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An Efficient Detection System of Plant Leaf Disease to Provide Better Remedy

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***Abstract:** Machine learning is the one of the leading studies in Artificial Intelligence to extend research irresistibly or give the edification to a particular task to implement a scenario. The role of machine learning is to deduce the format of the data, make it feasible to design models that can be easily understood and apply them. This application could also be done in the field of agriculture in detecting the crop diseases. Plant diseases caused by microorganisms lead to serious reaping loss all-around. The most frequently effected diseases to plants are bacterial Canker, Blank knot, Brown Rot, Anthracnose, Apple Scarb etc. The prototype framework in this research model is for predicting and identifying the plant disease and provides remedies that can be used as protective measures against the disease. The implementation of the model described in this paper incorporates dense neural networks (DNN) Algorithm which is the sub part of Convolutional Neural Network (ConvNet/CNN). To build the model we have used TensorFlow DNN models.*

***Keywords:** CNN,DNN,MachineLearning,Plant disease detection.*

***Abbreviations:** CNN-Convolutional Neural Networks, DNN-Dense Neural Networks*

I. INTRODUCTION

Framing is an essential occupation in India and ranks second in the agricultural output worldwide. Agricultural productivity contributes a major role on which Indian economy is depended. Over 70% of rural areas depend on agriculture. Agriculture contributes approximately 17% to the total GDP [1] and to over 65% of the population employment was provided. Farming covers the production of almost all kinds of crops, fruits and vegetables for a moderate to subtropical climate as well as soil condition. All these crops growth is based on strength of leaves and roots. There are certain factors that lead to various plant diseases for the plant leaves, which damages crops and further effecting on economy of the country. Early identification of plant diseases can avoid these big economy losses. Due to lack of knowledge, for farmers it is difficult to pinpoint different diseases at their primary stage and they are unable to take precautions for those plants.

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Hence, feasible and efficient techniques to detect various types of diseases of plants need to be developed that can save time. The present process for plant (leaf) disease identification is done through naked eyeview which requires more man labour, highly equipped laboratories, expensive devices, etc. This paper focuses on presenting an efficient method for detecting and predicting the plant diseases thereby provides remedies using the convolution neural networks and dense neural networks through image processing.

Machine Learning is a vast field that concerns more about efficient construction of a system in order to train the system that automatically improves efficiency of learning with experiences. In modern years, many successful machine learning applications have been developed that behaves like self-learning concept which will work without any interruption of a human, like self-driving cars, hand-writing recognition, Stock market, predicting human disease, plant disease etc. Machine learning is a way for estimating the detecting patterns in a given dataset in order to make assumptions in another, similar datasets. This research paper deals with detecting and predicting the plant disease with the help of machine learning DNN (Dense Neural Network) Algorithm incorporating image processing. This paper discusses about numerous types of plant diseases and techniques for identifying of diseases in plants extend by suggesting remedies for them.

The physiological abnormality observed in plants is identified as a Disease. If plant suffers from any diseases it shows up specific unusual symptoms. The physical appearances that are regularly developed and can be observed by naked eyes are the normal features. Symptom– are the appearance of the disease seen as the physiological reaction of the plant is caused by the manifestation due to some harmful movements of the microorganisms.

Symptoms are classified into: Morphological symptoms, Histological symptoms.

Some of symptoms are observed with leaf spots, rots, cankers and many more. The visible effects of disease can be generally categorised into the following types: -

Damping off-This results in quick death and on the ground, the falling of seedling is cause due to collapse of seedling tissues near soil-line.

Spot:-(Leaf spot) –Flecks or Specks are tiny spots on a leaf can be seen as tan or brown necrotic lesion or self-limiting grey.

Blotch-Dark- Mostly seen in on the surface of leaves, shoots, and stems, which produces a cord of fungal pathogen.

Rot - Plant decomposition and putrefaction are two characterized diseases offen it will seen as softening, discoloration, which results fungal or bacterial infection.

Blast-it is quick death of new bud or inflorescence cause by Magnaporthegresia.

Anthracnose*:* Formation of discrete, dark- necrotic lesions on the stems of plants, leaves or fruits of plants.
Wilting, is the loss of rigidity of non-woody parts of plants, occurs when the turgor pressure in non-lignified plant cells falls towards zero.
Rust-Petty pustules of spots, usually it breaks down through the epidermises.
Powdery mildew, Pathogen gives a dusty powdery presence of mostly of gray and white colour.
Galls: An anomalous plant structure is found like are simple lumps or complicated structures, plain brown or brightly colored in response to parasitic attack by certain microorganisms (bacteria, fungi, viruses) or insects.

II. LITERATURE REVIEW

Recently various techniques have been developed by researchers which had been performing several studies on numerous plants and their diseases, to identify that disease. Mechanization of identifying disease leads to the input data collection from various resources. In this section of the paper we discuss certain research papers, in which presented different studies on plant diseases and techniques used by the researchers in achieving their goal.
In papers[2,10], authors implemented different classification techniques for plants disease classification. The author has used a classification based on leaf study based on different morphological features, such as k-Nearest Neighbor Classifier, Probabilistic Neural Network, Genetic Algorithm, Support Vector Machine, and Principal Component Analysis, Artificial neural network, Fuzzy logic. The author gave brief an overview of various classification method used for plant leaf disease classification using SVM, but also, he gave drawback of SVM is that when training data is not linearly separable, its very difficult in finding optimal parameters.
The author in paper [3] used deep convolution network approach for leaf disease recognition using classification method. The author proved that climate change can alter stage and pathogen development rate. This paper implemented augmented process to increase dataset. Augmentation includes rotations, transformation and affine transformation. The complete steps were briefly explained, respectively, like from collecting the images which were used for training and for validating to image pre-processing and augmentation and finally the process of training the deep CNN and fine-tuning. The author presented Caffe in these papers, Berkley Vision and Learning Centre developed a deep learning framework, for performing the deep CNN training framework. The experimental results on the developed model achieved on average 96.3%.
In these paper author gave concept [4] for identifying disease from the images, the author has provided a web-based application designed based on modern techniques. The author used concept of clustering and classification and used K-means and SVM respectively. In this paper, bacterial blight disease in pomegranate fruit has been detected.
In this paper [5], the author detected spot diseases in leaves using numerous neural network algorithms which are further classified based on the diseased leaf types. They described an approach for minimizing the loss of production necessary steps should be taken by detecting the disease leaf variety.
The proposed methodology mentioned here classifies the diseased plant leaves using Feed Forward Neural Network (FFNN), Learning Vector Quantization (LVQ) and Radial Basis Function Networks (RBF) by processing the set of shape, size and texture features which induces leaf image.
Testing done for various diseased leaf image classifications such as bean and bitter gourd leaves using some neural network techniques like feed forward neural network (FFNN), learning vector quantization (LVQ) and radial basis function network (RBF).
Accuracy, Precision, recall ratio and Measure are classification parameter by which performance of the system is measured. With the given four parameters the performance is analyzed that the FFNN classification gives better result.
The system proposed in [6], provides a software-based solution for automatic detection and computation of plant leaf diseases using ANN classification depending on different features such as color, proximity, size and centroid distance. The proposed methodology uses leaf features for disease detection where feature extraction is done on segmented diseased area.
The proposed and evaluated framework for detection of plant leaf/stem diseases in [7] is based on image processing that is the combination of the following main steps; in initial step the images are segmented using the concept of the K-Means technique, followed by the next step where segmented images are crossed through a pretrained neural network which produces fast, automatic, cheap and accurate solutions. Based on statistical classification it is observed that classified the tested diseases with a precision of around 93% performed well and could detect successfully by the developed Neural Network classifier.
The author in [8], had applied Deep Learning to extremely improve the performance and accuracy of object detection and recognition systems. In this paper,
Using images of plants leaves, leave disease has been detected using deep-learning approach. Faster Region-based Convolutional Neural Network (Faster R-CNN), Region-based Fully Convolutional Network (R-FCN), and Single Shot Multibox Detector (SSD) are some of the deep learning approaches given by the author.

III. METHODOLOGY

The framework proposed in this paper facilitates the process of developing a model for plant disease prediction as well as identifying and providing the remedies using Dense Neural Network which the subset of convolutional neural network (CNN). The developed model addresses the challenge of building a dense neural network for the accurate and efficient plant disease detection. In this framework, we introduce Dense Neural Network (DNN), which are dense local features obtained from discriminatively trained convolutional neural networks. The effectiveness of the proposed approach is demonstrated with plant disease object detection framework.
DNN-As the name illustrates that layers are connected densely in a network layer by the neurons. Each neuron in a layer collects an input from all the other neurons introduced in the previous layer which are densely connected [9]. In other words, the dense layer is a fully connected layer, that means all the neurons in a layer are connected to followed in the adjacent layer.

As mentioned in previous works, CNN has four basic layers:

(a) Convolution layer: The inner most building block of a CNN is called convolutional layer which consists of a set of learnable filters (or kernels), having a short receptive field.

(b) Max pooling is a pattern-based discretization process [9]. The main prospective is to perform an input sample (image, hidden-layer output matrix, etc.), by decreasing its dimensionality. Therefore, the most extrusive features of the preceding feature of map will be the output after max-pooling layer.

(c) Flatten is the action that converts the pooled feature map to a single column which will be passed to the fully connected layer [9].

(d) Fully connected layers are a fundamental component of Convolutional Neural Networks (CNNs), which have been proven very successful in acknowledge and classifying images for main frames vision. The CNN process establishes with convolution and pooling, shaping up the image into features, and testing them independently.

A layer between input layers and output layers in neural network, is known as hidden layer, where artificial neurons are taken in a group of measured inputs and provides an output through an activation function. In this paper, instead of using normal activation functions, convolution and pooling functions are used as activation functions.

In detecting the plant disease, the methodology presented here developed a network model using TensorFlow as shown in the Fig.1. The entire framework of proposed approach is elaborated with the help of a flowchart shown below. The initial step of the framework begins with data gathering. The input data has been adapted from the famous data repository namely *Kagle* repository. The input in the form of images has been used whose volume is 1000. From the 1000 images 500 images are used as trained data and 500 images were used for testing data. These images are generally appearing in the form of a matrix holding the values of the cells in the form of neurons. These neurons are fed as an input to the layers of the network. In this paper, as mentioned in the flowchart there are 6 hidden layers and two layers which are fully connected. The next step in the experimentation is the establishment of the connection between the layers which has been done by importing tensor flow libraries. Thereby construction of DNN model is done for further analysis. Now, the model is tested for implementation. If the model is accurate then the data is satisfied to the network or else the model is modified for achieving a better construction.

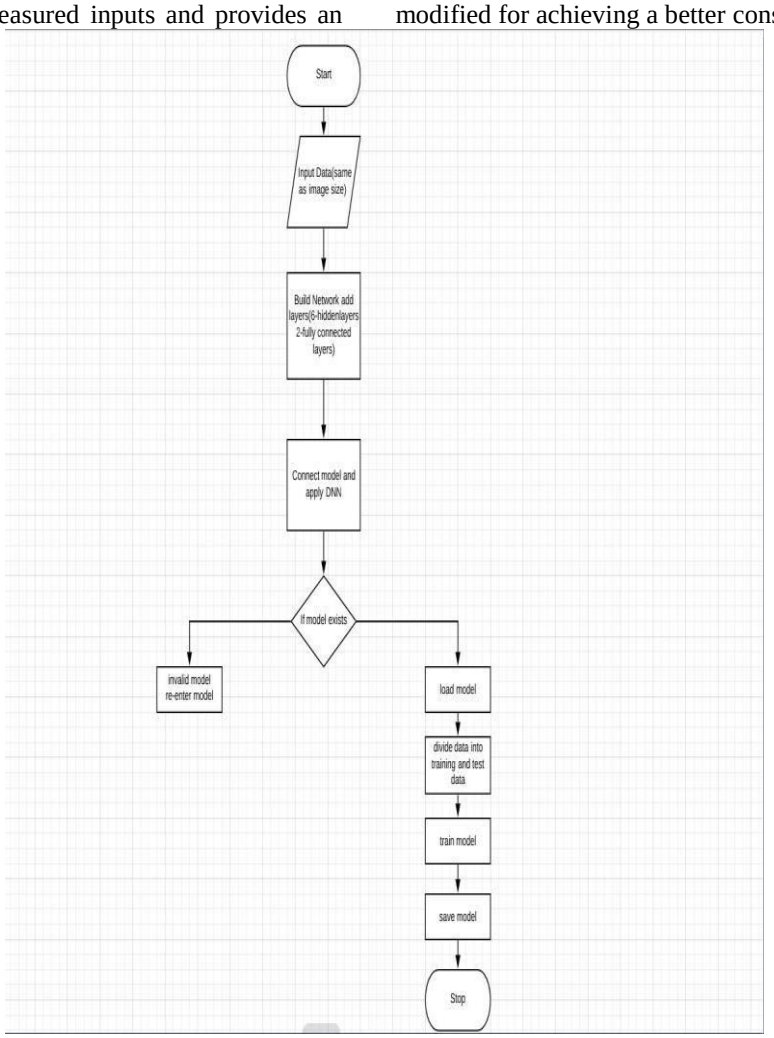

Fig.1 Flowchart for building the DNN Model.

IV.EXPERIMENTAL RESULTS

In this framework, we have designed programs using DNN Classifier of TensorFlow.The Programming language used here is Python, Python packages namely Numpy,

Matplotlib, Pandas, SKlearn, Keras are used. The following are the steps to be performed to get the experimental results. The initial step is importing the required libraries and reading the data from the file into a dataset. Next, evaluating the data to understand unique values, types of features, and generating input features and target variables or labels. After evaluating, the next step is encoding the labels using LabelEncoder and hence splitting the dataset into two sets i.e. train and test set. Further transforming input features to Tensors for both numeric and categorical variables and features columns are defined. Input function for Training and Evaluation are generated and hence the model using DNN Classifier has been developed. The final step is to train the model and analyse the data.

The framework of detecting and providing the remedies to the disease is presented below the flowchart Fig.2. From the database directory Image reshaping, resizing and conversion to an array form is performed in the pre-processing phase. Similarly for testing the image processing i.e.preprocessing directory consisting of different plant species is procured, hence for testing any image can be used as a test image. The trained image is used for training the model using DNN and hidden layers.DNN based classification model is created for training and evaluating the input function. After successful training implemented in the preprocessing phase, testing data is fed to the network for evaluating the accuracy of the network by classifying the images in order to predict the presence of disease on leaves. If any disease is detected in the plant then the framework suggests an appropriate remedy through which the goal of the framework is achieved.

The algorithm performance is measured in terms of accuracy. The algorithm implemented for proposed framework is compared with different algorithms which were already performed

Accuracy: The total number of all correct predictions (true positives, true negatives) in the set of data by total number of all sample's values. True positive, true negatives, false positives, false negatives are included in all sample value includes The formula used for calculating the accuracy is:

$$Accuracy = \frac{True\ Positives + True\ Negatives}{All\ Samples}$$

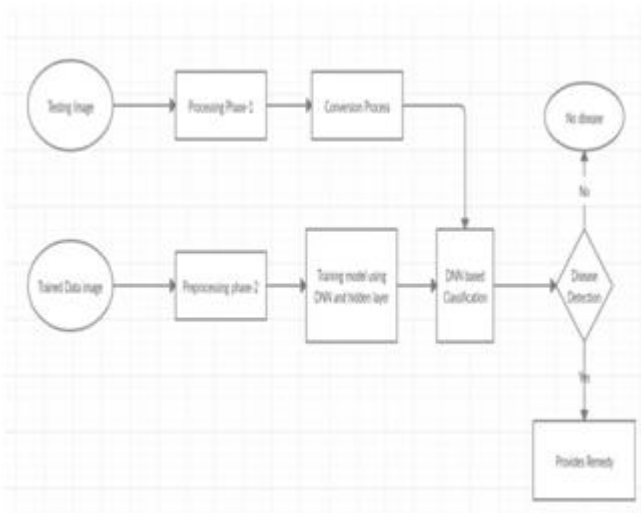

Fig.2. Flowchart for detecting the plant diseases

Table.1. Accuracy of different Algorithm.

S.NO	ALGORITHM	ACCURACY (%)
1.	CNN	78%
2.	DEEP LEARNING AND CNN	95%
3.	DEEP LEARNING USING ANN	91%
4.	DECISION TREE	89.97-97%
5.	NAVIES BAYES	83.98-86.76%

6.	DNN BY IMAGE CLASSIFICATION	96.3%
7.	**DNN(DENSLY CONNECTED NEURAL NETWORKS) OUR MODEL**	**98%**

Figure 3, shows the output screen of implementation through which remedies for the disease are suggested. The algorithm perfectly classifies healthy or unhealthy plant When the plant is detected unhealthy, it detect the disease and provides the remedy.

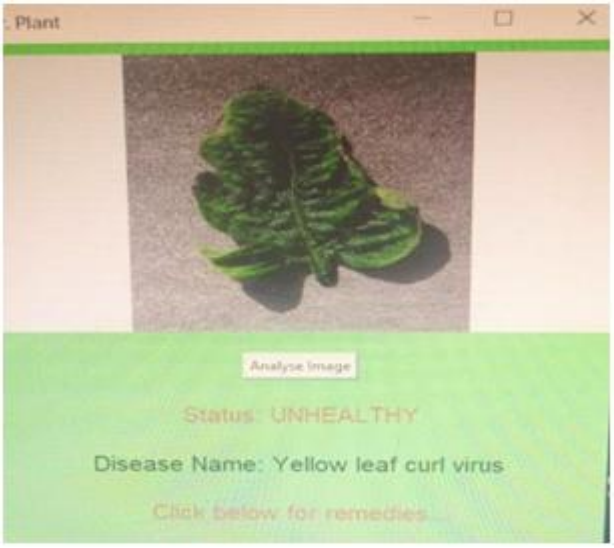

Fig.3. Detection of plant disease.

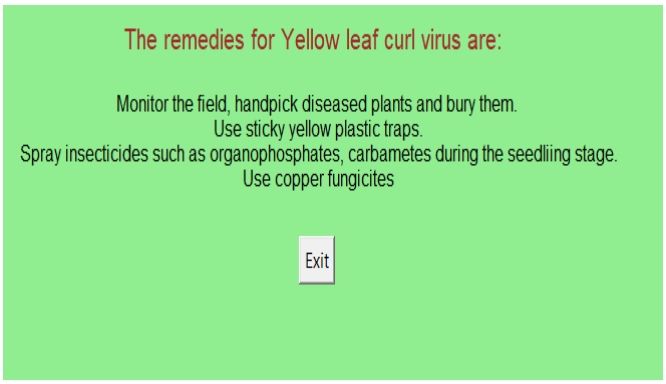

Fig.4. Providing remedies for detected plant disease.

The accuracy is compared between different algorithms like deep learning with CNN, decision tree etc. as shown in Fig.5 and the proposed model. It is noticed that the novel model used has the highest accuracy 98% for detecting the plant diseases.

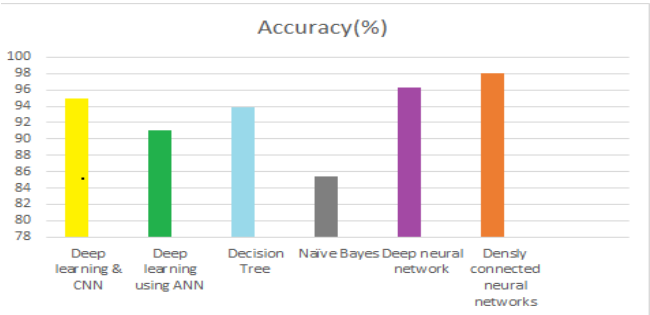

Fig.5. Table consisting of accuracy for different algorithm for detecting the plant diseases.

V. CONCLUSION

We presented an efficient model based on DNN Classifier for an effective detection of plant disease that occur frequently. Also, the framework described in the paper mentions a remedy for the detected disease. As it has been clearly projected in the experimentation that the accuracy of the developed model is better when compared to the previously used methods by other researchers. The framework mentioned in this paper can be further extended by accepting more input and increasing the number of hidden layers.The accuracy obtained for detecting the plant diseases using DNN classifier model is 98%.

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