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An Efficient Method for Lemon Disease Detection Using Digital Image Processing

Dilip Singh Solanki[1] Research scholar, SAGE University Indore India, dilip.solanki70@gmail.com
Dr. Harish patidar[2] Professor, SAGE University Indore India, harish.patidar.sage@gmail.com

Abstract: The detection and identification of lemon fruit disease is important for preventing a large loss and increasing the quantity of agricultural product. Lemon fruit diseases are a major threat to food security, which will lead to productivity loss, economic loss, quality loss and quantity loss. There are minimal numbers of technologies that have been developed to assist farmers throughout the world, but if automated detection techniques are employed, it will require less effort, take less time, and be more accurate. The symptoms can be seen on plant parts such as the leaves, stems, and fruits. Therefore, this paper demonstrates a new method in which a Lemon fruits disease detection approach will be identify using digital image processing techniques. The SURF feature-based technique, which uses feature extraction, features matching, and the RANSAC algorithm for disease detection. Early identification of diseases in lemon plants helps in the prevention of disease spread in orchards, reducing financial loss to farmers.

Keywords— Lemon Fruit disease, SURF Features, Feature Extraction, Feature Matching, Filtered Match, Ransac algorithm.

I. INTRODUCTION

Indian economy is highly dependent of agricultural productivity Therefore in the field of agriculture detection of disease in plants plays a significant role. The detecting of a plant disease in a very early stage as well as use of automatic disease detection technique is very useful. The usual way is to hire professional agriculturists who supervise the plants, but this may not always be possible for farms set in remote rural areas. Moreover, the cost may not be affordable for smaller farmers. At present a new concept of smart farming has been introduced where the field conditions are controlled and monitored using the self operating systems. Detection of disease from image is the key feature to extract the characteristic of the diseased region. The features that are extracted from the image are color, size, shape etc. However for detection of disease more features are extracted and this extracted feature would increase the hardware as well as software cost. The disease in plant leads to the major role in decrease both the quality and quantity of agricultural products. Researchers in agriculture are aimed towards increase the productivity and food quality at reduced expenditure with large profit. The numbers of studies illustrate that quality of agricultural products might be reduced due to plant diseases.

Different types of Plant disease

The studies of plant disease refer to the studies of visually visible patterns on the plants. In the majority of the cases disease symptoms are seen on the leaves, stem and fruit. The plant leaf for the detection of disease is considered which shows the disease symptoms. In plants, some general diseases seen are brown and yellow spots, early and late scorch, and others are fungal, viral and bacterial diseases. The researchers can understand type of image processing operation and type of feature need to be considered by observing various diseases. Effect on plant leaves can vary from discoloration to death. Here we are discussing some common diseases in lemon tree fruits.

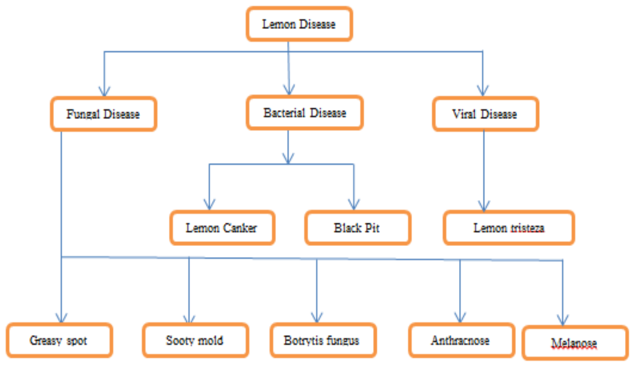

Figure1. *Different types of Lemon disease*

1.1 Fungal Disease

Greasy spot fungus – Greasy spot is a fungus that attacks lemons and causes a yellow-brown blister on the underside of the leaves. The blisters become greasy as the condition progresses.

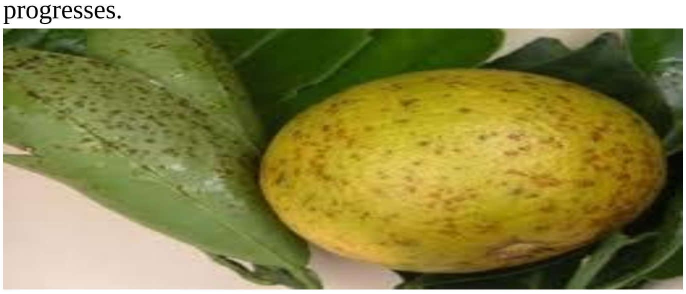

Figure 2. G*reasy spot fungal disease*

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Sooty mold fungus – A fungal infection that causes black leaves is known as sooty mould. Honeydew produced by aphids, whiteflies, and mealy bugs causes this mould to grow.

Figure 3. *Sooty mold is a fungal*

Botrytis fungus – Another fungal disease that can affect lemon trees is botrytis rot. It grows after extended periods of rain, usually by the shore, and transforms from old blooms to newly forming blossoms in the spring.

Figure 4. *Lemon botrytis rot*

Anthracnose – Twig dieback, leaf loss, and discolored fruit are all symptoms of anthracnose, a fungal infection. Colletotrichum causes it, and it's more common after extended periods of rain.

Figure 5. *Anthracnose*

1.2 Bacterial Disease

Citrus canker – Citrus canker is a highly contagious bacterial infection that forms yellow halo-like lesions on citrus fruit, leaves, and twigs. This lemon tree condition will eventually result in dieback, fruit drop, and foliage loss if left untreated. Air currents, birds, insects, and even humans help spread this disease through the air. Treat citrus disease with a prophylactic spray of liquid copper fungicide. If the tree is already afflicted, there is no way to save it; it must be cut down.

Figure 6. *Citrus* canker

Black Pit - The bacteria Pseudomonas syringae causes black pits in lemons. Citrus blast is caused by the same bacterium, which causes water-soaked or reddish black lesions on the twigs and leaf petioles of primarily oranges, mandarins, and grapefruit. Small light brown to black pits or larger sunken patches (5-20mm) on fruit are signs of black pit. During post-harvest storage, the pits may enlarge. When the bacterium which is widespread on citrus leaves invades an injury produced by wind, strong rain, or thorns, infection occurs. The black pit bacterium prefers prolonged cool wet conditions at temperatures of 8-20o C.

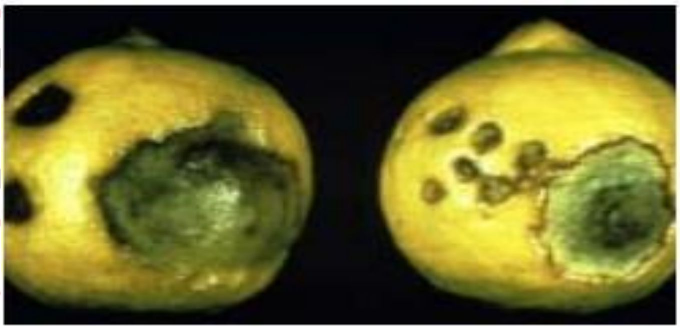

Figure 7. *Black pit*

1.3 Viral Disease

Lemon tristeza virus - Lemon tristeza virus (CTV) is a Clostero virus of the family Clostero that causes the most economically devastating disease in the genus Lemon. Millions of Lemon trees have died as a result of the illness, and millions more have been rendered unusable for production.

Figure 8. *Lemon tristeza viru*

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II. LITERATURE REVIEW

Monika Jhuria et al. describe an image processing system for detecting and grading grape and apple fruit diseases. Black Rot and Powdery Mildew are the two most common illnesses in grapes, whereas Rot and Apple Scab are the two most common diseases in apples. Capturing digital images is the image acquisition method, and the author then presented image preparation techniques, including feature extraction. For feature extraction, it uses three features: morphology, texture, and colour. Morphology is used to extract image components for boundaries. The texture feature describes many visual patterns. In colour feature extraction, RGB colour space is transformed to HSI colour space, and the image's histogram is produced. The classification of diseases in the network is done using an ANN neural network and a back propagation technique [1].

Sachin Jagtap et al. discuss the image processing technique after which the background noise is removed and the foreground leaf picture is extracted for further processing. After that, the images are transformed to HSV colour space, grayscaled, and finally binary images. The images were subjected to a morphological operation in order to obtain the outlines of the images, minor components were deleted from the images, and a morphology-based expansion operation was performed on those images. After that, all the images' related pixel components are labeled, and all of the noisy zones are removed. Finally, for all enhanced binaries images and shape associated features, the edges are found using the canny edge detection technique and extracted using the preprocessing results [2].

Ashwini Awate et al. describe an image processing technique for detecting disease in apples, grapes, and pomegranates. Grape diseases include Powdery Mildew, Downy Mildew, and Black Rot. Apple Scab, Apple Blotch, and Apple Rot are apple fruit diseases, whereas pomegranate fruit diseases include Fruit Rot, Gray Mold, and Bacterial Blight. In this illustration after obtaining natural images of fruits, image segmentation is used to locate the objects and the bounding line of the photographs. For identifying each pixel in the image, the K-means clustering technique was used, as well as the SURF (Speed up Robust Feature) algorithm for extracting features like colour, structure, texture, and morphology. The SURF technique employs a blob detector as well as local descriptors. Blob analysis is the process of refining, extracting, and analyzing images to determine their area of interest. The artificial neural network (ANN) is used to match patterns and classify disorders [3].

Gabor wavelet transform techniques were presented by Usama Mokhtar et al. to extract tomato leaf features. They employed SVM to detect leaf diseases The author observed two types of disease in tomato leaves during studies using genuine sample images of tomato leaves, including early blight and powdery mildew. Images are downsized to 512*512 resolutions in the preprocessing phase to reduce computational time, and then a background removal method is used to eliminate the image's backdrop. The kernel function and the SVM were used to train and test the classification phase [4].

Feng Qin et al. retrieved texture, shape, and colour features for Alfalfa Leaf diseases in this research. Three supervised learning methods were used to create the classification models: support vector machine, K-nearest neighbor algorithm, and random forest. The support vector machine model was developed with some important features isolated from a group of futures to be the optimal model when the features were picked, according to a comparison of the recognition outcomes. The recognition accuracy of the support vector machine was almost 97 percent for the training data set and 98 percent for the testing data set [5].

In this study, Pujitha N et al. presented image processing algorithms for mango fruit disease diagnosis. A video of mango fruits is captured using a camera, and the video is then transformed to frames for each mango sample. By creating histograms of the image, preprocessing turns the original image to binary and displays colour threshold ranges. For picture segmentation and automatic identification of video frames to identify defective regions, the watershed method is presented. The blob extraction approach uses a template matching algorithm to extract features from a segmented image. Finally, utilizing normalized correlation approaches in the template matching algorithm; automatic fruit disease recognition is classified. This method takes less time to recognize items in an image, and it also displays regions of the fruit that are defective, as well as fruit grading for diseased fruits [6].

In this paper, Srdjan Sladojevic et al. proposed a deep convolution network strategy for recognizing leaf illness using a classification algorithm. Climate change, according to the experts, can affect the stage and rate of disease growth. To differentiate the surroundings of leaves, a deep neural network technique was applied. All images are manually cropped to represent the region of interest by putting squares around the leaves. To expand the dataset, the author used an augmented approach. Rotations, transformations, and affine transformations are all examples of augmentation. A deep CNN framework was provided in this publication [7].

In this study, Amar Kumar Dey et al. have implemented Otsu's threshold technique for the separation of leaf rot diseases, our technique focuses on image handling calculations. The proposed vision-based technique is effective at detecting and observing external diseases. The image acquiring stage was the first of three stages in this method. The real-world test is initially recorded in a computerized frame with a level. The test image was next subjected to a preprocessing stage, during which its size and outstanding quality were drastically reduced. Finally, image preparation calculations determined the location of the damaged leaf fragment [8].

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Vijai Singh *et al* in this paper proposed a CNN based on the AlexNet architecture and able to significantly outperform the baseline MLP, presenting comparable performance to that of a group experts and outperforming every single expert. They have used dataset of 2539 images of apple tree species: Maxigala, Fuji Suprema and Pink Lady for diseases a nutritional imbalance leaves with potassium and magnesium deficiency [9].

Gittaly Dhingra *et al.* in this paper illustrate application of agriculture using computer visissson technology to recognize and categorize plant leaf disease. It deals with correlation between disease symptoms and impact on product yield. Moreover it deals with increasing the number of training data and testing data to accomplish better accuracy [10].

F.G. Febrinanto *et al.* in this paper describe that citrus plant diseases are a major cause to reduce the production of citrus fruits and their usages in several industries. The most common disease identified by the domain experts and researchers are Greening, Melanose, Downy, Black spot, Canker, Scab, and Anthracnose. These citrus plants disease can be identified on the basis of their visual symptoms by applying some computer vision and deep learning techniques [11]

Peng Jiang *et al.* used Alternia leaf spot, Brown spot, Mosaic, Grey spot, and Rust are five common types of apple disease that severely affect apple yield. However, the existing research lacks an accurate and fast detector of apple disease for ensuring the healthy development of the apple industry. Object detection algorithms such as SSD, DSSD and R-SSD can be regarded as consisting of two parts: The first part is the pre-network model, which is used as a basic features extractor. The other is an auxillary structure that utilizes multi-scale feature map for detection [12].

[13]. Citrus plant diseases are a major cause to reduce the production of citrus fruits and their usages in several industries. The most common disease identified by the domain experts and researchers are Greening, Melanose, Downy, Black spot, Canker, Scab, and Anthracnose. These citrus plants disease can be identified on the basis of their visual symptoms by applying some computer vision and deep learning techniques

[14] S. Janarthan et al presents a deep metric learning-based framework to recognize citrus diseases effectively from leaf images. The dataset contains a total of 609 annotated leaf images categorised into healthy and four citrus disease classes, namely black spot, canker, greening, and melanose. The proposed architecture comprises an embedding module, a cluster prototype module, and a simple neural network classifier to perform the disease recognition. In the evaluation, both of our models achieve 95.04% accuracy.

III. PROPOSED METHODOLOGY

In this method the image acquisition takes place and the infected lemon disease containing images matched with the original image, identifying the key points in both the images, and match between those points to find similarity. Then surf feature based method is used to detect two sets of features from the reference and sensed image. The extract features are used for the feature extraction on each key point, which are unique to the objects in the image in such a way that we are able to detect an object based on its features. The SURF descriptor based on interest points, Object detection and image registration with scale and rotation changes with integral images finally locate the object in scene using matching features. Estimate Geometric Transform calculates the transformation relating the matched points, whereas eliminate outliers. This transformation permits us to localize the object inside the scene and finally alter the reference image into the match up system in the target image. The image descriptors and feature matching are both quite noisy processes, to make our algorithm more robust, we will use the RANSAC algorithm.

Image acquisition

Lemon disease detection starts with image acquisition and supported any of the given image format such as JPEG, TIF, BMP, PNG etc. The process of image collection and lots of information may bring noise which may easily lead from operating and saving to the image would make the quality of image dropped, thereby affects subsequent of diseases. To perform de-noising different kinds of reduction technique are applied.

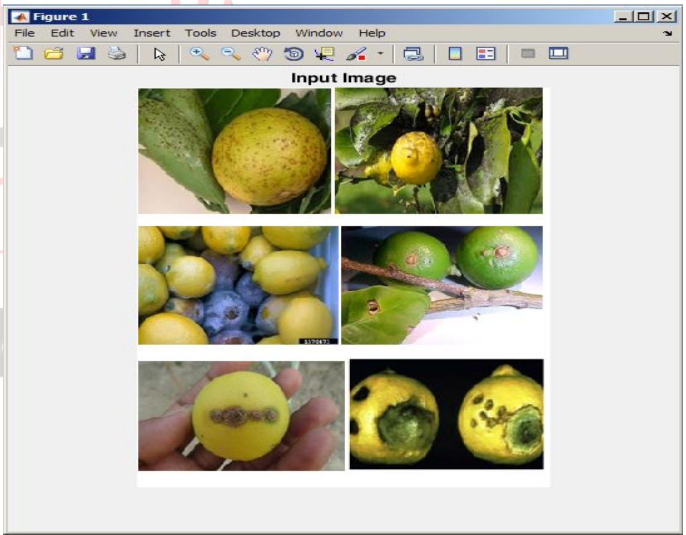

Figure 9. *Disease containing images*

Detect SURF Features

The feature based methods are utilized to detect two sets of features from the reference and sensed image. The features can be an edge, a corner, a point, a line or a curve, etc. Feature matching is to discover the pair-wise corresponding features. The actual matching accuracy will result these applications, normally these types of applications require the matching accuracy to sub-pixel. The matching part of the feature based methods is one pixel. The pair wise corresponding features can be used as an input regarding sub-pixel matching with other methods

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Extract Feature

The extract Features is used for the feature extraction on each key point. The feature extraction methods are used to detect two sets of features within the reference and sense images. A large amount of attempts has been used up in developing accurate and fast method for corner detection.

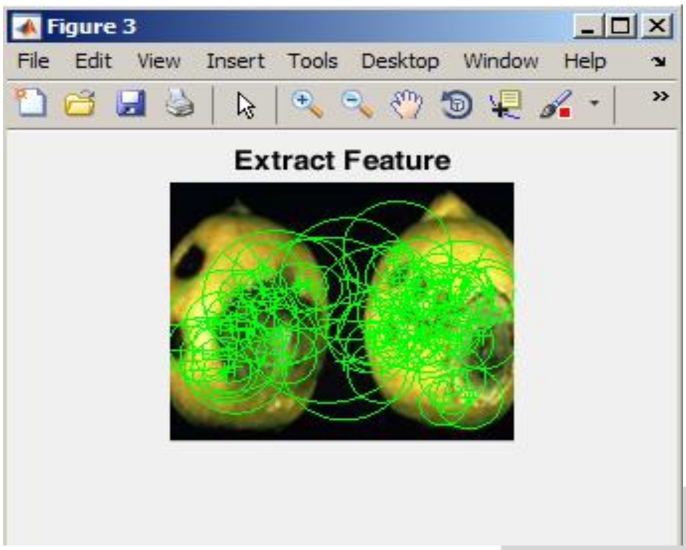

Figure 10. *Image having feature extraction*

Matching Feature

Matching features including outliers using their descriptors to locate the object in scene using matched points. In order to locate the object in scene estimate geometric transformations i.e. affine transform is calculated. The transformation relating the matched points, allow us to restrict the object in the scene and finally transform the reference image into the match up system of the target image. The transformed image indicates the position of the object in the scene image.

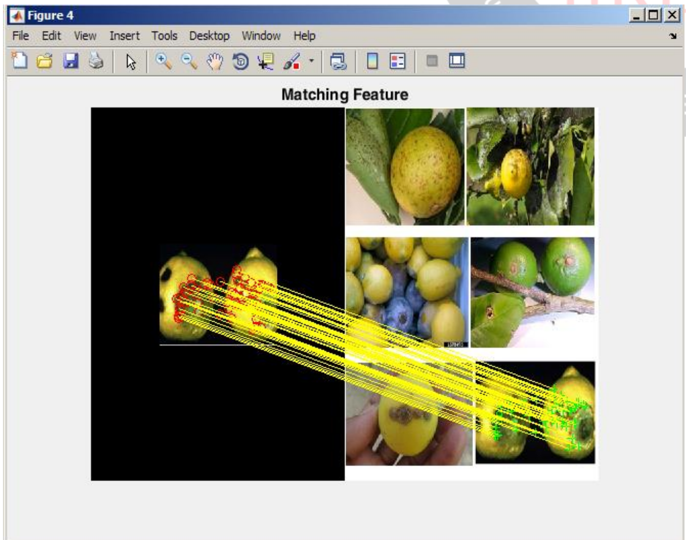

Figure 11. *Image with matching feature*

Filtered Matching

The transformation between the images needs to be as accurate as possible however image descriptors and feature matching are both noisy processes. The descriptors are subject to image noise and compression artifacts and not all assumed correspondences are true correspondences due to descriptor error and ambiguities in the matching.

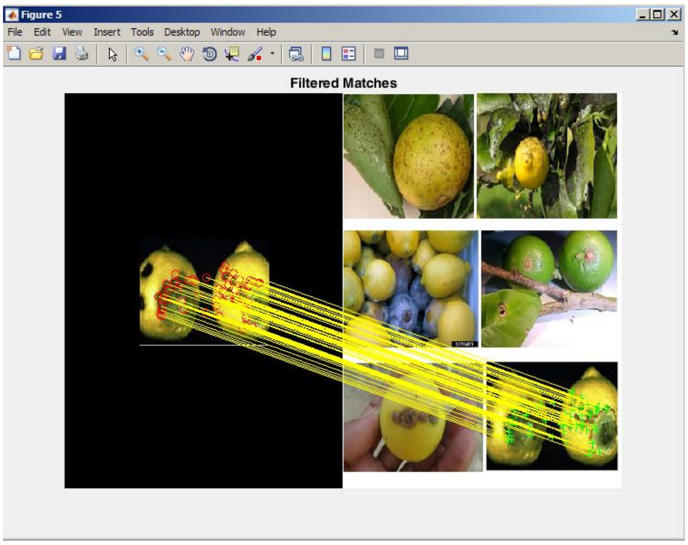

Figure 12. *Image with filtered matching*

Disease Image detection

The focus of this technology is to detect the geometric shapes of the disease affected image. To make our algorithm robust, we will use the RANSAC algorithm, it is a predictive modeling tool widely used in the image processing field for cleaning noisy observations. Geometric transform calculates the transformation relating to the matched points. This type of transformation allows us to restrict the object in the scene and finally transform the reference image into the match up system of the target image. The transformed image indicates the position of the affected area in the scene image. After detection of the disease the defected are is marked on the image.

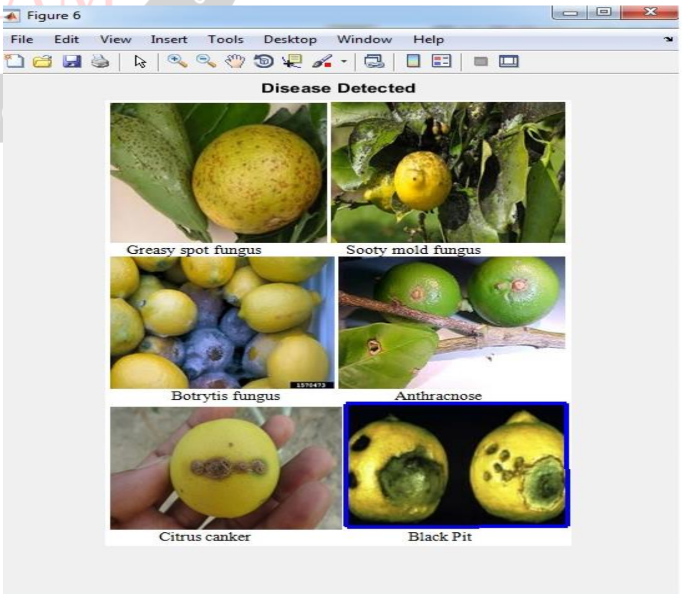

Figure 13. *Disease detected image*

IV. TEST RESULTS

The test result is applied to the group of 140 images which contains 20 Greasy spot fungus images out of which disease

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was detected in 19 images, 23 images found disease infected from 24 images of Sooty mold fungus, 18 out of 20 images with Botrytis fungus, from 21, 19 images containing Anthracnose, 21 from 22 images containing lemon canker, 19 from 21 images containing Black Pit and 11 from 12 images containing Lemon tristeza virus. The table 1 shows the detection rate with the percentage. Detection rates decrease with the improper or low illumination conditions images. Therefore, detection rate of algorithms using shape properties does not reduce. Only in case of very low illumination these algorithms may fail.

Diseases	Disease to be Detected	Detected Disease	% of Detection accuracy
Greasy spot fungus	20	19	95.00
Sooty mold fungus	24	23	91.66
Botrytis fungus	20	18	90.00
Anthracnose	21	19	90.47
Lemon canker	22	21	95.45
Black Pit	21	19	90.47
Lemon tristeza virus	12	11	83.33

Table: 1 *Different disease detection accuracy*

The average success rate is 90.91%. The highest rate of success is Lemon canker with 95.45% as shown in Table 1. The lower rate of success in disease detection is lemon tristeza virus with 83.33%.

V. CONCLUSION

In this paper, seven commonly found lemon diseases were studied, and prepared a data set having those diseases. Then applied SURF Feature based Method to identify an image having disease on prepared dataset. The method is tested with images with different lemon diseases. The feature extraction method is used to extract features of infected lemon fruits images, which will then be used to identify lemon diseases with greater accuracy.

This solution will be extremely useful in areas where disease identification expertise is lacking. It will assist farmers to increasing their profits. It is expected that the number of infected lemon disease will decrease once this solution is fully operational.

In future, Image processing could be used in agriculture for a variety of purposes, which may consist of detecting diseased fruits, measuring the affected area by diseases, and determining the affected area.

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