AUTOMATIC MARKER BASED MORPHOLOGICAL IMAGE SEGMENTATION, CLASSIFICATION AND DISEASE DETECTION USING SVM CLASSIFIER IN DISEASED TOMATO PLANTS

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Abstract

The process of identifying parts of plants and its diseases with modern electronic devices is called biometric Image processing. Many algorithms are proposed and implemented to discover finite outcomes in agriculture. But one of the efficient approaches to be used is Morphological Watershed. Markers of type internal and external are used for foreground and background region based Segmentation. This approach can be done with or without any preprocessing steps. The goal of this approach is to develop a descriptive algorithm for fully automated segmentation, classification and identification of diseased tomato leaf image modalities. There are 2D as well 3D Automatic Markers Controllers developed and implemented in Segmentation. Automatic identification can be done using Support Vector Machine (SVM) along with feature extraction. Many methods are used and reviewed for Segmentation as well as detection and Classification of tomato Plant Diseases in Image processing.

Keywords – Agriculture, Image Processing, Leaf diseases, Tomato, Automation Algorithms

1. INTRODUCTION

Agriculture is the basic occupation for 70% of Indian population. So a standard approach helps to improve agriculture. Early detection of diseases in plants fortify yield. Detection of diseases through automatic technique is highly beneficial and helps to reduce large amount of manual monitoring in agricultural fields [1]. Automation method is highly computational and cost effective. These methods are more attractive to do accurate, forceful and speedy analysis. Morphological based watershed segmentation gives outstanding results [2]. Illustration of the marker-based watershed transform is done by transforming original image into the gradient image with boundaries of stridently changing intensity levels. Compared with user-depended interactive segmentation, this approach shows a hopeful accuracy. Segmenting a 2D or 3D mandible is typically done 'interactively' in computer software [3].

2. MATERIALS AND METHODS

2.1. DATASET DESCRIPTION

Plants that affected with disease caused by any living organism are known as biotic plant disease. This can be further classified as Fungal disease, Bacterial disease, Viral[4].A variety of diseases affect on Tomato plants .Diseases may cause problems during growing season and may damage a crop, leading to reduced or poor-quality of yields. Tomato disease pathogens may be fungal, bacterial or even viral. The following table shows example of one fungal, bacterial and viral disease respectively with its optimum temperature condition. Image database consists of healthy and diseased Tomato images. All images are captured by using a high resolution digital camera with 16 mega pixel resolution to get the better image and in jpeg format. An image database of total 100 images, include 25 images of healthy, and 75 images of diseased Tomato affected by various diseases namely Tomato Early Blight, Bacterial spot, yellow Curled Virus

Disease	Causal organism	Optimum temperature
Tomato Early Blight	Alternaria tomatophila and Alternaria solani(Fungal)	28°C -30°C
Tomato Bacterial spot	Xanthomonas vesicatoria, Xanthomonas euvesicatoria, Xanthomonas gardneri, and Xanthomonas perforans(bacterial)	24°C- 30°C

Tomato yellow Curled Virus	Begomoviruses transmitted by *Bemisia tabaci*.(Viral)	30°C

Table 1. Optimum growth temperature ranges for pathogens of Tomato

3. PROPOSED METHODOLOGY

Proposed method includes the following steps

3.1 Image Acquisition

The first stage in Image Processing is Image Acquisition in which image is acquired by using Di digital camera in RGB format. Better quality resolutions are used for image-analysis that images are in the format such as TIF, JPEG, PNG, BMP etc. Mat lab software R2018 is used for processing images. Images are reserved and exhibited as gray scale images with dimension of 256*256.The intensity of these gray scale images represented from 0 to 255,where 0 represents purely black color and 255 represents purely white color. A sensor equipped computer is used to minimize the noise of the acquired images by minimizing the physical connection length of the camera. The modules of acquired images are moved from acquired source system to another system after finishing the acquisition. The module repeats these processes by moving along the pathway of sensor. All images are stored in the embedded computer and automatically sent to the database-and-analysis computer after finishing acquisition [5].

3.2 Image segmentation

The process of partitioning a digital image into multiple regions (sets of pixels) is called Image segmentation. In Segmentation, segmented part image of the image is the most convoluted and essential part of leaf disease identification [6].The result of Image Segmentation brings set of regions that collectively cover the entire image, or a set of contours extracted from the image. Segmentation is one of the most important image processing methodologies [7]. Each pixel within a region is uniquely similar with respect to some characteristic or computed property, such as color, intensity, or texture, depth, or motion.

3.3 Watershed Segmentation

Another stage is Watershed segmentation in which a technique of nonlinear mathematical morphology is used to separate connected objects during segmentation. Input image should be binary grey gradient image or distance transform image, and its output forms a persistent single pixel image. But if gradient operator is used directly, the influence of noise and quantization error is high. This leads to over-segmentation occurrence after watershed transform. Various techniques including pre-processing, region merging, marker-controlled watershed segmentation approach, etc. are applied to solve the over-segmentation problem. Obtaining foreground marker automatically involves histogram equalization and morphological operations [8].

3.4 Morphological Segmentation

Read the color Image and Convert it to Grayscale. Then use segmentation function for calculating Gradient Magnitude. It has been found in much research that when watershed algorithm applied directly on any image and its gradients, results in over segmentation. So, in this stage an Algorithm is developed to trace Internal and External markers of image and that is carried out to achieve smooth and significant boundaries between catchment basins [9]. So, opening and closing by reconstruction using erosion helps to mark foreground markers. Computation of Background markers can be done by Threshold opening-closing by Reconstruction. Morphological marker and watershed algorithm combination helps to segment the Tomato diseases leaves and brings accurate segmentation results. To solve over segmentation problem, marker based morphological watershed helps to find foreground as well as background objects [10]. Pixel variations within a region of interest can be balanced with the help of Marker-Controlled Watershed algorithms that are calculated using traditional Morphological Markers calculated from image [11].

3.5 Marker Controlled Watershed Transform

The most popular technique is a Marker-controlled watershed segmentation approach which is based on the concept of markers whose aim is to pinpoint regions that are homogeneous in terms of texture, color and intensity and then merge them to get relatively accurate segmentation. Various papers can be found in literature using this technique to overcome the problem mentioned in previous paragraph. The important keywords involve in this method are internal/foreground marker and background marker. Internal marker I (f) is inside each of the objects of interest, whilst external markers E (f) are contained within the background. These markers are used to modify the image wherefore regional minima takes place only in marked location. The image obtained by marker image M (f) is a binary image such that pixel belonging to homogeneous region will be marker. Morphological operation is more suitable in separating the Regions of Interest from others [ROI]. This situation is considered as complex background. In this paper we focus on marking the region of interest for watershed segmentation using morphological reconstruction and gradient modification. The results of applying Marker based Segmentation for Tomato healthy, Yellow Curled Virus, Bacterial Spot, and Early Blight.

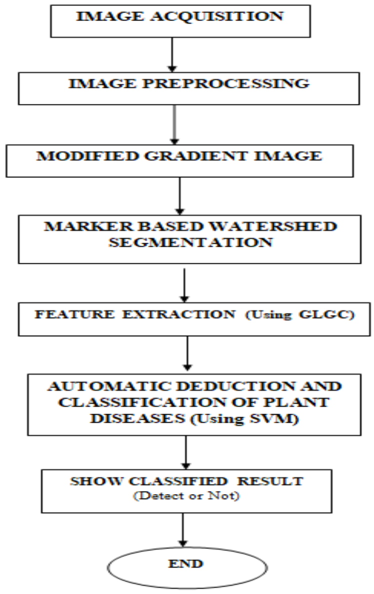

Figure 1.Proposed Methodology of classification of marker based Segmented Tomato leaves

3.6 Feature Extraction

Feature Extraction is one of the most interesting steps of image processing to reduce the efficient part of an image [12].Image usually consist of lot of information. The information can be used to distinguish between different situations. The various features can be extracted by using one of the feature extractions called Gray-Level Co-Occurrence Matrix (GLCM) method.

3.7 Detection and classification

Detection and classification of diseases can be done by using Support Vector Machine (SVM). SVM algorithm works based on Feature Extraction .This can be classified in to: a).Linear b).Non linear c). Multiclass. All these types feature extraction gives better results when compared with other algorithms [13]. Diseased and healthy regions of plant leaves are separated by extracting features [14].

4. RESULTS AND DISCUSSIONS

The objective of this presented research work is detection and classification of healthy and diseased Tomato plants of selected Bacterial, Fungal and Viral disease Images. The experiments were carried out on various images of healthy/diseased Tomato leaves by implementing algorithms in MATLAB platform 2018b.

4.1 Marker Controlled Watershed Transform Segmentation Results

The Figure 2,Figure 3,Figure 4,Figure 5 shows the Marker Controlled Watershed Transform Segmentation results which highlights the region based segmentation of Tomato leaves very well.

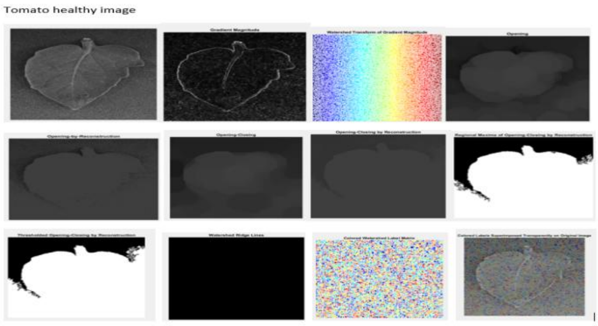

Figure 2.Results of Marker based Segmented Tomato Healthy Images

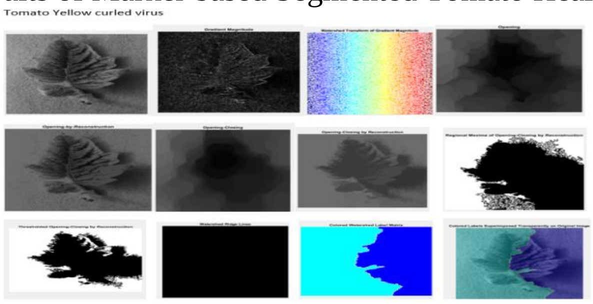

Figure 3.Results of Marker based Segmented Tomato Yellow Curled Virus Images

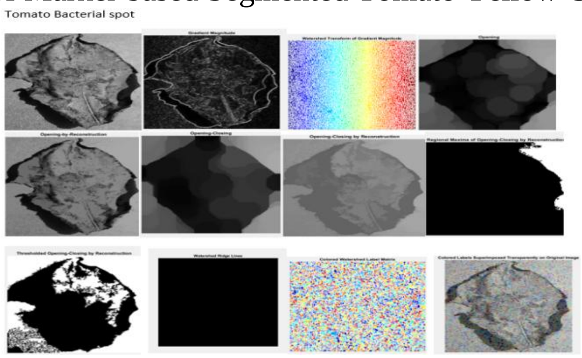

Figure 4.Results of Marker based Segmented Tomato Bacterial Spot Images

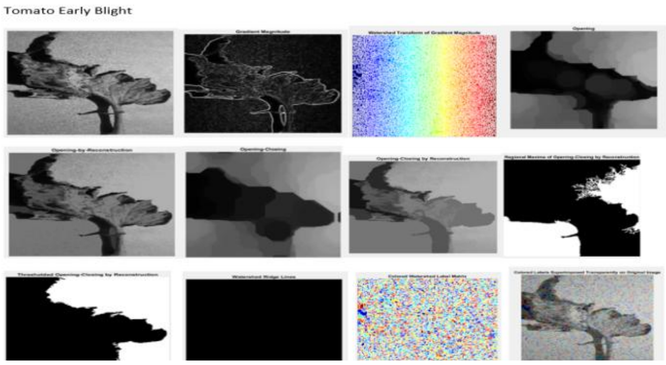

Figure 5.Screen Shots of Marker based Segmented Tomato Early Blight results

4.2 Feature Extraction Results

The main features namely; Correlation,Varience,Mean, Energy,Probability,Angular Second Moment,Homogeneity,Dissimilarity and Contrast are calculated out and extracted for disease affected areas of Tomato leaves. Figure 6 shows the average values of the extracted features for both healthy/diseased Tomato leaves.

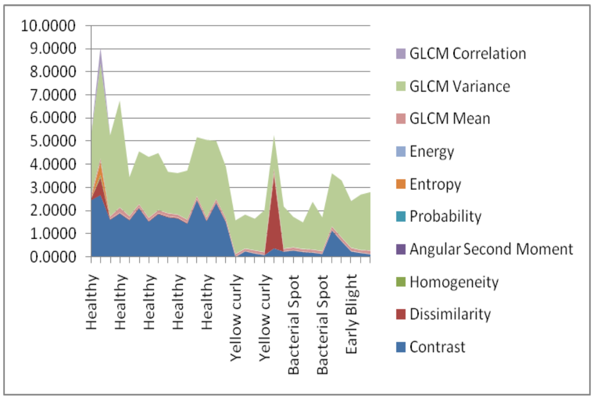

Figure 6.Analysis of Feature Extraction of Healthy and diseased Tomato Images

From the above graph it has been identified that with increase in contrast, helps to find healthy images from the infected images.

4.3 Classification results

Classification helps to put in to different classes based on the diseased and healthy images. Sample database taken for Classification is shown in Figure 7. The classification results of Diseased Images of Healthy, Yellow Curly, Bacterial Spot and Early Blight are shown in Figure 8, Figure 9, Figure 10, and Figure 11 respectively.

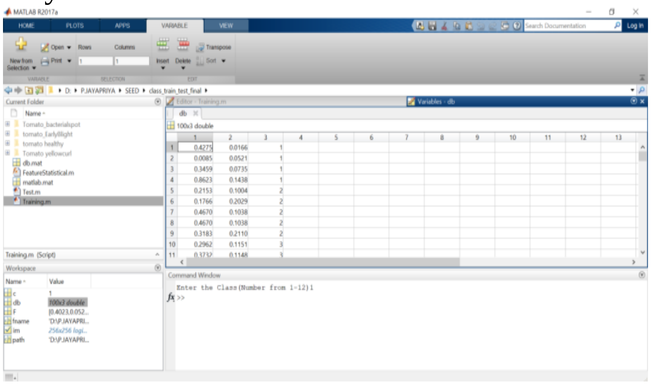

Figure 7.Dataset Classification

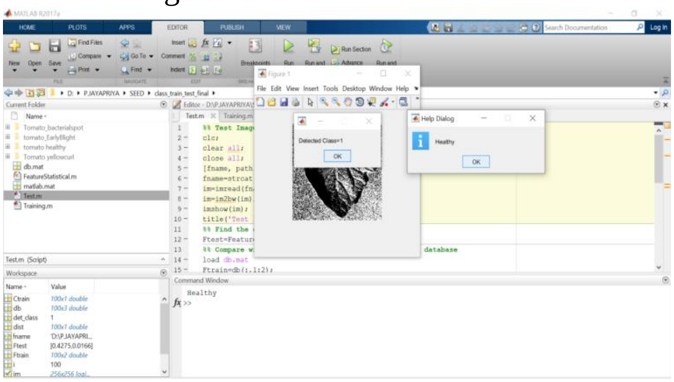

Figure 8.Class 1: Healthy Images detection

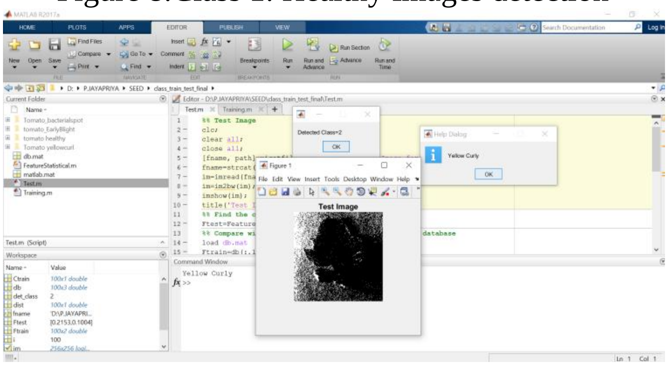

Figure 9.Class 2: Yellow Curly Images detection

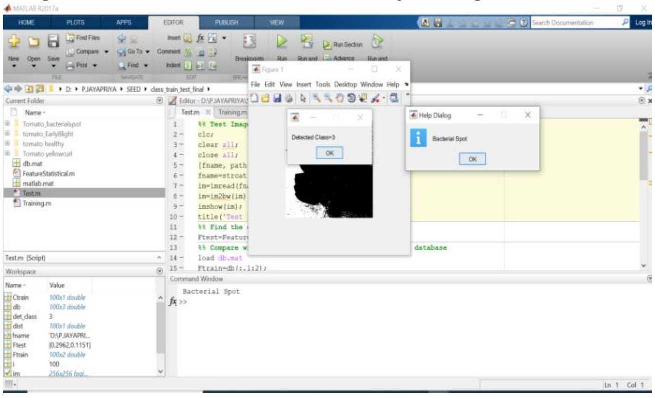

Figure 10.Class 3: Bacterial Spot Images detection

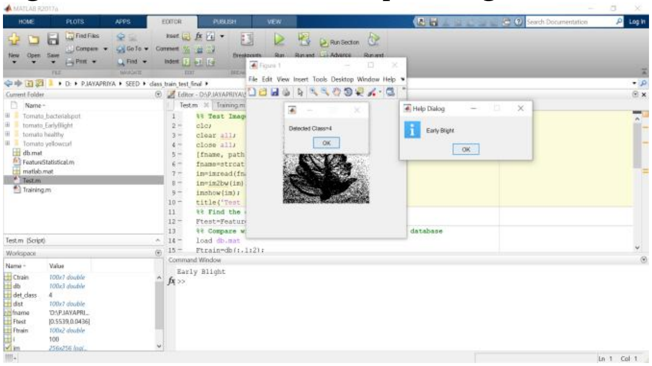

Figure 11.Class 4: Early Blight Images detection

4.4 Quality Measures Results

Peak Signal-to-Noise Ratio (PSNR) gets better with increase in compressed image bit rate as shown in Table 2. The results show that increase in PSNR values and decrease in MSE gradually improves compressed image bit rate. Hence greater the compressed image bit rate, better the quality of the image as well as lowers the error rate. Higher value of Structural Content as well as Normalized Absolute Error shows that image is of poor quality.

Hence estimation of different image quality metrics (PSNR, SNR, and MSE) is essential task in digital image processing as it provides a better way for image quality assessment as well as improvement. It can be observed that higher value of PSNR and lower value of MSE are desired results. The results of applying Marker Controlled Watershed Segmentation and their quality metrics results are shown in Table 2

Images	**Peak-SNR value**	**Normalized Absolute Error**	**Structural Content**	**Mean-Squared Error**
Tomato Bacterial Spot	22.3071	8.5088e-04	0.9993	382.2681
Tomato Early Blight	22.4992	8.5070e-04	0.9991	365.7309
Tomato Yellow Curled Virus	22.0394	8.5052e-04	0.9991	406.5715
Tomato Healthy Image	20.9395	8.5034e-04	0.9990	498.0185

Table 2.Quality measure value of Marker Controlled Watershed Transform Images

5. CONCLUSION

The accurate Segmentation, Detection and Classification of Tomato plant leaf image are very significant for the successful cultivation and yield. The automatic Segmentation, detection and monitor of plant Diseases helps farmers to reduce work as well as time. Effective and Efficient results can be observed in disease detection of Tomato plants and that can be improved by increasing number of Training samples using MATLAB. Segmentation can be done by using Automatic Marker based Segmentation. Detection and Classification of diseases can be done by Support Vector Classification (SVM) method.

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