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MULTIPLE DISEASE DETECTION IN PEPPER LEAF USING IMAGE PROCESSING

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Abstract: Detecting and monitoring plant diseases are a crucial task in agriculture. The agricultural sector plays a vital role in the Indian economy, and early detection of crop diseases can improve both the quantity and quality of crops while reducing the time required for disease detection. This system for pepper plant leaf disease detection begins with data collection, which can be done through either surveying local agricultural land or collecting data from agricultural colleges. The collected images are then pre-processed to suppress unwanted distortions and enhance image features like contrast and size. Feature extraction is performed using the discrete wavelet transform, particularly the Haar wavelet compression, which samples the wavelet at discrete intervals. An artificial neural network classifier then classifies the image as healthy or unhealthy by utilizing the extracted image features. The classifier employs the back-propagation algorithm to achieve higher performance and accuracy.

Keywords: Artificial Neural Network (ANN), DWT2 (2-D Discrete Wavelet Transform), Image Processing, Pepper Plant

I. INTRODUCTION

India is a predominantly agricultural country, with about 70% of the population dependent on agriculture. Black pepper is a popular spice that is widely cultivated in India, particularly in the states of Karnataka, Kerala, and Tamil Nadu. Known as the "King of spices," India is one of the major producers, consumers, and exporters of black pepper in the world. However, the presence of plant diseases in agricultural fields can cause significant losses for farmers. According to research, crop losses due to diseases, pests, and animals account for about 20 to 40% of global agricultural productivity. Traditional methods of identifying plant diseases by visually inspecting features like leaf texture, colour, and shape are not always effective, and hiring professional agriculturists to diagnose crops can be time-consuming and expensive. Early detection of diseases is crucial for reducing plant damage, improving crop quality, and increasing yields, but it requires continuous monitoring, which is less practical on large farms.

To address these challenges, many automatic technologies are emerging in the market, including those based on image processing. Image processing technology has greatly promoted the development of agriculture in countries like China. It plays a crucial role in disease detection in plants and is constantly evolving with new research and progress. Several studies are currently underway to identify different types of plant diseases, which not only help farmers increase yields but also promote various agricultural practices.

This paper proposes an algorithmic program for detecting and categorizing different diseases of pepper plants using artificial neural network tools. The proposed system involves four steps: image acquisition, pre-processing, feature extraction, and classification. Each of these modules is crucial in the field of agriculture. The system first detects and records the contaminated area and then performs image pre-processing. The infected area is then identified, and feature extraction is performed on it before classifying the image as healthy or diseased. The main purpose of image processing is to enhance image quality for human perception and analyse the image for autonomous machine perception. The proposed system enables farmers to identify the type of diseases in pepper plants and make informed decisions regarding the proper treatment.

II. RELATED WORK

Kiran S M et al., [1] proposed a system for the identification of tomato plant diseases using Discrete Wavelet Transforms (DWT) and Support Vector Machines (SVM). The system involved pre-processing of tomato leaf images collected from a database by resizing, enhancing, filtering using the component of color space, and segmenting using k-means clustering technique. The system utilized fourteen image textual features extracted from the images with the help of SVM classifier.

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The proposed system achieved an accuracy of 88%, specificity of 84% and sensitivity of 92% for identifying the tomato plant diseases.

Nikhil Shah et al., [2], a system for the detection of cotton plant diseases using Artificial Neural Networks (ANN) was proposed. The system involved various steps such as image acquisition, image pre-processing, image enhancement, and classification using ANN. During the testing stage of the system, 18 cotton leaf images were used to detect six different types of disease.

Gaurav Kandalkar et al., [3] presented a system for the classification of agricultural pests using DWT and Back Propagation Neural Networks (BPNN). The system involved image processing techniques such as image segmentation for separating different regions with special significance in the image. The DWT helped in the featuring of segmented images such as energy of an image, where the extracted features were stored in a database with respective images of agricultural pests. The BPNN helped in identifying particular pests, and the system provided preventive measures as well as control measures for the farmers to take respectable action to increase production of the crop.

S. Deepika et al., [4], a system for the detection of fruit and vegetable diseases using Artificial Neural Networks (ANN) was proposed. The system involved capturing the image of a fruit or vegetable using a camera or any mobile phone camera, and the features of the fruit or vegetable were efficiently extracted from the captured image using colour, shape, and size respectively. The ANN methodology was used for the detection of disease and classification of the crop.

Sachin D. Khirade [5] presented a system for the detection and classification of plant diseases using image processing techniques and Artificial Neural Networks (ANN). The system involved various steps such as image acquisition, image pre-processing, image segmentation, image feature extraction, and classification of plant diseases. The system utilized the Back-propagation algorithm for the classification of disease which was identified in plants.

III. METHODOLOGY

The primary objective of this research project is to analyse the disease of the pepper plant using various methods and using various image processing techniques that can produce comprehensive and reliable models.

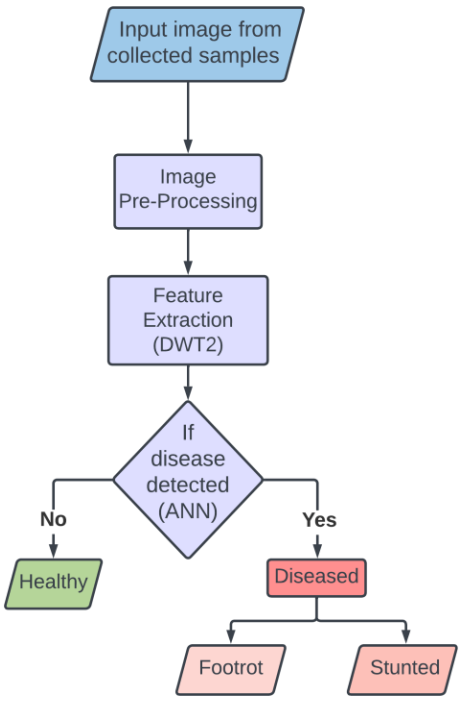

FIG.1: System Architecture of Pepper Plant Disease Detection

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A. Data Collection: The first step in the methodology is to collect a diverse and representative dataset of pepper plant images, where each image is either healthy or contains one or more diseases. This dataset is essential for training and testing the ANN model accurately

B. Image Pre-processing: Once the dataset is collected, the images undergo pre-processing, which includes resizing, cropping, and normalization of pixel values to a fixed size. This process helps to focus on the key areas of interest and reduce noise from the background. After pre-processing, the next step is to label the images using a multi-label classification approach. In this approach, multiple labels are assigned to each image, where each label represents a disease present in the image. This labelling is crucial for the ANN model to learn and distinguish different types of diseases accurately

C. Feature Extraction: Feature extraction is performed using the Discrete Wavelet Transform (DWT) algorithm. This algorithm extracts features from the pre-processed images, which are then used to train the ANN model. The extracted features represent the characteristics of the image that are relevant to distinguish between healthy and unhealthy pepper plants. Overall, this methodology provides a structured approach for detecting pepper plant diseases using artificial neural networks. By collecting a diverse dataset, pre-processing the images, labelling the images with multiple diseases, and extracting relevant features using DWT, the ANN model can achieve high accuracy in detecting diseases in pepper plants.

D. Classification: Artificial Neural Networks (ANNs) are a type of machine learning algorithm used in image processing for classification tasks. They are modelled after the biological structure of the human brain and consist of multiple layers of interconnected nodes or neurons. ANNs use a supervised learning approach, where a labelled dataset is used to train the network and adjust the weights between the neurons to achieve accurate classification. In image classification, ANNs can extract features from an input image and use those features to classify the image into different categories of disease. The input image is first pre-processed to extract features such as colour, texture, and shape, which are then fed into the input layer of the ANN. The input layer is connected to one or more hidden layers, which perform computations to extract higher-level features. The final layer, the output layer, produces the classification result. ANNs have shown to be highly effective in image classification tasks due to their ability to learn complex patterns and relationships between features. They can handle a large number of input variables, which makes them suitable for processing high-dimensional image data. Furthermore, ANNs can adapt to new and unseen data, making them useful for tasks where the input data varies widely.

Recent research has focused on improving the performance of ANNs in image classification tasks through various techniques, including the use of convolutional neural networks (CNNs) and deep learning. CNNs are a type of ANN that is specialized for image processing tasks, and they use convolutional layers to extract features from an input image. Deep learning involves the use of ANNs with multiple layers, which can extract highly complex features and achieve high accuracy in classification tasks.

In conclusion, ANNs are powerful tools for image classification tasks, and ongoing research is focused on improving their performance and expanding their applications. The use of ANNs, especially in combination with CNNs and deep learning, is expected to lead to significant advances in image processing and classification in the future.

IV. RESULTS AND DISCUSSION

The proposed system describes a novel procedure which uses the Wavelet features and Artificial Neural Network for the detection of diseases in pepper plant leaf images. A separate training network is considered to train the diseased and healthy images. After testing the images for recognition, the results obtained are satisfactory. The healthy as well as two types of diseased images are recognized clearly. Table 1 shows the total sample images considered for healthy, foot-rot and stunted that are used for training and testing of the input data. Table 2 shows the accuracy of the tested data.

TABLE 1: TRAINING AND TESTING DATA

Images	Training	Testing	Total
Healthy	80	20	100
Foot-rot disease	80	20	100
Stunted disease	80	20	100
Total	240	60	300

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TABLE 2: ACCURACY OF THE TESTED DATA

Classification	Healthy	Foot-rot	Stunted	Accuracy
Healthy	19	0	1	95
Foot-rot disease	0	20	0	100
Stunted disease	1	0	19	95
Average				96.67

Result Snapshots:

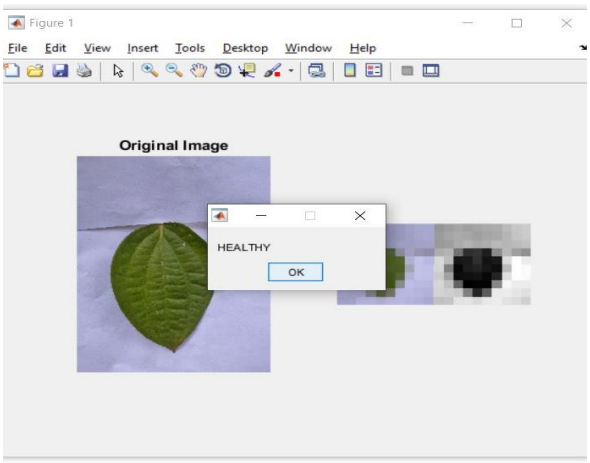

FIG 2: Snapshot of healthy output which represents the image of trained data is getting correct output as healthy.

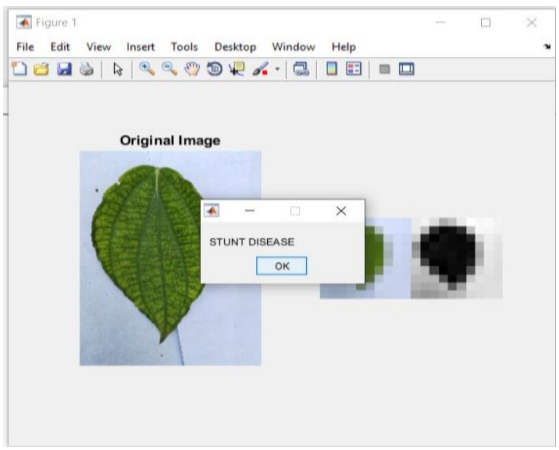

FIG 3: Snapshot of stunted disease output which determines that the sample input leaf as stunted disease

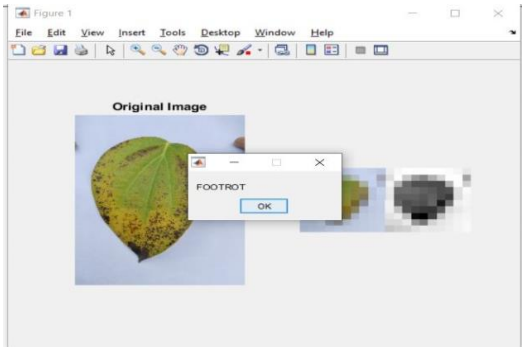

FIG 4 Snapshot of Foot-rot disease output which represents that given input sample have foot-rot disease

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V. CONCLUSION

The use of image processing for the detection of multiple diseases in pepper plants is a promising approach. It offers a non-destructive and cost-effective method for disease diagnosis. The application of various image processing techniques, such as Pre-processing, feature extraction, and classification, can help to identify and distinguish different diseases in pepper plants accurately. These techniques can also be used to analyse different parts of the plant, including leaves, stems, and fruits, allowing for a comprehensive diagnosis of the plant's health. However, further research is necessary to optimize the accuracy and efficiency of the image processing algorithms. The detection system classifies image as healthy, foot-rot disease and stunted disease with 96.67% accuracy. Additionally, the development of automated systems for disease detection and diagnosis can greatly benefit the agricultural industry by reducing labour costs and improving crop yields.

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