Use of Artificial Neural Network (ANN) & Fuzzy Logic for Grape Leaf Disease Detection and Grading

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Abstract— Automatic grape leaf disease detection is a key area of agricultural research since it has the potential to assist in monitoring vast grape crop fields and, as a result, automatically identify symptoms of disease as soon as they appear on plant leaves. Disease causes damage to crops or plants in the agriculture sector. We can protect the crop against disease by using a variety of medications if we can identify the illness in its early stages. The agriculture industry has seen rapid advancements in both the quantity and quality of grape production from grape plants or crop cultivation, but the presence of pests and diseases on crops, particularly on leaves, has lowered the quality of agricultural goods. The quality and amount of grape farming will decline if the presence of pests on plants and leaves is not adequately monitored and the prompt remedy is not given, leading to an increase in poverty, food insecurity, and the mortality rate. This negative impact might be particularly disruptive to a nation's economy, particularly in one where 70% of the population depends on the agricultural industry's output for their survival. One of the key challenges for farmers is to reduce or eliminate the proliferation of pests that harm crop production. An organism is considered a pest if it transmits disease, causes harm, or is simply annoying. The most typical pests impacting plants are aphids, fungus, gnats, flies, thrips, slugs, snails, mites, and caterpillars. Pests cause sporadic outbreaks of diseases, which result in hunger and a scarcity of food.

I. INTRODUCTION

In most nations, farmers physically identify pests by observing them with the naked eye. This necessitates constant monitoring of the plant stems and leaves, which is a time-consuming, labor-intensive, unreliable, and costly process for big farms. Additionally, the early identification of plant diseases is essential because a single diseased leaf can transmit the illness to the entire lot of fruits and vegetables, which in turn has an impact on the future storage and marketing of agricultural goods. Plant diseases have this effect, which is quite harmful since many farmers were demoralized to the point where some chose to quit growing crops. As a result, it is imperative to detect these illnesses early or at a higher stage and provide remedies in order to minimize damages and enhance crop production. Digital image processing methods have been used in a variety of industries, including remote sensing, industrial inspection, agricultural processing, medical imaging, and others. The use of digital image processing methods in the agriculture sector has been proven to be a valuable tool for analytical purposes in a variety of agricultural applications, including plant identification, crop yield estimation, soil quality assessment, and more. Given the enormous number of plant species and their usage across many industries, the quality of agricultural goods has become a key concern in the agriculture industry. The use of image processing methods, like machine vision systems, has been shown to be a successful automated approach. The computational time can be decreased by using image processing-based artificial intelligence computer vision methods, which will allow for a much quicker automated leaf disease detection.

A basic understanding of concepts like precision agriculture, computer vision technology, soft computing methodologies, and the necessity for an automated system for leaf disease detection is essential for a clearer comprehension of future research on the issue.

II. GRAPE LEAF DISEASE DETECTION AND GRADING SYSTEM

The suggested approach is depicted in Figure 1. The suggested system has been split into two stages.

The first training phase, which includes picture acquisition, image preprocessing, feature extraction, and artificial neural network-based training.

The second phase of testing, which includes test image acquisition, preprocessing, feature extraction, categorization, percentage infection computation utilizing K-means based segmentation, and disease grading utilizing fuzzy logic.
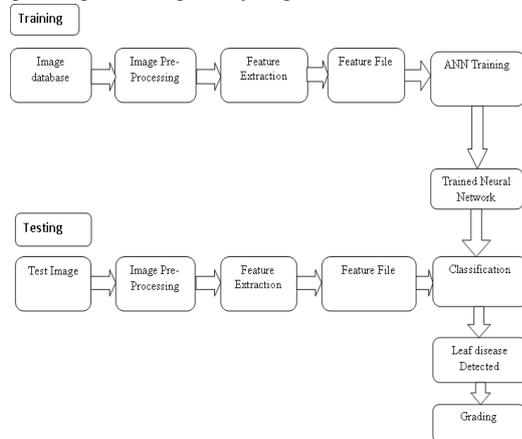

Figure. 2.1 Methodology of Leaf Disease Detection & Grading System

2.1 Image Acquisition

Acquiring an image using a camera from any real-world setting is referred to as image acquisition. Taking images with a digital camera is the most popular technique nowadays. However, there are additional ways that may be employed. In this project, the images will be retrieved and the algorithm will be trained and evaluated via a predetermined directory.

2.2 Image Pre-Processing

Before an image may be used to train and test Zhe algorithm, it must first be processed. This is known as image pre-processing. The captured images will be resized and cropped during this stage of our cycle in order for them to be tested effectively [4]. The application of computer algorithms to perform image processing on digital images is known as digital image processing. A number of procedures, such as: make up pre-processing.
 • Change the size of the image
 • Filter Image

2.3 Feature Extraction

In image processing, feature extraction is a property in which the key characteristics that need to be examined are extracted from the image. From the leaf, several features have been taken out in order to identify the leaf disease to which it belongs. Some of these features would be used to train the system, while others would be used to test the system. On the other hand, some characteristics of the GLCM matrix, such as contrast, uniformity, and correlation, have been determined in order to identify the kind of disease in the plant leaf and categorize it more precisely. Because of this, a feature file is being generated and sent to the ANN toolbox for training.

2.4 Artificial Neural Network based training

The artificial neural network offers the capability to create intricate, nonlinear systems that cannot be readily represented by a closed form formula [1]. The system may be trained using a neural network once the feature file has been generated and the output values of the images have been determined.

2.5 Testing phase and classification

The test images are captured during the testing period, and their characteristics are extracted in the same way as the training images after they have been preprocessed. The input from Trained Neural Network is used to further categorize.

2.6 Total Leaf Area (AT) and Diseased Area (AD) calculation

Similar pixels in an image are grouped using K-means segmentation. It's a simple and quick method. The input photos are used to create k number of clusters in k-means. The color space of the RGB space is transformed into L*a*b space, where L stands for luminosity. The initial input picture is converted into a binary image after being resized during preprocessing. The total leaf area (AT) is determined by taking into account the entire number of on pixels in this picture. The clusters that result from the color image segmentation that includes the sick areas are also taken into account when calculating the diseased area (AD).

2.7 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.

2.8 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	Between 1 to 10%
B	Low Risk	Between 10% - 20%
C	Medium Risk	Between 20% -40%
D	High Risk	Between 30% - 50%
E	Very High Risk	Between 50% -100%

Table 1 Grading Scale for diseased leaves

A Fuzzy Inference System (FIS) has been developed to categorize the leaf illnesses into distinct groups, using Table 1 as a guide. The input variable for this FIS is percentage infection, and the output variable is Class. For grading purposes, five fuzzy rules are established, and the variables are defined using the triangular membership functions [3].

IV. RESPONSE OF THE SYSTEMS

The goal of identifying and grading Grape leaf disease using an ANN and Fuzzy logic system is to make it simple for farmers to spot and grade the disease davanya.
act appropriately. The outcomes for the same are listed below.The goal of identifying and grading Grape leaf disease using an ANN and Fuzzy logic system is to make it simple for farmers to spot and grade the disease davanya.
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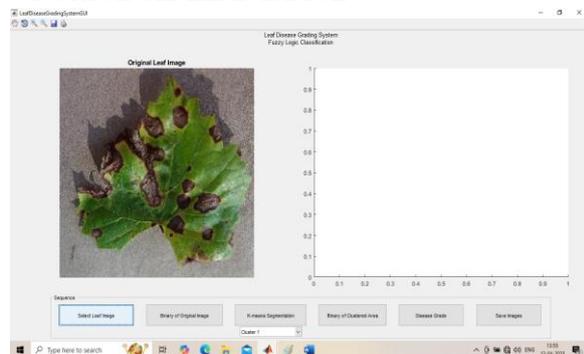
4.1 ORIGINAL LEAF IMAGE

Figure 4.1 Original leaf Imagr
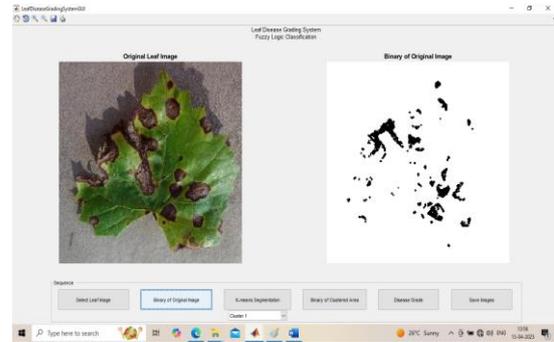
4.2 Binary of Original Image

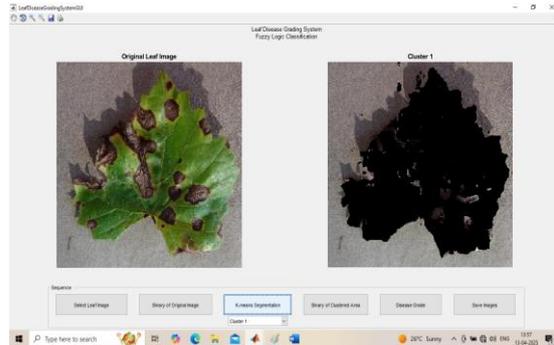Figure 4.2 Binary of Original Image

4.3 SEGMETATION OF IMAGE

Figure 4.3 Segmentation of Image

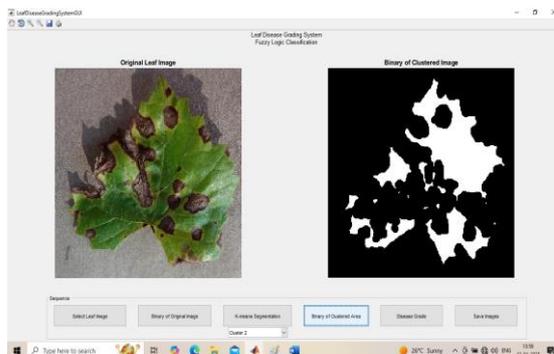### 4.4 BINARY OF SEGMETATED IMAGE

Figure 4.4 Binary of Segmented Image

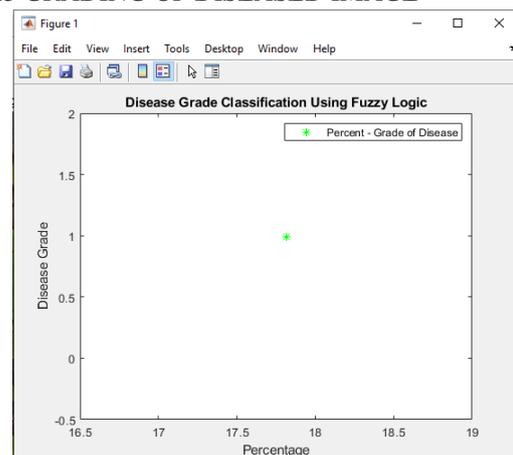### 4.5 GRADING OF DISEASED IMAGE

Figure 4.5 Grading of Diseased Image

V. CONCLUSION

"DAVANYA" is the particular grape leaf disease that our system is designed to detect. The system uses ANN technology to classify the disease and measure the severity of the infection. Based on the proportion of the leaf area that is impacted, the system classifies the severity of the condition into five different categories:

- Very Low Risk: 1% to 10% affected area
- Low Risk: 10% to 20% affected area
- Medium Risk: 20% to 30% affected area
- High Risk: 30% to 50% affected area
- Very High Risk: Above 50% affected area

The modern agricultural environment necessitates an automated method for identifying and classifying grape leaf illnesses. The automated identification and evaluation of grape leaf illness are particularly facilitated by a system that combines fuzzy logic and ANN. When compared to conventional manual approaches, the system is more efficient, which makes it extremely useful to farmers. The K-Means segmentation method is used for image segmentation in the grape leaf identification and classification system. With this method, the system can differentiate the grape leaf region, the afflicted area, and the backdrop in the input photos, which makes it easier to determine the infection percentage and then rank the illness.

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