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Leaf Disease Detection and Remedy Recommendation Using CNN

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ABSTRACT: People's lives and economic wellbeing are influenced by agriculture. In terms of GDP, it employs a large number of people and accounts for a significant portion of it. Crop losses are caused in large part by diseases, which are common and unavoidable. Agricultural yields are reduced each year due to poor disease control, which can have a significant impact on the quality, quantity, and productivity of the crop. There is a great deal of value in detecting leaf disease using an automated method such as image processing. Convolutional Neural Networks (CNNs) are the most commonly used deep learning classification technique.

An artificial intelligence (AI) classification system that uses a neural network is referred to as a neural network classification system (NNCCS).

Key Words: CNN, Leaf Disease , Classification, Deep learning , Remedies.

1. INTRODUCTION

There are a large number of farmers in India that grow a wide variety of crops. Agriculture is the key industry and the primary source of employment for most people. In terms of agricultural output, India is second only to the United States. A large number of individuals are either directly or indirectly reliant on the agriculture sector's output. To ensure the longterm viability of the country, it is essential to produce high-quality agricultural products. There are a number of variables that can affect crop productivity.

As the world's population grows, political unrest persists, and the weather changes, the agricultural business is scrambling to find new and improved ways to produce more food. Many farmers are leaving agriculture in favor of other employment because of a lack of productivity and industrialisation. With today's advanced farming technology, we can significantly boost crop yields while lowering the cost of production and enhancing the quality of food. Temperature, humidity, and light conditions must be monitored and controlled in order to produce crops that are more productive and of higher quality.

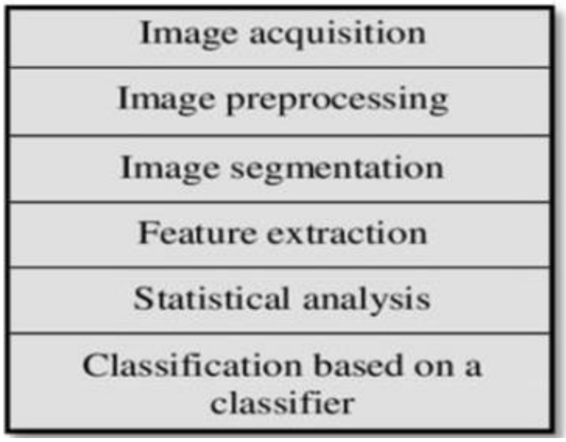

Fig.1: Modules in DL model

Leaf disease is another big danger to food security. It degrades product quality and lowers harvest yields. Diseases in leaves are spread by microorganisms such as insects, pests, fungi, bacteria, and viruses. The entire plant is harmed when they consume the top and bottom of the leaf. There must be an early detection of leaf diseases for future agricultural losses to be avoided. In turn, this boosts the economy by increasing food yields, which in turn helps farmers. It is critical to determine the health of the plant. The illness can be identified by looking at the diseased leaves. Patches of irregularly shaped black pigment form on the leaf's surface, and fungus can grow in these patches if they are humid. Initially, these spots are minor, but with time, they spread to cover the entire leaf, causing it to decay. A precise window of time must be allowed for the accurate detection of leaf diseases, i.e., at the initial stage, before the basic functions of plants, such as pollen transport and fertilizer absorption are compromised.

2. LITERATURE REVIEW

In the paper ―Deep learning for Image-Based Plant detection" [1] the authors Prasanna Mohanty et al., has proposed an approach to detect disease in plants by training a convolutional neural network. The CNN model is trained to identify healthy and diseased plants of 14 species. The model achieved an accuracy of 99.35% on test set data. When using the model on images procured from trusted online sources, the model achieves an accuracy of 31.4%, while this is better than a simple model of random selection, a more diverse set of training data can aid to increase the accuracy. Also some other variations of model or neural network training may yield higher accuracy, thus paving path for making plant disease detection easily available to everyone.

Malvika Ranjan et al. in the paper ―Detection and Classification of leaf disease using Artificial Neural Network" proposed an approach to detect diseases in plant utilizing the captured image of the diseased leaf. Artificial Neural Network (ANN) is trained by properly choosing feature values to distinguish diseased plants and healthy samples. The ANN model achieves an accuracy of 80%.

According to paper ―Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features" [3] by S. Arivazhagan, disease identification process includes four main steps as follows: first, a color transformation structure is taken for the input RGB image, and then by means of a specific threshold value, the green pixels aredetected and uninvolved, which is followed by segmentation process, and for obtaining beneficial segments the texture statistics are computed. At last, classifier is used for the features that are extracted to classify the disease.

Kulkarni et al. in the paper ―Applying image processing technique to detect plant diseases" [4], a methodology for early and accurately plant diseases detection, using artificial neural network (ANN) and diverse image processing techniques. As the proposed approach is based on ANN classifier for classification and Gabor filter for feature extraction, it gives better results with a recognition rate of up to 91%.

In paper ―Plant disease detection using CNN and GAN" [5], by Emaneul Cortes, an approach to detect plant disease using Generative Adversarial networks has been proposed. Background segmentation is used for ensuring proper feature extraction and output mapping. It is seen that using Gans may hold promise to classify diseases in plants, however segmenting based on background did not improve accuracy.

In the paper ―Convolutional Neural Network based Inception v3 Model for Animal Classification‖ [6], Jyotsna Bankar et al. have proposed use of inception v3 model in classifying animals in different species. Inception v3 can be used to classify objects as well as to categorize them, this capability of inception v3 makes it instrumental in various image classifiers.

3. IMPLEMENTATION

[4][5][6]] Human-level accuracy has been achieved using generic object recognition in the last few years. Leaf diseases may now be detected early and accurately using a camera and image processing integrated with machine learning, an automated expert system [9][12]. Deep learning is extensively utilized because it enables the computer to discover the best features on its own, without the need for human intervention. Computational model: Neural Network In the human brain, it resembles the activity of neurons. The primary goal of a neural network is to eliminate the need to manually create feature vectors.

Because it saves both labor and time, CNN is frequently employed for image identification [13][14]. For the classification task, CNN does not employ hand-made features but rather optimizes and creates the hidden layer's filter parameters and weights. Different layers of CNN are used to identify, detect, categorize, and predict diseases. As a result of the faster treatment and more precise results, it has less of a negative impact on harvest. Increased agricultural output and productivity are achieved with minimal outlay of resources. Chemicals used on the plants are being minimized. Smaller areas can be better monitored by utilizing different methods for layer- and neuron-based visualisations together.

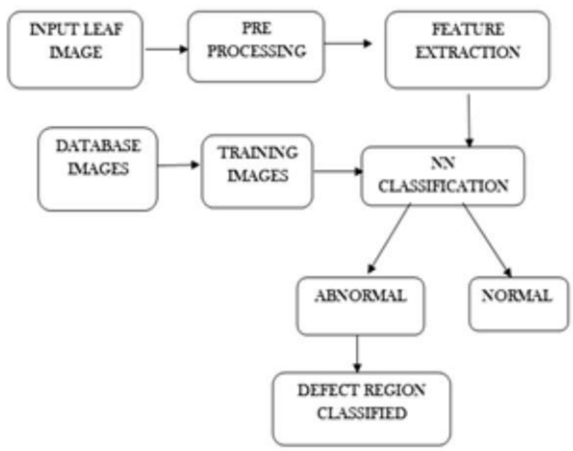

Fig.4: System architecture

A class of feed-forward neural networks known as convolutional neural networks can handle data in several dimensions. Perceptrons constitute layers in feed-forward neural networks. The first layer receives inputs, and the last layer produces outputs. The socalled secret layers are not connected to the rest of the world. Layer-specific perceptrons are interconnected, but not with those of the same layer. Constantly, new information is fed upwards from one layer to the next. The quality of the features essential for effective prediction isn't sacrificed in the process of making images easier to analyse using CNN. In order to accurately classify leaf diseases, images are used as input. Using these photos as a starting point, an image filter called a convolution layer extracts the information. The pooling layer derives the feature values from the retrieved features. Convolution and max pooling can be used to gain additional information from images that are more complicated. The output of the previous layer is converted into a single vector, which is then used as the input for the following layer by a fully connected layer. A convolution and other layers repeatedly extract feature maps, and the network eventually outputs a label that indicates an expected class. As depicted in Fig. 3, the steps needed to implement the CNN model for leaf disease detection. Each step is significant in and of itself.

STEPS:

1) To do feature extraction, obtain the input leaf image, preprocess it, and then convert it to an array.

Make that the database of leaf photos has been properly sorted and preprocessed.

3) Use the CNN classification technique to train the model on practice photos.

When comparing the preprocessed test image with the trained model, the leaf is either identified as normal or abnormal, as seen below in step 4.

5) If the leaf has a flaw, the sickness and treatment are visible.

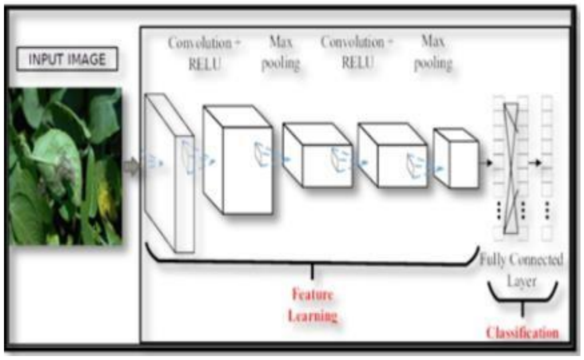

Fig.5: Internal structure of the CNN model

The CNN is trained using the Keras python package and the Tensorflow backend framework. It was utilized to improve Adam Optimizer's performance. Training and testing data are sent as inputs to model.fit generator. The number of epochs is also passed. In order to accurately fit the dataset of leaves collected, carefully segregated, and inspected by agricultural professionals and independently validated for distinct leaf diseases, CNN has been fine-tuned. The trained model is compared with the test image to forecast the disease. Using gradient descent and back-propagation algorithms, adjust the network parameters to reduce classification error.

4. ALGORITHM

CNN:

The reader is expected to be familiar with neural networks. Artificial Neural Networks are excellent in Machine Learning. Image, audio, and word classification are all examples of tasks where artificial neural networks are applied. LSTM and Convolution Neural Networks are both used for picture classification, whereas Recurrent Neural Networks and Convolution Neural Networks are used to predict word sequences. Let's go over the basics of a neural network again before getting into the Convolution Neural Network. Normal Neural

Networks have three layers: the input, the output, and a hidden layer.

Layers of data to be entered: Essentially, this is the layer where we feed our model with data. There are exactly as many neurons in this layer as there are in our data (number of pixels in the case of an image).

The input from the input layer is fed into the hidden layer. Depending on our model and data size, there may be several hidden layers. As the number of characteristics increases, so does the number of neurons in each buried layer. A nonlinear network's output is generated by multiplying the previous layer's output by the layer's learnable weights and biases, then applying an activation function to the resulting matrix.

A logistic function such as sigmoid or softmax is used to translate the output of each class into a probability score for each class in the output layer.

Using the model's output, we can next calculate the error using an error function, such as cross-entropy or square loss error, among others. This phase is referred to as "feedforward." After that, we use the derivatives to retrace our steps back to the model. Backpropagation is a technique used to reduce the amount of data that is lost.

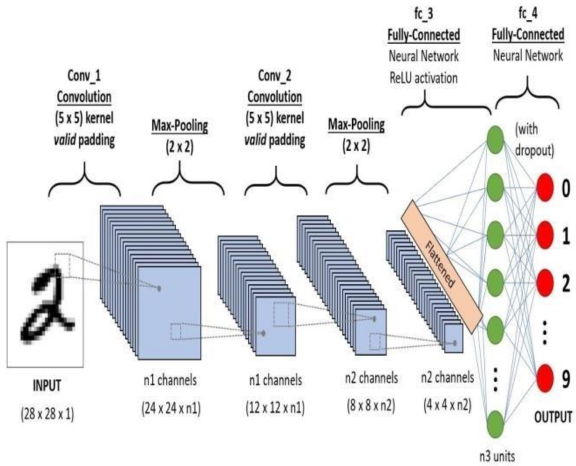

Fig.6: CNN architecture

Step by Step Procedure:

Step 1: Choose a Dataset. ...

Step 2: Prepare Dataset for Training. ...

Step 3: Create Training Data. ...

Step 4: Shuffle the Dataset. ...

Step 5: Assigning Labels and Features. ...

Step 6: Normalizing X and converting labels to categorical data. ...

Step 7: Split X and Y for use in CNN.

5. EXPERIMENTAL RESULTS

For example, it can identify between 12 different types of damaged leaves and their healthy counterparts in the image using the model that was designed for this task alone. The pesticide to be employed as a cure is displayed after the treatment, i.e., the pesticide, is successfully detected with a high level of confidence. As a preventative measure, this treatment helps to keep the disease at bay. Flask was used to integrate the pickle model into the remedy suggestion system. Leaf illnesses can be diagnosed more accurately and quickly using the proposed CNN methodology, compared to current methods.

Fig.7: Home screen.

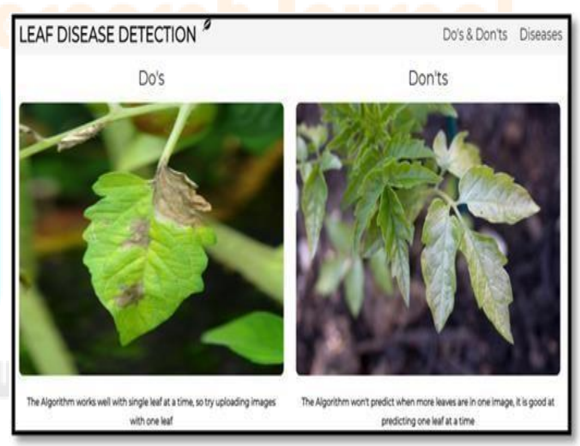

Fig.8: Upload image

Fig.9: Detection result

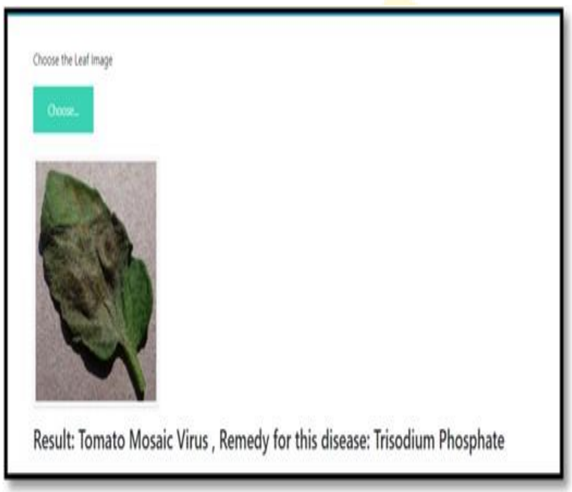

Fig.10: Another detection result

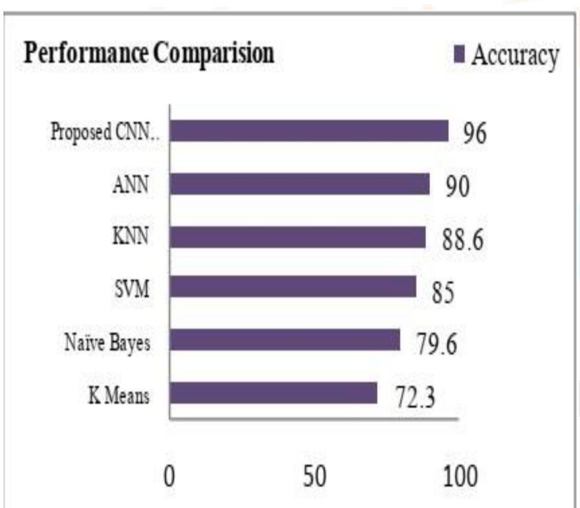

Fig.9: Comparison graph

6. CONCLUSION

The primary objective is to effectively identify and detect leaf diseases while also considering the advantages that farmers will derive. Using neural networks, a model of the human brain can be generated. There were very few models that could be trained in this manner prior to the invention of neural networks. Python's CNN model has a 96 percent accuracy rate for detecting leaf disease automatically. Increased accuracy and speed can be achieved with the use of a graphics processing unit (GPU). The proposed approach eliminates the need for an exorbitantly priced domain expert. In addition to accurately predicting leaf illness, it also offers a treatment that may be used to speed up the recovery of the plant's health. An airborne surveillance and live video coverage of huge agricultural fields may be done using this technology, which reduces the amount of manual work and time required. The model is fed data from photos taken by a highresolution camera mounted on the drone. The cost is prohibitive for small-scale farming, but it is essential for large-scale farming.

7. FUTURE SCOPE

It is possible to create a voice-activated smartphone application that illiterate farmers may easily utilize. Expanding the model to include the diagnosis of more leaf diseases would be advantageous.

Expansions, such as displaying the proportion of the leaf that is damaged, are possible.

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