Estimation of Fungus/Disease in Tomato Crop using K-Means Segmentation

Shruti¹ and Nidhi Seth²

JMIT, Radaur, Haryana, INDIA,
JMIT, Radaur, Haryana, INDIA,

Abstract: Tomato crop is primarily infected by various common diseases like Bacterial Canker, bird’s-eye fruit spots, Bacterial Spot, Chlorosis, Curly Top, Early Blight, Fusarium Wilt, Gray Leaf, Gray Mold Rot, Leaf Mold, Leaf Roll and Leaf Curl, Powdery mildew, Septoria Leaf Spot, Tobacco Mosaic Virus, Verticillium Wilt. The presented work describes a algorithm for different disease detection based on the infected images of various tomato plants. Images of the infected tomato plants are captured by closed circuit CCD cameras to cover approximately 5 sq. meter area that could acquire good quality images of tomato crop. The acquired images are in jpeg format and are converted to gray scale image. The gray scale image are the enhanced and made noise free. The Otsu algorithm is applied in order to get the thresholded image. The segmentation techniques based in pixel neighborhood are applied to get the segmented leaf and infected part of the leaf. The methods evolved in this system are both image processing and soft computing technique applied on number of diseased tomato plant images. The tomato images are acquired by using a CCD camera of approx. 3 M-Pixel resolution in 24-bits color resolution. The images are then transferred to PC and represented in MATLAB software. The RGB image is then segmented using K-means algorithm for segmentation of fungus in the tomato crop. The segmented fungus part is now analyzed for its percentage presence.

Keywords: Segmentation, K-Means, Pixel Neighborhood

1. Introduction

The correct and timely identification of diseases is the basis for integrated management of a farm. Generally, the features of any plant or leaf are subjectively extracted by manual inspection. To make this task more efficient and accurate, various studies have been carried out and are undergoing to automate plant identification process with the aid of image processing techniques. There occurs a need for a simple and cost-effective optical device for remote disease detection, to assist in monitoring diseases in plants. Machine vision system in the presented case is the most renewed area and application of image processing techniques that could bring the agriculture sector profit top a maximum. Due to vast area of agriculture land, it is not possible to monitor the entire area to a fair accuracy. Machine vision is the answer to this problem. Although, machine vision should be used for low scale i.e. short distance monitoring, computer vision technique is the more appropriate term to describe the role of image processing in agriculture sector.

2. Related Works

In order to reduce the work of human and also time consuming the most important technology in the realization of automatic tomato sorting machine is to identify the tomatoes based on quality in the food industry. The work represents a hierarchical grading method which is applied to the tomatoes. From the proposed range they can identify the good and bad tomatoes. Thus good and bad tomatoes are analysed with a very high accuracy successfully using image processing. [1]

Leaf colour is used as a measurement of nutrient level and plant health status. [An hand-held system is proposed, a new inexpensive and easy-to-use technique for the detection of foliar nitrogen content in plants and chlorophyll content in plants based on leaf colour. [2].

An experiment was developed on sorting system for bunches of longan fruits by using an image processing technique. Mainly a machine-vision system was developed for determining the size and location of individual longans in the bunch. The images of longans were processed to eliminate noise and then converted the images to gray scale. In the meanwhile a Canny edge detector was operated to detect edges in the images of longan fruits. Since the shape of longans is circular, for this a circular Hough transform was also applied to the images in searching for longans.[3]

Sometimes there are many instances in which it is desirable to determine relationship between various physical characteristics of fruits and vegetables. Although fruits and
vegetables are often graded on the basis of size and projected area, it may be more useful to develop a machine which would grade by produce mass. Single and multiple variable regressions of projected areas, single and multiple variable regressions of tomato dimensions and modeling tomato mass based on its measured volume and mass. [4]

The tomato crop ripeness level may be estimated by the use of analysis of color. A histogram of the crop image may give a very fair idea of the ripeness level. Image histogram processing and analysis will be used to get the exact color range for ripen and unrippen tomato. Further the leaf color may also be used to predict or correlate the ripeness level. [5]

Image processing proved to be effective tool for analysis in various fields and applications. In agriculture sector where the parameters like canopy, yield, quality of product were the important measures from the farmers point of view. The availability of expert and their services may consume time and many times expert advice are not affordable. [6]

Tomatoes have the high consumption for Indonesian people for agriculture. Tomato fruit have different shape and color, and the level of maturity can be characterize by color of tomato. The research has been determine the level of maturity of tomatoes based on the color. The various tomatoes for counting levels of tomato color image are taken using a digital camera. [7]

An experiment was conducted from November 2012 to February 2013 at the Gladstone Road Agricultural Centre. The study evaluated five tomato varieties: ‘BHN 543’, ‘Finishline’, ‘Rocky Top’, ‘Soraya’ and ‘Yellow Jubilee’. The trial was set out on evaluated varieties in a completely randomised design with three replications. The tomato varieties are all matured within range of the expected number of days to maturity from transplanted seedlings. [8]

3. Tomato Crop Image Acquisition

The very first step in the presented work is to acquire the tomato crop images using the CCD cameras. Following Images are acquired using 14 MPixel Nicon camera from the field.

4. Segmentation using K-means

K-means clustering provides partitioning of the image depending upon the feature base choosed. The feature base selection in the presented case is color and area of the infected leaf in the crop. K is the no. of segments that are created based on k-means clustering. Initially, a no. of clusters is decided depending upon the application. In the presented case, the no. of clusters is 3. Now, three centers of clusters are choosen and distance of each pixel color from the centre of cluster is computed, normally a Euclidean distance.

Based on Euclidean distance of each pixel color from the center of masses, the pixel is tagged to the cluster from which the Euclidean distance is minimum.

After one iteration, the centers of mass are updated by taking average of each pixel color and the above step is repeated again and again until the center of mass comes same in continuous two iterations. At this moment, the iteration is stopped.

The centers created by k-means clustering have the following two properties: 1) each cluster is characterized by its unique centre of mass and 2) the Euclidean distance of each member of the cluster has minimum average distance from its centre of mass and maximum average distance from other centers of mass.

The pixel of different color intensity update their cluster position based on minimum Euclidean distance from the respective center of mass during each iteration. This way, a clear and well segmented images are obtained. The fresh leaf and infected portion may be observed in the images given below.
The leaf area and perimeters are computed as follows:

Leaf area is given by counting the total no. of leaf pixels present on the leaf. This can be computed from the binary image having black as leaf. Therefore, total no. of black pixels accumulates to leaf area. Further, the leaf perimeter is computed by using the `regionprops` command in MATLAB. This command gives leaf perimeter.

Also, the leaf images are segmented into its fungus or infected parts by using the neighborhood pixel connectivity criterion and using the MATLAB command `bwlabel`. The segmented parts are again exposed to `regionprops` command and the individual part’s perimeter and area can be computed.

Following images shows the result after implementing the K-means algorithm on original tomato crop images.

![Image](image1.png)

**Fig. 3 (Original Tomato Crop)**

![Image](image2.png)

**Fig. 4 (Binary Image)**

![Image](image3.png)

**Fig. 5 (Segmented Disease Parts)**

5. Results

The segmented image i.e. the fungus image is now exposed to measurement algorithm, where the fungus area is computed with respect to entire acquired image area. This gives the degree of fungus penetration in the tomato crop under scanner.

<table>
<thead>
<tr>
<th>Fig. No.</th>
<th>Tomato Leaf Area</th>
<th>Fungus Area</th>
<th>% Fungus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2018 sq. pixels</td>
<td>1289 sq. pixels</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>2134 sq. pixels</td>
<td>1323 sq. pixels</td>
<td>62</td>
</tr>
<tr>
<td>3</td>
<td>1897 sq. pixels</td>
<td>345 sq. pixels</td>
<td>18</td>
</tr>
</tbody>
</table>

Conclusion

% Penetration of the fungus has been computed from the ratio of the fungus infected area and complete leaf area. This is an estimate of the fungus penetration into a single plant and a fair idea of fungus spread into the entire crop can be estimated by inspecting the entire crop segmented into zones and brought under the purview of the imaging sensors i.e. cameras.

References


Author Profile

1Shruti has received the B.Tech. degree in cse from GGSCMT, Kharar, Punjab and M.Tech. degree in CSE from JMIT, Raigarh, Haryana respectively. Her field of interest is in image processing based application system developments.