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A Review Paper on Image Segmentation For Plant Leaf Disease Detection Based on ANN

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Abstract—India is a country where Agronomic production is approximately on which economy extremely depends. This is the one of the reasons that infection identification in flowers, vegetable, crop, leaf plays an important role in agriculture field, as having infection in land & Field are relatively usual. If appropriate action can take to care in this field, then its foundations thoughtful properties on plants and due to which particular production quality percentage, quantity or efficiency of production is affected. For the proposed work we try to explain the type of disease detection with the help of Artificial Neural Network approach in this method we have a very huge amount of dataset which either save in the system or save in the server if this work can be implanted over worldwide.

Keywords: Image Processing, Genetic Algorithm, Plant disease Detection, Segmentation, Bacterial Blight, Alternaria.

I. INTRODUCTION

The agriculture sector is the main contributor in Indian economy and doing well in white, green and blue revolution. According to APEDA by 2014 export of Indian agriculture will reach to 5% of total production of the world and rank 10th in the ranking [1]. Agriculture plays very important role in the provision of food surplus to expanding population, contribution to capital formation, provides raw material to industries, market for industrial products and major contribution in international trade. With increasing population, even though the contribution is continuously falling since independence from 55.1% in 1950 to 14% in 2012, it remained the major employment sector with a marginal difference. So there is a need to accelerate the pace for competitive, productive, diversified and sustainable agriculture. Raising agricultural productivity per unit of land, reducing rural poverty through a socially inclusive strategy and ensuring that agricultural growth responds to food security needs are three major challenges for Indian agriculture [2]. Fig.1.1 voltage source active power filter. The agricultural land mass is something other than being a nourishing sourcing in this day and age. Indian economy is profoundly reliant of horticultural efficiency. Consequently, in field of agribusiness, location of infection in plants assumes an imperative part. To identify a plant ailment in extremely introductory stage, utilization of programmed malady recognition system is gainful. For example, an illness named little leaf infection is an unsafe malady found in pine trees in United States.

Table 1.1: Horticulture production in India for last five years

Year	Fruits		Vegetables		Flowers	
	A	P	A	P	A	P
2007-08	5857	65587	7848	128449	166	868
2008-09	6101	68466	7981	129077	167	987
2009-10	6329	71516	7985	133738	183	1021
2010-11	6383	74878	8495	146554	191	1031
2011-12	6705	76424	8989	156325	254	1652

Area And production statistics for 5 years (Indian Horticulture database- 2012) (A= Area in '000 hectors, P= Production in '000 MT)

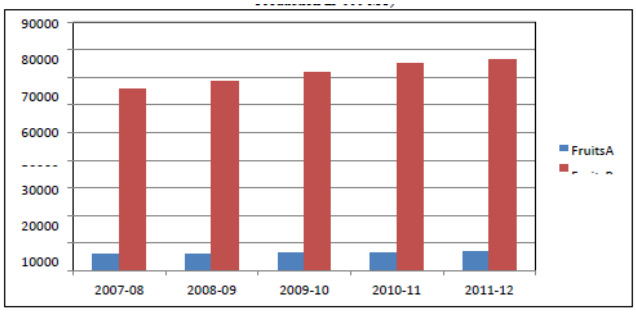

Figure 1.1: Fruit Area and Production in India

Maharashtra, Andhra Pradesh, Tamilnadu, Karnataka, Uttar Pradesh and Gujarat are the states that contributes in fruit production in India. Banana, Mango, Guava, Papaya, Citrus and Grapes are the major fruits produced in these states. Maharashtra and Karnataka are the major contributors in the production of grapes. In India, grape production marked enormous growth from 1235K MT to 2221K MT in last two years. The major contribution is from the southern part of India, about 85- 90 % of total production. Maharashtra is one of the largest producers of grapes.

1.2 Digital Image Processing -Advanced picture handling is essential field of outlining and development. In current period each field relies upon the employments of modernized picture dealing with, in cutting edge picture getting ready, automated depiction of pictures for the most part require a generous number of bits. In various applications, it is basic to examine approach for suggesting

a photo, or the information contained in the photo, with less bits. By wiping out dull or unnecessary information, picture weight is the development that tends to this point. Picture getting ready systems have been associated with a couple of scopes of picture and video taking care of, for instance, correspondence, video conferencing et cetera. In the automated picture and video weight it is required to diminish bit rate need and improves speed of transmission. Picture weight strategies are generally detached in two social events is lossless and lossy. In picture denoising it is required to recover the main picture at the yield, in both examination this investigation focus to upgrade the execution of curvelet change for better nature of recovered pictures in term of PSNR.

1.3 Feature Extraction **-** By feature extraction we can diminish the picture into few numbers or gatherings of numbers that depict the material components of the picture [26]. These components fundamental be deliberately chosen such that they create great portrayal of the picture and outline the basic data. Certain cases of elements are mean, standard deviation, angle and edges of picture. More often than not, a gathering of components is utilized to deliver a model for the pictures. By Cross validation on the pictures, we can see which highlights speak to the picture well. Components can be doled out weights to show the significance of that elements. For instance, the mean in a chose picture might be given a weight of 0.9 on the grounds that it is more noteworthy than the standard deviation which may have a weight of 0.3. The scope of weights from 0 to 1, speak to the significance of elements. These elements and their specific weights are utilized to figure significant data of test picture.

1.4 Segmentation of Image

Image segmentation is generally the first stage in any attempt to analyze or interpret an image automatically. It can also be regarded as a process of grouping together pixels that have similar attributes (Rafael et al 2002). Segmentation partitions an image into distinct regions that are meant to correlate strongly with objects as features of interest in the image. Segmentation is a critical component of computer vision system because errors in this process will be propagated to higher-level analysis processes and increases the complexity of the subsequent tasks. Ideally the segmented regions within the image should have the following characteristics:

1.5 Image Clustering - Cluster by nature are the collection of identical objects. Each set or cluster is homogeneous, i.e., objects relating to the similar set are having equivalent behavior to each other. Also, each set or cluster should be different from other clusters, i.e., objects which are allocated to a cluster should be dissimilar from the objects which are found in different cluster. It is the process of putting together identical objects, and it may be hard or fuzzy. Every element is destined to a particular cluster in the time period of its operation in hard clustering; however, each element has a degree of membership depending on its degree of association to several other clusters in cluster which is created through fuzzy clustering. In the statistics, image retrieval, bioinformatics, data retrieving and machine learning areas, clustering problem for unsupervised data exploration and analysis has investigated for decades.

1.6 Self-Organized Partitioning

A mechanism to partition the space which adapts to the search space. By self-organizing, we signify that agent will be produced and deleted relying on the supportive optimization process. Agents will divide when points are collected inside a single region (creation), and will be merged when local optima converge (deletion).

1.7 Moving Sub-Regions Centers

The way of space partitioning we propose focuses on dynamic the sub-regions‟ centers to different local optima. As a outcome, every agent can select a substitute that is exact just about the local optimum, and the agent can also discover the sub-region in the region of the local optimum. At the start of the process, only one agent exists and is pushed in to the whole search space. Then it starts optimization by selecting a surrogate, dealing with it and optimizing on this surrogate. In outcome the agent computes a latest point xˆ∗t−1. Then, the midpoint of the sub-region is pushed to the “best” point in the sub-region in conditions of feasibility and purpose function value this is done by comparing the center at the final repetition ct−1 to the end point referenced by the agent xˆ∗t−1. The center is pushed to the end point referenced by the agent if it is better than the current center. Otherwise, the center remains at the previous center.

1.8 Hierarchical Agglomerative Clustering

Hierarchical agglomerative clustering (HAC) is a bottom-up hierarchical clustering algorithm. In HAC, Singleton clusters allocates points initially, and at every step the “closest” pair of collection of point is combined, where proximity is determined according to a similarity measure among clusters. The algorithm generally come to an end when the specified “convergence criterion” is achieved, which in our matter is when the count of recent clusters becomes equal to the count of clusters preferred by the user. Distinct cluster-level similarity scope are used to distinguish the closeness between clusters to be merged – single-link, complete-link, or group-average. There are distinct HAC schemes which have been just shown to have well specified underlying generative models – single-link HAC conforms to the probabilistic sample of a assortment

of branching random walks, complete-link HAC corresponds to consistent equal-radius hyper spheres, while group-average HAC corresponds to equal-variance configurations. So, the HAC process can be classified as productive clustering algorithms.

II. LITERATURE REVIEW

2.1 Introduction

Neural network procedures have been effectively pertinent to the conclusion of a few restorative issues. In this study we dissect the diverse neural system strategies for the determination of diabetes. The different information pre-preparing strategies are assessing to enhance the speculating exactness of the neural system calculations. Plant nutrients are essential for the healthy growth of any plant. The plant takes up different nutrients from various sources. It shows visible symptoms on leaves in deficiency as well as toxicity. These symptoms can lead towards a chance for Image processing to play role in nutrient analysis. In this chapter plant nutrient for grapes and its effects in the deficiency and toxicity are discussed. Also review of plant pest or diseases for grapes is discussed along with its symptoms and effects on yield and growth of plant. A detailed review of application of image processing in agriculture is taken into consideration viz. weed detection, food processing, chlorophyll and nitrogen analysis, and pest/ disease detection, etc. Basics of color image processing, i.e., color models are discussed which are near to human perceptions. A review of, discussion and opinions with experts is also discussed.

2.2 Plant Nutrition: Plant growth and metabolism depends on 17 elements or nutrients even though 60 elements are found in the chemical analysis of plant tissues. Nutrients keep plants healthy which leads to less susceptibility to pests. Nutrients are broadly classified into two: Macro and micro nutrients. Macronutrients are those elements which are required in larger quantity whereas micronutrients are required in lesser quantity [5,6]. Table 2.1 shows the nutrients with their

Macronutrients		Micronutrients
From Air	From Soil solids	From Soil solids
Carbon(C)	Nitrogen (N)	Iron (Fe)
	Phosphorus (P)	Manganese (Mn)
Hydrogen (H)	Potassium (K)	Boron (B)
	Calcium (Ca)	Molybdenum (Mo)
Oxygen (O)	Magnesium (Mg)	Copper (Cu)
	Sulphur (S)	Zinc (Zn)
		Chloride (Cl)

Table 2.1: Classification of nutrients and their sources

For normal growth and development of grapevines, availability of all plant nutrients in optimum concentration is essential. Deficiency of nutrients affects the growth and yield of grapevines. Toxicity also affects the yield causing excessive growth of plants. Toxicity of nutrients leads to deficiency of other macro or micro nutrients, which is known as antagonism. Each nutrient play a specific role in growth and development of grapevine as discussed in table 2.3 [4, 7]. Table 2.3 also discusses the influence of deficiency and toxicity of each element. Table 2.4: Grape diseases and its effects.

2.3 Segmentation and Soft Computing Techniques: [1] Vijai Singh et all in “Detection of plant leaf diseases using image segmentation and soft computing techniques in INFORMATION PROCESSING IN AGRICULTURE 4 (2017) 41–49” in 2017 Proposed Agricultural productivity is something on which economy highly depends. This is the one of the reasons that disease detection in plants plays an important role in agriculture field, as having disease in plants are quite natural. If proper care is not taken in this area then it causes serious effects on plants and due to which respective product quality, quantity or productivity is affected. For instance, a disease named little leaf disease is a hazardous disease found in pine trees in United States. Detection of plant disease through some automatic technique is beneficial as it reduces a large work of monitoring in big farms of crops, and at very early stage itself it detects the symptoms of diseases i.e., when they appear on plant leaves.

This paper presents an algorithm for image segmentation technique which is used for automatic detection and classification of plant leaf diseases. It also covers survey on different diseases classification techniques that can be used for plant leaf disease detection. Image segmentation, which is an important aspect for disease detection in plant leaf disease, is done by using genetic algorithm. the survey on different diseases classification techniques used for plant leaf disease detection and an algorithm for image segmentation technique that can be used for automatic detection as well as classification of plant leaf diseases later. Banana, beans, jackfruit, lemon, mango, potato, tomato, and spot are some of those ten species on which proposed algorithm is tested. Therefore, related diseases for these plants were taken for identification. With very less computational efforts the optimum results were obtained, which also shows the efficiency of proposed algorithm in recognition and classification of the leaf diseases. Another advantage of using this method is that the plant diseases can be identified at early stage or the initial stage. To improve recognition rate in classification process. Artificial Neural Network, Bayes classifier, Fuzzy Logic and hybrid algorithms can also be used.

2.4 Image Processing Based Leaf Rot Disease, Detection of Betel Vine (Piper Betlel.): [2] Amar Kumar Dey et all in “Image Processing Based Leaf Rot Disease, Detection of Betel Vine (Piper BetleL.)” in International Conference on Computational Modeling and Security 2016 Proposed deals with leaf rot disease detection for betel vine (Piper

betel L.) based on image processing algorithm. The measurement of plant features is a fundamental element of plant science research and related applications. The information related to plant features is especially useful for its applications in plant growth modeling, agricultural research and on farm production. Few methods have been applied in leaf rot disease detection for betel vine leaf (Piper Betel L.). Traditional direct measurement methods are generally simple and reliable, but they are time consuming, laborious and cumbersome. In contrast, the proposed vision-based methods are efficient in detecting and observing the exterior disease features. In the present investigation, image processing algorithms are developed to detect leaf rot disease by identifying the color feature of the rotted leaf area. Subsequently, the rotted area was segmented and area of rotted leaf portion was deduced from the observed plant feature data. The results showed a promising performance of this automatic vision-based system in practice with easy validation. This paper describes the steps to achieve an efficient and inexpensive system acceptable to the farmers and agricultural researchers as well for studying leaf rot disease in betel vine leaf. In this paper, we have implemented Otsu thresholding-based image processing algorithm for segmentation of leaf rot diseases in betel vine leaf. The proposed method was successfully applied to twelve leaf images with very high precision. The proposed scheme will be helpful in the diagnosis of leaf disease. A leaf disease severity11 scale can be prepared by calculating the total leaf area12, 13and finding the percentage diseased area. Based on the disease severity levels amount and frequency of specific quantities of pesticide application can be regulated, which reduces the cost pesticide used for treatment. Also helpful in reducing environmental pollution due to regulated and controlled application of pesticides. This is an innovative approach ever done for extracting disease features of the leaf. The methodology uses a blend of machine vision and machine intelligence for precision agriculture. In machine vision part, image processing is used where the leaf details, the disease infected area will be extracted. This is a small contribution towards agriculture and growing this medicinally valued precious plant species, to boost up the national economy as well as the national employment generation through proper exploitation of betel vine crop.

2.5 An Image Processing Technique for Estimation of Betel Leaf Area :-[3] Amar Prasad Soni et all in “An Image Processing Technique for Estimation of Betel Leaf Area” in Electrical, Electronics, Signals, Communication and Optimization (EESCO), 2015 The green heart shaped betel leaf, in India it is known as Paan. It is useful in number of traditional remedies such as weakness of nerves, stomach disorder, headache, respiratory disorders, constipation, sore throat, inflammation, scanty or obstructed urination and wounds. There are many more traditional uses of the betel leafs. This paper includes the easy, accurate, and less expensive method of leaf area measurement. Leaf area of plants is a useful tool in physiological and agronomic studies. Investigation of betel leaf area is done over 100 leaves out of which some are included in this paper. Results are compared with the graphical technique of leaf area measurement. The advantage of this method is the easiness and the stability of precise estimation of area. As the leaf area calculation is done to check the health of the crops and is not a work for the whole year so it requires a method which can be done with the help of most available devices. In this method a laptop and scanner is used which could be available in any part of the country. In this method very specific devices are not needed which will serve only one purpose and will be kept idle until they are required again. So estimation of the leaf area using this method is easy, cheap and rapid in response.

2.6 Detection of Diseases on Cotton Leaves Using K-Mean Clustering Method: [4] Pawan P. Warne et all in “Detection of Diseases on Cotton Leaves Using K-Mean Clustering Method” in International Research Journal of Engineering and Technology Volume: 02 Issue: 04 in 2015 proposed an approach for careful detection of diseases, diagnosis and timely handling to prevent the crops from heavy losses. The diseases on the cotton are critical issue which makes the sharp decrease in the production of cotton. So for the study of interest is the leaf rather than whole cotton plant because about 85-95 % of diseases occurred on the cotton leaves like Alternaria, Cercospora and Red Leaf Spot. In this proposal initially preprocessing the input image using histogram equalization is applied to increase the contrast in low contrast image, K-means clustering algorithm is used for segmentation which classifies objects based on a set of features into K number of classes and finally classification is performed using Neural-network.

Thus image processing technique is used for detecting diseases on cotton leaves early and accurately. It is used to analyze the cotton diseases which will be useful to farmers. Study of diseases on the cotton leaf can robustly studied by using the image processing toolbox and also the diagnosis by using MATLAB helps us to suggest necessary remedy for that disease arises on the leaf of cotton plant. We know that perception of the human eye is not so much stronger that he can differ minute variation in the infected part of image because that minute variation pattern of color can be a different disease present on the leaf of cotton. MATLAB software can provide the exactly differentiate the variation of color present on these leaves and depending upon that variation the further compare with database stored image features related to the color. This paper provides a method

to detect cotton leaves diseases using image processing technique. Firstly, Kmeans clustering algorithm is used for segmentation which classifies objects based on set of features into K no. of classes where feature extraction is color feature variance used for matching the train image features from database images and finally recognition is performed using Neural-network. The recognition accuracy for KMean Clustering method using Euclidean distance is 89.56% and the execution time for K-Mean Clustering method using Euclidean distance is 436.95 second and also thresholding is done by a dynamically range [0,1] depending on color intensity from leaves image.

2.7 Extraction of Rice Disease Using Image Processing: [5] Daisy Shergill et all in "EXTRACTION OF RICE DISEASE USING IMAGE PROCESSING" In INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY in 2015 proposed a Crop diseases cause significant damage and economic losses in crops worldwide. It is difficult for farmers as well as experts/doctors to identify the symptoms of diseases correctly and to specify right remedy. It is very difficult task for farmers to monitor the large farms always so farmers are in great need to develop a computerized system that monitors crop when it is infected with diseases. This can be performed by capturing an image of a crop leaf, then extracting a predefined feature from the captured image and finished by determining the disease.

The proposed method is useful in crop protection especially large area farms, which is based on computerized image processing techniques that can detect diseased leaves using color information of leaves. It can be summarized by capturing an image of a certain plant leaf followed by extracting feature from the captured image then convert rgb to gray image & resize it, Create stem, stirs, canny edge detection, apply various comparison techniques, which would decide the disease and would also detect the type of plants diseases at early stages and enables early control and protection measures.

This is an accurate and efficient technique for automatically detection of plant diseased. Rice leaf diseased is detected by using stem, stairs, canny edge detection, surf, entropy, warp, images techniques of image processing. The color features extraction are applied on samples that are contained the healthy leaf of plant and the diseased rice Leaf of the plant. Once the Stairs, Stem any canny edge of leaf Image are generated for both samples and the testing image, immediately we applied the comparison technique. As we are using std2 & mean2, images, warp & surf to as to find that the leaf rice is diseased or not. Hence it detects the Drechsleraoryzae disease of rice. The future work mainly concerns with the large database and advance feature of color extraction that contains a better result of detection.

III. THEORY OF PROPOSED WORK

3.1 Color Image Processing(CIP):

Color is a powerful descriptor of an object and has an advantage over gray scale. Color information is an important feature like shape, texture which has been successfully used for many image processing applications like object recognition, image matching, CBIR, color image compression. The object in the scene as perceived by human eyes or the camera system is characterized by its radiance R (λ, x, y, t) where λ is the wavelength of the electromagnetic radiation at position (x, y) and at time t for a particular color.

The fundamental difference between color image and gray image is the values assigned. For color images in color space a color vector is assigned to a pixel where as in gray image a gray value is assigned. Thus, in Color Image Processing vector valued functions are used. Depending on the principles of processing CIP can be broadly classified into two classes [8].

3.2 Discussion and opinion of Experts

The widely investigated field of image processing, image analysis and important module of early vision problem is image segmentation. Image segmentation is the process of separating an image into some disjoint or distinct regions whose characteristic such as intensity, color, texture etc. are similar. No two such regions are similar with respect to these characteristics [1], [2]. In digital image processing, digital image analysis usually involves a „low-level" and a „high-level" processing. In low-level analysis, the representation of an image is transformed from a numerical array of pixel intensities to a symbolic set of image primitives: edges and regions.

In high-level analysis, object labels (or interpretations) are assigned to these primitives, thereby providing a semantic description of the image. Image analysis techniques can be classified into two major groups: 1) Statistical, which uses probability distribution functions of pixels and regions to characterize the image, and 2) Structural, which analyzes the image in terms of organization and relationship of pixels and regions by the specified relations [3]. Image segmentation is a fundamental part of the `low level' aspects of computer vision and has many practical applications such as in medical imaging, industrial automation and satellite imagery. Traditional methods for image segmentation have approached the problem either\ from localization in class space using region information, or from localization in position, using edge or boundary information. Segmentation algorithms for monochrome images generally are based on one of two basic properties of gray-level values: discontinuity and similarity. In the first category, the approach is to partition an image based

on abrupt changes in gray level. The principal areas of interest within this category are detection of isolated points and detection of lines and edges in an image. The principal approaches in the first category are based on edge detection, and boundary detection. Basically, the idea underlying most edge-detection techniques is the computation of a local derivative operator. The first derivative of the gray-level profile is positive at the leading edge of a transition, negative at the trailing edge, and zero in areas of constant gray level. Hence the magnitude of the first derivative can be used to detect the presence of an edge in an image.

3.3 Segmentation Techniques

In segmentation phase, the image (such as multi-resolution, multispectral) is divided into its constituent parts as shown in figure (3.1).

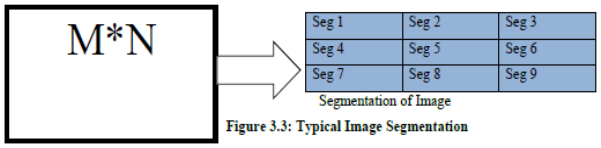

Figure 3.3: Typical Image Segmentation

3.4 Diseases type 1 -Alternaria - The shape Alternaria is a very much perceived sensitivity causing organism. Alternaria spores can be recognized from spring through pre-winter in most calm territories, and can achieve levels of thousands of spores for every cubic meter of air. Alternaria spores can be at their most elevated fixations amid dry, breezy conditions that are perfect for the spores to end up airborne. Alternaria is right now contained around 40-50 species. It is ordinarily disengaged from plants, soil, sustenance, and indoor air.

Figure 3.5 Sample Image

One of the animal categories, Alternaria alternate, has been confined from various sorts of natural materials in soggy circumstances, including materials, put away sustenance, canvas, cardboard and paper, electric links, polyurethane, fly fuel, sewage and effluents. Alternaria alternate causes dark spot in numerous foods grown from the ground far and wide. It is an inactive organism that creates amid the cool stockpiling of natural products, getting to be obvious amid the promoting time frame along these lines causing extensive postharvest misfortunes. With a specific end goal to control Alternaria alternate infections, it is essential to enhance the present methods to recognize this species.

IV. PROBOLEM FORMULATION & PARMETER TO BE CALCULATED

By this experimental various parameter is to be calculated according to requirement the no of parameter is to be increased.

***4.1 Mean Calculation* :-** The mean is the average of all numbers and is sometimes called the arithmetic mean. To calculate mean, add together all of the numbers in a set and then divide the sum by the total count of numbers.

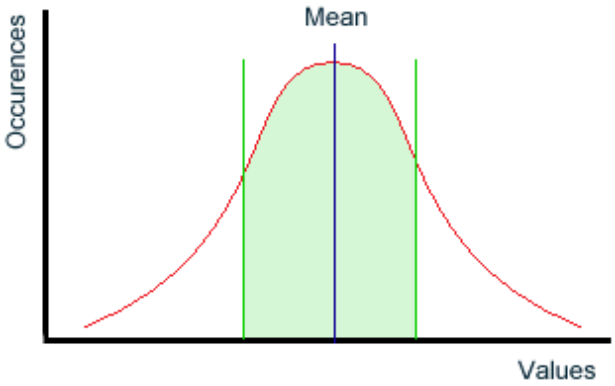

Figure 4.1 Mean Calculation

4.2 Standard Deviation calculation - Standard deviation is a measure of dispersement in statistics. “Dispersement” tells you how much your data is spread out. Specifically, it shows you how much your data is spread out around the mean or average. For example, are all your scores close to the average? Or are lots of scores way above (or way below) the average score?. Standard deviation represented by σ.

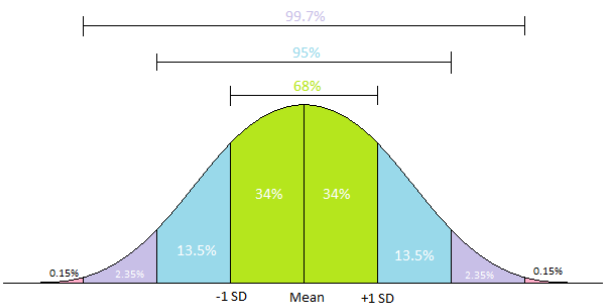

Figure 4.2 Standard Deviation calculation

V. SIMULATION RESULTS

5.1 Introduction of MATLAB Software: - MATLAB is a commercial "Matrix Laboratory" package which operates as an interactive programming environment. It is a backbone of the Mathematics Department programming

lineup and is additionally accessible for PC's and Macintoshes and might be found on the CIRCA VAXes. MATLAB is all around adjusted to numerical analyses since the hidden calculations for MATLAB's worked in capacities and provided m-records depend on the standard libraries LINPACK and EISPACK.

MATLAB program and content records dependably have filenames finishing with ".m"; the programming dialect is extraordinarily direct since relatively every information protest is thought to be an exhibit. Graphical yield is accessible to supplement numerical outcomes. MATLAB (lattice lab) is numerical processing condition and fourth-age programming dialect. Made by Math Works, MATLAB grants framework controls, plotting of limits and data, use of computations, making of UIs, and interfacing with programs written in various lingos, including C, C++, Java, and Fortran.

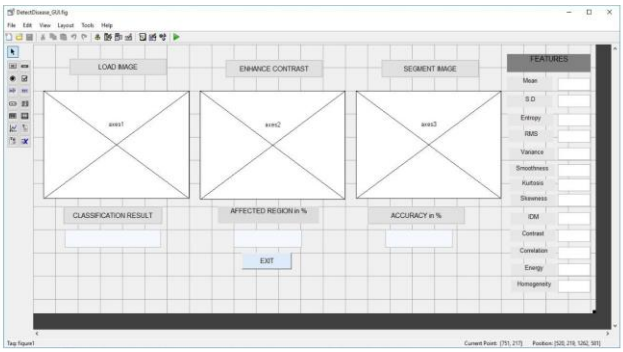

Figure 5.1 Graphical User Interfaces for proposed work

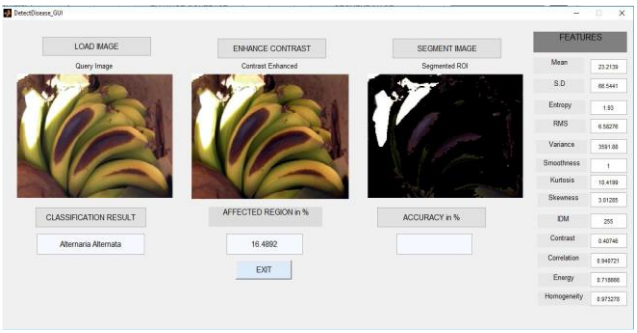

Figure 5.2 Image Graphical User Interfaces for proposed work

VI. CONCLUSION & FUTURE WORK

6.1 CONCLUSION

Image Processing Toolbox™ provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. You can perform image enhancement, image deploring, feature detection, noise reduction, image segmentation, geometric transformations, and image registration. Many toolbox functions are multithreaded to take advantage of multi core and multiprocessor computers. Image Processing Toolbox supports a diverse set of image types, including high dynamic range, Gig pixel resolution, embedded ICC profile, and topographic. Graphical tools let you explore an image, examine a region of pixels, adjust the contrast, create contours or histograms, and manipulate regions of interest (ROIs). With toolbox algorithms you can restore degraded images, detect and measure features, analyze shapes and textures, and adjust color balance [19].

The method reported in the thesis can be used to design a soya bean expert system for farmers for the early detection of plant foliar infection, infection grading and getting the appropriate cure remotely.Through the thesis work, we have tried to highlight the problems associated with the cultivation of soybean and causes of low yield loss in the developing countries like India. It has been taken-up six soya plant foliar diseases, namely; Rust, Bacterial Blight, Sudden Death Syndrome, Brown Spot, Downy Mildew, and Frog Eye, which are mainly responsible for significant yield loss; it has been proposed a fully automatic method for identification and classification by different digital image processing techniques and also to classify the disease severity level using five classes. It has been derived and development various new parameters and indices like DSI, IPR, DLP, which are subsequently used for disease level prediction. The methodology has been implemented successfully and performance tested on a real set of soya leaf data. The result is quite convincing and wide adaptability in developing countries, where such information plays an important role for improvement in yield. The proposed method uses mobile cams for capturing the diseased images and does not require any kind of special training and sophisticated capturing devices. The proposed method is (i) fully automatic for ROI calculation, background separation and parameter

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