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Research Article

FUNGUS/DISEASE ANALYSIS IN TOMATO CROP USING IMAGE PROCESSING TECHNIQUES

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ABSTRACT
The crop of tomato is very often infected by a disease that leaves spots of brown, gray or off-white colors on the plant's leafs in winter. Scientifically, this disease is known as cercospora leaf spot or cercospora cruciferarum. It's a kind of fungus that often kills young seedlings. The fungus spreads by air and can also infect tomato plants. Therefore, it is important to monitor the leaf at regular intervals so as to keep track on quality of growing tomato crop. In the presented paper, a novel machine vision system has been proposed that visual inspects the leafs coming out of the soil and based on spots on leaves, it determines the nature of fungus and its depth into the tomato steam. The size of the fungus, color depth and location and locus of the fungus on leaves give an accurate determination of crop quality under the soil. In the presented thesis work, the image of the crop leaves are taken by a good quality color camera and processed for getting a gray colored and segmented image depending upon the nature and size of the fungus. A criterion is set for acceptable and rejects crop quality based on the fungus level.

Keywords: *Segmentation, K-Means, Pixel Neighborhood*

INTRODUCTION

Fruits and vegetables production and related activities face significant losses in India, which are close associated to the lack of appropriate technology. Vegetable quality is frequently referred to size, shape, mass, firmness, color and bruises from which it can be classified and sorted. However, technological implementation in that sector turns unfeasible by software, equipment as well as operational costs. For delicate products as eggs, fruits and others plant organs, optical techniques, including moiré methods, are especially useful for geometrical characterization as well as to implement sorting techniques, due to speedy, non-physical contact with the specimens, low cost and automation possibilities. The program supports all image manipulations as reading and writing of image files, operation on individual pixels, image regions, whole images and volumes. Volumes ordered as a sequence of images can be operated upon as a whole. It also can perform basic operations as convolution, edge detection, Fourier transform, histogram, editing and color manipulation, dilatation as well as mathematical operation on sets of images such as multiplication and/or division. Visualization operations includes color space conversions from as from RGB to Hue Saturation Intensity color space, 2D and 3D plotting as well as surface and volume rendering.

Related Works

The presented work is based on tomato crop grading. The tomato grading is based on color based segmentation of tomatoes using k-means clustering (Kalaivani *et al.,* 2013). Leaf color 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 color (Mahdi *et al.,* 2012). 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 (Chawaroj *et al.,* 2013).

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 (Hadi *et al.*, 2013).
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 (Meenu and Banga, 2012).

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 is not affordable (Anup and Bodhe, 2012).

Tomatoes have the high consumption for Indonesian people for agriculture. Tomato fruit have different shape and color and the level of maturity can be characterized by color of tomato.

The research has been determining 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 (Aristoteles and Dwi, 2013).

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 (Kenneth, 2013).

Tomato Image Acquisition and Preprocessing

Tomato images are acquired by using the digital camera focused on leaves so as to get the fair quality images of the same. Normally, a digital camera of good resolution, at least of the order of 6MPixel should be used to get a fair quality image.

Followings are the images acquired using the Nikon 14 MP camera.

Figure 1:

Figure 2:

The acquired tomato leaf images are in jpeg format i.e. in true color format (24-bit color format). The color images are now decomposed into R-, G- and B- color component for disease identification based on color histogram. This is shown in below screen shot of the matlab program:

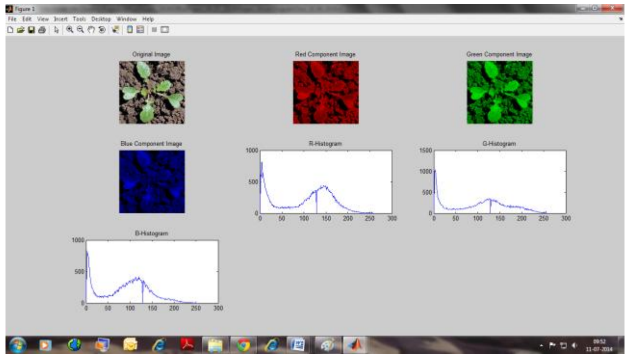


Figure 3:

The true color images are converted into gray scale format using rgb2gay command in matlab. The gray images are now enhanced using the histogram equalization technique. A thresholding technique based on Otsu algorithm is applied to get the binary image with white as back ground and black as tomato leaves. Following are the results of enhancement and thresholding techniques.

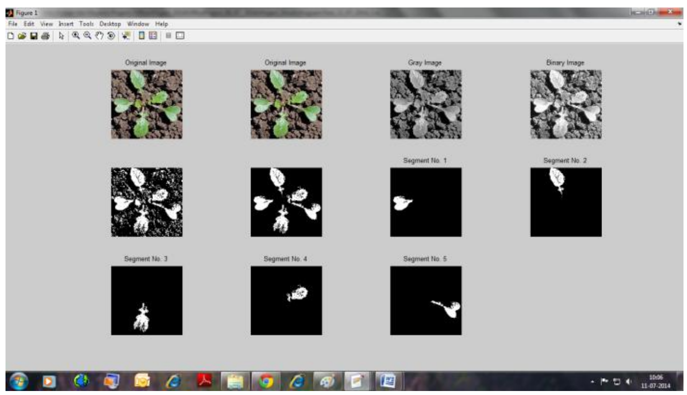


Figure 4:

The threshold image i.e., binary image is segmented in different leaves using pixel neighborhood algorithm. The binary image is converted to labeled image where each segment is given a label based on pixel connectivity. The segmented images are given in above screen shot. A tomato leaf image after color segmentation looks like as shown below:

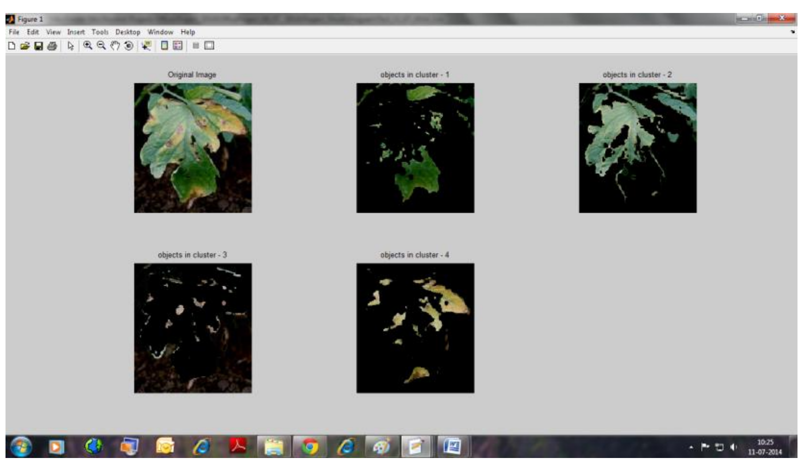


Figure 5:

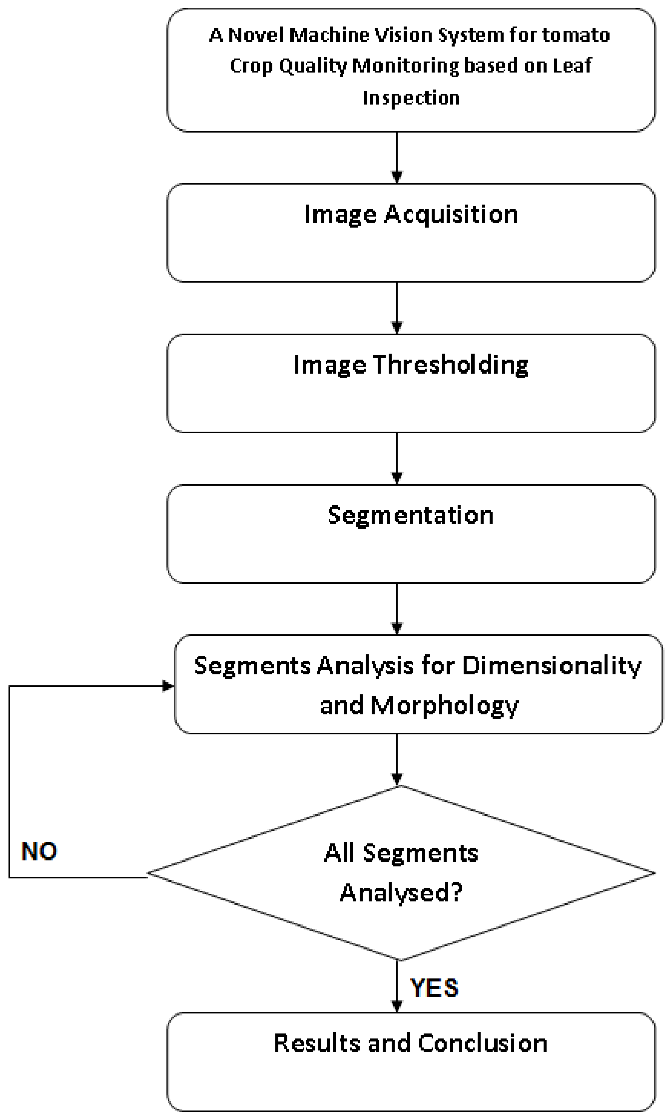
The yellow portion of the leaf is extracted clearly in the last segment. The color segmentation is done using the k-means clustering

Feature Extraction

Following features are extracted from the segmented image of tomato leaves:

1. Tomato Total Leaf Area
2. Leaf Perimeter
3. Fungus Leaf Area
4. Fungus Location
5. Fungus Perimeter

Flow Chart of the Proposed System



RESULTS AND DISCUSSION

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.

In figure 5, The total leaf area = 3564 sq. pixel units
Leaf Perimeter = 876 pixel units
Yellow Portion area = 327 sq. pixels
Yellow Portion Perimeter = 235 pixel units
% Infection = (Fungus Area/Leaf Area)x100
= (327 x 100)/3564 = 9.1%

Thereby, the infection can be quantified by the fungus area computation via fungus image segmentation and thereafter by mathematical analysis.

Conclusion

For mapping of type of infection or fungus, some more data are required like rate of spread of fungus in tomato leaf and its initiation in the leaf. However, the initiation and rate of spread could be monitored if a continuous camera is installed on the tomato plant and snaps are taken out at regular interval of time, for example at every 5 minutes in a day. Once, these data re available, the type of disease may be very well mapped with the presented algorithm. The exact quantification is quite possible as suggested in the methodology.

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