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Prediction of Plant Leaf Diseases using Drone and Image Processing Techniques

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Abstract: *Plant diseases are one of the major threats to global food production. Efficient monitoring and detection of plant pathogens are instrumental in restricting and effectively managing the spread of the disease and reducing the cost of pesticides. Traditional, molecular, and serological methods that are widely used for plant disease detection are often ineffective if not applied during the initial stages of pathogenesis, when no or very weak symptoms appear. Moreover, they are almost useless in acquiring spatialized diagnostic results on plant diseases. On the other hand, remote sensing (RS) techniques utilizing drones are very effective for the rapid identification of plant diseases in their early stages. Currently, drones, play a pivotal role in the monitoring of plant pathogen spread, detection, and diagnosis to ensure crops' health status. The advantages of drone technology include high spatial resolution (as several sensors are carried aboard), high efficiency, usage flexibility, and more significantly, quick detection of plant diseases across a large area with low cost, reliability, and provision of high-resolution data. Drone technology employs an automated procedure that begins with gathering images of diseased plants using various sensors and cameras. After extracting features, image processing approaches use the appropriate traditional machine learning or deep learning algorithms. Features are extracted from images of leaves using edge detection and histogram equalization methods. Drones have many potential uses in agriculture, including reducing manual labor and increasing productivity. Drones may be able to provide early warning of plant diseases, allowing farmers to prevent costly crop failures.*

Keywords: Plant health monitoring, Remote sensing, Sensor networks, Agricultural monitoring, Spectral analysis

I. INTRODUCTION

Plant diseases are responsible for enormous yield losses and for threatening global food production hence, proper detection and reliable diagnostic methods for identifying the etiological agents of disease are essential to conserving time and money by preventing or limiting crop damages . Classically, diseases were recognized based on traditional methods; these methods, often subjective, were strictly dependent on the observer and though time consuming overall, were prone to inaccuracy. Additionally, human scouting is expensive and, in many cases, impractical due to human error and/or the occurrence of cryptic when not mild symptoms, making diagnosis at early stages impossible. Therefore, a technologically driven agricultural revolution is important to permanently solve the problems mentioned earlier at a reasonable cost with little environmental impact. With the continuous adoption of recent advanced technologies such as Internet of Things devices, intelligent algorithms, sophisticated sensors, and modern machines, agriculture has changed. It is currently changing from being accomplished by human workers to using smart agricultural machines and robots. Smart agricultural machines and robots have been developed which detect plant diseases early on and at the same time monitor their long-distance movement. Many researchers have used high resolution imagery collected from satellites, airplanes, on-the-ground machines, and drones to identify agricultural diseases. Satellites and airplanes can cover vast areas in a short amount of time. However, satellites and airplanes have poor spatial and temporal image resolutions

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compared to drones and are highly susceptible to weather conditions that can affect overflight. Therefore, aerial remote sensing (RS) using drones (Unmanned Aerial Vehicles (UAV) or Unmanned Aerial Systems (UAS)) with intelligent visual systems may be an efficient and inexpensive way for farmers to detect crop and plant diseases in a variety of agricultural fields from the most intimate greenhouse to the largest farm. However, despite being highly efficient, low-cost, flexible, accurate, and quick at field scale, their limited flight duration makes drones unsuitable for data acquisition within large areas, and their ability to carry heavy sensors is limited. Thus, the choice of a specific drone and the selection of the sensors, software, algorithms, and settings of the drones are critical for achieving the best performance. Keeping in view the importance of drones in plant disease diagnosis, the following parts have been included in this review: methods for plant disease detection, including old and new generations; types of sensors and cameras mounted on drones; types of drones; novel approaches to detecting plant diseases, focusing on drones; and drone applications for plant disease detections using traditional and deep learning algorithms.

II. LITERATURE SURVEY

Paper Name: Expert System for Diagnosis Mango Diseases Using Leaf Symptoms Analysis
Author: Chutinan Trongtorkid, Part Pramokchon
Abstract : This research presents the development of an expert system for diagnosis plant diseases in Barracuda mango (Nam-Dok Mai) which is one of a major export agricultural yield of Thailand. However, Thailand is in a tropical country and the climate causes the variation of plant diseases that affect to the growth of mango trees. Many type of agriculture yield are decreased due to an agriculturist are lacking of knowledge on how to classify type of plant disease correctly. Moreover, there is no suggestion system for a decision-making in choosing a suitable way to prevent or treat the disease that occur in their farm. This causes a lot of error in their infected plant treatments. Therefore, this system has been developed for help an agriculturist to diagnose the infected plant and to solve the problem immediately. The agriculturist should have the application which work in process of specific plant disease diagnosis as an expert human work.

Paper Name - Detection of unhealthy region of plant leaves using Image Processing and Genetic Algorithm
Author : Vijay Singh Varsha, Prof .A K. Mishra
Abstract : Agricultural productivity is that thing on which Indian Economy highly depends. This is the one of the reasons that disease detection in plants plays an important role in agriculture field, as having disease in plants are quite natural. If proper care is not taken in this area then it causes serious effects on plants and due to which respective product quality, quantity or productivity is affected. Detection of plant disease through some automatic technique is beneficial as it reduces a large work of monitoring in big farms of crops, and at very early stage itself it detects the symptoms of diseases means when they appear on plant leaves. This paper presents an algorithm for image segmentation technique used for automatic detection as well as classification of plant leaf diseases and survey on different diseases classification techniques that can be used for plant leaf disease detection. Image segmentation, which is an important aspect for disease detection in plant leaf disease, is done by using genetic algorithm

Paper Name: Computer Vision image Enhancement For Plant Leaves Disease Detection
Author: Dr. K. Thangadurai, K. Padmavathi
Abstract : Enhanced images have high quality and clarity than original captured images. Computer vision image enhancement (Color conversion and Histogram equalization) is used in different real time applications such as remote sensing, medical image analysis and plant leaves disease detection. Original captured images are RGB images. RGB images are combination of primary colors (Red, Green and Blue). It is difficult to implement the applications because of the range of this color is 0 to 255. Grayscale images have only the range between 0 and 1. So it is easy to implement many applications. Histogram equalization is used to increase the images clarity. Grayscale conversion and histogram equalization is used in plant leaves disease detection.

Paper Name: Disease Detection of Plant Leaf using Image Processing and CNN with Preventive Measures.
Author: Husnul Ajra,Mst. Khairun Nahar, Lipika Sarkar, Md. Shohidul Islam

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Abstract: Agriculture is a very significant field for increasing population over theworld to meet the basic needs of food. Meanwhile, nutrition and the world economy depend on the growth of grains and vegetables. Many farmers are cultivating in remote areas of the world with the lack of accurate knowledge and disease detection, however, they rely on manual observation on grains and vegetables, as a result, they are suffering from a great loss. Digital farming practices can be an interesting solution for easily and quickly detecting plant diseases. To address such issues, this paper proposes plants leaf disease detection and preventive measures technique in the agricultural field using image processing and two well-known convolutional neural network (CNN) models as Alex.Net and ResNet-50. Firstly, this technique is applied on Kaggle datasets of potato and tomato leaves to investigate the symptoms of unhealthy leaf. Then, the feature extraction and classification process are per-formed in dataset images to detect leaf diseases using Alex.Net.

Paper Name: Plant Leaf Detection and Disease Recognition using Deep Learning.
Author: Sammy V. Militante Bobby D. Gerardoij , Nanette V. DionisioJ
Abstract The latest improvements in computer vision formulated through deep learning have paved the method for how to detect and diagnose diseases in plants by using a camera to capture images as basis for recognizing several types of plant diseases. This study provides an efficient solution for detecting multiple diseases in several plant varieties. The system was designed to detect and recognize several plant varieties specifically apple, corn, grapes, potato, sugarcane, and tomato. The system can also detect several diseases of plants. The trained model has achieved an accuracy rate of and the system was able to register up to accuracy in detecting and recognizing the plant variety and the type of diseases the plant was infected.

III. PROBLEM STATEMENT

In contemporary agriculture, the early and accurate identification of plant leaf diseases is crucial for preventing significant crop yield losses. However, traditional methods of disease detection are often labor-intensive, time-consuming, and may lack precision. Leveraging the potential of drone technology and advanced image processing techniques presents an opportunity to develop a more efficient and automated system for the timely identification and prediction of plant leaf diseases. This approach aims to integrate the capabilities of drones equipped with high resolution cameras and image processing algorithms to capture, process, and analyze visual data from agricultural fields. The primary objective is to create a robust predictive model that can accurately identify and classify various types of plant leaf diseases based on the analysis of aerial imagery. This proposed solution not only facilitates early disease detection but also enables prompt intervention strategies, thereby enhancing overall crop management practices and ensuring sustainable agricultural productivity. Addressing the challenges of disease identification and prediction through the convergence of drone technology and image processing methodologies is essential for improving crop yield and mitigating economic losses within the agricultural sector.

IV. RESEARCH METHODOLOGY

4.1 Algorithm

A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

4.2 Proposed CNN Model

The proposed Deep Convolutional Neural Network (CNN) model was developed with transfer learning. The system determines plant health and predicts the specific disease if present. First model is made using the CNN algorithm as CNN is the most efficient image processing algorithm and provides the best model accuracy. To build a model 8 CNN filters are used in the layer selection 4 are convolution with activation function and every convolution is followed by max pooling. First convolution layer contains input shape (150, 150, 3), filter size 64, kernel size (3 x 3).

The Utilization of a Deep Convolutional Neural Network (CNN) model and Choice of the CNN Algorithm are as follow:

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Utilization of a Deep Convolutional Neural Network (CNN)

- For leaf disease detection, a deep convolutional neural network (CNN) is employed as the core model architecture.
- CNNs are specifically designed for image processing tasks and have demonstrated excellent performance in various computer vision applications.
- The ability of CNNs to automatically learn relevant features from images makes them well-suited for detecting patterns and distinguishing between healthy and diseased leaves.

Choice of the CNN Algorithm

- The CNN algorithm is chosen due to its effectiveness in capturing spatial hierarchies and local patterns in images.
- The layers of the CNN perform operations such as convolution, pooling, and non-linear activations, enabling the extraction of meaningful features from the input images.
- By utilizing multiple layers, the CNN can learn increasingly complex and abstract representations, enhancing its ability to detect subtle disease-related characteristics.

4.3 Dataset, Data Preparation And Sources of Data

The dataset consists of three parts: training, validation, and testing, each containing images of leaves. There are total of 10 classes representing different types of leaf diseases.(Target spot, Yellow leaf curl virus, Healthy leaf, Leaf Mold, Spectoria leaf spot, Spider mites two spotted spi, Bacterial spot, Mosaic virus, Early Blight, Late Blight). Each class corresponds to a specific disease, such as target spot, yellow leaf curl virus, early blight, late blight, and more.Total images in dataset were 22000 out of which 18000 were used for training and 4000 for validation purpose. 85% of the total images were used for training and 15% were used for testing.

The data set collection is the plant leaf disease image data collected from the information on the performance. Then, data cleaning and data reduction are done from the collected plant leaf dataset records. These data of the plant disease, plant leaf information for the leaf size, leaf color, quality and then plant characters are collected from the dataset performance. The dataset used in this project was obtained from Kaggle, a popular platform for data science and machine learning. Kaggle provides a diverse collection of datasets contributed by the community, including agricultural datasets for plant disease detection.

Dataset contains of total of 31279 leaf images, which are categorized in 10 different classes out of which 9 are diseased and 1 is healthy. The dataset used in this project was obtained from Kaggle, a popular platform for data science and machine learning. Kaggle provides a diverse collection of datasets contributed by the community, including agricultural datasets for plant disease detection.

4.4 Image Collection And Image Pre-processing

Image Collection :- The dataset was downloaded from Kaggle which consisted of 3 parts train ,validation, and test with 10 classes each.

Image Pre-processing :- The images initially consisted of non-uniform size so to create uniformity in the image size we converted all the images in fixed size. Deep learning projects need a large amount of data to acquire good accuracy for the model hence, image augmentation is good technique to obtained large data from existing data by performing various operations on the image like rotation, flip, width shift, height shift, fill, etc. This creates more images from the existing images which help in increasing the accuracy of the model.

4.5 Image Lablling

There are ten Labels including

- Target spot
- Yellow leaf curl virus
- Healthy leaf

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- Leaf Mold
- Spectoria leaf spot
- Spider mites two spotted spi
- Bacterial spot
- Mosaic virus
- Early Blight
- Late Blight

4.6 Training and Testing datasets

Total images in dataset were 31279 out of which 24847 were used for training and 6432 for validation purpose. 80% of the total images were used for training and 20% were used for testing.

4.7 Model Building and Deployment

First model is made using the CNN algorithm as CNN is the most efficient image processing algorithm and provides the best model accuracy. To build a model 8 CNN filters are used in the layer selection 4 are convolution with activation function and every convolution is followed by max pooling. Deployment of the model will be done through a website and android app which will take image as input and predict the type of disease

V. PROPOSED METHODOLOGY

With the help of drone Images of different types of leaves are captured with its inbuilt digital camera and analyze to pinpoint the locations of damage. After capturing the photos, a number of image processing methods are applied to them to extract the many and relevant information needed for analysis. Here is an algorithm that shows how the suggested methods of image recognition and segmentation work in practice

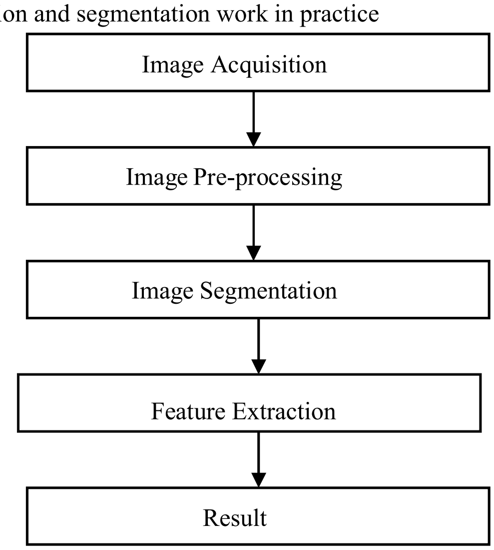

Image Acquisition:

In this process, model pictures are gathered to train the system. The sample images are taken using digital cameras and considered for system training and testing. The captured pictures may be different forms and dimensions.

Pre-processing:

For developing the superiority of the image, image preprocessing is done. Removal of background noise and suppress the pixel values are found in this step. It also enhances the quality of the images.

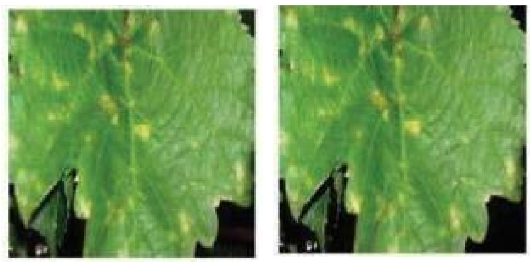

Fig1. (a) Real Image (b) Adjusted Image

Image Segmentation:

Concerning particular features, the specified image is separated into homogenous areas in image segmentation. In this K-means clustering is utilized for segmenting a picture into three sets as exposed in figure 1. The clusters have a affected element of the leaf. Before clustering 'a' part is extracted from L*a*b space.

Feature Extraction:

It is an important part to extract the data that can be utilized to obtain the implication of the specified model. Here the shape and textural trait extraction is found. The subsequent procedures are utilized to find out the color features of an image

Result:

The final result section, provides an 88.8% accuracy result. Accuracy is calculated by using,

$$\text{Accuracy (\%)} = \frac{\underline{Correctly\ identified\ images}}{Total\ number\ of\ test\ images} * 100 \quad (2)$$

VI. SYSTEM ARCHITECTURE

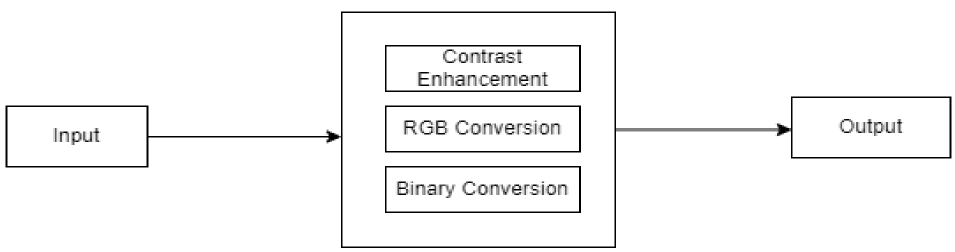

Fig. Data flow diagram

To get high accuracy of images, the RGB pictures are changed into grayscale pictures.

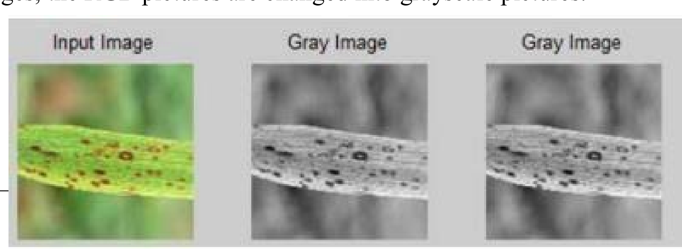

Fig. Image Pre-processing

In image segmentation, the noises and unnecessary spots are detected and removed using the K-means algorithm. The binary picture with noise is adapted into noise-free image which detects the leaf disease.

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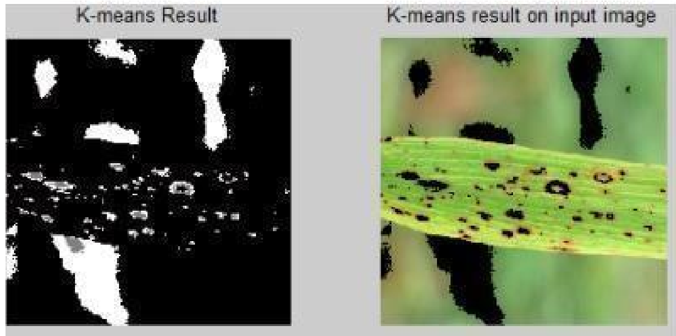

Fig. K-means result (Binary Conversion)

Here, image classification features like artificial neural network (ANN), fuzzy classification, SVM are used. Based on spot color, paddy leaf color, lesion type, boundary leaf, fuzzy logic is used to predict the diseases in paddy field. 94.70% accuracy final result is achieved using this techniques.

After the final result by the system, it will also recommend the useful pesticides for affected plant leaves. The minimum time required will be 15 sec or sometimes less than that...!

VII. RESULTS AND DISCUSSION

7.1 Results

- Disease should be predicted correctly
- Farmer should be able to use interface easily
- Farmer should be able to prevent disease spreading by taking proper measures
- Loss of crop yield should be reduced.

7.2 Discussions

As from literature survey we understood that after doing a comparative study on same datasets with different type of algorithms the CNN was the algorithm which was giving the best results among other also in that Dense net was a pre-trained model which was giving overall good results. SVM was not giving good results with more than 2 different types of disease, so in case of a greater number of accuracy and getting good accuracy the CNN algorithm was best to be implemented".

VIII. CONCLUSION

Some type of problems can be recognized with human visual at early points while a little take some time to predict. In this survey paper, various image processing techniques for predicting multiple plant diseases are scheduled and explained. In plant pathology, image processing techniques play a main role. Multiple segmentation techniques and feature extraction methods were explained to enhance prediction and accuracy. Researchers can increase a new hybrid technique using various image processing techniques to develop system performance. All the efficient techniques are useful for analyses the strong and diseased plants leaves. The overview proposes a survey on various disease classification methods that can be utilized for automatic plant leaf disease identification.

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