# PLANT DISEASE DETECTION USING CONVOLUTIONAL NEURAL NETWORK

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**Abstract**

**When plants and crops are suffering from pests it affects the agricultural production of the country. Usually, farmers or experts observe the plants with eye for detection and identification of disease. But this method is often time processing, expensive and inaccurate. Automatic detection using image processing techniques provide fast and accurate results. This paper cares with a replacement approach to the development of disease recognition model, supported leaf image classification, by the utilization of deep convolutional networks. Advances in computer vision present a chance to expand and enhancethe practice of precise plant protection and extend the market of computer vision applications within the field of precision agriculture. a completely unique way of training and therefore the methodology used facilitate a fast and straightforward system implementation in practice. All essential steps required for implementing this disease recognition model are fully described throughout the paper, starting from gathering images to make a database, assessed by agricultural experts, a deeplearning framework to perform the deep CNN training. This method paper may be a new approach in detecting plant diseases using the deep convolutional neural network trained and finetuned to suit accurately to the database of a plant's leaves that was gathered independently for diverse plant diseases. The advance and novelty of the developed model dwell its simplicity; healthy leaves and background images arein line with other classes, enabling the model to distinguish between diseased leaves and healthy ones or from the environment by usingCNN. Plants are the source of food on earth. Infections and diseases in plants are therefore a big threat, while the foremost common diagnosisis primarily performed by examining the plant body for the presence of visual symptoms [1]. As an alternative to the traditionally time-consuming process, different research works plan to find feasible approaches towards protecting plants. In recent years, growth in technology has engendered several alternatives to traditional arduousmethods [2]. Deep learning techniques are very successful in image classification problems.**

**Key Words: Plant Disease Detection.CNN, Deep Learning, Image Processing**

**Introduction: -**

**Materials And Methods:-**

**Dataset:**

The Dataset was taken from Kaggle of Plant Village dataset existing online as such the code was also inscribed on theonline kernel of Kaggle for well computation and study of training loss and validation.

**Image Preprocessing and Labelling:**

Pre-processing pictures generally includes eliminating low-recurrence foundation commotion, normalizing the powerof the individual particles' pictures, eliminating reflections, and veiling segments of pictures. Picture pre-processing is the strategy of improving information Furthermore, the strategy of picture pre-processing included editing of the apparent multitude of pictures physically, making the square around the leaves, to feature the district of intrigue (plant leaves). During the period of gathering the pictures for the dataset, pictures with a more modest goal and measurement not exactly 500 pixels were not considered as substantial pictures for the dataset. In expansion, just the pictures where the locale of intrigue was in higher the goal was set apart as a qualified possibility for the dataset. Inthat manner, it was guaranteed that pictures contain all the required data for highlight learning. Numerous assets can be found via looking over the Internet, in any case, their significance is frequently problematic. Considering a legitimate concern for affirming the exactness of classes in the dataset, at first assembled by a catchphrases search, horticultural specialists inspected leaf pictures and marked all the pictures with fitting infection abbreviations. As it is known, it is significant to utilize precisely characterized pictures for the preparation and approval dataset. Just in that manner may a fitting and solid identifying model be created. In this stage, copied pictures that were left after the underlying the emphasis of get-together and gathering pictures into classes were eliminated from the dataset.

**Neural Network Training :-**

Preparing the profound convolutional neural organization for taking a picture grouping model from a dataset was proposed. Tensor Flow is an open-source programming library for mathematical calculation utilizing information stream diagrams. Hubs in the diagram speak to numerical tasks, while the diagram edges speak to the multidimensional information exhibits (tensors) imparted between them. The adaptable engineering permits you to convey calculation to at least one CPUs or GPUs in a work area, worker, or on the other hand cell phone with asolitary API. Tensor Flow was initially created by scientists and designers dealing with the Google Brain Group inside Google's Machine Intelligence research association for the motivations behind directing AI and profound neural organizations research, yet the framework is sufficiently general to be material in a wide assortment of different spaces also. In AI, a convolutional neural organization is a sort of feed-forward fake neural organization in which the

network design between its neurons is roused by the association of the creature visual cortex. Individual cortical neurons react to improvements in a limited district of room known as the responsive field. The responsive fields of various neurons incompletely cover with the end goal that they tile the visual field. The reaction of an individual neuron to boosts inside its open field can be approximated numerically by a convolution activity. Convolutional networks were propelled by natural cycles and are varieties of multilayer perceptron intended to utilize negligible measures of pre-handling. They have wide applications in picture and video acknowledgment,recommender frameworks and regular language preparing. Convolutional neural organizations (CNNs) comprise of various layers of responsive fields. These are little neuron assortments which cycle parts of the info picture. The yields of these assortments are then tiled so their info districts cover, to get a higher-goal portrayal of the first picture; this is rehashed for each such layer. Tiling permits CNNs to endure interpretation of the information picture. Convolutional organizations may incorporate neighborhood or worldwide pooling layers, which consolidate the yields of neuron bunches. They too comprise of different mixes of convolutional and completely associated layers, withpoint savvy nonlinearity applied toward the finish of or after each layer. A convolution procedure on little locales of info is acquainted with lessen the quantity of free boundaries and improve speculation. One significant bit of leeway of convolutional networks is the utilization of shared weight in convolutional layers, which implies that a similar channel (loads bank) is utilized for every pixel in the layer; this both lessens memory impression furthermore, improves execution. The layer's boundaries are involved a set of learnable portions which have a little open field yet stretch out through the full profundity of the info volume. Amended Linear Units (Re LU) are utilized an alternative for soaking nonlinearities. This initiation work adaptively learns the boundaries of rectifiers and improves precision at unimportant extra computational expense. In the unique situation of fake neural organizations, the rectifier is an enactment work characterized as:$f(x)=\max(0, x)$

where x is the contribution to a neuron. This is otherwise called an incline work what is more, is like half-wave correction in electrical designing. This enactment work was first acquainted with a dynamical organization by Hahn failure et al. in a 2000 paper in Nature with solid organic inspirations what is more, numerical avocations. It has been utilized in convolutional networks more successfully than the generally utilized strategic sigmoid (which is roused by likelihood hypothesis; see strategic relapse) and its more down to earth partner, the exaggerated digression. The rectifier is, starting at 2015, the most famous actuation work for profound neural organizations. Profound CNN with ReLU's trains a few times quicker. This technique is applied to the yield of each convolutional and completely associated layer. Despite the yield, the information standardization is not needed; it is applied after ReLU nonlinearity after the first and second convolutional layer since it lessens top-1 and top-5 mistake rates. In CNN, neurons inside a covered-up layer are fragmented into "include maps." The neurons inside an element map share a similar weight and inclination. The neurons inside the component map look for a similar component. These neurons are exceptional since they are associated with various neurons in the lower layer. So, for the first concealed layer, neurons inside an element guide will be associated with various districts of the info picture. The shrouded layer is portioned into highlight maps where every neuron in an element map searches for a similar component in any case, at various places of the information picture. Essentially, the component map is the aftereffect of applying convolution over a picture. The convolutional layer is the center structure square of a CNN [6]. The layer's boundaries comprise of a lot of learnable channels (or pieces), which have a little open field, yet reach out through the full profundity of the information volume. During the forward pass, each channel is convolved over the width and tallness of the input volume, registering the speck item between the sections of the channel also, the info and creating a 2-dimensional actuation guide of that channel. Therefore, the organization learns channels that initiate when it recognizes some sort of highlight at some spatial situation in the info. Stacking the actuation maps for all channels along the profundity measurement structures the full yield volume of the convolution layer.
Three hyper parameters control the size of the output volume of the convolutional layer [7]: the depth, stride, and zero-padding.

**Depth:**
Depth of the yield volume controls the quantity of neurons in the layer that interface with a similar district of the information volume. These neurons will figure out how to initiate for various highlights in the information. Formodel, if the primary Convolutional Layer accepts the crude picture as info, at that point various neurons along the profundity measurement may initiate in the presence of different arranged edges, or masses of shading.

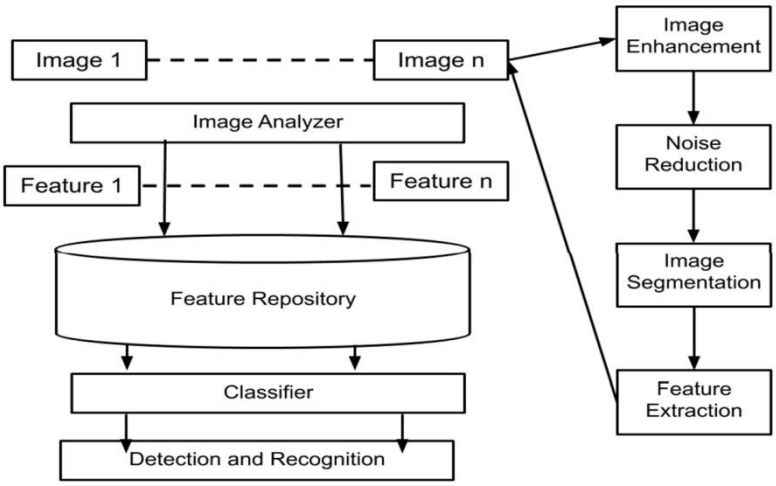
**Stride:**
It controls how depth columns around the spatial dimensions (width and height) are allocated. When the stride is 1, a new depth column of neurons is allocated to spatial positions only 1 spatial unit apart. This leads to heavily overlapping receptive fields between the columns, and to large output volumes [8]. Conversely, if higher strides are used then the receptive fields will overlap less and the resulting output volume will have smaller dimensions spatially.

**Zero Padding:**
Zero padding happens as we include a border of pixels each with value zero across the boundaries of the input pictures. This adds sort of a padding of zeros across the outside of the picture, hence the name zero padding.

**System Architecture:**

**System Architecture Diagram:**
To diagnose the reason for the symptom by using an automatic tool, therefore the image processing system is proposed to develop

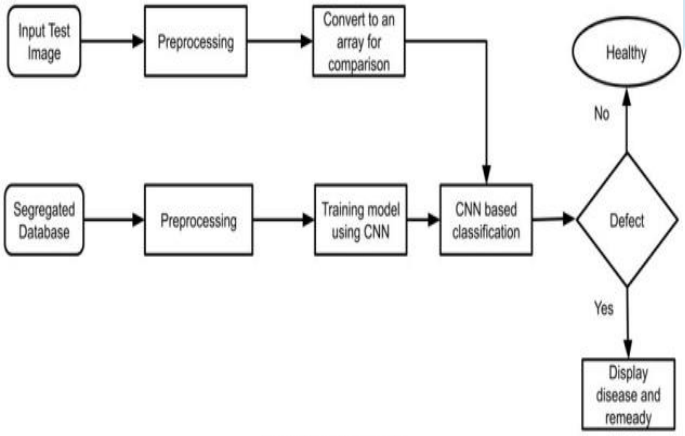
to automate the identification and classification of the leaf batches into specific disorders. As shown within the figure above the system consists of three main blocks: Image Analyzer, Feature Database and Classifier resp. [9]. The processing proposed to try to by these blocks is split into two phases as follows offline Phase: an outsized set of defected images are processed by a picture analyzer for extracting abnormal features.



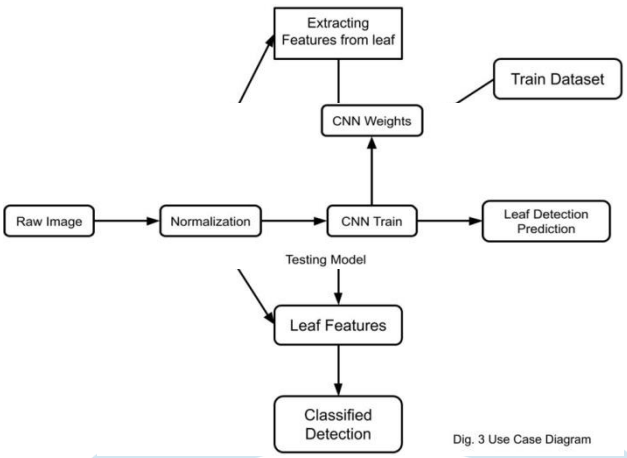

Dig. 1 System Architecture

**Flow Chart:**

The input test image is developed and pre-processed in the following phase and then it is transformed into array form for difference. The chosen database is appropriately separated and pre-processed and then retitled into suitable folders. The model is well trained using CNN and then classification takes position. The evaluation of the test image and the trained model take position tracked by the display of the result. If there is a flaw or infection in the plant the package displays the disease along with the remedy.



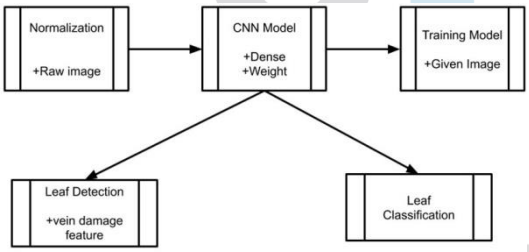

Dig. 2 Flow chart diagram



Dig. 3 Use Case Diagram

**Use Case Diagram:**
When we provide a new input image first the module extracts the leaf features. Then it goes through the CNN model. It then compares the features with already trained dataset. Then it goes through dense CNN and therefore the leaf features are extracted separately. Then the module will predict whether the plant leaf is affected by any disease or not.It shows the output from one among the38 classes which are predetermined and trained. Then the output is going to be during a textual format.

**Class Diagram:**
The normalization class comprises raw images and it is fed to the CNN model which comprises dense and weight. The CNN model categorizes and identifies by using the training model. The training model class contains the image dataset. Leaf recognition becomes utilized of the features.



Dig. 4 Class Diagram

**CNN Model Steps**
**Conv2D:** It is a 2D Convolution Layer, this layer creates a convolution kernel that's wind with layers input which helps produce a tensor of outputs.
keras.layers.Conv2D(filters, kernel_size, strides=(1, 1), padding='valid', data_format=None, dilation_rate=(1, 1),activation=None, use_bias=True, kernel_initializer='glorot_uniform', bias_initializer='zeros', kernel_regularizer=None, bias_regularizer=None, activity_regularizer=None, kernel_constraint=None, bias_constraint=None

**Maxpooling:**
Max pooling may be a pooling process that choose the very best element from the region of the feature map covered by the filter. Thus, the output after max-pooling level would be a feature map comprising the foremost important features of the previous feature map.[10].

**Flatten:**
In between the convolutional layer and therefore the fully connected layer, there is a 'Flatten' layer. Flattening transforms a two-dimensional matrix of features into a vector which will be fed into a totally connected neural network classifier.

**Image Data Generator:**
Image Data Generator quickly found out Python generators which will automatically turn image files on disk into batches of preprocessed tensors.

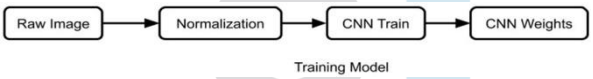
**Training Process**:

Effective training begins well before a trainer delivers a private training session and continues then training session is complete. Training are often viewed as a process comprised of 5 related stages or activities: assessment, motivation, design, delivery, and evaluation.

**Epochs:**
An epoch may be a term utilized in machine learning and indicates the amount of passes of the whole training dataset the machine learning algorithm has completed. Datasets are usually grouped into batches (especially when the quantity of knowledge is extremely large).

**Validation Process:**
Validation is mentioned because the process where a trained model is evaluated with a testing data set. The testing data set may be a separate portion of an equivalent data set from which the training set springs . the most purpose of using the testing data set is to check the generalization ability of a trained model.

**Training and Testing Model:**
The dataset is preprocessed like Image reshaping, resizing and conversion to an array form. Similar processing is additionally done on the test image. A dataset consisting of about 38 different plant leaf diseases is obtained, out of which any image is often used as a test image for the software.



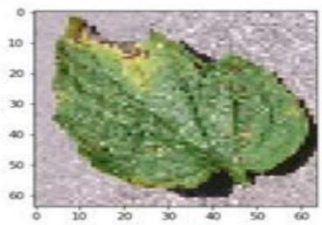

Training Model

The train dataset is employed to coach the model (CNN) so that it can identify the test image and therefore the disease it is CNN has different layers that are Dense, Dropout, Activation, Flatten, Convolution2D, and maxpooling2d. After the model is trained successfully, the software can identify the disease if the plant species is contained within the dataset. After successful training and preprocessing, comparison of the test image and trained model takes place to predict the disease.

**Experimental Result and Conclusion: -**
As it is known that convolutional networks are ready to learn features when trained on larger datasets, results achieved when trained with only original images will not be explored. After fine-tuning the parameters of the network, an overall accuracy of 88% was achieved. Furthermore,

the trained model was tested on each class individually. Test was performed on every image from the validation set. As suggested by good practice principles, achieved results should be compared with some other results. additionally, there are still no commercial solutions on the market, except those handling plant species recognition based on the leaf's images. during this paper, an approach of using deep learning method was explored to automatically classify and detect plant diseases from leaf images. the entire procedure was described, respectively, from collecting the pictures used for training and validation to image pre-processing and augmentation and eventually the procedure of coaching the deep CNN and fine-tuning. Different tests were performed to see the performance of newly created model. As the presented method has not been exploited, as far as we all know, in the field of disease recognition, there was no comparison with related results, using the precise technique. Here the test picture we have provided is tomato leaf with Septoria leaf spot.

```
In [50]: import matplotlib.pyplot as plt
         img = plt.imshow(test_image)
```




```
In [51]: test_image=image.img_to_array(test_image)
In [52]: test_image=np.expand_dims(test_image,axis=0)
In [53]: result=model.predict(test_image)
In [54]: prediction = result[0]
```

```
    print("Tomato_Leaf_Mold")
elif output['Tomato___Septoria_leaf_spot']==1.0:
    print("Tomato_Septoria_leaf_spot")
elif output['Tomato___Spider_mites Two-spotted_spider_mite']==1.0:
    print("Tomato_Spider_mites_Two-spotted_spider_mite")
elif output['Tomato___Target_Spot']==1.0:
    print("Tomato_Target_Spot")
elif output['Tomato___Tomato_Yellow_Leaf_Curl_Virus']==1.0:
    print("Tomato_Tomato_Yellow_Leaf_Curl_Virus")
elif output['Tomato___Tomato_mosaic_virus']==1.0:
    print('Tomato_Tomato_mosaic_virus')
elif output['Tomato___healthy']==1.0:
    print("Tomato_healthy")
```

```
Tomato_Septoria_leaf_spot
```

The output is tomato_septoria_leaf_spot.

**Future Work:**

Agricultural department wants to automate the detecting the yield crops from eligibility process (real time). To automate this process by show the prediction end in web application or desktop application. To optimize the work to implement in AI environment. The proposed system is based on python and provides an accuracy of around 88%.The accuracy and therefore the speed are often increased by use of Googles GPU for processing. The system is often installed on Drones in order that aerial surveillances of crop fields are often done.

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