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|  | Abstract—One of the important and tedious task in agricultural practices is detection of disease on crops. It requires huge time as well as skilled labor. This paper proposes a smart and efficient technique for detection of crop disease which uses computer vision and machine learning techniques .The proposed system is able to detect 20 different diseases of 5 common plants with 93% accuracy.  Keywords: Digital image processing, Foreground detection, Machine learning, Plant disease detection.   1. INTRODUCTION   In India about 70% of the populace relies on agriculture. Identification of the plant diseases is important in order to prevent the losses within the yield. It's terribly troublesome to observe the plant diseases manually. It needs tremendous quantity of labor, expertize within the plant diseases, and conjointly need the excessive time interval. Hence, image processing and machine learning models can be employed for the detection of plant diseases. In this project, we have described the technique for the detection of plant diseases with the help of their leaves pictures. Image processing is a branch of signal processing which can extract the image properties or useful information from the image. Machine learning is a sub part of artificial intelligence which works automatically or give instructions to do a particular task. The main aim of machine learning is to understand the training data and fit that training data into models that should be useful to the people. So it can assist in good decisions making and predicting the correct output using the large amount of training data. The color of leaves, amount of damage to leaves, area of the leaf, texture parameters are used for classification. In this project we have analyzed different image parameters or features to identifying different plant leaves diseases to achieve the best accuracy. Previously plant disease detection is done by visual inspection of the leaves or some chemical processes by experts. For doing so, a large team of experts as well as continuous observation of plant is needed, which costs high when we do with large farms. In such conditions, the recommended system proves to be helpful in monitoring large fields of crops. Automatic detection of the diseases by simply seeing the symptoms on the plant leaves makes it easier as well as cheaper. The proposed solution for plant disease detection is computationally less expensive and requires less time for prediction than other deep learning based approaches since it uses statistical machine learning and image processing algorithm.   1. LITERATURE REVIEW   Literature reviews on image-based plant disease detection highlight the shift from traditional image processing and manual feature extraction to advanced deep learning (DL) and Convolutional Neural Networks (CNNs), which offer automated feature extraction and improved classification accuracy. Key components of these systems include image acquisition (often from datasets like PlantVillage), segmentation of infected areas, feature extraction (e.g., color, texture, shape), and classification using algorithms like CNNs and support vector machines. The field continues to evolve with advancements in sensor technology, data analytics, and the integration of AI, enabling more precise and timely diagnoses for improved crop yields and food security.   1. METHODOLOGY    * Dataset |  |

For this project we have used public dataset for plant leaf disease detection called PlantVillage curated by Sharada P. Mohanty et Al. [6]. The dataset consists of 87000 RGB images of healthy and unhealthy plant leaves having 38 classes out of which We have selected only 25 classes for experimentation of our algorithm These classes are shown in Table 1.

* Data preprocessing and feature extraction

Data preprocessing is important task in any computer vision based system. Fig. 2 illustrates the preprocessing steps for each image. To get precise results, some background noise should be removed before extraction of features. So first the RGB image is converted to greyscale and then Gaussian filter is used for smoothening of the image.

Then to binaries the image, Otsu’s thresholding algorithm is implemented.

Then morphological transform is applied on binarised image to close the small holes in the foreground part. Now after foreground detection, the bitwise AND operation on binarised image and original color image is performed to get RGB image of segmented leaf. Now after image segmentation shape, texture and color features are extracted from the image. By using contours, area of the leaf and perimeter of the leaf is calculated. Contours are the line that joins all the points along the edges of objects having same color or

intensity. To obtain amount of

Mean and standard deviation of each channel in RGB image is also estimated.

green color in the image, image is first converted to HSV color space and we have calculated the ratio of

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| number of pixels having pixel | | intensity of hue (H) channel in between 30 and 70 and total number of pixel | |
| one channel. | Non green part of image is calculated by subtracting green color part from 1. | |  |

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After extracting color features from the image, we have extracted texture features from grey level co- occurrence matrix (GLCM) of the image [7].

Fig. 2. Steps for data preprocessing and feature extraction.

* Classification Algorithm
* Random forest classifier has been used for classification or detection task. It is the part of ensemble learning, where the output is predicted from multiple base estimators [8]. Generally, to achieve higher accuracies, decision trees are used. But they are prone to overfitting problems. So to overcome this issue, random forest classifier is used which is a combination of multiple decision trees. Each tree is trained by using different subsets of the whole dataset, this can reduce the overfitting and improves the accuracy of the classifier. We have splitted the dataset into train set (80%) for fitting the model and test set (20%) for

validation. This method can find

K-fold cross validation technique is implemented to find the accuracy score.

the accuracy on whole dataset without any bias. After fitting the data, f1 score, precision, recall, accuracy has been calculated from test data to analyze the performance of the model. ROC curve and confusion matrix was plotted to analyze

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In this project we have analyzed different image parameters or features to identifying different plant leaves diseases to achieve the best accuracy. Previously plant disease detection is done by visual inspection of the leaves or some chemical processes by experts.

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Fig. 2 illustrates the preprocessing steps for each image. To get precise results, some background noise should be removed before extraction of features.

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