Design Engineering

ISSN: 0011-9342 | Year 2021
Issue: 8 | Pages: 1356-1368

Morphological and Otsu's Segmentation, Classification and Disease Detection of Maize Plant Using Texture Feature Analysis

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Abstract

Diseases affected on plants causes' major loss in production as well as economic growth. To enhance crop production it is most important that plant diseases must be analyzed earlier so that effective control actions can be taken almost in advance. This paper discusses about the various fungal diseases of maize, how to identify/classify these diseases using image segmentation along with classification Algorithm. Disease symptoms can be distinguishable as earlier as possible through inspecting either stem or leaf part of the maize. This proposed algorithm/method automatically identifies the maize diseases and classifies whether the stem or its leaf is normal or diseased i.e. having Bacterial, Viral or Fungal disease. Gray Level Co-occurrence Matrix (GLCM) is used for extracting features of infected area. Then diseased leaves of Watershed segmentation or Otsu's clustered Maize images are classified by Support Vector Machine (SVM). Various fungal maize diseases are taken and can be classified by using different classifiers like Tree, Linear Discriminate, K-Nearest Neighbors (KNN) and SVM.The algorithms can be used for training and classification purpose, out of these, SVM gives better results for most of the application. In this work 40 images of Watershed Segmented and Otsu's clustering segmented healthy/diseased maize are taken and texture features are calculated using GLCM.Based on these features along with SVM classifier, it can be classified into healthy and diseased with accuracy of high percentage compared with other classifiers.

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

I. INTRODUCTION

In India, maize is almost important crop after wheat and rice. Common Rust, Leaf Spot and Leaf Blight are the common diseases affected and caused substantial loss of growth in India on maize cultivation in India. Plants affected with diseases that can be caused by any living organisms are called as biotic disease. This can be further classified in to Fungal, Bacterial, and Viral diseases [1]. Diseases can be identified by frequent monitoring of leaves, stem or fruit parts of the plant [2]. Identifying plant diseases without proficient knowledge is very difficult task for the farmers.

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Farmers may experience lot of problems in detecting/identifying various plants diseases. So it is necessary to have the experienced knowledge of plants and their various diseases in advance for preventive measures [3]. Monitoring and identification of plant diseases will be done manually with the help of the experts in that field during earlier days. This method of detecting plant diseases is time-consuming, less laborious. The detection of these diseases facilitates farmers to treat them appropriately to increase the agriculture production. Automatic disease detection technique of plant is an essential research topic because of its benefits like monitoring large field of crops and detects disease symptoms earlier [4, 5]. The image-based processing techniques are being used in agriculture field for several applications in detecting plant diseases correctly and timely. Digital image processing involves enhancing image features of interest, and then useful information is extracted out from the enhanced image for further processing. Authors in [6] describes an expert system developed for plant disease diagnosis by using descriptive and graphical representational methods, it provides different methods of plant disease diagnosis and treatment to the user. Authors proposed a technique for detection as well as classification of plant diseases in leaf or stem part of the plant [7]. The proposed framework uses marker based image processing technique to segment the images followed by pre-trained Support Vector Machine for classification purpose. By this approach plant diseases can be successfully identified also classified with an accuracy of 93%. Authors in [8], proposes an image processing based scheme to detect/identify diseases in pepper plant leaves, by this algorithm recognition of healthy or unhealthy pepper plants can be done, which results in better productivity of pepper plants. Also an evaluative study about various existing plant disease detection systems is provided by this paper. The paper [9] proposes a digital image processing method for disease detection in different plants; it discusses various methods used in the proposed work such as feature extraction, techniques to extract infected plant leaf features and classification approaches to classify plant diseases. Various techniques are discussed in [10] to segment the diseased plant part along with feature extraction techniques to extract the infected area features and classification techniques. It involves various steps that a plant image has to go through are such as image acquisition, pre-processing, segmentation and feature extraction. The detection of unhealthy plant leave region using SVM technique and classification of these plant leaf diseases using texture features is done by the authors in paper [11]. This method is compared to other method and found that this method execution is fast, easy implementation and recognition is done efficiently. A disease detection system using support vector machine for pomegranate leaf is proposed in [12]. This methodology uses k-means clustering algorithm for segmentation and for disease classification support vector machine is used. In [13] authors does the comparison of the two image segmentation techniques namely; k-means clustering and thresholding. Comparison of these two techniques is done by using parameters Mean-square error (MSE), Peak signal-to-noise ratio (PSNR), and Signal-to-noise ratio (SNR). This work concluded that PSNR values is higher and MSE value is lower for the images segmented by k-means clustering than that of images segmented by Thresholding technique. Feature extraction can be done using

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three ways of classifiers: a).Linear SVM b).Non Linear SVM c).Multiclass SVM. All these types feature extraction gives the better result as compare to other algorithms [14].

II. LITERATURE SURVEY

In recent days, Segmentation, Classification and Detection of Diseased plants are in wide range of study. Many papers have been published in recent years. The following Table 1 shows literature survey

Table 1.Review of paper

Sr. No	Title	Author Name and year of publication	Techniques Used
1	Improving Leaf Segmentation by Creating the Automatic Marker Used in Marker-Controlled Watershed Segmentation	Wan Mahani Abdullah, ShahrulNizamYaakob, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-1S, May 2019	A creation of marker is used to locate finely the objects and background.
2	Hybrid System for Detection and Classification of Plant Disease Using Qualitative Texture Features Analysis	Anjnaa , MeenakshiSooda *, Pradeep Kumar Singhb, ICCIDS 2019,	Accurate detection and classification of plant diseases Using feature Analysis
3	Plant Leaf Disease Detection Using Support Vector Machine	Mohammed A. Hussein*, Amel H. Abbas, Volume 30, Issue 1, 2019	Classifier that was trained using the knowledge base for detection and diagnosis of plant leaf diseases.

III. MATERIALS AND METHODS

Healthy and diseased maize images are collected from Plant Village dataset. These images are captured by using a high resolution digital camera with 16 mega pixel resolution to get the better image and in jpeg format. Database taken for our work totally consist of 40 images. That includes 10 images of healthy and 30 images of maize images affected by various diseases namely Cercospora Leaf Spot, Common Rust and Northern Blight.

Maize is one of the most important cereal crops of the world and contributes to food shelter in most of the developing countries. In India, maize is emerging as third most important crop after

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rice and wheat. Its importance lies in the fact that it is not only used for human food and animal feed but at the same time it is also widely used for corn starch industry, corn oil production, baby corns etc.Maize disease pathogens may be caused due to fungal, bacterial or even viral [15]. Figure 1 shows some of the fungal disease sample Images. Table 2 shows organism that causes diseases and its optimum growing temperature condition.

(a) (b) (c) (d)

Figure1.Sample Images from dataset (a)Cercospora Leaf Spot (b) Common rust (c) Northern Blight (d) Healthy

The organisms that causes diseases like Cercospora Leaf Spot, Common rust and Northern Blight and their optimum temperature of growth are shown in Table 2

Table 2. Optimum growth temperature ranges for pathogens of Maize plants

Disease	**Causal organism**	**Optimum temperature**
Cercospora Leaf Spot	CercosporaCoffeicolaBerk	27-32° C
Common rust	Pucciniasorghi	15 and 20°C
Northern Blight	Setosphaeriaturcica	18 to 27°C

a)Cercospora Leaf Spot

Cercospora Leaf Spot is caused by fungal Cercosporabeticola Sacc.There are circular spots having a light gray center with a margin of reddish brown, later these spots turn tan with a dark ring having a yellowish halo around the ring that results/appears as “frog-eye” appearance.

b) Common Rust

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Common rust is caused by the fungus Pucciniasorghi and occurs every growing season. It is seen in hybrid Maize. Rust pustules usually first appear in late June. Early symptoms of common rust are chlorotic flecks on the leaf surface. These soon develop into powdery, brick-red pustules as the spores break through the leaf surface.

c) Northern Blight

Northern Corn Leaf Blight (NCLB) is caused by the fungus Setosphaeriaturcica. Symptoms usually appear first on the lower leaves. The cigar-shaped lesions that occur on leaves disease cause significant yield loss in vulnerable maize hybrids.

IV. PROPOSED METHODOLOGY

The methodology adopted in the present work is detailed in block diagram shown in Figure.2 showing various steps and described below. The images of healthy and diseased maize plants are used in present work were captured by a high resolution camera that are collected from the plant village dataset.Pre-processing of images is done so that certain features in an image can be highlighted; pre-processing step includes image resizing, color-space transformation, image enhancement. To improve quality and visibility of the image, the contrast of these images is enhanced by using histogram equalization. Image segmentation process do partitioning of an image into segments/parts to better understand the image, it is commonly performed to determine boundaries or objects in an image. The Matlab 2018b software is chosen as a platform where some of the processing methods are applied on the captured images of dataset. A Graphical User Interface (GUI) is made with the help of MATLAB; through this GUI various Maize diseases are identified and classified.

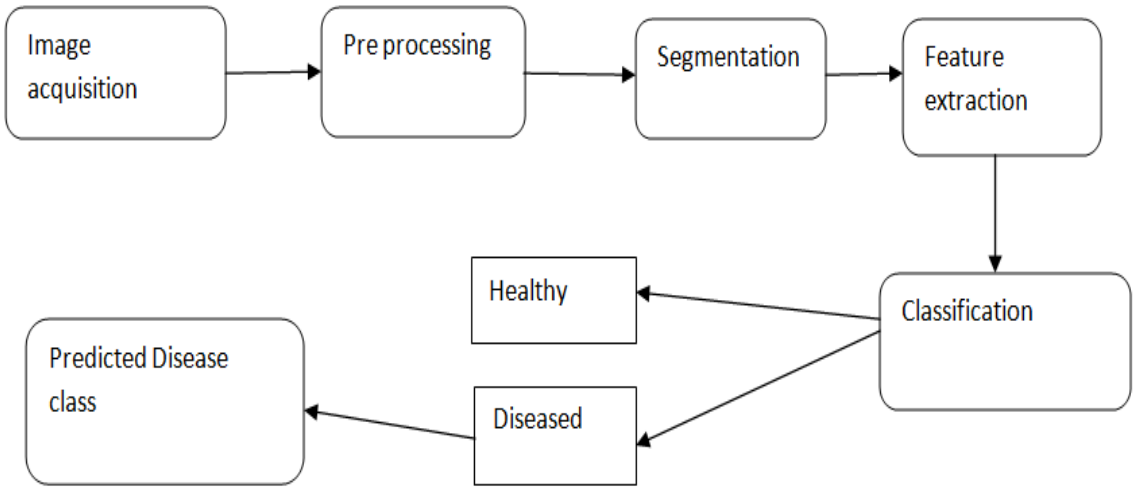

Figure 2.Proposed framework of SVM classification for Maize Disease detection

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Segmentation can be performed by various methods namely; segmentation based on region, based on edges, and based on clustering. Otsu's segmentation is one of the mostly used region based techniques employed for segmentation task. Image segmentation process do partitioning of an image into segments/parts to better understand the image, it is commonly performed to determine boundaries or objects in an image. Segmentation can be performed by various methods namely; segmentation based on region, based on edges, and based on clustering. Otsu's segmentation is one of the mostly used region based techniques employed for segmentation task. The Otsu method of image segmentation performs the segmentation of digital image using grey level histogram [16].

Feature Extraction [FE] is very important for differentiating objects of one class from another class. It is the process of transforming input data into useful set of features. FE is an essential step to extract the features of interested region of an image, there are three most common methods used for feature extraction are Texture-based, Color-based, and Shape-based. FE is one of the most interesting steps of image processing to reduce the efficient part of an image [17]. The information can be used to distinguish between different situations.

V. RESULTS AND DISCUSSIONS

The objective of proposed work is detection and classification of healthy as well as diseased maize plants for various selected fungal diseases. The experiments were carried out on various images of healthy/diseased maize by implementing Morphological and Ostu's segmentation algorithms in MATLAB platform 2018b.

5.1 Feature Extraction Results

Various Texture Features based on Gray Level Co-occurrence Matrix(GLCM) like Contrast,Correlation,Energy,Homogeneity, Mean, Standard_Deviation(SD), Entropy, Root Mean Square(RMS), Variance, Smoothness, Kurtosis, Skewness, Inverse Difference Movement(IDM) are calculated. The above features for healthy/diseased Maize leaves of Otsu's and Marker based segmented images are calculated.

The main three features namely Mean, Standard Deviation (SD) and Variance values after applying Feature Extraction of some sample Otsu segmented Maize leaves are shown in Table 3

Table 3.The values of applying Feature Extraction on Otsu Segmentation

Type of Segmentation	**Otsu**		
Diseases/Features	Mean	SD	Variance
Cercospora Leaf Spot	0.0247	0.0509	2.2907
	0.0701	0.0692	3.4673
	0.0695	0.0665	3.4589

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	0.0633	0.0700	2.8975
	0.0675	0.0829	4.1570
Northern Blight	0.0170	0.0552	2.8287
	0.0178	0.0562	2.9318
	0.0198	0.0585	3.1953
	0.0472	0.0795	4.7523
	0.0512	0.0802	5.9023
Common rust	0.0533	0.0778	4.9868
	0.0310	0.0601	3.2516
	0.0300	0.0454	1.5144
	0.0319	0.0696	1.8093
	0.0312	0.0566	2.7938
Healthy	0.0238	0.0443	4.8404
	0.0611	0.0876	6.8247
	0.0360	0.0608	5.8749
	0.0558	0.0694	4.8930
	0.0587	0.0904	7.4019

Mean, Standard Deviation (SD) and Variance values after applying Feature Extraction of some sample Marker based segmented Maize leaves of are shown in Table 4.

Table 4.The values of applying Feature Extraction on Marker based Segmentation

Type of Segmentation	**Marker based**		
Diseases/Features	Mean	SD	Variance
Cercospora Leaf Spot	0.0013	0.0019	2.9904
	0.0014	0.0020	3.2768
	0.0014	0.0021	3.7072
	0.0013	0.0018	2.5390
	0.0013	0.0017	2.3541
Northern Blight	0.0015	0.0021	3.5415
	0.0014	0.0021	3.5187
	0.0014	0.0020	3.4524
	0.0014	0.0020	3.4648
	0.0013	0.0017	2.1640
Common rust	0.0101	0.0117	2.3896

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	0.0039	0.0080	2.1716
	0.0099	0.0112	2.3386
	0.0013	0.0018	2.0263
	0.0015	0.0020	2.2126
Healthy	0.0013	0.0023	4.3433
	0.0016	0.0023	4.5449
	0.0016	0.0023	4.5449
	0.0014	0.0023	4.3216
	0.0015	0.0022	4.1141

Analysis graph based on comparison with those three features is shown in Figure 3.The variation in performance of mean, standard deviation and variance of all sample 30 infected images have higher values than 10 healthy images.

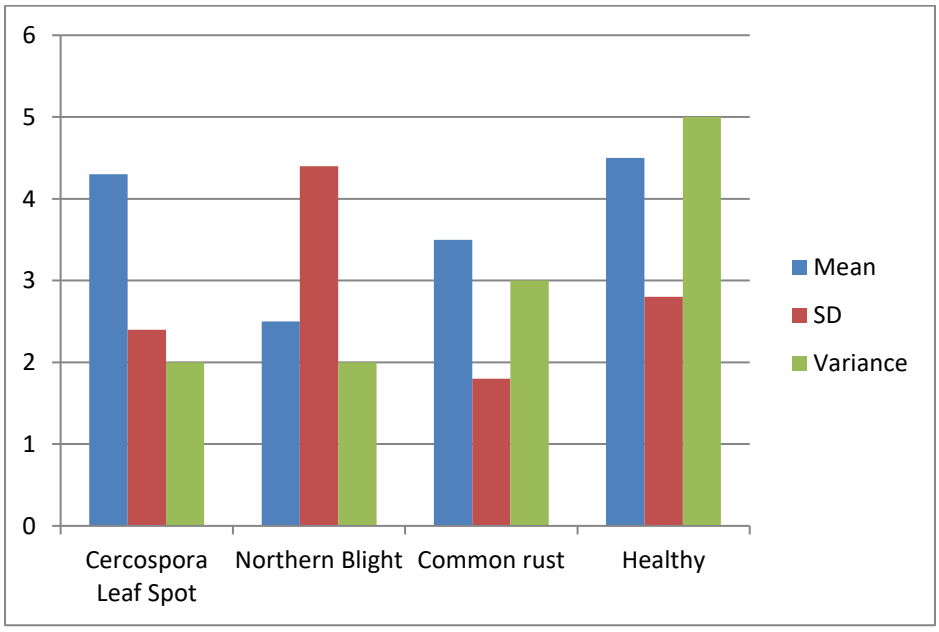

Figure 3.Mean, Standard Deviation and Variance Comparison of Diseased and healthy

It is found that when compared to disease affected images, healthy images have higher values in case of both Morphological Segmentation and Otsu's Segmentation Images.

5.2 Classification results

Classification helps to put in to different classes based on the diseased and healthy images. One of the important Classifier is SVM which is mostly used in plant disease detection. All collected images of maize diseases were taken and saved in JPG format and divided into four different categories.

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Here, three categories represent infected maize leaves and one category represents healthy leaves. Classification can be done based on diseases and might be put in to different classes as shown in Table 5.

Class 1	Class 2	Class 3	Class 4
Cercospora Leaf Spot	Common Rust	Northern Blight	Healthy

Table 5.Category of Classes

Detection and classification of diseases can be done by using Support Vector Machine (SVM). SVM works mainly based on Feature Extraction. Diseased and healthy regions of plant leaves are separated by using SVM and can be classified as infected and healthy category.

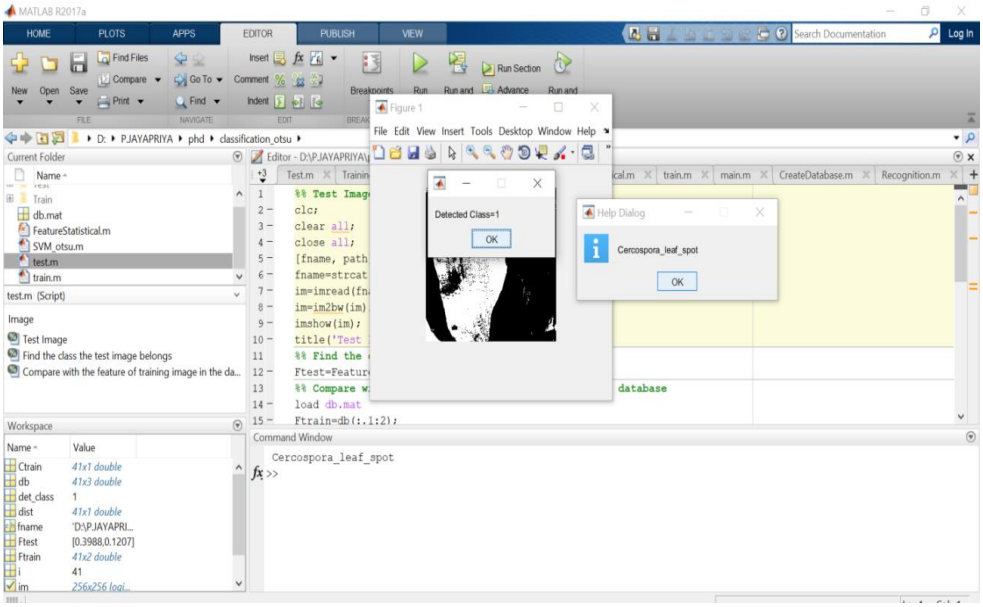

Figure 4.Class 1: Cercospora Leaf Spot Images detection

Classification result of class namely Cercospora Leaf Spot is shown in Figure 4.Ten different Cercospora Leaf Spot sample images can be detected out from 40 samples.

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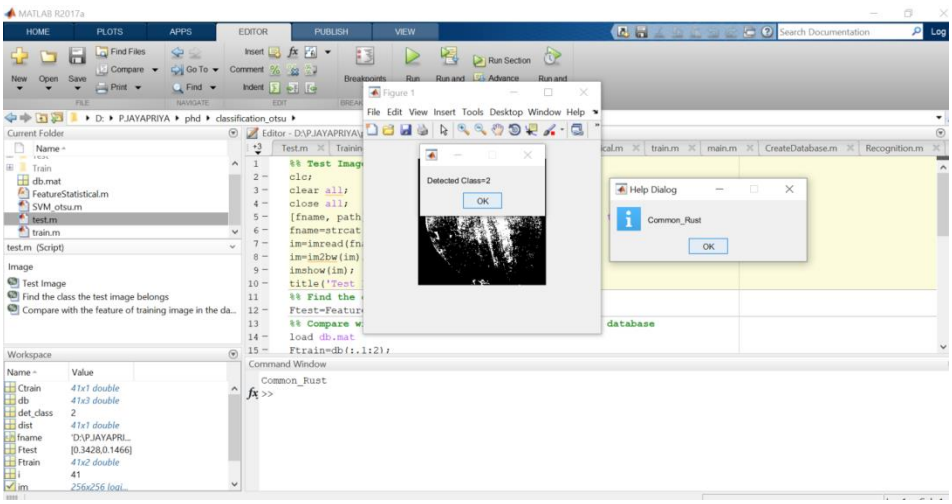

Figure 5.Class 2: Common Rust Images detection

Classification result of class namely Common Rust is shown in Figure 5. Ten different Common Rust sample images can be detected out from 40 samples.

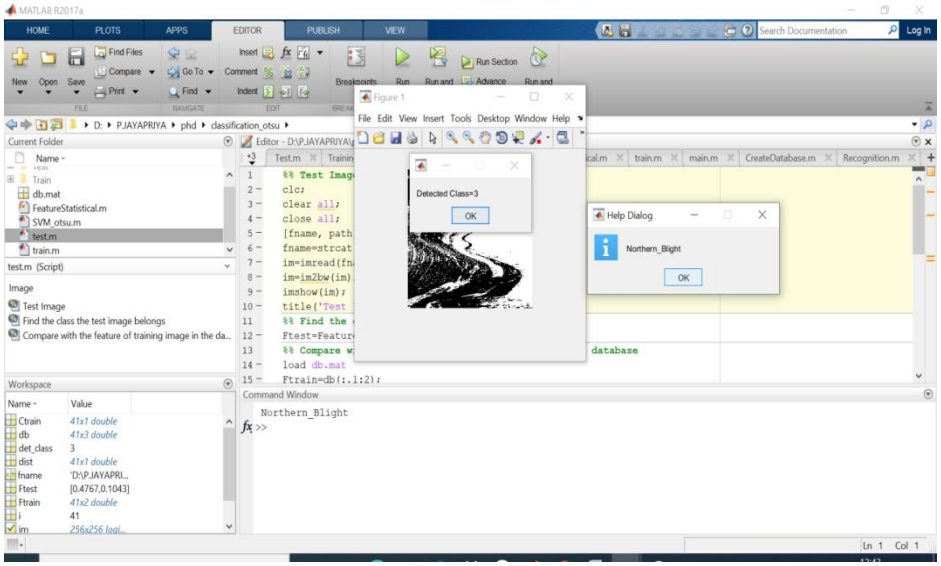

Figure 6.Class 3: Northern Blight Images detection

Classification result of class namely Common Rust is shown in Figure 6. Ten different Northern Blight sample images can be detected out from 40 samples.

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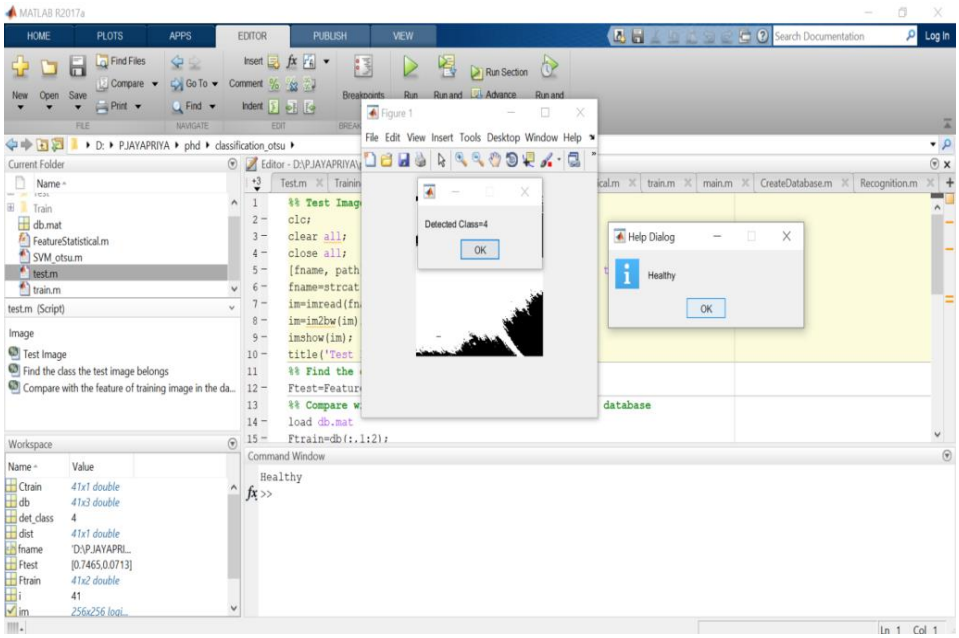

Figure 7.Class 4: Healthy Images detection

Classification result of class namely Healthy Image is shown in Figure 7. Ten Healthy sample images can be detected out from 40 samples.

VI. CONCLUSION

The accurate Segmentation, Detection and Classification of maize plant leaf images are very important for the successful cultivation and yield. The automatic Segmentation, classification of Maize plant Diseases based on Feature extraction helps to reduce time as well as improve cultivation. Figure 3 graphically depict the variation in performance change in Standard Deviation, Mean and Variance. These three features can be identified for healthy and diseased Maize images and compared. It is found that healthy images have 10 to 15 percentage higher values of Standard Deviation, Mean and Variance than diseased maize leaf values. This can further increased by increasing number of Training samples using MATLAB, which gives successful and proficient results. Effective Segmentation can be done by using Automatic Segmentation using Otsu as well as Marker based Segmentation. Detection and Classification of diseases can be done by Support Vector Classification (SVM) method.

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