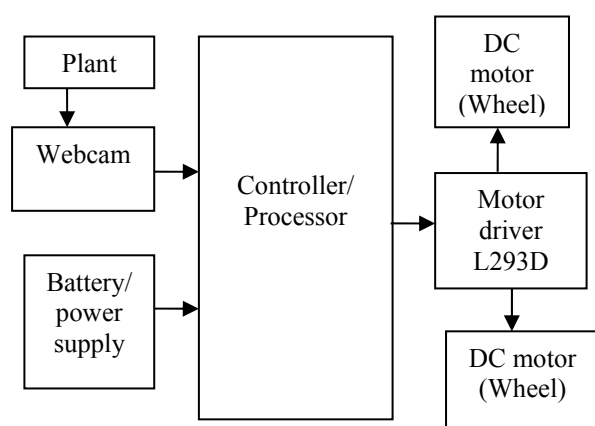


Fig 1. General block diagram of Agrobot [23]

A. Webcam

Input to the system is given through Webcam. It captures images or video of plant and for further process is send to controller/processor. Webcam of resolution 640*480 and up to 30 Megapixel can be used.

B. Battery or Power Supply

The power supply or battery can be used to operate Agrobot. To drive DC motor 12V is required and for controller/processor it depends on which processor/controller is used. Hence 12V battery is used to drive DC motor [23].

C. Controller or Processor

Various controller or processors can be used for Agrobot. Controller or processor controls various units of robot and is heart of system.

D. DC Motor Driver (L293D)

To drive a DC motor, DC motor driver called L293D [23] is needed. The L293D driver is monolithic, high voltage and high current device. It has four channel drivers which are assembled in a16 lead plastic package [23]. For heat sink it has 4 centered pin connected together.

E. DC Motor

To physically drive the application like wheel in robot DC motors are used. These motors work on 12V [23] and needs motor driver L293D. One L293D can drive 2 DC motors.

Various diseases and their symptoms are explained in next section.

III. OVERVIEW OF PLANT DISEASES

Plants are infected by various pests. Various symptoms are seen such as color change of leaves, texture or shape change. In India various types of cash crops, vegetables or fruits are planted at different places. Hence various diseases are observed on leaves and stems of plant due to various pests. They cause damage to plant severely. Diseases on plants may be fungal, viral or bacterial.

Some of diseases and their symptoms are explained in brief as-

A. Diseases and their symptoms on foodgrains

In India major food grains are rice, wheat, maize, millets (jowar, bajra) and pulses. Few diseases on rice, wheat and maize with their symptoms are described in brief in this section. Sheath blight is major disease of rice plant with symptoms like lesions on sheaths of lower leaves and with age may grow irregular [3] tan to brown border. Figure.2 shows sheath blight in rice.

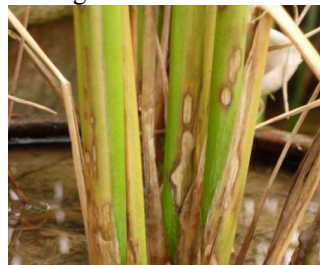


Fig.2. Sheath blight in rice [30]

Rust on wheat are of two types mainly brown or orange rust and yellow or stripe rust both of which are found on leaves with brown and dark brown [3] in color respectively. Figure.3 shows brown rusts on wheat.



Fig.3. Brown rust on wheat [29]

Similarly in Maize leaf blight shown in figure.4 affected by fungus causes yellowish round to oval spot on leaves and gradually turns to grayish brown [3].



Fig.4. Leaf Blight in maize [28]

B. Diseases and their symptoms on cash crops

A cash crop grown in India consists of cotton, sugarcane, groundnut etc. In sugarcane, rust causes minute, elongated and yellow spots. It later grows dark brown to black on lower surface of leaves. Also Grassy shoot shown in

figure.5 is usually seen two months after planting. Leaves become pale yellow and plants appear bushy and grass like [3].



Fig.5. Grassy Shoot in sugarcane [27]

In groundnut, *Puccinia Arahidis* (rust) attacks all aerial parts of plant [3]. In this brown spots appear on upper surface of leaves.

In cotton plant, wilt appears on seedlings in the cotyledons i.e. turns yellow and then brown. The first symptom appears on leaves edge yellowing them and around veins. Anthracnose infected by fungus produces small reddish circular spots on cotyledons and primary leaves [3]. Also Bacterial Blight attacks in all stages while leaf blight causes small, pale to yellow brown spots with irregular shapes. Figure.6 shows Cotton wilt.



Fig.6.Cotton Wilt [25]

C. Diseases and their symptoms on fruit plants

Horticulture crops like banana, mango, grapevine etc. are also grown in India. These plants are also affected by various pathogens. In banana fungus attacks young fruits by causing Anthracnose disease shown in fig.7 turns fruit skin black. It results in ripening and shriveling of fruits. Also Vascular wilt affects plant by yellowing leaf blades.



Fig.7. Anthracnose on Banana [24]

In grapevine, Anthracnose commonly called bird's eye spots [3] attacks on shoots, petioles, leaves, veins and stems. Similarly Bacterial canker disease begins from water-soaked spots which are surrounded by yellowish halo on lower surface of leaves. Also powdery mildew and downy mildew causes white patches and pale yellow spots respectively on leaves surface [4]. Figure.8 shows leaf of grape affected by Downy Mildew disease.



Fig.8. Downy mildew in grapevines [26]

Hence these diseases can be detected using various image processing techniques. Next section gives review of various methods of image processing to detect diseases on plant.

IV. OVERVIEW OF METHODS TO DETECT PLANT DISEASES

This section discusses about image processing techniques used in detection of plant diseases.

A study of visual symptoms [5] of plant disease from analysis of colored images using image processing methods has been proposed. The RGB image of diseased plant has been then converted to H, I3a, and I3b. A set of maximum threshold cutoff has been used. A correct detection of infected part by disease with various ranges of intensities has been obtained using segmentation process.

A K-means and neural network approach for detection of plant leaf/stem diseases has been proposed [6]. Images of leaves from Jordon region of Al-Ghor has been taken to test results using these techniques. After applying clustering, a feature extraction process called Color Co-Occurrence or CCM method has also been applied to detect different features of diseases like early scorch, cottony mold, ashen mold etc.

Some of the fungal diseases cause brown spots on leaves. Sugarcane plants infected by fungus also causes brown spot appearance on leaves. Simple threshold and triangular threshold methods [7] has been used to segment the leaf area and lesion region of sugarcane respectively. Results obtained have been proved fast and accurate by using these methods. The accuracy has been resulted to 98.60%.

Agriculture is growing and most important sector. Pest causes loss in production by means of quality and quantity. Hence to identify and detect pest in farm a novel algorithm for segmentation and automatic detection pest has been proposed in [8]. Accuracy obtained is 96% which was tested for several whiteflies. Color conversion, segmentation, counting of whiteflies and RDI algorithm has been used.

Wheat powdery mildew, wheat sharp eyespot, wheat stripe rust identification using morphological characteristics from their images has been extracted [9]. Use of statistical analysis

software to analyze the data with the principal component analysis and the discriminant analysis along with five characteristic parameters such as Sphericity, Roundness, Hu1, Hu2, equivalent radius were selected as the identification factors.

Sometimes deficiencies in minerals are also some of the factors affecting appearance change of rice leaves. Blast and Brown spots are cause of this deficiency. Image based techniques for detection of possible changes in rice leaves has been described [10]. Similarly, soya bean rust is another harmful disease that causes damage to plants. Dust severity from multi-spectral images detection using image processing has been researched [11]. The two disease diagnostic parameter namely, ratio of infected area (RIA) and rust color index (RCI) has been taken into account. Centroid of leaf color distribution for detecting rust severity without segmentation has been used.

Thus study of various plant diseases means studying visual pattern because it is difficult to monitor diseases on plant manually. Basic steps like image acquisition, preprocessing, segmentation, extraction; detection and classification of plant disease are used [12]. K-means clustering followed by thresholding and feature extraction is described. Classification by using neural network ANN and BPNN has also been used for detection of disease.

The support vector machine or SVM [13] is applied on cucumber leaves using principal component analysis. To carry out comparative test Radial Basis Function (RBF), polynomial and Sigmoid Kernel function has been used.

In Thailand, vegetables and fruits are important agricultural products that are exported [14]. The grape leaf color segmentation, leaf disease segmentation and analysis and classification of disease have been focused. Grape leaf disease appearance features using Gabor filters allows SVM to achieve every efficient disease classification. BPNN gives extraction with complex background has been concluded.

Also image processing can be used for fruits diseases like grapes, apple and pomegranate. For Grape -Black Rot, Powdery Mildew, and Downy Mildew; for Apple -Apple Scab, Apple Rot, and Apple Blotch and for Pomegranate - Bacterial Blight, Aspergillus Fruit Rot, Gray Mold diseases has been detected and classified [15]. Image segmentation by using K- means clustering and feature extraction by using speed up robust feature or SURF algorithm has been used for detecting diseases. ANN has been applied for pattern matching which then is used for classifying diseases. OpenCV library has been used for implementation.

To give advice to farmer using mobile internet has been developed [16]. The proposed system aims at giving inputs to Decision Support system (DSS). SVM has been used to detect and classify healthy and diseased soya bean leaves. The RGB to HSV (Hue Saturation Value) conversion in preprocessing step has been used followed by extracting the region of interest (ROI) from the original image using multi thresholding. The color based and cluster based methods has been used for segmentation. The Scale Invariant Feature

Transform (SIFT) technique automatically recognizes the plant species based on the leaf shape has also used.

The diseases caused by fungus are very harmful which affects cereals, fruits or vegetables [17]. For fruit diseases detection features have been extracted using techniques like block-wise, Gray Level Co-occurrence Matrix (GLCM), and Gray Level Run length Matrix (GLRLM) [17] from image samples of fruits. Probabilistic Neural Network (PNN) [17] for classification has been used to detect fungal diseases on commercial crops.

Overview of various crop diseases and image processing techniques has been discussed [18] for classification and quantification purposes. Similarly oil palms are also severely affected by pests [19]. Excess of fertilizers too causes damage to plant. The proposed method has been useful to benefit oil palm industry demands [19]. High end image capturing device [19] has been used to capture images of leaves surface followed by extraction of features like shape, color and texture of disease type. Feature vector inputs have been obtained by acting as inputs to Fuzzy classifier [19]. Also image features of cotton leaf spot using advance computing enrichment techniques has been proposed [31].

Diseases like Blight, Leaf Necrosis, Gray Mildew, Alternaria etc [20] are observed mostly on cotton plant. Principle Component Analysis (PCA) and Nearest Neighbourhood Classifier (KNN) [20] have been used to detect these diseases on cotton plant leaves. 95% accuracy has been obtained in results after using these algorithms [20].

Early scorch, Cottony mold, ashen mold etc has also been detected using K-means and Neural Network (NN) [21]. SGDM matrix [21] formation after the conversion of image from RGB to HSV for obtained infected cluster has been done.

Thus using these techniques in other applications like agricultural robot is another boon to farmer and society. A novel cloud computing for smart farming has been proposed [22] including robotics and video processing on tomato plant. Here use of Internet of things importance with agricultural world has been told.

Also using various controllers or processor in agricultural robot for detection of plant disease has become interesting concept. Detection of Downy Mildew disease using raspberry pi along with image processing method i.e. morphological operation has been proposed [23].

Similarly to detect early diseases on crop an eAgrobot has been proposed [2]. Image processing using K-means and Neural network is heart of system. It has been tested on groundnut and cotton plantation to avoid excess use of fertilizers. Magnesium deficiency and leaf blight in cotton while anthracnose and yellow spots in groundnut have been detected using image processing.

Next section gives discussion and remarks.

V. DISSCUSSION AND REMARK

In this paper various techniques have been discussed for detecting and classifying various diseases on plants. To increase production in agricultural sector it is necessary to detect diseases on plants and take accurate measures. Hence

image processing algorithms are one of the ways to detect various diseases and can prove helpful to farmers.

Most of the methods include pre-processing followed by feature extraction in detection of diseases. Neural network classifier to classify leaves disease has been chosen as classification tools. Color Co-occurrence for feature extraction is also proved to be helpful in many of plant diseases detection based on color and texture. Table1 gives summary of few methods and their accuracy.

Table1. Summary of methods

Crops	Algorithm/ classifier/ Methods	Accuracy
Soyabean leaves	SIFT algorithm [11] And SVM classifier	Correctly recognize plant species and accuracy is as high as 93.79% [11]
Cotton leaves	PCA/KNN [19]	Overall accuracy 95% [19]
Wheat leaves	PCA & Morphological features [9]	96.7% for wheat powdery mildew, 86.6% stripe rust [9]
Grape leaf	BPNN & K-means[14] [17]	Efficient leaf disease color extraction[14] and for Anthracnose [17] 76.6%

VI. CONCLUSION

For proper and successful cultivation of crops it is necessary to detect diseases accurately. Hence from above discussion it can be seen that image processing techniques have proved useful in all means. We can accurately detect and classify diseases on various plants using all above techniques. K-means Clustering to detect infected objects and Neural Networks are thus commonly used for obtaining accuracy in detecting and classifying diseases. Hence these techniques have potential to be use in Agrobot system.

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