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ADVANCES IN IMAGE PROCESSING FOR DETECTION OF PLANT DISEASES

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ABSTRACT:

The studies of plant trait/disease refer to the studies of visually observable patterns of a particular plant. Nowadays crops face many traits/diseases. Damage of the insect is one of the major trait/disease. Insecticides are not always proved efficient because insecticides may be toxic to some kind of birds. It also damages natural animal food chains. A common practice for plant scientists is to estimate the damage of plant (leaf, stem) because of disease by an eye on a scale based on percentage of affected area. It results in subjectivity and low throughput. This paper provides a advances in various methods used to study plant diseases/traits using image processing. The methods studied are for increasing throughput & reducing subjectiveness arising from human experts in detecting the plant diseases.

Keywords: plant disease, trait, image processing

[I] INTRODUCTION

India is an agricultural country; wherein about 70% of the population depends on agriculture. Farmers have wide range of diversity to select suitable Fruit and Vegetable crops. However, the cultivation of these crops for optimum yield and quality produce is highly technical. It can be improved by the aid of technological support. The management of perennial fruit crops requires close monitoring especially for the management of diseases that can affect production significantly and subsequently the post-harvest life.

The image processing can be used in agricultural applications for following purposes:

1. To detect diseased leaf, stem, fruit
2. To quantify affected area by disease.
3. To find shape of affected area.
4. To determine color of affected area
5. To determine size & shape of fruits.
   Etc.

In case of plant the disease is defined as any impairment of normal physiological function of plants, producing characteristic symptoms. A symptom is a phenomenon accompanying something and is regarded as evidence of its existence. Disease is caused by pathogen which is any agent causing disease. In most of the cases pests or diseases are seen on the leaves or stems of the plant. Therefore identification of plants , leaves, stems and finding out the pest or diseases, percentage of the pest or disease incidence , symptoms of the pest or disease attack, plays a key role in successful cultivation of crops.

It is found that diseases cause heavy crop losses amounting to several billion dollars annually. Following two examples shows that how some diseases have shattered the economies of nations.

i)Late blight of potato[1,2]: It occurred in 1845-1847 in Ireland. Approximately 1.5 million people died from starvation and another 1.5 million were displaced and forced to emigrate from Ireland to other regions of the world

Figure1: potato leaf affected by late blight

Figure2: Late blight stem lesions

ii) Canker: It is the most serious disease in Citrus. It is widely prevalent in Florida, Georgia, Alabama, Louisiana, South Carolina, Texas, Brazil and Mississippi. Eradication programs have been initiated by several states since 1915.The study carried by Renato & others [3] shows that from 1999 to 2008 about 2,327,772 plants were eradicated in citrus nurseries & more than US$ 116 million were lost eliminating infected and exposed trees in the last ten years. Still the Asiatic citrus canker is prevalent in several parts of the United States.

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Figure3: leaf symptoms of canker on top and bottom leaves

Disease management is a challenging task. Mostly diseases are seen on the leaves or stems of the plant. Precise quantification of these visually observed diseases, pests, traits has not studied yet because of the complexity of visual patterns. Hence there has been increasing demand for more specific and sophisticated image pattern understanding.

In biological science, sometimes thousands of images are generated in a single experiment. These images can be required for further studies like classifying lesion, scoring quantitative traits, calculating area eaten by insects, etc. Almost all of these tasks are processed manually or with distinct software packages. It is not only tremendous amount of work but also suffers from two major issues: excessive processing time and subjectiveness rising from different individuals. Hence to conduct high throughput experiments, plant biologist need efficient computer software to automatically extract and analyze significant content. Here image processing plays important role.

This paper provides a wide survey carried to study advances in different image processing techniques used for studding plant diseases/traits & pests.

[II] ADVANCES IN IMAGE PROCESSING FOR PLANT DISEASE DETECTION

2.1. Literature Survey

Brendon J. Woodford , Nikola K. Kasabov and C. Howard Wearing in paper titled **"**Fruit Image

Analysis using Wavelets"[4] proposed wavelet based image processing technique and neural network to develop a method of on line identification of pest damage in pip fruit in orchards. Three pests that are prevalent in orchards were selected as the candidates for this research: the leaf-roller, codling moth, and apple leaf curling midge. Fast wavelet transform with special set of Doubenchies wavelet was used to extract the important features. To retrieve the related images, the search is done in two steps. The first step matches the images by comparing the standard deviations for the three color components. In the second step, a weighted version of the Euclidean distance between the feature coefficients of an image selected in the first step and those of the querying image is calculated and the images with the smallest distances are selected and sorted as matching images to the query.

Stereomicroscopic method and Image analysis method is compared for usefulness of image analysis as an efficient and precise method to measure fruit traits like size, shape dispersal related structures by Mix & Pico[5].In general fruit length obtained with image analysis was significantly greater than that recorded with a stereomicroscopic. Only fruit length estimates did not differ between the two methods. Nevertheless there was a highly significant correlation between fruit length estimates obtained from both methods for all species of study. This indicates that both stereomicroscopic and image analysis accurately discriminated fruits of different sizes. But it was concluded that image analysis has following advantages: 1) the high amount of fruit parameters obtained with one single measurement 2) the minimization of human errors 3) the reduction of time needed to obtain large data sets concerning fruit trait variability 4) the possibility to estimate variability in traits of fruits with complicated shapes

Pests leaves distinctive outward effects on plants like rolling the leaves or destroying the whole plant. The sucking pest reduces the moisture content of the leaves. All these effects change the chlorophyll content of a plant with corresponding variation in its spectral image. Ahsan and Umer studied the possibilities for detecting these effects by using various remote sensing techniques for acquisition of spectral image by satellite imagery, airborne images from chartered or model planes [6].

A novel approach is proposed [7] for integrating image analysis technique into diagnostic expert system. A CLASE (Central Lab. of Agricultural Expert System) diagnostic model is used to manage cucumber crop. The expert system finds out the diseases of user observation. In order to diagnose a disorder from a leaf image, four image processing phases are used: enhancement, segmentation, feature extraction and classification .They tested three different disorders such as Leaf miner, Powdery and Downey. The proposed approach has greatly reduced error prone dialogue between system and user.

The morphological features of leaves are used for plant classification and in the early diagnosis of certain plant diseases. Paper[8] presents design and implementation of an artificial vision system which extracts specific geometric and morphological features from plant leaves. The proposed system consists of an artificial vision system (camera), a combination of image processing algorithms and feed forward neural network based classifier. A fuzzy surface selection technique for feature selection was used.

A prediction approach based on support vector machines for developing weather based prediction models of plant diseases is proposed by Rakesh & Amar[9]. The performance of conventional multiple regression, artificial neural network (back propagation neural network, generalized regression neural network) and support vector machine (SVM) was compared. It was concluded that SVM based regression

approach has led to a better description of the relationship between the environmental conditions and disease level which could be useful for disease management.

Prasad Babu & Srinivasa Rao proposed Back propagation neural network for recognition of leaves in [10]. It was proved that just a back propagation network and shape of leaf image is enough to specify the species of a leaf. Prewitt edge detection and thinning algorithm is used to find leaf tokens as input to back propagation algorithm. It was reported that there is a scope for enhancement of this work which involves more experimentation's with large training sets to recognize various leaves with pest or damaged leaves due to insects or diseases and develop an expert system.

Neural network approach for segmentation of agricultural landed fields in remote sensing data is proposed [11]. A neural network algorithm based on back propagation is used for segmentation of the color images of crop field infected by diseases that changes usual color of plants.

Paper [12] implements a leaf recognition algorithm using easy-to-extract features and high efficient recognition algorithm. A Probabilistic Neural Network (PNN) approach for plant leaf recognition is used. The features are extracted and processed by PCA to form input to PNN. It was found that algorithm works with an accuracy of 90% on 32 kinds of plants

Paper [13] describes a system which introduces computer management into the cultivation process in low-tech greenhouse. The proposed system is implemented as a web-based application using open source technologies & subsystems comprised of modules that provide: 1) static information about the cultivation process and marketing of supported crops, 2) simulation and forecast models of general interest, 3) a collaboration environment and 4) expert system capabilities and support. The expert system is an adaptation of the VEGES expert system. It is used as a web based application. It can be used for identification of pests, diseases and nutritional disorders.

Santanu &Jaya described a software prototype system in paper [14] for disease detection based on the infected images of various rice plants. They used image growing, image segmentation techniques to detect infected parts of the plants. Zooming algorithm is used to extract features of the images .Self Organize Map(SOM)neural network is used for classifying diseased rise images.

In [15] fast & accurate novel method is developed which is based on image processing for grading of plant disease. They segmented leaf region using Otsu segmentation. The plant diseases are graded by calculating the quotient of disease spot & leaf area.

Grape leaf disease is detected in [16] from color imagery using hybrid intelligent system. They used self organizing maps &back propogation neural networks to recognize colors of grape leaf. This information is used to segment grape leaf pixels within the image. Then the grape leaf disease segmentation is performed using modified self organizing feature maps with genetic algorithms for optimization &support vector machines for classification. The segmented image is filtered using Gabor wavelet which allows the system to analyze leaf disease color features more efficiently. The support vector machines are then applied to classify types of grape leaf disease.

Ying & others studied methods of image preprocessing for recognition of crop diseases in [17] . They used cucumber powdery mildew, speckle & downy mildews as study samples & reported comparative study of effect of simple filter and median filter. They stated that Leaves with spots must be pre-processed firstly in order to carry out the intelligent diagnosis to crop based on image processing and appropriate features should be extracted on the basic of this.

They reported following important image preprocessing methods

1)image clipping : Separating the leaf with spots from the complex background.

2) noise reductions: two filters—Simple filter and Median filter were compared and at last the Median filter was chosen to wipe noises for the image.

3）threshoilding: to segment or partition image in to the spot background

In a word, the image pre-processing can make following extracting of characteristic parameters not to be affected by background, shape and size of leaf, light and camera and make a good foundation for following effective characteristic parameters for the disease diagnoses ,as well as setting up pattern recognition system

In [18] the design &development of an exper t system with two different methods for diagnosing plants Diseases were presented:1) step by step descriptive method 2)graphical representation method. It is reported that the expert system with the graphical representation is more favourable .it is found that the graphical representation requires few desaription from users. The praposed system saved a lot of time & effort in identifying plant disease .

Images features extraction is very important for the grading process of flue-cured tobacco leaves. In Paper[19] a system based on machine vision techniques is proposed for the automatic inspection of flue-cured tobacco leaves. Machine vision techniques are used in this system to solve problems of features extraction and analysis of tobacco leaves, which include features of color, size, shape and surface texture. The experimental results show that this system is a viable way for the features extraction of tobacco leaves, and can be used for the automatic classification of tobacco leaves.

Paper [20] present a method to monitor plant disease which caused by spores. The color image is first converted in to gray image so as to carry the analysis and processing, such as histogram generation, the gray-level correction, image feature extraction, image sharpening and so on. In order to remove low frequency components, the input gray image is preprocessed by edg eenhancement using the Median filter and canny edge algorithm. After thresholding binary image obtained is processed by using morphological features like dilation, erosion, opening etc. it is found that this method fits for many works which under the microscope to count or recognition, for example, optics stripe counting, the chromosome counting, and other plant diseases monitor etc.

For detecting rice disease early and accurately, paper [21] presented an application of image processing techniques and Support Vector Machine (SVM) for detecting rice diseases.Rice disease spots were segmented and their shape and texture features were extracted. Because the color features are influenced largely by outside light, they selected shape and color texture features of disease spot as characteristic values of classification. The SVM method was employed to classify rice bacterial leaf blight, rice sheath blight and rice blast. The results showed that SVM could effectively detect and classify these disease spots to an accuracy of 97.2%.

Method for fast & accurate detection & classification of plant diseases is proposed in [22]. They used Otsu segmentation , K-means clustering &back propagation feed forward neural network for clustering & classification of diseases that affect on plant leaves.

A feasible methods for detecting soybean rust and quantifying severity is explored[22]. The images of soybean leave with different rust severity were collected by using both multispectral CCD camera and portable spectrometer. Three parameters i.e. ratio of infected area, lesion color index and rust severity index were extracted from the multispectral images and used to detect leaf infection and severity of infection.

An experiment was carried out by Helmi Zulhaidi Mohd Shafri and Nasrulhapiza Hamdan in [23] on oil palm trees which requires on-time

detection of diseases as the ganoderma basal stem rot disease presents in more than 50% of the oil palm plantations. Airborne hyperspectral can provide data on user requirement and has capability of acquiring data in narrow and contiguous spectral bands. This made it possible to differentiate between healthy and diseased plants better compared with multispectral imagery. It was found that airborne hyperspectral imagery offers better solution to detect and map the oil palm trees that are affected by the disease. They used vegetation indices and red edge techniques to detect and map the oil palm trees that are affected by the disease and proved that the red edge based technique s are more effective than vegetation indices.

Method for fast & accurate detection & classification of plant diseases is proposed in [24]. They used Otsu segmentation , K-means clustering &back propagation feed forward neural network for clustering & classification of diseases that affect on plant leaves.

2.2. Summary of Literature Survey:

From above literature survey it is found that the following methods are used by different researchers for plant disease detection & analysis:

1.Back propagation neural network.

2.Airborne hyperspectral imagery & red edge techniques.

3.Image analysis integrated with Central Lab. of Agricultural Expert System (CLASE) diagnostic model.

4.Combination of morphological features of leaves, image processing ,feed forward neural network based classifier & fuzzy surface selection technique for feature selection.

5.Support vector machines for developing weather based prediction models of plant diseases.

6.Wavelet based image processing technique and neural network.

7.Image Processing with PCA & Probabilistic Neural Network (PNN).

8. Combination of image growing, image segmentation, Zooming algorithm & Self Organizing Map (SOM) neural network for classifying diseased rise images.

9. Self organizing maps &back propagation neural networks with genetic algorithms for optimization &support vector machines for classification.

10. Image clipping, filtering & threshoulding.

11. Otsu segmentation, K-means clustering &back propagation feed forward neural network.

[V] CONCLUSION

The literature survey done in this paper provides a new insight in detection of the diseases of plant . The scope in doing research in this field is as follow:

1.There are two main characteristics of plant-disease detection using machine-learning methods that must be achieved, they are: speed and accuracy. Hence there is a scope for working on development of innovative, efficient & fast interpreting algorithms which will help plant scientist in detecting disease.

2. Work can be done for automatically estimating the severity of the detected disease.

3. Work proposed by researcher Yao[21] can be extended for development of hybrid algorithms such as genetic algorithms & neural networks in order to increase the recognition rate of the final classification process

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