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Developing an algorithm for Tomato leaf disease detection and classification

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Abstract: Tomato is widely cultivated economical crop in the India; so diseases in plants cause major production and economic losses as well as reduction in both quality and quantity of agricultural products. Therefore, automatic detection of plant diseases is an essential research topic as it may prove benefits in monitoring fields of crops, and automatically detect the symptoms of diseases. Farmers experience great difficulties in switching from one disease control policy to another. The naked eye observation of experts is the traditional approach adopted in practice for detection and identification of plant diseases. Mostly diseases are seen on the leaves. Therefore, looking for fast, less expensive and accurate method to automatically detect the diseases from the symptoms that appear on the plant leaf is of great realistic significance. Early information on crop health and disease detection can facilitate the control of diseases through proper management strategies. Hence the algorithm is to design, implement and evaluate an image processing based software solution for automatic detection and classification of plant leaf diseases. The method used in this work is divided into two major phases. First phase concerns with training of healthy sample and diseased sample. Second phase concerns with the training of test sample and generates result based on the segmentation and feature extraction. And classifies the diseases into fungal, bacterial and viral. It also helps the farmer to take superior decision about many aspects of crop development process.

Keywords: Image Processing, Image Segmentation, Feature Extraction, Disease Detection, Disease Classification.

I. INTRODUCTION

India is an agricultural country wherein most of the population depends on agriculture. Plant diseases have turned into a dilemma as it can cause significant reduction in both quality and quantity of agricultural products. Therefore, plant disease identification is a very important and challenging task. Mostly diseases are seen on the leaves or stems of the plant on the fruits also. 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 analyse significant content. Here image processing plays important role.Diseases are impairment to the normal state of the plant that modifies or interrupts its vital functions such as photosynthesis, transpiration, pollination, fertilization, germination etc. These diseases are caused by pathogens viz., fungi, bacteria and viruses, and due to adverse environmental conditions. Therefore, the early stage diagnosis of plant disease is an important task [1]. Farmers require continuous monitoring of experts which might be prohibitively expensive and time consuming. Therefore, looking for fast [2], less expensive and accurate method to automatically detect the diseases from the symptoms that appear on the plant leaf is of great realistic significance. Most leaf diseases are caused by fungi, bacteria and viruses. Fungi are identified primarily from their morphology, with emphasis placed on their reproductive structures. Bacteria are considered more primitive than fungi and generally have simpler life cycles. With few exceptions, bacteria exist as single cells and increase in numbers by dividing into two cells during a process called binary fission viruses are extremely tiny particles consisting of protein and genetic material with no associated protein.

II. PROPOSED SYSTEM

Image Processing is the enhancement of image that is processing an image so that the results are more suitable for a particular application.

Design Modules: Mainly there are 4 design modules in this project.

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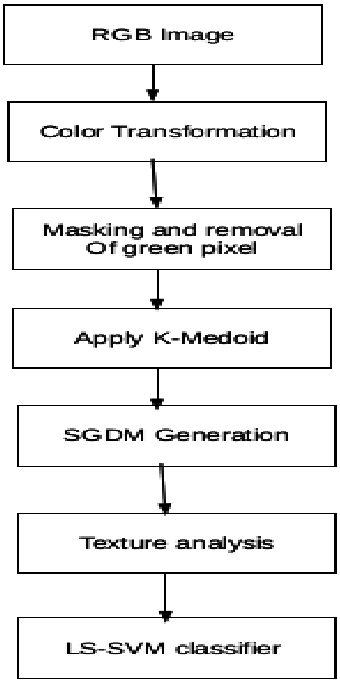

Fig 1: System Block Diagram

- Image Pre processing

The RGB images of leaves are converted into HSI color space representation. Is a popular color model because it is based on human perception. After transformation process, the H component is taken into account for further analysis. Green colored pixels mostly represent the healthy areas of the leaf so masking and removal of the green pixel is done. It significantly reduces the processing time.

- Segmentation

From the pre processing step infected portion of the leaf is extracted. Then it is segmented into a number of patches of equal size. The K-medoid clustering is used for segmentation. A general version of K-means algorithm is called K-Medoids clustering method. K-medoid is a classical partitioning technique of clustering that clusters the data set of n objects into k clusters known a priori. Instead of taking the mean value of the objects in a cluster as a reference point, a Medoid can be used, which is the most centrally located object in a cluster. It differs from K-means mainly in its representation of the different clusters. Each cluster is represented by the most centric object in the cluster, rather than by the implicit mean that may not belong to the cluster. A medoid can be defined as the object of a cluster whose average dissimilarity to all the objects in the cluster is minimal. i.e. it is a most centrally located point in the cluster. Calculate distances to each center so as to associate each data object to its nearest medoid. Cost is calculated using Manhattan distance.

- Feature Extraction

For extracting the feature set color co-occurrence method or CCM is used. In which both the color and texture of an image are taken into account to arrive the unique features. The CCM texture analysis method is developed through the use of spatial gray-level dependence matrices ,in short SGDM .These matrices measure the probability that a pixel at one particular gray level will occur at a distinct distance and orientation from any pixel given that pixel has a second particular gray level. The SGDMs represented by the function P(i,j,d,θ). Where i represents the gray level of the location (x,y) in the image I(x,y).j represent the gray level of the pixel at a distance d from location (x,y) and an orientation angle of θ. Properties of SGDM like contrast, energy, homogeneity and correlation are calculated.

- Classification

Extracted feature sets are fed into the LS-SVM classifier. Least Squares Support Vector Machine (LS-SVM) classifier is one particular sample of Support Vector Machine (SVM).LS-SVM is used for finding an optimal hyper plane, which separates various classes. It obtains this optimal hyper plane by using maximum Euclidean distance to the nearest point. Kernel based SVM are used for the LS-SVM classifier. We could find the solution in LS-SVM by solving a set of linear equations instead of a convex quadratic programming problem for classical SVM. The LS-SVM classifier maps the input vectors into a high dimensional feature space for non-separable data.

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Proposed System Algorithm

- Input a RGB image.
- Convert the input image from RGB to HSI.
- Masking the green pixel.
- Removal of masked green pixel.
- Segment the components using K-medoid clustering.
- Computing the texture features using color co-occurence methodology.
- Use these information for LS SVM training.
- For test images same process is done and classify them with the LS SVM which is trained.

A. RGB to HSI conversion Algorithm

- Start
- Input RGB image
- Hue value is calculated as $H=COS^{-1}(1/2[(R-G)+(R-B)]/ (R-G)^2+(R-B)(G-B))$
- Saturation $S=1-3/(R+G+B) * [min(R, G,B)]$
- Intensity value $I=1/3 * (R+G+B)$
- Hue component is taken into account for further analysis.

B. Masking Green Pixel

- Input the Hue component of the image
- Derive the red, green and blue component.
- Threshold value is set.
- If green component of the pixel is less than the pre-computed threshold value.
- Set red, green and blue components of the pixel to zero and removed.
- Finally get the infected region.

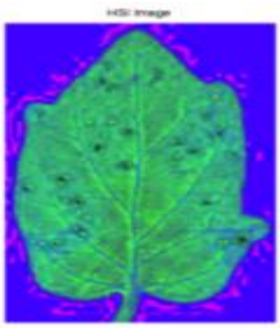

Fig2.RGB image Fig 3.HSI image

Fig. 2 and 3 shows an example of RGB to HSI conversion.

C. Segmentation using K-Medoid

- Randomly select K of the n data points as the medoids.
- Associate each data point to the nearest medoid.
- For each medoid m and each data point o associated to m swap m and o and compute the total cost of the average dissimilarity of o to all the data points associated to m by using Manhattan distance.
- Select the medoid o with the lowest cost of the configuration.
- Repeat alternating steps 2 and 3 until there is no change in the assignments.

D. Feature Extraction

Input the hue component of the image.

- Compute SGDM matrices by calculating the probability value using $P(i,j,d,\theta)$.
- Calculate the properties like contrast, energy, homogeneity and correlation from the SGDM matrix.
- Query image constructed by cumulative HSV color histogram.
- Construct a combined feature vector for color and texture.
- Find the distances between the feature vector of the query image and the feature vectors of the target images using the city block distance.

Fig 4.Clusters formed from K-Medoid Segentation

E. Classification

Extracted feature sets are fed into the LS-SVM classifier. Least Squares Support Vector Machine (LS-SVM) classifier is one particular sample of Support Vector Machine (SVM). LS-SVM is used for finding an optimal hyper plane, which separates various classes. It obtains this optimal hyper plane by using maximum Euclidean distance to the nearest point. Kernel based SVM are used for the LS-SVM classifier. We could find the solution in LS-SVM by solving a set of linear equations instead of a convex quadratic programming problem for classical SVM. The LS-SVM classifier maps the input vectors into a high dimensional feature space for non-separable data.

III. CONCLUSION

In this paper an image-processing-based approach is proposed and used for leaf disease detection. A new algorithm for plant leaf disease detection and classification has been proposed. The proposed project is overcome the naked eye observation of plant leaf disease by botanist. An application of texture analysis has been used to classify the plant leaf diseases. It is tested on tomato plants. By this method we can identify the plants diseases at the initial stage itself.

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