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An Overview of the Detection and Grading of Grape Leaf Disease using Artificial Neural Network (ANN) and Fuzzy Logic

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Abstract: *In agriculture research of automatic grape leaf disease detection is essential research topic as it may prove benefits in monitoring large fields of grape crops, and thus automatically detect symptoms of disease as soon as they appear on plant leaves.*
In Agriculture sector plants or crop are damaged due to disease. If we diagnose the disease in early stage then we can protect the crop from disease by using the different medicine.
In Agriculture sector grape plants or crop cultivation have seen fast development in both the quality and quantity of grape production, however, the presence of pests and diseases on crops especially on leaves has hindered the quality of agricultural goods. If the presence of pests on crops and leaves is not checked properly and the timely solution is not provided then the quality and quantity of grape farming will be reduced, which results in upsurge in poverty, food insecurity and the mortality rate. This severe effect can disturb any nation's economy especially of those where 70% of the inhabitants rely on the products from the agricultural sector for their livelihood and endurance. One of the major problems for agriculturists is to lessen or eradicate the growth of pests affecting crop yields. A pest is an organism that spreads disease, causes damage or is a nuisance. The most frequent pests that affect plants are aphids, fungus, gnats, flies, thrips, slugs, snails, mites and caterpillars. Pests lead to sporadic outbreaks of diseases, which lead to famine and food shortage.

Keywords: Agriculture, leaf, disease, detection, yields, farming

I. INTRODUCTION

In most of the countries farmers detects pests manually through their observation of naked eyes, which requires continuous monitoring of the crop stems and leaves, which is a difficult, labor intensive, inaccurate and expensive task for large farms. Further the early detection of diseases on plants is really required as a very small number of diseased leaves can spread the infection to the whole batch of fruits and vegetables and thus affects further storage and sales of agriculture products. This effect of plant diseases are very destructive as a lot of farmers were discouraged to the point where some decided to give up the work of crop cultivation. Therefore there is a need to identify these diseases at an early or superior stage and suggest solutions so that maximum harms can be avoided to increase crop yields. Digital image processing techniques has found a number of applications in various fields such as medical imaging, remote sensing, industrial inspection and agricultural processing etc. In the field of agriculture digital image processing techniques have been established as an effective means for analyzing purposes in various agricultural applications like plant recognition, crop yield estimation, soil quality estimation etc

With the existence of massive volume of plant species and their use in various fields, the quality of agricultural products has become a major issue in agriculture sector. Image processing technique such as machine vision system has been proven to be an effective automated technique. Image processing based artificially intelligent computer vision techniques can reduce the computational time and as a result, the automated leaf disease detection can be made much faster.

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In order for better understanding of the further studies of the problem area, it is vital to have an idea about some basic concepts like precision agriculture, computer vision technology, soft computing techniques and the need for an automated system for leaf disease detection etc.

II. LITERATURE REVIEW

Visual identification of diseases on leaves is labor demanding, less precise and can be done for small regions only. The automated detection of diseases in plants is an important research topic as it may provide advantages in supervising large fields of crops.

Some already developed systems in the problem area are explained below:-

India's agriculture is the main occupation, affecting 70% of the population and contributing to the GDP. Detecting diseases early is crucial in agriculture, as sudden growth can lead to reduced yield and quality. Plant diseases, caused by viruses, bacteria, fungi, nematodes, and nutrient deficiency, can cause crop damage and affect land cultivation. Banana plants are affected by various diseases, such as black sigatoka, yellow sigatoka, bunchy top virus, and strain virus. Automatic disease detection systems can provide accurate detection and reduce labor work, but this method is only convenient for smaller farms[1] .

Agriculture in India is crucial due to the rapid population growth and increased food interest. However, low harvest yield is often due to infections caused by microorganisms. To combat this, plant disease detection techniques are used. Image processing is used to distinguish plant diseases, and machine learning algorithms are used for classification. This research aims to create a model that classifies healthy and diseased harvest leaves and predicts plant diseases. The model uses the ResNets algorithm, a residual neural network subpart of artificial neural networks, to recognize unique harvests and 26 diseases from a public dataset of 54,306 images. ResNets achieves high accuracy in image classification, with parameters such as scheduling learning rate, gradient clipping, and weight decay. The researchers anticipate high accuracy results and the detection of more diseases from various harvests using the ANN[2].

Agriculture is a major occupation contributing to GDP and ecosystem health. Plant diseases, such as blights and leaf spots, can lead to significant food supply losses. To minimize these losses, a novel method using photos of leaves is proposed. This method uses a machine learning model for plant leaf disease identification, focusing on leaf color, damage, area, and texture. The CNN algorithm is used to examine various image parameters, aiming to help farmers create defense systems for robust and fruitful food crops[3].

Over 50% of Indians work in agriculture, and disruptions like climate change, infertile soils, and plant diseases affect the population. Leaf diseases are a major problem, and their detection is difficult. This work aims to detect plant leaf diseases using images, involving feature extraction, dataset creation, classifier training, and classification feature algorithm. Failure to detect these diseases can lead to significant losses[4].

Rice plant disease detection and classification using Computer Vision and Machine Learning techniques can help agricultural experts manage and diagnose diseases, leading to food security and better crop yield. Deep Learning (DL) has emerged as an effective strategy for automatic disease detection. This study uses the DL-ARPDRC approach, which includes pre-processing, image resizing, Gaussian Filter, Otsu's threshold-based segmentation, feature extraction using VGG-19 architecture, and XGBoost classification model. The DL-ARPDRC technique achieves better performance compared to other recent approaches, enhancing accuracy and diagnosis performance in rice plant disease detection and classification[5].

The development of a comprehensive agricultural support system, integrating plant disease classification, crop prediction, and fertilizer recommendation models. Leveraging the ResNet- 9 architecture, the plant disease classification model accurately identifies diseases in crop leaves[6].

Automatic detection and monitoring is very essential for precisionagriculture It may achieved with the help of image processing techniques .This workpresents an approach for disease classification on paddy leaves that makes use of Fuzzy Inference System(FIS)[7] .

Digital image processing techniques has found a number of applications in various fields such as medical imaging, remote sensing, industrial inspection and agricultural processing etc. In the field of agriculture digital image processing techniques have been established as an effective means for analyzing purposes in various agricultural applications like plant recognition, crop yield estimation, soil quality estimation etc[8] .

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Offered algorithms which were based on image processing for the purpose of feature extraction and classification. Color co-occurrence methodology was used for extracting features, which uses both the color and texture of an image to draw unique features of the input image. Though, there are crucial drawbacks to this methodology. Firstly, the ability of discrimination of the color histogram is largely dependent upon the selection of the method used for quantization of color as well as upon the size of the color codebook. Secondly, the histogram representation for most of the real images is very meager, and thus effective and accurate[9].

Explained a system in paper for detection of diseases taking into reference various diseases in rice plants. Image growing and segmentation techniques were used to detect diseased portions in the plants. In this features of the images were extracted using Zooming algorithms. Self Organize Map (SOM) neural network is utilized for classifying of the diseased rice leaves. The disadvantage of this technique is that when the image gets zoomed, the output is very blurry sometimes. Also the results can be improved visually as well as quantitatively[10].

III. METHDOLOGY FOR SYSTEM IMPLEMENTATION:

The proposed methodology is shown in Figure 1. The proposed system has been classified into two phases:-

(1) Training Phase: which includes Image Acquisition, Image Pre-Processing, Feature Extraction and Artificial Neural Network based training

(2) Testing Phase: which includes Test Image Acquisition, Test Image Pre-processing, Feature Extraction, Classification, K- means based Segmentation and Percentage Infection Calculation and Disease Grading using Fuzzy Logic.

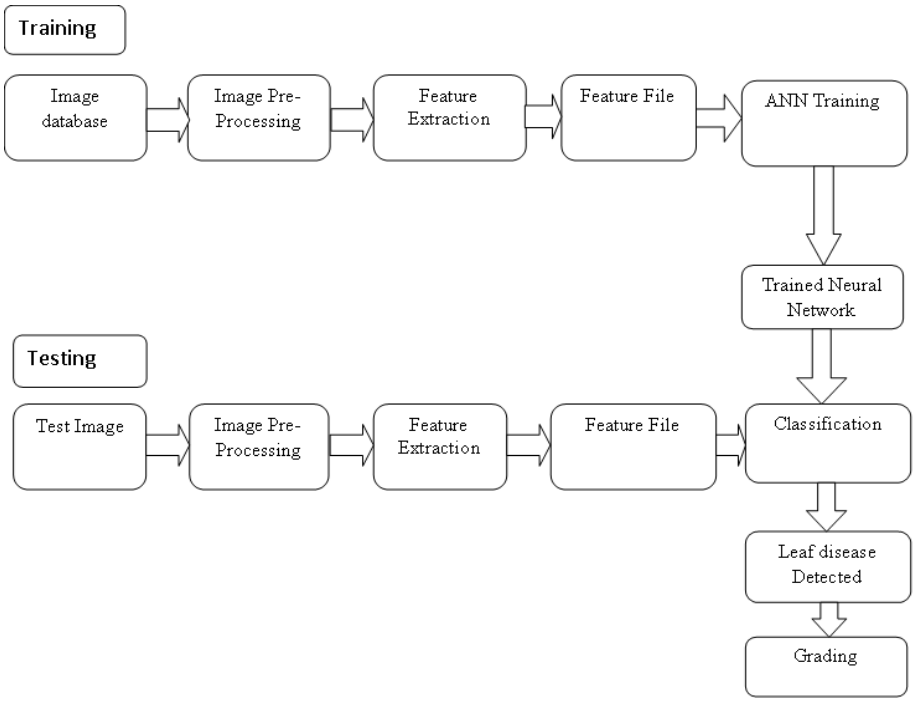

Figure.1 Methodology of Proposed System.

A. Image Acquisition

Image Acquisition means acquiring an image by means of camera from any real life scene. In today's world, commonly used method for this is photography by digital camera. But other methods can also be used. In this project, there will be a predefined directory through which the images will be fetched and the algorithm will be trained and tested.

B. Image Pre-Processing

Image Pre -processing means working on images in order to convert it in a suitable form on which the algorithm can be trained and tested upon. In this phase of our cycle, the captured images will be cropped and be resized so that it can be

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effectively tested [4]. In Digital image processing, computer algorithms are applied to execute image processing on digital images. Pre-processing consists of many processes that include:-

- Resize Image
- Filter Image

C. Feature Extraction

Extraction of features of an image is a property in image processing where the major attributes which have to be analyzed are extracted. For recognizing the leaf disease to which the leaf belongs number of features have been extracted from the leaves of which some leaves would be considered for training the system and some leaves would be used for testing the system. On the other hand, some features of the GLCM matrix (including contrast, homogeneity, and correlation) have been calculated for detecting the type of disease in the plant leaf and further grading it. As a result, a feature file is being created which is being sent to the ANN toolbox for training.

D. Artificial Neural Network based training

The artificial neural network provides functionality for designing complex systems of nonlinear nature that cannot be modeled easily using a closed form equation [1]. Once the feature file is created and output values of the images are decided, then the system can be trained using neural network.

E. Testing phase and Classification

In testing phase the test image are taken which are pre- processed and there features are extracted as similar to training image. Further the classification is done by taking the input from Trained Neural Network.

F. Total Leaf Area (AT) and Diseased Area (AD) Calculation

K-means segmentation is used for grouping similar pixels of an image. It is a straightforward and fast approach. In k-means, k no. of clusters is generated from the input images. RGB space is converted into L*a*b space where L is Luminosity and a*b are the colour space.

The original input image which was resized during preprocessing is transformed into a binary image. For calculating the total leaf area (AT), total no. of on pixels in this image are considered. Further for calculating the diseased area (AD), the clusters formed after the color image segmentation containing the diseased spots are considered.

G. Percentage Infection (P) Calculation

After calculation of the total leaf area (AT) as well as the diseased area (AD) of the leaf, the percentage infection (P) is calculated by using the Equation P= (AD / AT) *100

H. Grading using Fuzzy Logic Toolbox

After calculating the percentage infection in the diseased leaf, the result will be graded using fuzzy logic toolbox based on different categories as given below:

Class	*Risk*	*Percentage Infection*
A	Very Low	Risk Up to 1%
B	Low Risk	Between 1% - 10%
C	Medium Risk	Between 10% -20%
D	High Risk	Between 20% - 40%
E	Very High Risk	Between 40% -100%

Table 1 Grading Scale for diseased leaves

On the basis of Table 1, a Fuzzy Inference System (FIS) has been formed to grade the leaf diseases into different classes. For this FIS, percentage infection is the input variable and Class is the output variable. The variables are defined using the Triangular membership functions and five fuzzy rules are set for grading purpose [3].

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IV. CONCLUSION

The system is implemented for detection and grading of disease on grape leaf by using Artificial Neural Network (ANN) and Fuzzy Logic. Points on timely diagnosis and accurate identification of grape leaf diseases are decisive for controlling the spread of disease and ensuring the healthy development of the grape cultivation. The limited information available about grape disease “davanya”. This disease can spread rapidly in 1 acre within a 4 to 5 hours hence study and analysis is important to develop model in controlling davanya disease is needed.

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