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APPLICATION OF MULTI-ATLAS SEGMENTATION IN IMAGE PROCESSING

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Abstract: *In this paper, multi-atlas segmentation is applied on an image of cotton plant leaf which is affected by some disease or infection. Multi atlas based method is commonly used in image segmentation. In multi atlas based image segmentation, atlas selection and combination are considered as two key factors affecting the performance. However, due to the complexity of structures in raw images, it is difficult to get accurate atlas selection results only by measuring the distance between raw images. Although the distance between the regions to be segmented across images can be readily obtained by the label images, it is infeasible to directly compute the distance between the test image (gray) and the label images (binary). Here is a small try to solve this problem by proposing a label image constrained atlas selection method, which helps in detecting the infected area of cotton plant leaf in its image. Multi-atlas-based segmentation algorithms consider concurrently complementary information from multiple atlases to produce optimal segmentation outcomes.*

Keywords: *Multi-atlas segmentation, plant leaf, infection, combination, test image, label image.*

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INTRODUCTION

Image segmentation is often the first step in image analysis. Its goal is to simplify or change the representation of an image into something more meaningful or easier to analyze. Comparative advantage of the atlas-based segmentation with respect to the other segmentation methods is the ability to segment the image with no well defined relation between regions and pixels' intensities. Accurate segmentation of the image can be helpful for assisting the diagnosis of the disease on plant leaf. Traditionally, the affected plant image segmentations are performed manually by experts. However, manual segmentation is tedious, time consuming, and not reproducible. To overcome these shortcomings, a large number of automated image segmentation methods have been proposed [1]–[2]. Although these existing methods are effective in some cases, automated segmentation of plant image is still very challenging due to the unclear boundary information in some areas.

The diseases on the cotton leaves are classified as

a) Fungal diseases: e.g. Anthracnose, Leaf Spot.

b) Viral disease: e.g. Leaf Curl,Leaf Crum, brown spots.

c) Diseases Due To insects: e.g. Whiteflies, Leaf insects.

Out of the above types of disease these diseases dramatically affect the leaf of cotton plant and its leaves. We go through the selective type of diseases on the cotton leaves. And further we discuss the multi–atlas segmentation method to detect the diseases on cotton plant by scanning of cotton leaves through our portable dedicated scanner or specially designed camera. Pre-processing is done on image given as input test image. Following are the three pre-processing steps performed on input test image.

a) Contrast enhancement

b) Region Of Interest

c) Image registration

1.1 Contrast Enhancement:

Image values are concentrated near a narrow range (mostly dark, or mostly bright, or mostly medium values). Contrast enhancement changes the image value. It also changes the image value distribution to cover a wide range. Contrast of an image can be revealed by its histogram. The affected part of image is enhanced and highlighted. Contrast enhancement performs isolated pixels removal, Holes filling, Morphological operations such as erosion dilatation, thinning. Total number of pixel value for enhanced image is 0 to 255. 0 denotes most dark part and 255 denotes most bright part. Far apart pixel values are easy to distinguish and close by pixel values are difficult to distinguish.
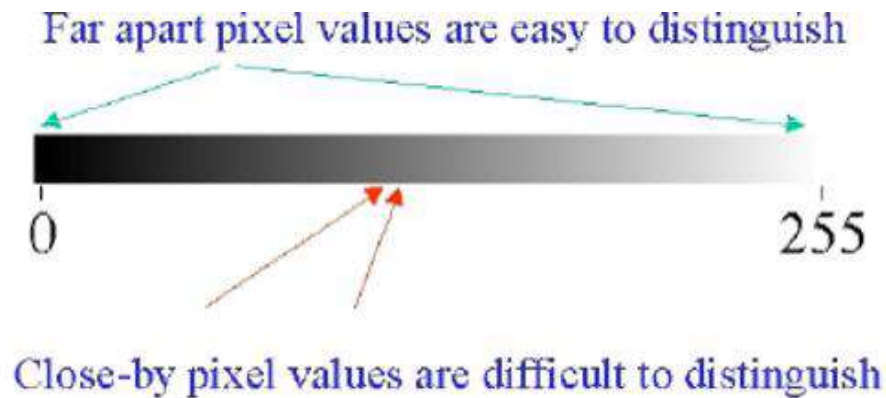
Far apart pixel values are easy to distinguish

0   255

Close-by pixel values are difficult to distinguish

Fig.1 Range of pixel count

Contrast enhancement of color image is typically done by transforming an image to a color space that has image intensity as one of its components. This enhanced image is further used to calculate region of interest.

1.2 Region of Interest:

A region of interest (ROI) is a portion of an image that you want to filter or perform some other operation on. You define an ROI by creating a binary mask, which is a binary image that is the same size as the image you want to process. In the mask image, the pixels that define the ROI are set to 1 and all other pixels set to 0. You can define more than one ROI in an image. The regions can be geographic in nature, such as polygons that encompass contiguous pixels, or defined by a range of intensities. In the latter case, the pixels are not necessarily contiguous. Region of interest is highlighted by dark region. Further it is highlighted by white color to get more accurate results.

1.3 Image Registration:

Image registration is an image processing technique used to align multiple scenes into a single integrated image. It helps overcome issues such as image rotation, scale, and skew that is common when overlaying images. Image registration is often used in medical and satellite imagery to align images from different camera sources. Digital cameras use image registration to align and connect adjacent images into a single panoramic image. Image registration is the process of overlaying two or more images of the same scene taken at different times, from different viewpoints, and/or by different sensors. It geometrically aligns two images—the reference and sensed images. The present differences between images are introduced due to different imaging conditions. Image registration is a crucial step in all image analysis tasks in which the final information is gained from the combination of various data sources like in image fusion, change detection, and multichannel image restoration. Typically, registration is required in remote sensing (multispectral classification, environmental monitoring, change detection, image masking, weather forecasting, creating super-resolution images, integrating information

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into geographic information systems), in medicine (combining computer tomography data to obtain more complete information about the patient, monitoring tumor growth, treatment verification, comparison of the patient's data with anatomical atlases), in cartography (map updating), and in computer vision.

2. Methodology:

Following are the steps followed to apply multi-atlas algorithm on image of infected cotton plant leaf.

1) Select training directory

2) Generate training data

3) Generate eigen features

4) Input test image

5) Enhance image

6) Get ROI

7) Locate infection

8) Register image

9) Predict disease

10) Get accuracy

11) Classify image

12) Result analysis

13) Clear all

14) Exit application

Let us discuss each step in detail as

Step 1. Select training directory.

We have to select training directory. This will take the required data base of cotton plant leaf images in matlab. Training directory contains all the infected images which are to be compared with the input registered image. Training directory contains images of cotton plant leaf those are affected by viral disease, bacterial disease, fungal disease and white fly. The algorithm will not proceed to next step until and unless training directory is not selected.

Step 2: Generate training data.

This will extract the required data from the directory images. Trained data will help in generating eigen features in next step. It is not possible to generate eigen features if the data in the directory is not trained.

Step 3: Generate Eigen Features.

Eigen features give the features required to generate the required result. Theses features include type of disease detection, accuracy of detecting disease, percentage of disease affecting

the leaf of cotton plant, entropy. After generating eigen features from the trained data, conformation is shown on screen. We can proceed to next step only after getting confirmation of generation of eigen features.

Step 4: Input test image.

Any image of cotton plant leaf can be given as input image. The final result analysis will be given for this input image. This input image requires pre-processing before being given as input to multi-atlas algorithm. Input test image may be any image of infected cotton plant leaf taken from good resolution digital camera. This image is further processed by using contrast enhancement algorithm.

Step 5: Enhance image.

Contrast enhancement algorithm is used in this step to enhance the affected part of image. Infected part of cotton plant leaf is being highlighted by dark color.

Step 6: Get ROI.

In this step, Region of interest is calculated by comparing each pixel of infected part of input image with the pixel of original uninfected leaf image. ROI in image is highlighted with dark (black) colour. In the previous image, the pixels that define the ROI are set as 1 and all other pixels are set to 0.

Step 7: locate Infection.

In this step, region of interest is denoted by white color to get more accurate results. White colored area of cotton plant leaf shows the location of infection on leaf. The image to be registered for giving input to multi-atlas algorithm is built from the image obtained at the output in this step. This step also shows the percentage of infected area of cotton plant leaf.

Step 8: Register image.

In this step, the image is registered for result analysis. The infected part is denoted by white color and uninfected part is denoted by original form as in input test image. The disease affecting the cotton plant leaf can be detected only after registering the image through this step.

Step 9: Predict disease.

In this step, the disease affecting the cotton plant is predicted. This is done on the basis of pixel count of infected area. As the algorithm is used for detecting three basic types of conditions for detecting particular type of disease, the pixel count for each condition is of different value depending on the database images

Step 10: Get Accuracy.

Percentage of disease affecting the plant leaf is calculated and accuracy of calculation is determined. Accuracy is based on infected part denoted in register image.

Step 11: Classify image.

Multi-Atlas algorithm is used to classify the RGB contents in infected part of cotton plant leaf. The important condition required to classify image is to locate the infected part properly and accurately.

Step 12: Result Analysis.

The graphs displayed show the proportion of red, green and blue contents of complete input test image. The mean graph of red, green and blue contents also appears in the output. This is obtained in further process by selecting the registered image for generating output. The RGB graph and graph of its mean is compared for input test image and registered image.

Step 13: Accuracy of prediction

Accuracy of predicting the disease on cotton plant is obtained. Accuracy of prediction of disease affecting the cotton plant leaf depends on the register image given for the processing of multi-atlas algorithm. For example, accuracy of prediction of disease in following figure(fig.2) is 98.58%.
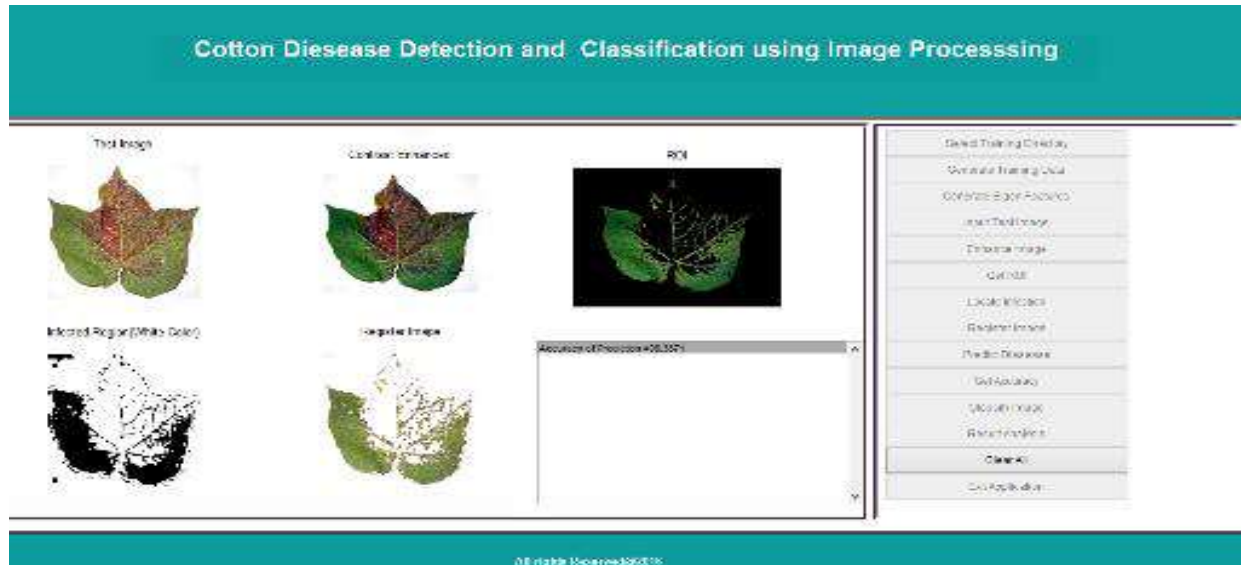

Fig.2. Algorithm Process

3. Result and Discussion:

3.1. Time for Feature Extraction:

Some Eigen features are to be extracted from enhanced cotton leaf image. Hence the time required for such extraction is calculated by using timer commands of image processing toolbox in matlab. Time taken for feature extraction in the above considered example is 0.57 seconds.

3.2. Percentage of area infected:

Percentage of area infected of cotton plant leaf is calculated by using peak signal to noise ratio in image processing toolbox of matlab. Percentage of area infected in an example considered above is 82.05%.

3.3. Prediction of type of disease:

Database of project contains all the possible symptoms and conditions for related diseases to be detected. Each disease has some specific number of pixel count of infected area. Hence, the pixel to pixel comparison is carried out and pixel count value is calculated by the logic of digital counter. The type of disease prediction in above example is Fungal.

3.4. Percentage of disease detection:

This shows how much percent of area of cotton leaf is affected by infection or disease. In the example taken, percentage of disease calculated is 98.38%.

3.5. Total image pixels:

The number of total pixels in input image are been calculated. This helps to predict the level of infection in an image.

3.6. Infection level:

Depending on the area of infection, there are three infection levels as low infection, medium infection, high infection. For example, the level of infection is high for the cotton leaf image taken in the following fig.3
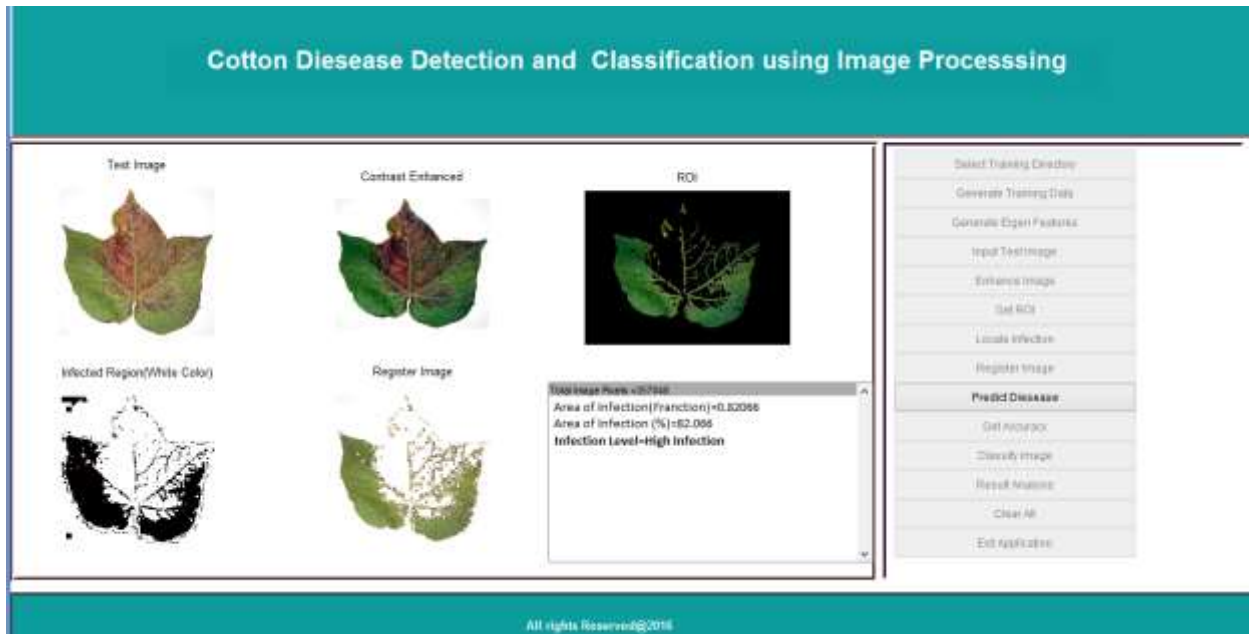
Fig. 3 Infection level

3.7. Accuracy of prediction:

Accuracy of predicting the disease on cotton plant is obtained. Accuracy of prediction of disease affecting the cotton plant leaf depends on the register image given for the processing of multi-atlas algorithm. For example, accuracy of prediction of disease in following figure is 98.58%.

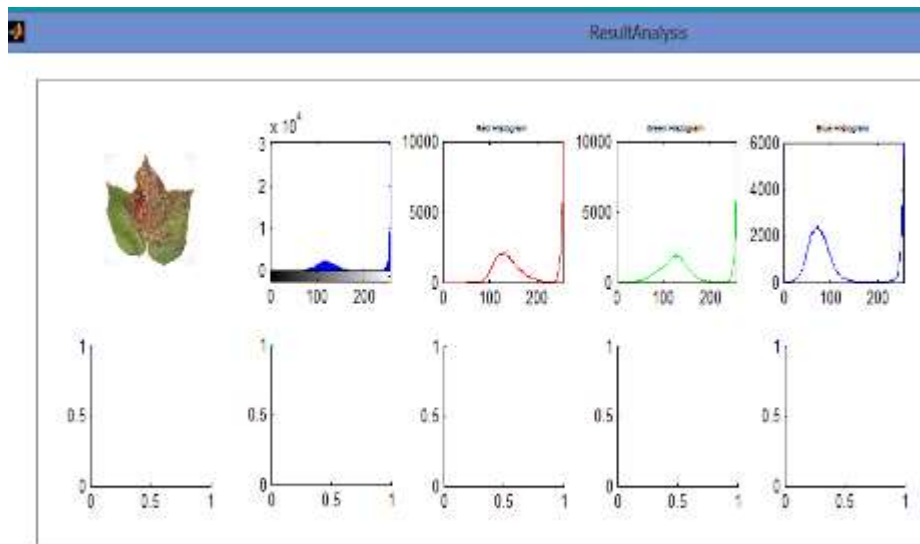### 3.8. Individual RGB and mean graph of input test image and register image:

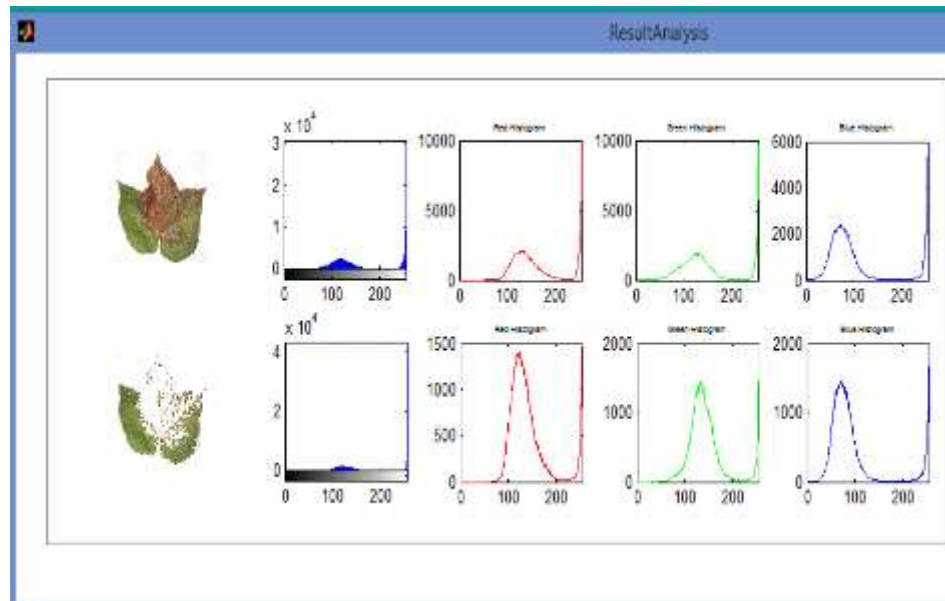**Fig.4 Graph for Input Test Image**

Fig.5 Graph for Register Image

4. CONCLUSION:

It can be concluded that current status of cotton plant leaf can be studied by implementing multi-atlas algorithm on raw image and affected image of cotton leaf. This method can detect the density of disease or infection on cotton plant leaf. Accuracy of prediction of disease affecting the cotton plant leaf , entropy , time required for feature extraction, percentage of disease detection are obtained as result of multi atlas segmentation on input test image.This considerably reduces the computational time required. Change in colors pixel wise gives the detail information about affected leaf of cotton plant. Hence, cotton plant can be prevented from being useless.

In other words, white pearl of agriculture can be safely preserved by using multi-atlas algorithm.

5. FUTURE SCOPE:

Multi-atlas segmentation in image processing has been successfully implemented on infected leaf of cotton plant. Hence, in future it can be implemented on infected leaves of other plants also. This algorithm can predict only three types of diseases in this project but it can be made to detect more than three diseases. This algorithm predicts only one disease at a time but it can be made more advanced by making it to predict more than one disease at a time.

6. APPLICATIONS:

1) In medical diagnosis

2) In agricultural field

3) For cardiac MR image segmentation

7. ACKNOWLEDGEMENT:

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