

Review

Investigation and monitoring for leaves disease detection and evaluation using image processing

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Image segmentation is useful in different applications. From the segmentation results, it is possible to identify regions of interest and objects in the scene, which is very beneficial to the subsequent image analysis. This system identifies leaves disease of plants and also determines the stage in which the disease is. The system has various image processing techniques. At first, the images are captured and processed for enhancement. Then image segmentation is carried out to get disease regions. Later, image features such as shape, colour and texture are extracted for the disease regions. These resultant features are given as input to disease classifier to appropriately identify and grade the diseases.

Keywords: Leaf disease, disease classification, image segmentation, image processing, leaf colour.

INTRODUCTION

Diseases in leaves cause major production and economic losses in agricultural industry. Monitoring of health and detection of diseases in leaves is critical for agriculture. This is report a machine vision system for the identification of the leaves diseases, from coloured images. Diseased regions shown in digital pictures of crops were enhanced, segmented, and a set of features were extracted from each of them. Image segmentation is critical to image processing and pattern recognition. Basically, colour image segmentation techniques are based on monochrome ones operating in different colour spaces. The image segmentation is used in the image about the disease regions and the normal regions in the leaves. We determine the RGB threshold value, through counting the characteristic parameter of stochastic picture element in the different image spot. The combined methods of the main factor three threshold values decide the division. This method not only retains the image real colour, but also has very good division effect.

Images are important data and information in biological sciences. Photography was the only method to reproduce and report such data. It is difficult to quantify or treat the photographic data mathematically. Digital image processing and image analysis technology based on the advances in microelectronics and computers circumvent these problems associated with traditional photography. This new tool helps to improve the images from microscopic to telescopic range and also offers a scope

for their analysis.

Disease management is a challenging task. Mostly diseases are seen on the leaves or stems of the plant. For examples ⊗ Figure 1, 2 and 3)

Plant leaf colour is also commonly used as an indication of health status of plants. The loss of chlorophyll content of leaves occurs due to nutrient imbalance, excessive use of pesticides, environmental changes and ageing. A variety of colour plates and chlorophyll meters were previously used to monitor chlorophyll content of leaves in situ. The concentration of chlorophyll per pixel can be measured from the colour image of any leaf taken under standard conditions of illumination. The concentration of chlorophyll per pixel multiplied by the area of leaf in pixels will yield the total concentration of chlorophyll per leaf. (Figure 4)

In biological science, sometimes thousands of images are generated in a single experiment. These images can be required for further analysis of plant diseases. Here image processing plays important role for analysing plant diseases (Figure 5).

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

1. To detect diseased leaf, stem, fruit
2. To find shape of affected area.
3. To determine colour of affected area
4. To determine size and shape of fruits.

In case of plant the disease is defined as any impair

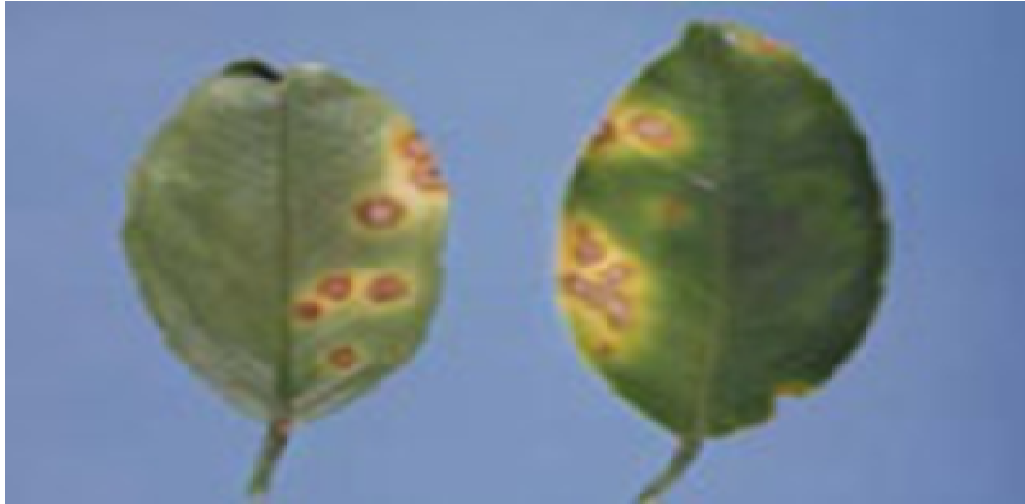


Figure 1. Leaf symptoms on top and bottom leaves



Figure 2. A fungal disease, verticillium wilt



Figure 3. Cottony mold

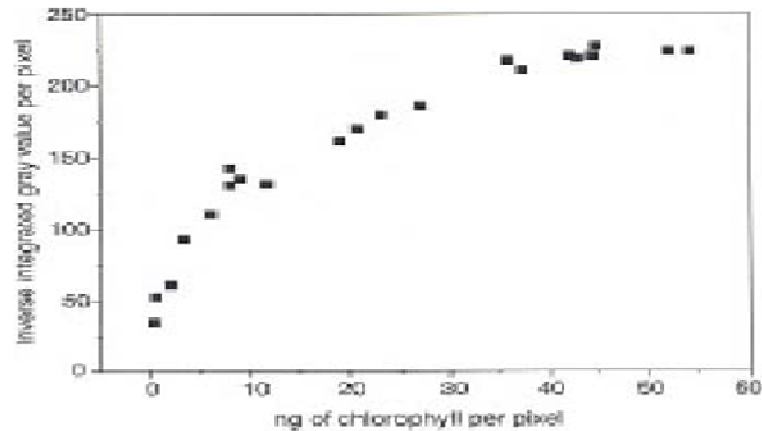


Figure 4. Estimation of chlorophyll in leaf disks

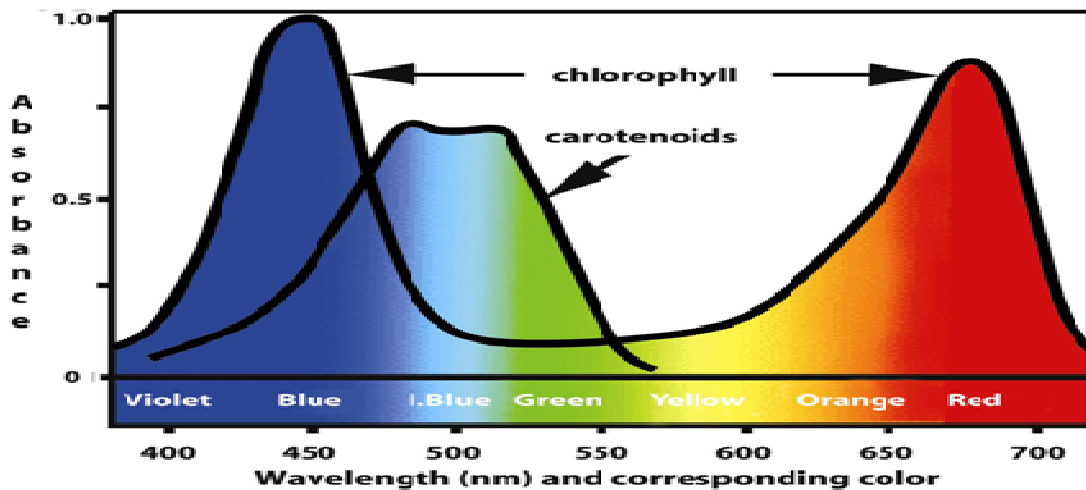


Figure 5. Chlorophyll variation chart

ment of normal physiological function of plants, producing characteristic symptoms.

5. Statistical analysis

6. Classification based on a classifier

The approach and implementation of image processing

Steps involved to detect diseases in plant leaves

Generally, first the digital images are acquired from the environment using a digital camera. Then image-processing techniques are applied to the acquired images to extract useful features and analysis. Several techniques are used to classify the images according to the specific problem at hand.

The system is divided into following steps

1. Image acquisition
2. Image pre-processing
3. Image segmentation
4. Feature extraction

Image acquisition

Image processing application begins with image acquisition. The images can be captured using a regular digital camera with required resolution for better quality; maintaining an equal distance, equal angle and equal illumination to the object with uniform background. All the images should be saved in the same format such as JPEG, TIF, BMP, PNG etc.

Image pre-processing

Image pre-processing is a technique in which the data from an image are digitized and various mathematical operations are applied to the data. Pre-processing crea-

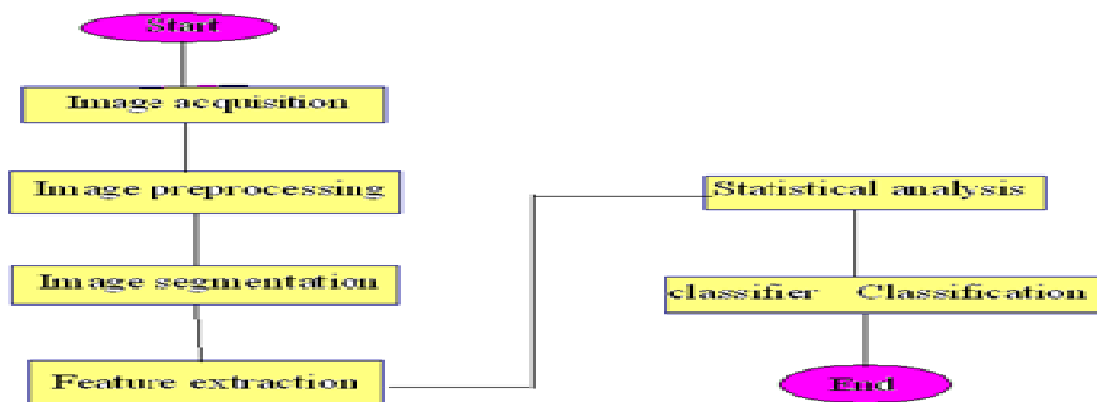


Figure 6. Image processing chart

tes an enhanced image that is more useful or pleasing to a human observer. Pre-processing uses various techniques like image resize, filtering, segmentation, morphological operations etc. In most of the image processing applications the initial captured images are resized to a fixed resolution to utilize the storage capacity or to reduce the computational burden. Since images may be captured from the fields it will be unavoidable that some due drops, insects' excretes and dust might appear on the captured images. In image processing these are treated as image noises. They must be removed or weakened before any further image analysis. Filters like Gaussian, median, Linear, Low pass, High pass, Laplacian filters etc can be used to remove the image noise. Once the image has been enhanced, the next process is to extract region of interest in the image i.e. diseased portion of the image. This can be achieved by image segmentation.(Figure 6)

Image segmentation

Image segmentation is the process of partitioning the digital image into multiple segments to change the representation of an image into something that is more meaningful and easier to analyse i.e. to identify regions in the image that are likely to qualify as diseased portions. The level to which the partitioning is carried depends on the problem being solved i.e. segmentation should stop when the objects of interest in an application have been isolated. There are various techniques for image segmentation such as clustering methods, compression-based methods, histogram-based methods, region growing methods etc.

Feature extraction

Once the image has been enhanced and segmented, there may be some stabs, empty holes etc remained in

the images. Hence to remove these noises morphological operations, region filling can be applied. Further, the interested part can be extracted and its features can be analyzed. For an image, a feature can be defined as the "interest" part in an image. The name feature is often used in the pattern recognition literature to denote a descriptor. The desirable property for a feature detector is repeatability; i.e., whether or not the same feature will be detected in different images. Features play a fundamental role in classification. In image processing, image features usually include colour, shape and texture features.

Statistical analysis

Once the texture statistics were generated for each image, statistical analyses were conducted using SAS statistical analysis package to reduce redundancy in the texture feature set which acted as the input data to our classifiers.

Classification based on a classifier

Once the features are extracted, next step is to find to which disease class the query image belongs to and in which stage the disease is. Once the disease stage is identified, appropriate treatment advisory can be provided by seeking the help from agricultural experts so that the disease can be prevented from further spreading.

Plant leaf colour is also commonly used as an indication of health status of plants. The loss of chlorophyll content of leaves occurs due to nutrient imbalance. A variety of colour plates and chlorophyll meters were previously used to monitor chlorophyll content of leaves. According to the leaf image, the disease type can be confirmed with the image processing technique.(Figure 7)

The feature extraction process used colour co-occurrence methodology (CCM method). It is a method,



Figure 7. A leaf image infected with tiny whiteness disease (left) and a normal leaf image (right).

in which both the colour and texture of an image are taken into account, to arrive at unique features, which represent that image. The manual feeding of the datasets, in the form of digitized RGB colour photographs was implemented for feature extraction and training the SAS statistical classifier. After training the SAS classifier, the test data sets were used to analyze the performance of accurate classification. The whole procedure of analysis was replicated for three alternate classification approaches to include; statistical classifier using the Mahalanobis minimum distance method, neural network based classifier using the back propagation algorithm and neural network based classifier using radial basis functions. The analyses prove that such methods can be used for agricultural applications in areas such as precision farming.

SUMMARY AND CONCLUSIONS

A study was completed to investigate the use of computer vision and image processing techniques in agricultural applications.

The image data of the leaves was collected using a digital colour camera. And these images were processed various image processing techniques. This was a

feasibility analysis to see whether the techniques investigated and implemented in outdoor applications.

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