

An Efficient Weed and Pest Detection System

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Abstract

In an agricultural field, farmers have a wide range of diversity to select suitable fruit and vegetable crops. However, the cultivation of these crops with quality produce is highly technical. Most challenging for farmers is to differentiate between crops and weeds. The proposed method identifies the weeds by using leaf parameters such as shape, color, and texture. Pest/disease detection is also possible by detection of varied shape and color of disease affected crop leaves. In order to improve the accuracy of weed detection, need to develop a weed detection algorithm which could be supported in all the cases accurately. Adding on, crops face many diseases. Pest/diseases are seen on the leaves of the plant. To avoid misclassification of such disease affected plant as weed, a new algorithm is developed for disease identification and included in weed detection algorithm. Recognition of normal leaf, diseased leaf and weed is based on similarity measure.

Keywords: Euclidean Distance, Leaf Parameters, Image-Processing, Plant Disease Detection, Weed Detection

1. Introduction

In India most people depend on agriculture. The main goal in farming is increasing agricultural protection. The protection decreased by many factors including weed, pest/disease, environmental conditions. Controlling weed is done by machineries, fertilizers and labours. To identify and remove weed efficiently, computerised weed detection system is proposed. In the proposed system some difficulties are faced such as misclassification of disease affected plant as weed. Because weed detection is based on shape, color, texture features. So the system prescribes same fertilizers used for destroying weed not for disease. In this project an efficient weed and pest detection system has been proposed.

2. Literature Review

In 'Real-Time Specific Weed Recognition System Using Histogram Analysis' proposed the histogram analysis for real time weed classification system⁶. Control weeds with less herbicide to reduce production costs and to protect

the environment. This algorithm is specifically developed to classify images into broad and narrow class for real-time selective herbicide application.

In 'Identification of Leaf Diseases in Tomato Plant Based on Wavelets and PCA', proposed the automatic identification of diseased leaves based on Wavelets and Principal component analysis⁵.

In 'Machine Vision System for Automatic Weeding Strategy in Oil Palm Plantation using Image Filtering Technique'¹⁰ proposed the an automatic weeding strategy in oil palm plantation using machine vision system for the detection and differential spraying of weeds. In 'Detection of weeds using image processing and clustering' proposed the classification based on the features reveals the type and number of weeds per image⁷. The weeds are extracted from the images described by shape features. Selection can be done using data mining algorithms, which rate the discriminants of the features of prototypes. A feature selection algorithms weight features according to their discrimination abilities.

In 'Color Image Processing of Weed Classification: A comparison of two Feature Extraction Technique',

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proposed to analyze which pre-processing method increase the efficiency of weed classification⁸. Two pre-processing techniques are greyscale conversion and excess green method. Along with these techniques two feature extraction techniques are compared for better accuracy. The excess green pre-processing method is effective compared to gray scale conversion for weed classification.

In 'Performance Improvement of Leaf Identification System Using Principal Component Analysis', proposed the leaf identification system using leaf parameters shape, vein, colour, and texture⁹. Using principal component analysis dimension of feature vectors are reduced from 54 to 25 and it is given as input to optimal classifier probabilistic neural network. High accuracy is reached when using 25 features on both dataset.

3. Modules

Following are the four modules of weed and pest detection system.

- Image Acquisition
- Pre processing
- Feature Extraction
- Recognition Based on similarity Measure

3.1 Image Acquisition

The project begins with capturing tomato leaves. Image acquisition is done by Sony digital camera DSC-W510 with the resolution of 4000x2248^{3,4}. Normal tomato leaves are captured in the white background. Meanwhile diseased tomato leaves also captured. Totally 60 images for training and 20 images for testing are captured in both normal and diseased leaf. For testing of weed leaf, 20 images of 3 kind of weed leaves are captured. Figure 1.1 shows sample image captured by Sony digital camera.



Figure 1.1 Captured Tomato Sample.

3.2 Pre Processing

After image acquisition images are not suitable for further processing. Pre-processing steps are applied to remove noise and to separate tomato leaves from its background. In this module five pre processing techniques are applied. They are^{2,1}

- Color Band separation
- Excess green removal
- Thresholding
- Eroding
- Dilation

3.2.1 Colour Band Separation

Capture the RGB values individually from captured colour image. Captured tomato leaves processed to separate three bands such as R, G, B. Input to this module is RGB IMAGE. Output is R, G, B bands that are separated from the input image. These values are calculated to find excess green image². The Figure 1.2 shows R, G, B band for tomato leaf.



Figure 1.2 R, G, B Bands.

3.2.2 Excess Green Removal

Computation of excess green using the following formula²

$$GE = 2 * G - B - R + 127 \tag{1}$$

Where,

- GE = excess green image;
- G = green band image;
- B = blue band image;
- R = red band image;
- 127 = constant.

Input to this module is R, G, B bands. Output from this module is Excess Green Image.

3.2.3 Thresholding

Threshold image is calculated. Input to this module is excess green image. Output from this module is threshold images.

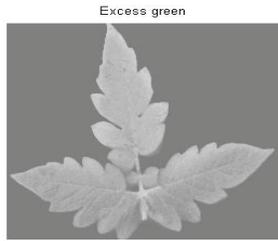


Figure 1.3 Excess Green Image.

3.2.4 Eroding

Erosion and dilation are morphological operations applied gray scale. In a gray scale image erosion reduces the brightness of objects on a dark. The image was eroded and dilated to avoid holes and blobs in the object. Erosion has been used to remove the linking objects. Using this technique, enhance and fine tune the image. Removing structures of certain shape and size, given by structure element. Input to this module is excess green image. Output is eroded image⁸.

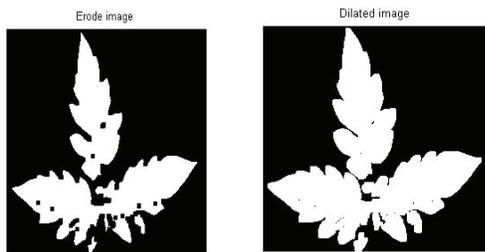


Figure 1.4 (a) Eroded Image. (b) Dilated Image.

3.2.5 Dilation

Dilation in the binary image is used to fill up blobs and holes in the images created and broken perimeter due to class variance or minor problems in thresholding². Input to this module is eroded image. Output is dilated image.

3.3. Feature Extraction

Tomato leaf significantly varies from weed leaf images. Geometrical features like shape, color, texture features are extracted.

3.3.1. Shape Features

Shape features such as^{2,11}

- Aspect ratio
- Rectangularity
- Perimeter ratio

- Circularity
- Compactness
- Elongation
- Bounding rectangle
- Perimeter
- Intercepts

3.3.2 Texture Features

Texture features extracted are^{2,11}

- Energy
- Entropy
- Correlation
- Contrast and
- Inverse difference moment

3.4 Recognition Based on Similarity Distance Measure

Extracted features are stored in database. Two databases are maintained, one for normal tomato leaf and another for diseased tomato leaf. Here 4 tomato diseases popularly seen on tomato leaf are addressed. They are³

Table 1.1



Bacterial pith necrosis(yellow leaf)



Early Blight



White trail



Target spot

3.4.1 Bacterial Pith

Leaves looks like yellowing and wilting blacking and moves to top of plant.

3.4.2 Early Blight

Initially appears a irregular lesions on oldest mature leaves near the ground; lesions expand, becoming dark brown and necrotic with concentric black rings giving a target-like appearance³; may have chlorotic area surrounding lesion.

3.4.3 White Trail

Leaf miner moves on leaves. The adult stage of leaf miners is small yellow and black flies that insert their eggs into the leaves of plants. After hatching, the larvae of leaf miners feed between the leaves surfaces, resulting in the white squiggly lines you found on your tomato plant leaves⁴.

3.4.4 Spot

Lower leaves show symptoms first. Round, yellow or water-soaked spots appear on the undersides of leaves. They quickly emerge on leaf tops and turn to black or brown with tiny black dots in the center. Heavily infected leaves turn completely yellow, then brown, and fall⁹⁻¹².

Figure 1.5 shows steps followed in weed and pest (disease) detection system. The works begins with image

acquisition. Captured images are pre-processed and trained to database. System is tested using test images of normal, diseased tomato leaf and weed leaf images. First it checks with normal (healthier) plant leaf parameters. If it is matched it is recognized as normal leaf¹³.

Otherwise check with disease parameter if it matches results as diseased leaf then provides, cause and solution. Test image features not matched with both parameters then it is recognized as weed. Euclidean distance measure⁴ is used for similarity measure between images. Equation for Euclidean distance is shown below in Equation (2). Euclidean distance uses both features vectors of stored and testing values

$$dist(X,Y) = \sqrt{(x_1 - y_1)^2 + \dots + (x_n - y_n)^2} \quad (2)$$

4. Results and Discussions

Screen shots showing results of weed and disease detection system. Figure 1.6 shows given test image is

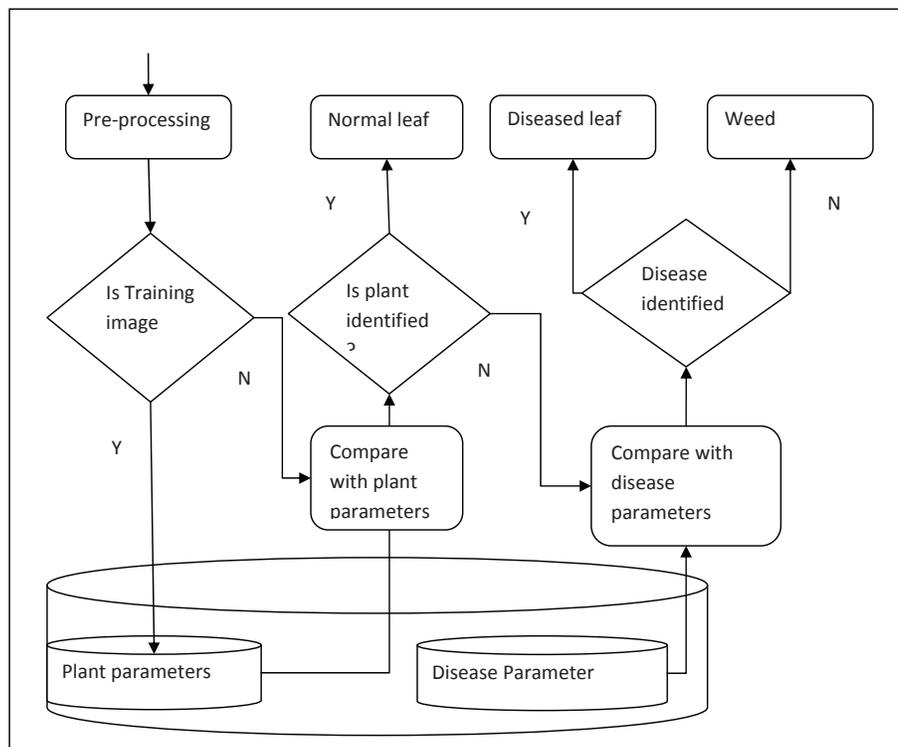


Figure 1.5 Steps in Weed and Pest Detection.

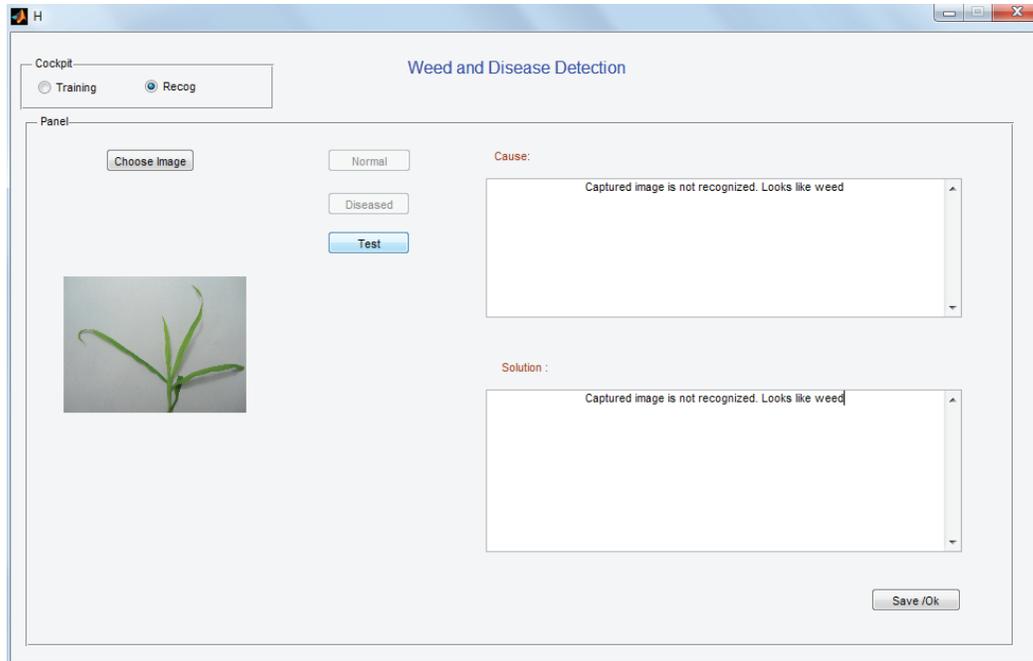


Figure 1.6 Result Showing Weed Detection.

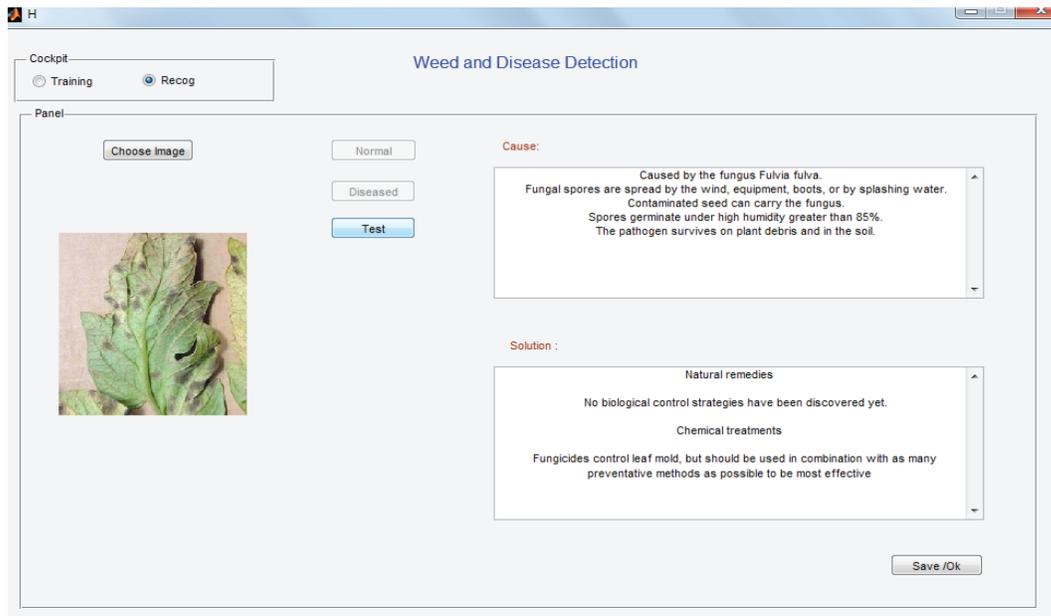


Figure 1.7 Result Showing Disease Detection.

recognized as weed. Figure 1.7 shows result as given plant image identified as diseased leaf¹⁴. In addition to identification cause and solution for disease also provided. Figure 1.8 shows test image is recognized as normal tomato leaf.

The system is trained with 100 images for both normal and diseased plant leaf. For testing 20 images in each kind of leaf like weed, normal tomato leaf and diseased tomato leaf are tested. Overall accuracy reached up to 92% for three kinds of leaves^{15,16}.

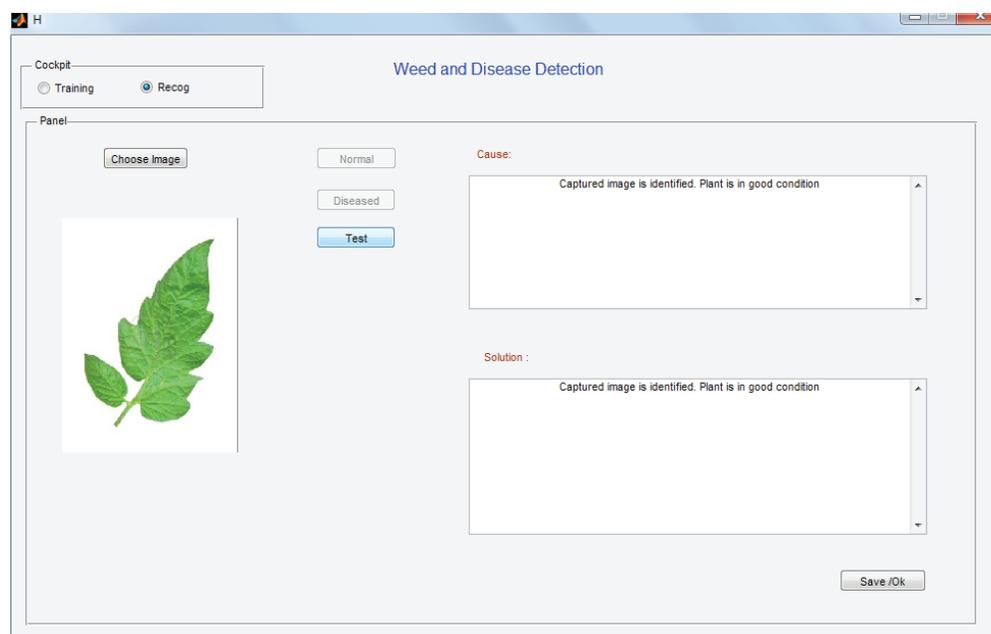


Figure 1.8 Result Showing Leaf Recognized as Normal Leaf.

5. Conclusion

In this system tomato plant leaves recognized using Euclidean distance. In this paper, an overview of the efficient weed and pest detection system is presented and similarity distance measure is obtained using feature vectors for better performance to find decision of leaf recognition. Therefore the system can help in reaching optimum accuracy of leaf recognition. A better and efficient solution overcoming the observed disadvantages is proposed. The design of the proposed solution and the implementation details of all modules are discussed.

6. Future Work

Thus, Weed and pest detection can be enhanced to account the various disease affected on the various parts of the plant for better efficiency than existing systems. The proposed system considers only for specific specie. Future work will consider all species.

7. References

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