

Plant Leaf Disease Detection Using Deep Convolution Neural Network Method of Deep Learning

¹S.Gopinathan, ²K.Madhavan

¹Professor , Department of Computer Science, University of Madras, Guindy campus,
Chennai -600025, India

²M.Phil Research Scholar, Department of Computer Science, University of Madras, Guindy
campus, Chennai -600025, India

ABSTRACT:

The plant leaf disease detection research work is based on good healthy agriculture and the economic growth of Indian formers. Agricultural growth is the forming of good vegetables and fruits. Plants and crops in India's highest production in agricultural lands. The economic growth affected plant diseases.it rectified the loss of farming lands. Produce the healthy crops and vegetables to support in our research plant leaf diseases identified deep neural network method. The plant leaves are the most common features to reflect the plants and healthy agriculture modules. the basic crops and vegetables are identified as good healthy crops vegetation. the most serious vegetable crop diseases reflected the leaves and crop images. The image processing deep learning approaches using to identified the convolution neural network model (CNN) to find tomato, brinjal, papaya, potato, cucumber, and bottle gourd affected leaves models. The deep learning model trained the system for using Keras to run on the TensorFlow framework. the plant leaves projected to find healthy and diseased leaves. the leaf symptoms of diseased leaves spots of the shot hole, brownish sickness. Unhealthy leaf spots to trained models identified the accuracy of the models achieved 93.99% accuracy. The trained model to develop a good identification model combines with live data and images.

Keywords: Deep learning, convolution neural network, Alex net, disease diagnosis, agriculture, Digital image processing.

Introduction:

India is one of the major agriculturally based nations in the world. Indian agricultural sector contributes about sixteen percent (16%) of GDP (Gross Domestic Product) in total economy Fig1(a). It is more than a high percentage of whole Asia. Agricultural is the most important occupation in 58% of rural Indian families. Vegetables are the major protection and forming of agricultural lands[2]. They are producing million tons of every year. Most of the time farmers are affected by heavy rainfall, severe drought, heavy snow, storm, and hurricane[2]. Also, the same disease disaster-affected the agricultural industry. Its affected crops, vegetables, fruits, and leaves. Plant diseases destroy the growth of the agricultural economy.

Agriculture, value added (% of GDP) in India

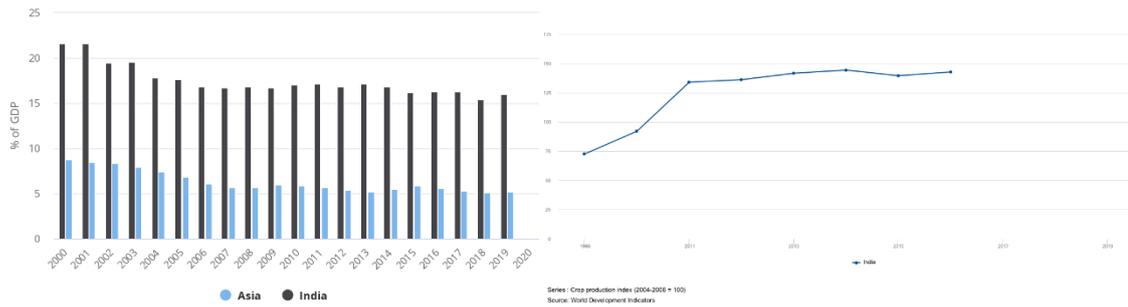


Fig 1. (a)Agriculture GDP value of India compared Asia

(b). Yearly crop production in India

The image processing techniques used in deep learning models to identify diseased and attacked vegetables also identified healthy or unhealthy leaves. the data-based trained convolution neural network (CNN) model.

Total agricultural lands of 394.6 million acres in India. The crops and vegetable production in India 6.74 million tons than the production in every year. Horticulture Crop and vegetables 285 million tons in last year (2018-2019)[3].horticulture vegetable planting and forming increases Fig1(b) In every year. Tamilnadu is one of the largest vegetable lands and crops. The vegetables and fruits are formed in many areas. The Weather condition of Tamilnadu is different from other states of India and other places [4] the major problem is attacks of virus diseases in plants[5]. the attacks are projected on the leaves and vegetables. the main reflection in the plants attacks virus and insects to see the human identification of manual recognition and the scientific model identification on PCR (polymerase chain reaction)[6] tests. The major detection of plant leaves is image recognition. Deep learning a model to identified affected and diseased plant leaves[7].

The python-based TensorFlow and Keras deep learning platforms.it collects the sample images for diseased tomato, potato, brinjal, cucumber, papaya plant leaves in agricultural lands. same as collected to identify to tomato yellow leaf curl virus (TYLCV)[8], pepper bell bacterial spot, potato early blight, potato late blight, tomato bacterial spot, tomato early blight, tomato late blight, Tomato mosaic virus, brinjal tobacco mosaic virus (TMV)[9]and tomato spider mites-based model images and classifications

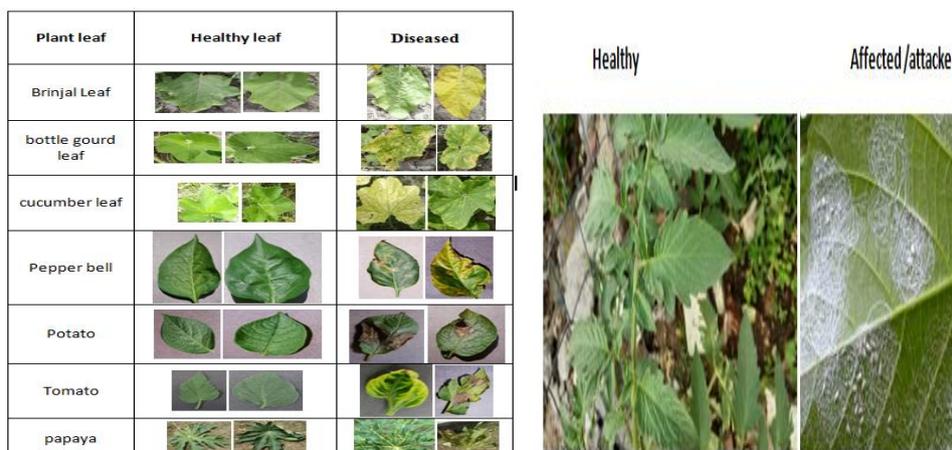


Fig 2. (a)Collected plant Leaves

(b). healthy and affected Leaves

Literature survey:

Plant disease detection is the finest model to find image processing techniques[10]. Fig (2) shows the images that diagnose leaf-infected plants. effective thresholding method is the image converted the histogram models to find the grayscale models and evaluate the models include input images. the normal leaves are the same values as affected and diseased leaves are different values of models. the convolution neural network model is trained in the model of healthy plants and unhealthy leaf images.

- ❖ Digital image processing techniques used to identify deep learning models diseased plants and leaves in the new AI agricultural forming[11] of effective recognition for different diseased labels. the affected vegetable and fruit plants are identified AI agricultural image processing in image classification datasets. It predicts the most accurate results.
- ❖ A Tomato plant is the most important daily usage of vegetables in India. It highly affected diseases in crops and vegetables. Tomato plants are affected by bacteria and viruses. Tomato yellow leaf curl virus (TYLCV) is based on begoma virus genus *geminiviridae*[12] the symptoms of the tomato leaves cupping, curling, and chlorosis on leaves flowers. the basic identification process includes the training data images on the convolution neural network model to differentiate the normal and curling tomato leaves.
- ❖ Pepper bacterial leaf spot in the affected leaves black-edged lesions, brown spots with yellow halos and tissue dries color changed object at break off lives[13]. It trained the model to find edges and to layer perceptron.
- ❖ Potato leaf roll virus (PLRV) [14]symptoms of the unhealthy leaf identification part yellowing, slightly curved, and purple pigmentation edges.it classified images healthy leaves potato early blight, late blight values form of layer values in cell pixel values[15].
- ❖ Papaya plants are affected by the papaya leaf curl virus (PaLcv)[16].it is infected with begoma virus for the family of *geminiviridae*.it transmits whitefly[17] moves and insects. The symptoms of the diseased leaves are curling, crinkling, and deformation of other leaves.
- ❖ Bottle gourd plants affected by diseases[18] of *Cercospora* leaf spot, downy mildew for fungal infections. the virus affected is the cucumber mosaic virus (CMV), squash mosaic virus (SqMV), and watermelon mosaic virus (WMV). the symptoms of diseased plants are mottled leaves, ring spots, disfigured leaves, yellow-green leaves.
- ❖ Cucumber plants are affected by *Alternaria* leaf blight, cucumber mosaic (CMV), Downy mildew, and *Cercospora* leaf spot. the symptoms of disease [19] plants are melon leaf, leaves yellow-spotted, purplish at upper sides of leaves, and gray lesions on leaf veins.
- ❖ Brinjal plants affected *Cercospora* leaf spot, early blight, powdery mildew, and *verticillium* wilt. the symptoms affected plants identified by leaves are yellow blotches, brown and twisted leaves, small circular and oval dark brown spots on the leaf.

Proposed Methodology:

The Deep learning approach on convolutional neural network model used to classification and detection of diseased various plant laves on digital image processing techniques. The proposed methodology using 16 labels data attributes values for plant dataset in CNN models[20] the proposed models plant diseased data identification in the simple convolutional neural network formation models.

Materials and methodology:

1.keras:

Keras is the deep learning API in Python where open-source neural networks are used to include a python library. it based on running on TensorFlow. The Keras API is used to create an unhealthy leaf and healthy leaf models. They included images to classify the model. Sequential preprocessing layers supporting convolutional layers.

2. Convolutional Neural Network

A convolutional neural network is used to class deep neural network models. It applies image processing and identification image layers. Fig (2) shows CNN layer models in a convolution neural network. The CNN model is used to train the image data sets for images. the visual imaginary convolutional networks were planted leaf structured training visual cortex.

$$x_{ij}^{(l)} = \sigma(b + \sum_{c=0}^n W_{r,c} X_{i+r,j+c}^{(l-1)}) \quad \dots (1)$$

In the convolutional layer every neuron input from a rectangular $n \times n$ section of the previous layer. The rectangular section is called a local receptive field. The layer combined with bias and weights to produce a feature map. A parameter could be viewed as a trainable filter or kernel F , the convolutional process could be considered as acting an image convolution and it takes input from the previous layer. The layer is a trainable filter from the input layer to the hidden layer based on a feature map with shared weights and bias.

2.1 convolution layers

A convolution layer was created to apply the filter to input feature maps to classify feed-forward network layers. Detect edges of patterns of a selected image used to reduce the image 256 x 256 size image conversion of the simple CNN training model using jupyter notebook and Keras API.

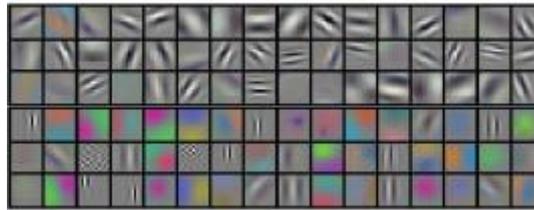


Figure (3). The convolutional kernels of size 11x11x3

2.2 Pooling Layer:

The pooling layer finds the layers and multi-dimension shapes of the mapping constraints. It identified a layer of Plant leaf difference from multiple image classifiers. A layer transformed identified each pixel and values. to convert the layer values connected model.

2.3. Activation Function:

The activation function is used in the RELU function. the convolution channel supports a rectified linear unit. It converts the layer has 32 filters and 3 x 3 kernels of activation function values. Activation function activates neural network plant leaf hidden layer models. The hidden layers are trained and activated function models. It considers normalization values RGB values. its unsupervised learning models created and activated every node in leaf weights.

The SoftMax function is used to normalize exponential function to a multiclass classification method. A function turns a vector real values into vector values of a sum to 1. It classified leaves to multiclass classification in a multi-layer neural network.

2.5 Fully Connected Layer:

The fully connected layer is an essential neural network component model. It connected max pooling image data set attributes CNN values its concurrent data leaf data set values identification unhealthy leaf variation data image values. Deep neural network models find hidden layers connected to the node of the image values in different layer models. Collected layer values in features analyzing independent values displayed. The convolutional model of kernel 3x3 values in running nodes and hidden layers.

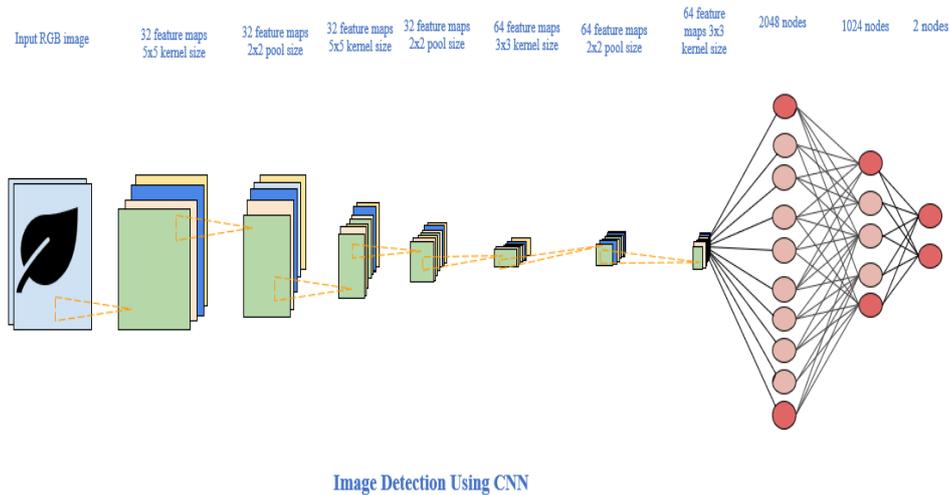


Fig4.Convolutional Neural Network Image Detection

2.6. Deep learning approach

The deep learning approaches are based on convolutional network layers. The image detection object-based trained models basically ImageNet models connect the convolutional layers. The existing deep learning approach to find the deep convolutional neural network model and Alex net classification image approach.

Alex Net:

The Alex Net is based to work deep learning ImageNet data classifiers connect to the trained neurons to interconnected layers[21]. They connected 5 convolutional layers and 3 fully connected layers in 96 kernels. The Alex net is comprised of eight layers. The input images were converted to 256 x 256 size of the RGB pixel format. The maxpooling layers extract a maximum number of features. The kernel size starting 96 kernels size of 11x11x3. the size converted to data augmentation 256 x 256 to 224 x 224 size. The pooling layers and convolutional layers running to the padding process. in fully connected neurons reached 4096 nodes based on 2 layers connected for SoftMax activation function. to filter and reduced values. to finally connected output 1000 classes to the image models.

Dataset and attributes:

A plant leaf diseased data set collected from internet plant village dataset for 45% of images for tomato, paper bell, potato leaf healthy and diseased images. 55% of images taken from around Tamilnadu Villupuram district[22] villages (Marakkanam, Tindivanam, and Vanur taluk) for adding papaya, brinjal, bottle gourd, cucumber healthy and diseased leaves. Table (1) shows on total collected leaves. The images are resized for 300 dpi inches, 256 x 256 sized. Each image size 20-25kb size converted formats total collecting leaves trained for 600 each healthy and diseased plants connecting fully connected layers in 21 class labels Fig (5). the converted images classified on the trained model.

Table 1. Total number of plants and leaves images datasets

Plant leaf	Healthy leaf	Diseased	Total
Brinjal Leaf	623	800	1423
Bottle Gourd Leaf	654	780	1434
Cucumber Leaf	700	870	1570
Pepper Bell leaf	1400	1000	2400
Potato leaf	900	2000	2900
Tomato leaf	1590	13000	14590
Papaya leaf	855	1000	1855
Total	6722	19450	26172

```
print(label_binarizer.classes_)  
  
['Pepper_bell__Bacterial_spot' 'Pepper_bell__healthy'  
'Potato__Early_blight' 'Potato__Late_blight' 'Potato__healthy'  
'Tomato_Bacterial_spot' 'Tomato_Early_blight' 'Tomato_Late_blight'  
'Tomato_Leaf_Mold' 'Tomato_Septoria_leaf_spot'  
'Tomato_Spider_mites_Two_spotted_spider_mite' 'Tomato__Target_Spot'  
'Tomato__Tomato_YellowLeaf_Curl_Virus' 'Tomato__Tomato_mosaic_virus'  
'Tomato_healthy' 'bottle_gourd_leaf_healthy' 'bottlegourd_leaf_disease'  
'brinjal_leaf_disease_Tmv' 'brinjal_leaf_healthy' 'cucumber_leaf_disease'  
'cucumber_leaf_healthy']
```

Fig5. Representing Dataset Class Labels

2.6. Trained Data:

The data trained API models included trained test data sets using python 3.7 version and Keras based on TensorFlow platforms backend. the python GPU is used to create layers of the batch process. The training system machine is an intel corei7 processor 16 Gb Ram and Nvidia 6 Gb 1660ti Graphical processing unit. the image data sets stored multiple data folders of healthy leaves and diseased leaves format. it resized the form of normalization to train a convolution model to split data in the trained model shows in sequential format of the weights of the plant leaf images to fit the parameters on Fig (6). It identifies the validation data sets to tune classifier diseases of plant leaves Fig (7). The time of running model 21 labels in 50 epoch iteration values is 485sec per epoch training model. The total time is 6 hours 55min in the running model.

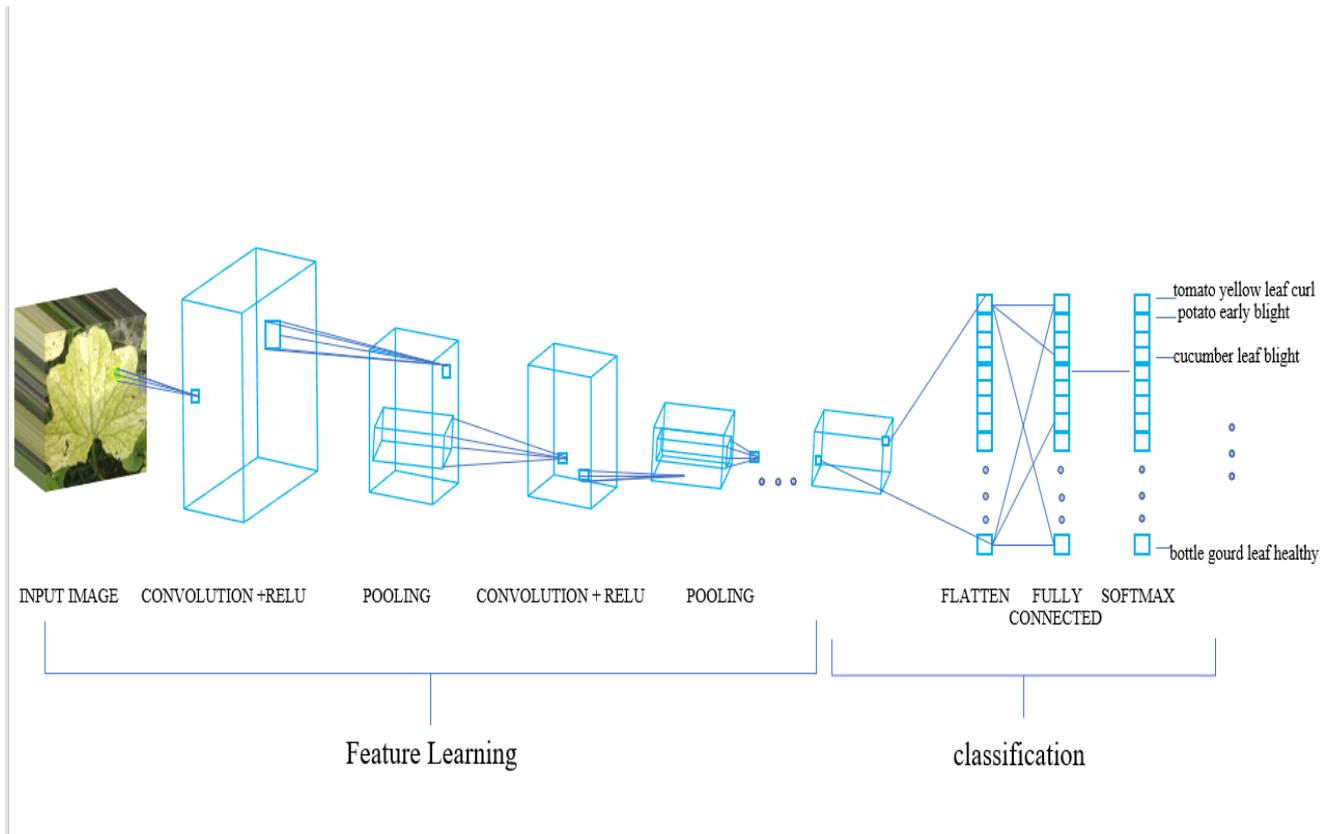


Fig 6. Block Diagram Classification CNN Method

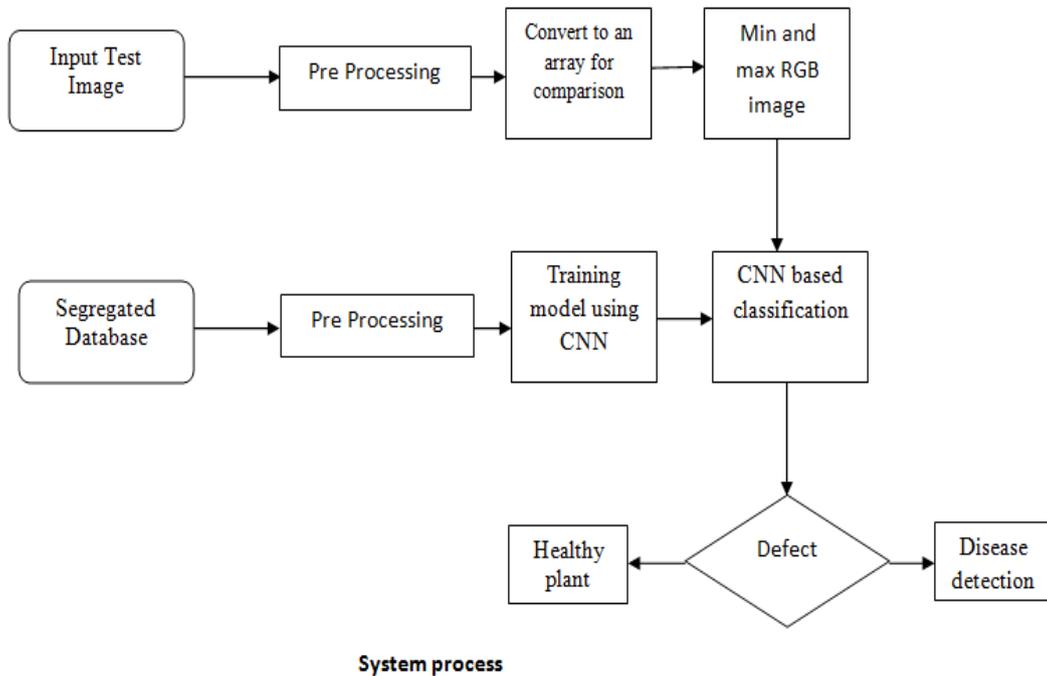


Fig7. Block Diagram of Disease Detection System

The plant healthy and unhealthy images are collected and stored in input test images. It is preprocessed to be converted to matrix array formation. The RGB values of the image preprocessing Fig (7). Input data by scaling the data points from 0,255 values of minimum and maximum. The range of 0,1. It connects to the CNN-based ImageNet classification deep Convolutional neural network model. The segregated databases of image data set models preprocessing of converting models. The training model using a convolutional neural network model in the weights of the layers. It connects to the ImageNet classification model. The two sides of the models training model and input RGB images are classified and detect the defected diseased detection and healthy plant leaves.

Result and analysis:

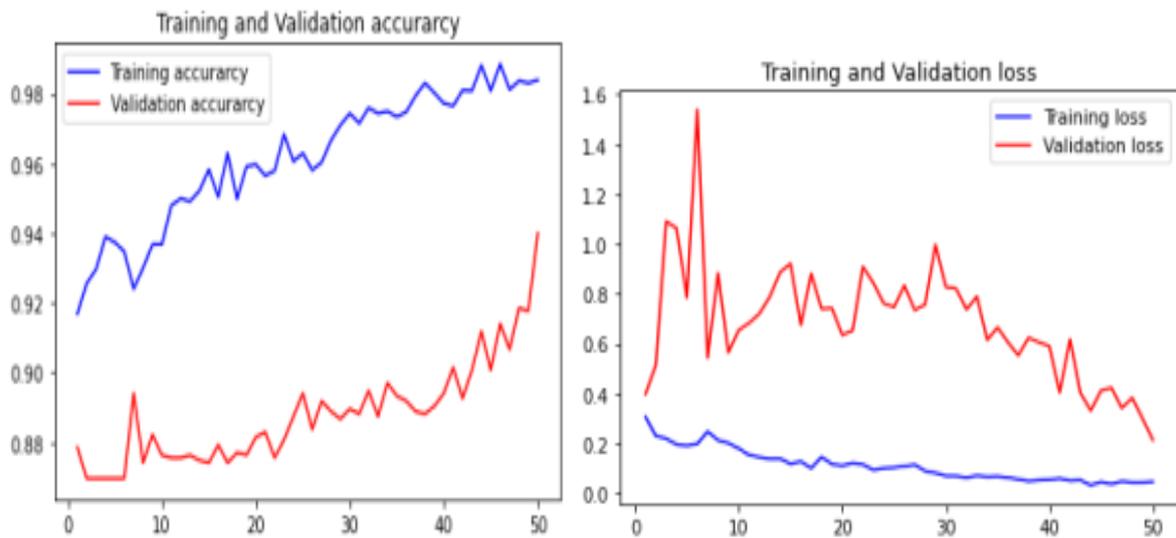


Fig8.validation of training accuracy and loss model

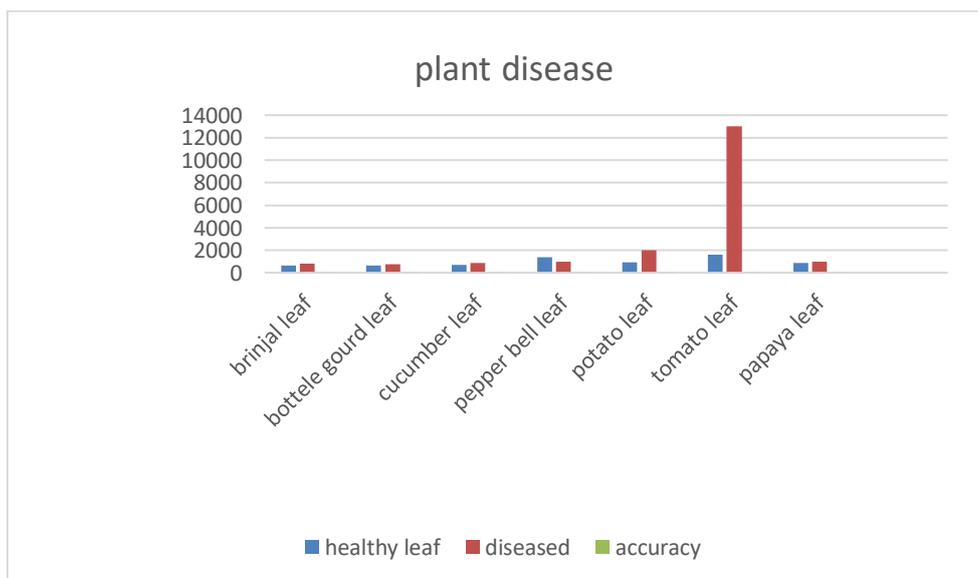


Fig 9. (a)Plant Disease and Accuracy

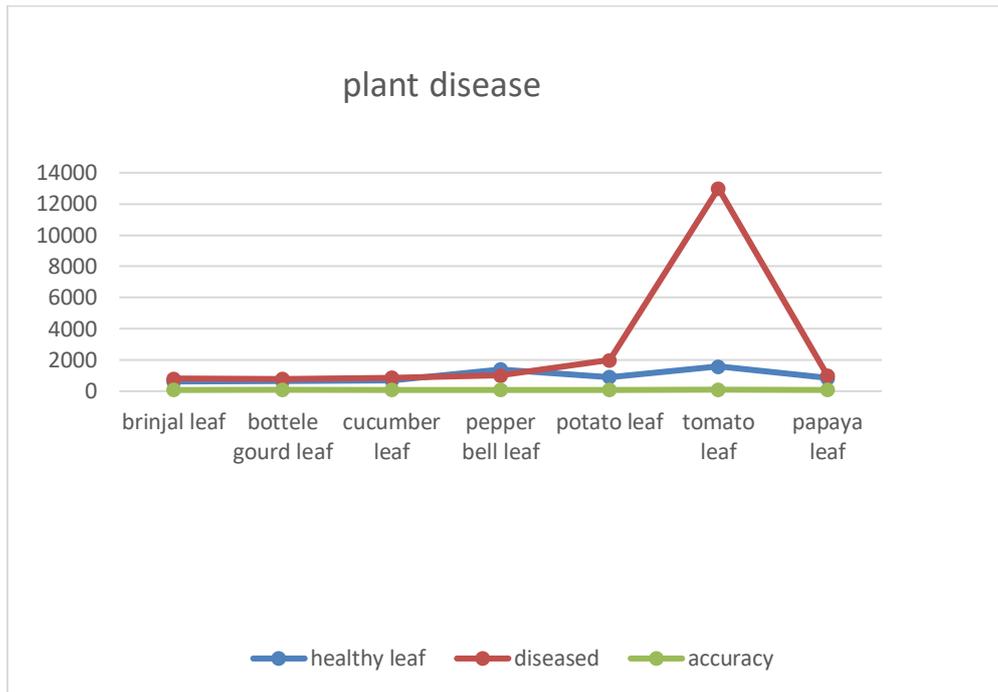


Fig 9. (b)Plant Disease and Accuracy

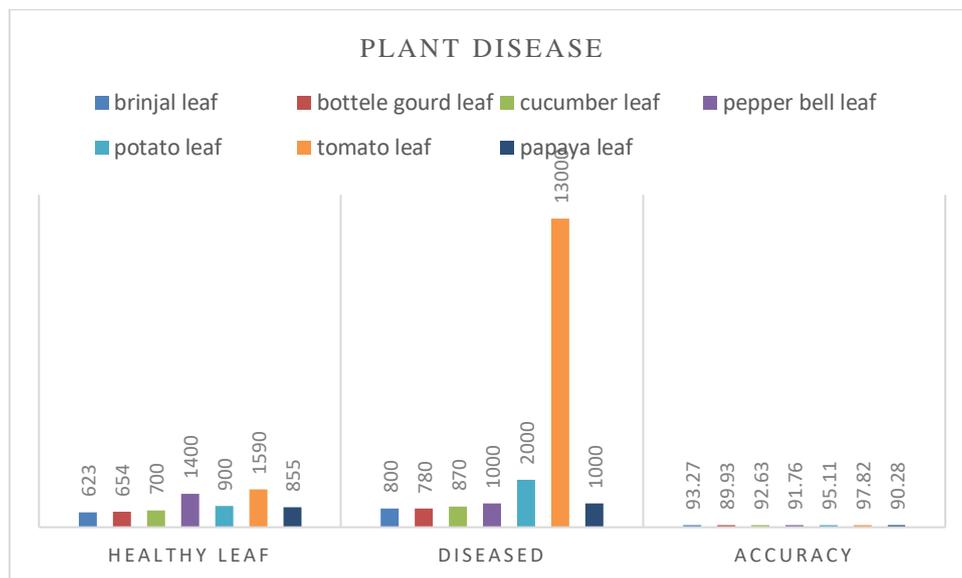


Fig 9. (c)Plant Disease and Accuracy

The trained model archives high accuracy in the tomato disease trained model Fig (9). The high accuracy achieved by training images is high in diseased images and healthy images. The plant diseased training model different form of all the combined training model and testing accuracy values in different leaves of bottle gourd and tomato Fig 9(c). the diseased plant leaves higher than healthy leaves affected by the accuracy levels Fig 9 (b).

```
print("[INFO] Calculating model accuracy")  
scores = model.evaluate(x_test, y_test)  
print(f"Test Accuracy: {scores[1]*100}")
```

```
[INFO] Calculating model accuracy  
645/645 [=====] - 8s 3ms / step  
Test Accuracy : 93.99999976158142
```

Fig10. Output accuracy of the trained model

Conclusion and Future Scope:

The plant leaf disease detection research in a very effective of agricultural plants and vegetable departments. the classification of multiple plant leaves was identified to use the model leaf structured and diseased. It trained 21 labels the 50 times epochs iteration feed-forward model to a different part of plant diseases in a particular part of leaf detection. it recognizes most of the time in multiple leaves. The Tamilnadu agricultural weather conditions and plant virus diseases different from other countries. this trained digital images model 55% Tamilnadu live image dataset accuracy level of training model of 93.99 % in the levels. The future scope used the trained model to find the live digital video processing to the identification of plant leaves disease detection of drone mapping and pest suggestions.

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