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Chilli Plant Disease Detection and Classification using DenseNet CNN Approach

Sheenu. N. V[1], Dr. K Anusudha[2]
[1]M .Tech, ECE, Department of Electronics Engineering, Pondicherry University
[2]Assistant Professor, Department of Electronics Engineering, Pondicherry University

Abstract: To fulfil the food requirement and economic growth, farming plays a very important role. Thus Farmers are the most important people in the world. Be it the smallest or the largest country, Because of them only we are able to live on the planet. Precision agriculture is the new trending term in the field of technology whose main motive is to reduce the workload ofthe farmers and increase the productivity of the farms by using technologies.

So the aim of this work is to detect the disease of the plant by classifying their leaves using deep learning algorithm. For this work chilli plants are considered, because of their economic importance. And there are various problems in chilli production due to the presence of various micro-organisms and pathogens and The plant disease detection can be done by observing the spot on the leaves of the affected plant. The method here adopting to detect plant diseases is image processing using Dense Net based Convolution neural network (CNN). CNN will be used for leaf image classification and will produce the good results with a good accuracy.

Keywords: Image processing, DENSE NET, CNN algorithm

I. INTRODUCTION

Agriculture is the most important sector of Indian economy. Indian agriculture sector accounts for 18 per cent of India's gross domestic product (GDP) and provides employment to 50% of the countries workforce. India is the largest producer and also the largest consumer of chilli in the world. There are many nutritional, medicinal and economic benefits of its production. Chilli is not only an important ingredient in food but is also used for essence production. It is used in foods for pungency and red colour while it also contributes in part tothe flavor of ginger ales. Chillies are an excellent source of vitamins A, B, C, E and P. But there are several problems in chilli production due to the presence of various micro-organisms and pathogens. The percentage of the yearly destroyed chilli crops by disease and pathogen is about 38% of the world's total agricultural. Manual grading of chilliis taking long period of time. Thus to overcome this manual method we need automated software for analyzing and grading of diseased chilli. To perceive a plant infection in very preliminary phase, usage of instinctive disease recognition procedure is advantageous. The newest group of convolutional neural networks (CNNs) has accomplished exciting outcomes in the arena of image cataloguing. Machine learning algorithms are also using for disease detection, but deep learning will help to get a high accuracy. The plant disease detection can be done by observing the spot on the leaves of the affected plant. The method here adopting to detect plant diseases is image processing using Dense Net based Convolution neural network(CNN).CNN will be used for leaf image classification and will produce the good results with a good accuracy.

II. LITERATURE REVIEW

The k-mean clustering procedure is utilized for the segmentation of input images. The GLCM (gray-level co-occurrence matrices) procedure is utilized which excerpts textural features from the input image and implementation of KNN (k-nearest neighbours) algorithm for image classification and produced classification accuracy from 70 to 75% for different inputs [1]. To remove unwanted noise from the captured image, different pre-processing and filtering techniques are used in [2]. Leaf features inspection methodology is used for early detection of chilli disease in [3].Machine learning applications for precision agriculture and it's comparison has been done in [4].Different wheat disease classification methods using decision trees are explained in[5].In [6], deep learning based leaf disease detection is explained. Textural feature extraction of leaves using GLCM and it's execution in MATLAB is explained in [7-10].

Ground nut leaf disease detection and classification using KNN is explained in [11]. A CNN method to identify 14 crop modules and 26 sicknesses. Finally, the method of working out deep learning prototypes on progressively great and openly accessible image groups offerings a clear track in the direction of smartphone helped crop disease identification on a enormous overall measure[12].

Early detection of plant diseases using different machine learning algorithms are explained in [13-20]. Machine learning uses algorithms to parse data, learn from that data, and make informed decisions based on what it has learned. Deep learning structures algorithms in layers to create an "artificial neural network" that can learn and make intelligent decisions on its own. (A deep learning model is designed to continually analyze data with a logic structure similar to how a human would draw conclusions. To achieve this, deep learning applications use a layered structure of algorithms called an **artificial neural network**. The design of an artificial neural network is inspired by the biological neural network of the human brain, leading to a process of learning that's far more capable than that of standard machine learning models. Deep learning is a subfield of machine learning. While both fall under the broad category of artificial intelligence, deep learning is what powers the most human-like artificial intelligence. While comparing the accuracy of machine learning and deep learning classifier,we can see deep learning will be helpful to get a high accuracy.)

Accuracy: Deep learning algorithms	Machine learning algorithms
ANN 84-93%	KNN 70-92%
CNN 95-99.9%	SVM 80-95%
R-CNN 95-100%	Random forest 80-94%

Table 2.1

III. MAJOR CHILLI PLANT DISEASES

1) *Bacterial spot (Xanthomonas campestris pv. Vesicatoria):* It is caused by mainly bacteriasThe leaves exhibit small circular or irregular, dark brown or black greasy spots. As the spots enlarge in size, the centre becomes lighter Surrounded by a dark band of tissue.The spot coalesce to form irregular lesions. Severely affected leaves become chlorotic and fall off. The spots turn brown developing a depression in the centre wherein shining droplets of Bacterial cozen may be observed.
2) *Leaf curl (PepLCV):* It is a most dangerous and destructive disease in chillies. It is caused by virus. It is a deformation and reciprocity of leaves. It also makes the leaves yellow or red. In peach it is caused by fungus.
3) *Whiteflies (Bemisia tabasi Gen):* The damage that whiteflies cause to a crop is the result of sucking out the sap from the plant leaves and secreting honeydew. In full sunlight, leaves can wilt and fall. Such leaf damage can in turn influence the development of fruit and lead to a reduction in yield.This will be spreaded by fungus.
4) *Yellowish (Candidatus Phytoplasma Asteris):* Pepper Plant Leaves are Yellow Due to a Lack of Water and Nutrients. One of the two most common reasons for yellow leaves on a pepper plant is either under watering or a lack of nutrients in the soil. In both of these cases, pepper plants will also be stunted and will commonly drop the pepper flowers or fruit.

1 2 3 4

Fig 3.1: Major chilli plant diseases

IV. EXISTING MODEL

In the existing work, Adaptive histogram equalization is used in pre –processing. The k-mean clustering procedure is utilized for the segmentation of input images. The GLCM (gray-level co-occurrence matrices) procedure is utilized which excerpts textural features from the input image and implementation of KNN (k-nearest neighbors) algorithm for image classification and it produced a classification accuracy from 75 to 82% for different inputs. The work has been executed by using MATLAB software.

Block Diagram

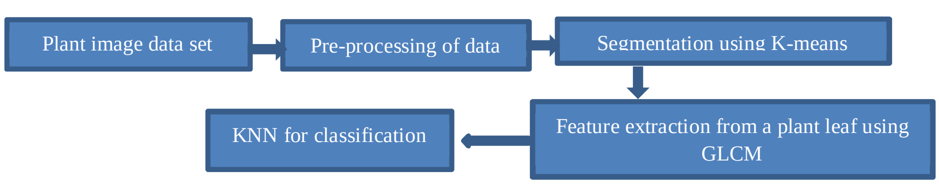

Fig 4.1

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V. PROPOSED MODEL

The proposed model is completely different from the existing model.As in the existingmodel machine learning algorithm is used for the classification (KNN), For the proposed deep learning algorithm is used (Convolutional neural network -CNN).DENSE NET architecture is used here.The idea is to detect maximum of 4 major diseases in chilli plants namely bacterial spot, leaf curl(viral), white flies(fungal)and yellowish(due to green pigment).The maximum accuracy of this model is 99.85%.we can say this a early detection method, as before the plant startruins completely,it will be detected.

A. Software Used

Anaconda (Python distribution). Anaconda distribution comes with more than 1,500 packages as well as the conda package and virtual environment manager. It also includes a GUI, Anaconda Navigator, as a graphical alternative to the command line interface (CLI).The main advantage of this software is that it will use keras and tensor flows for the training. It minimizes the number of user actions need for frequent use cases · Provide actionable feedback upon user error

Block diagram

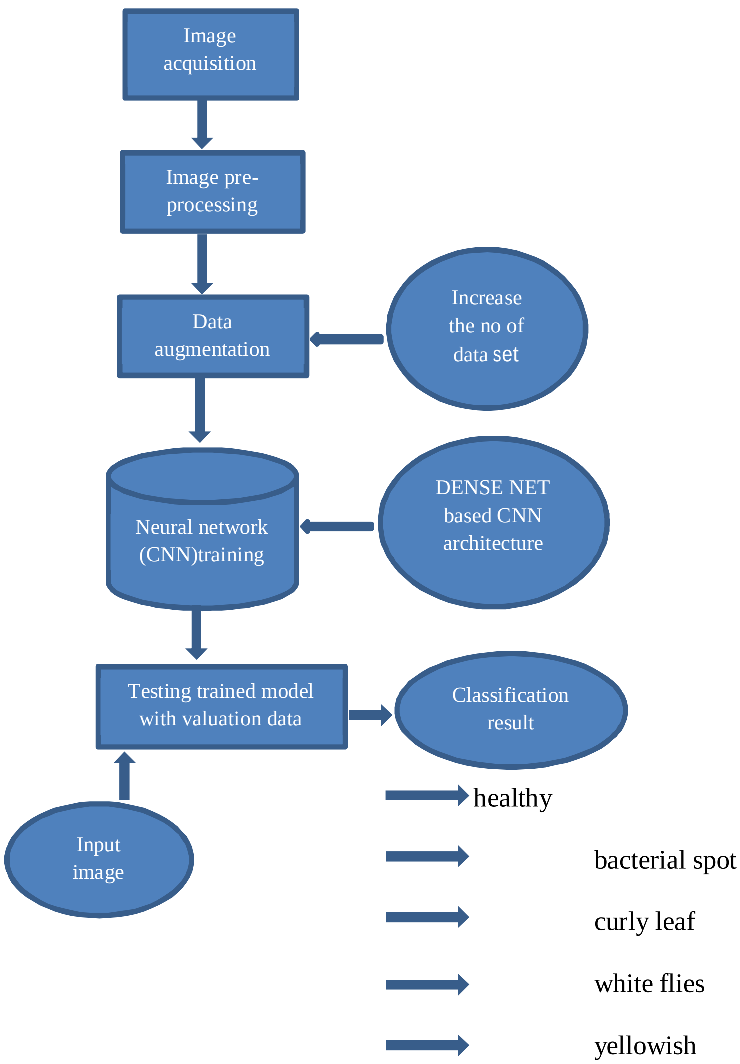

Fig 5.1:

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B. Steps Of Proposed Model

1) *Image Acquisition:* All the images were collected from home garden and downloaded from plant villa website.
2) *Image Pre-Processing:* Images collected were in various formats along with different resolutions and quality. In order to get better feature extraction, final images intended to be used as dataset for deep neural network classifier were preprocessed in order to gain consistency. Furthermore, procedure of image preprocessing involved cropping of all the images manually,

a) In order to highlight the region of interest,
b) Image resizig,
c) Transform the loaded training image data into numpy array
d) Check the number of images loaed for training,
e) Image labeling

3) *Augmentation Process :* The main purpose of applying augmentation is to increase the dataset and introduce slight distortion to the images which helps in reducing overfitting during the training stage.Image data augmentation is a technique that can be used to artificially expand the size of a training dataset by creating modified versions of images in the dataset.Training deep learning neural network models on more data can result in more skillful models, and the augmentation techniques can create variations of the images that can improve the ability of the fit models to generalize what they have learned to new images.
4) *Neural Network Training:* The main goal of training the network is for neural network to learn the features that distinguish one class from the others. Therefore, when using more augmented images, the chance for the network to learn the appropriate features has been increased. DENSE NET based CNN architecture is used here.
5) *Testing Trained Model with Valuation Data:* Finally the trained network is used to detect the disease by processing the input images in valuation dataset and results are processed based on edge detection.. 5 classification categories are considered here.They are Healthy leaf,Bacterial spot,Leaf curl,White flies and yellowish

VI. RESULTS

The different outputs obtained from each stage of the program are displayed in the following figures;

1) *DENSE NET Architecture :* model: “sequential”

Layer (type)	Output Shape	Param #
densenet169 (Functional)	(None, 7, 7, 1664)	12642880
dropout (Dropout)	(None, 7, 7, 1664)	0
flatten (Flatten)	(None, 81536)	0
batch_normalization (BatchNo	(None, 81536)	326144
dense (Dense)	(None, 2048)	166987776
batch_normalization_1 (Batch	(None, 2048)	8192
activation (Activation)	(None, 2048)	0
dropout_1 (Dropout)	(None, 2048)	0
dense_1 (Dense)	(None, 1024)	2098176
batch_normalization_2 (Batch	(None, 1024)	4096
activation_1 (Activation)	(None, 1024)	0
dropout_2 (Dropout)	(None, 1024)	0
dense_2 (Dense)	(None, 5)	5125

Total params: 182,072,389
Trainable params: 169,260,293
Non-trainable params: 12,812,096

Fig 6.1

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2) *Adding Dropout into the Network:* We can add a dropout layer to overcome the problem of overfitting to some extent. Dropout randomly turns off a fraction of neurons during the training process, reducing the dependency on the training set by some amount. How many fractions of neurons you want to turn off is decided by a hyper parameter, which can be tuned accordingly. This way, turning off some neurons will not allow the network to memorize the training data since not all the neurons will be active at the same time and the inactive neurons will not be able to learn anything.
3) *Training Results:* Table 2& 3 shows the training results.where ETA,loss and accuracy were mentioned during each stage of the training.where ETA is the estimated time of arrival.

ETA(seconds**)**	**LOSS**	**ACCURACY(%)**
228	1.3681	84.12
202	0.8066	93.19
197	0.6695	94.96
201	0.5836	95.60
148	0.4478	97.52
150	0.3947	97.61
189	0.3351	98.49
144	0.4128	97.91
146	0.1622	99.49
187	0.3276	97.89
145	0.3799	97.99
149	0.2641	98.84
156	0.2263	99.00
149	0.1793	99.41
151	0.1664	99.64

Table 6.1

ETA(seconds)	LOSS	ACCURACY(%)
181	0.2148	99.18
148	0.2349	98.85
146	0.1947	99.15
159	0.1599	99.69
148	0.1992	99.54
148	0.1491	99.52
148	0.2259	99.28
148	0.1491	99.52
149	0.2361	99.23
153	0.1024	99.83
164	0.1327	99.58

Table 6.2

Precision, Recall, F1score also calculated here for a better performance analysis.Their range from 1st epoch to last epoch are:

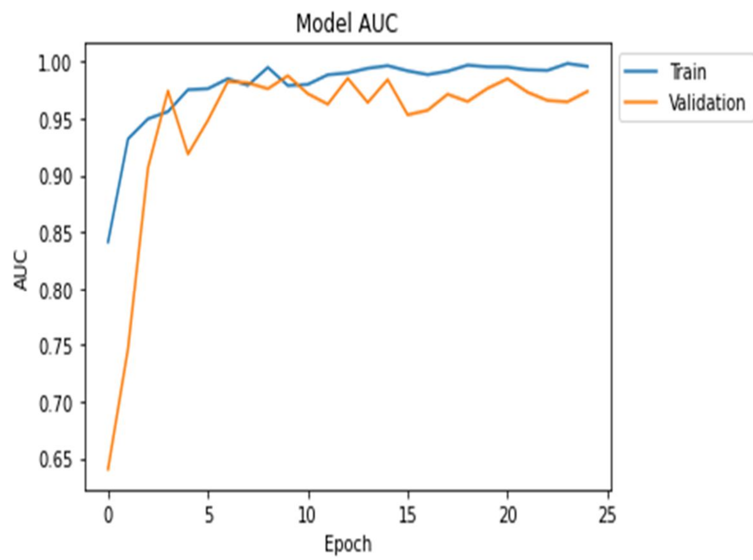
Precision: 0.5964 to 0.9949

Recall: 0.4983 to 0.9956

F1 Score: 0.5429 to0.9952

4) Model Evaluation on the Test Set

Training and validation accuracy



Training and validation loss

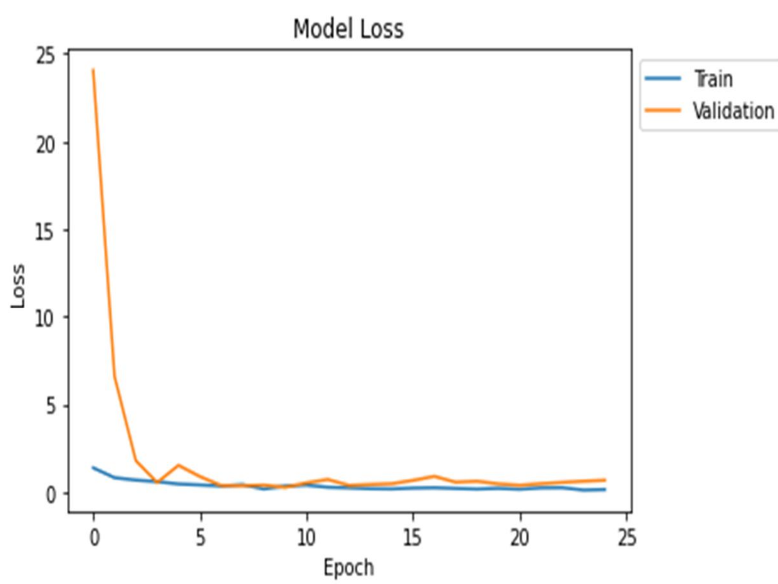


Fig 6.2

5) *Deep Feature Extraction*

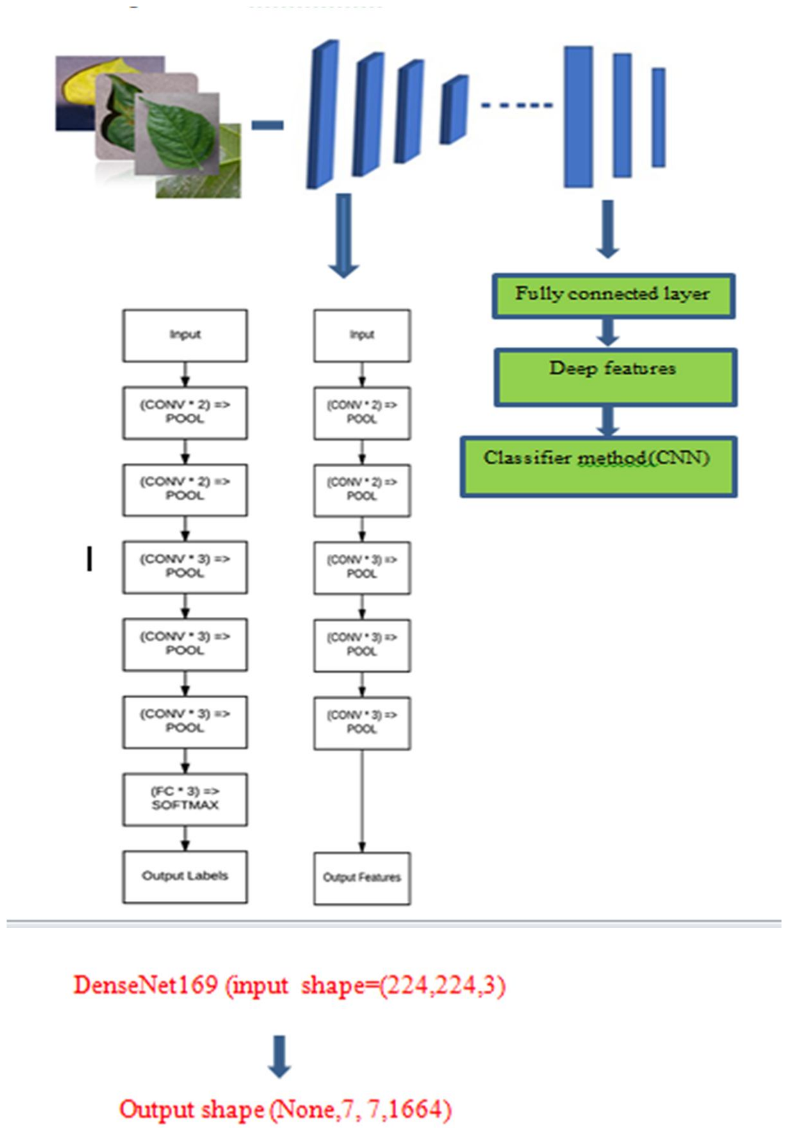
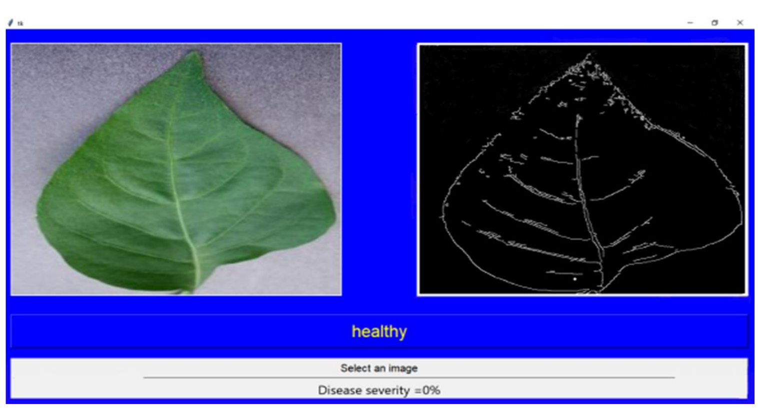


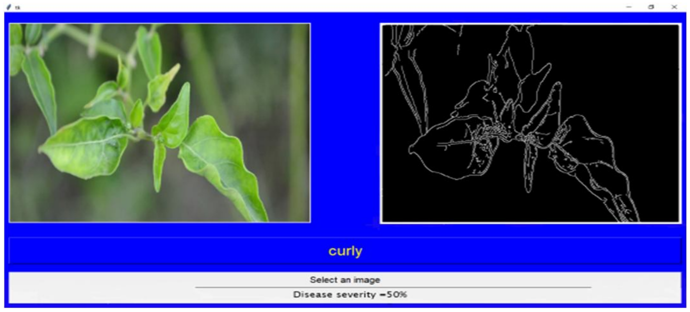
Figure 6.3

6) *Classification results : (5 classes)*

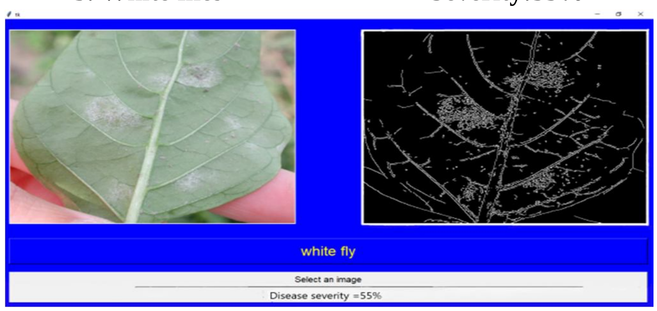
1.Healthy leaf **Severity: 0%**



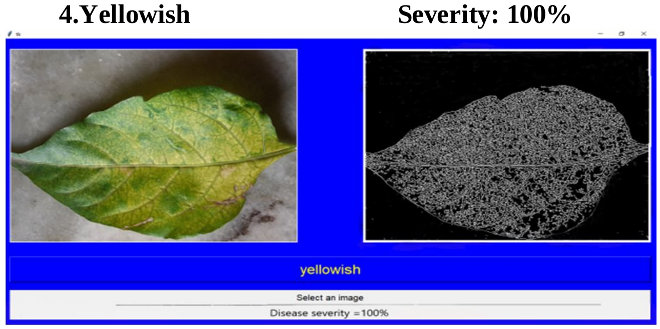
2.curly leaf **Severity:50%**



3. White flies **Severity:55%**



4.Yellowish **Severity: 100%**



5.Bacterial spot **Severity :30%**

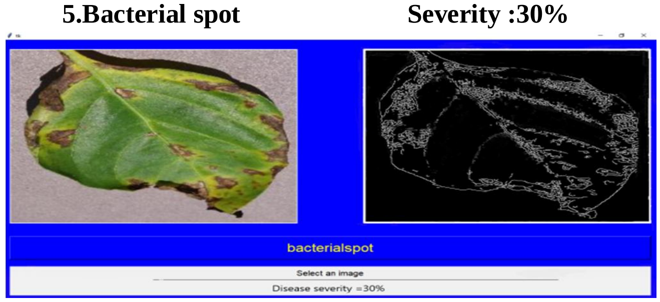


Fig 6.4

7) Disease Severity Calculation

Disease severity is the area (relative or absolute) of the sampling unit (leaf) showing symptoms of disease. It is expressed as a percentage or proportion The disease severity of the plant leaves is measured by the lesion area and leaf area ratio.

$$S = A_d / A_l$$

$$= P \sum_{(x, y) \in R_d} 1 \Big/ P \sum_{(x, y) \in R_l} 1$$

$$= \sum_{(x, y) \in R_d} 1 \Big/ \sum_{(x, y) \in R_l} 1$$

$$= P_d / P_l$$

VII. CONCLUSION AND FUTURE SCOPE

India is the largest producer and also the largest consumer of chilli in the world.There are many nutritional, medicinal and economic benefits of its production.So it is a very integral part of our indian economy. The percentage of the yearly destroyed chilli crops by disease and pathogen is about 38% of the world's total agricultural. SManual grading of chilliis taking long period of time. Thus to overcome this manual method we need automated software for analyzing and grading of diseased chilli. The accuracy of the result from the existing model is found to be 75-82% whereas in the proposed model accuracy is improved to 99.85%.Only 2fungal and 1 bacterial diseases were detected in the existing work, in proposed 4 disease categories are there namely, bacterial spot, leaf curl(viral),white flies(fungal),yellowish(lack of green pigment). And in the proposed method there is no need to extract the textural features because here in CNN, A CNN is composed of two basic parts of feature extraction and classification. Feature extraction includes several convolution layers followed by max-pooling and an activation function. The classifier usually consists of fully connected layers. In future, this work can be implemented with large no of data set by including large variety of diseases of different crops.

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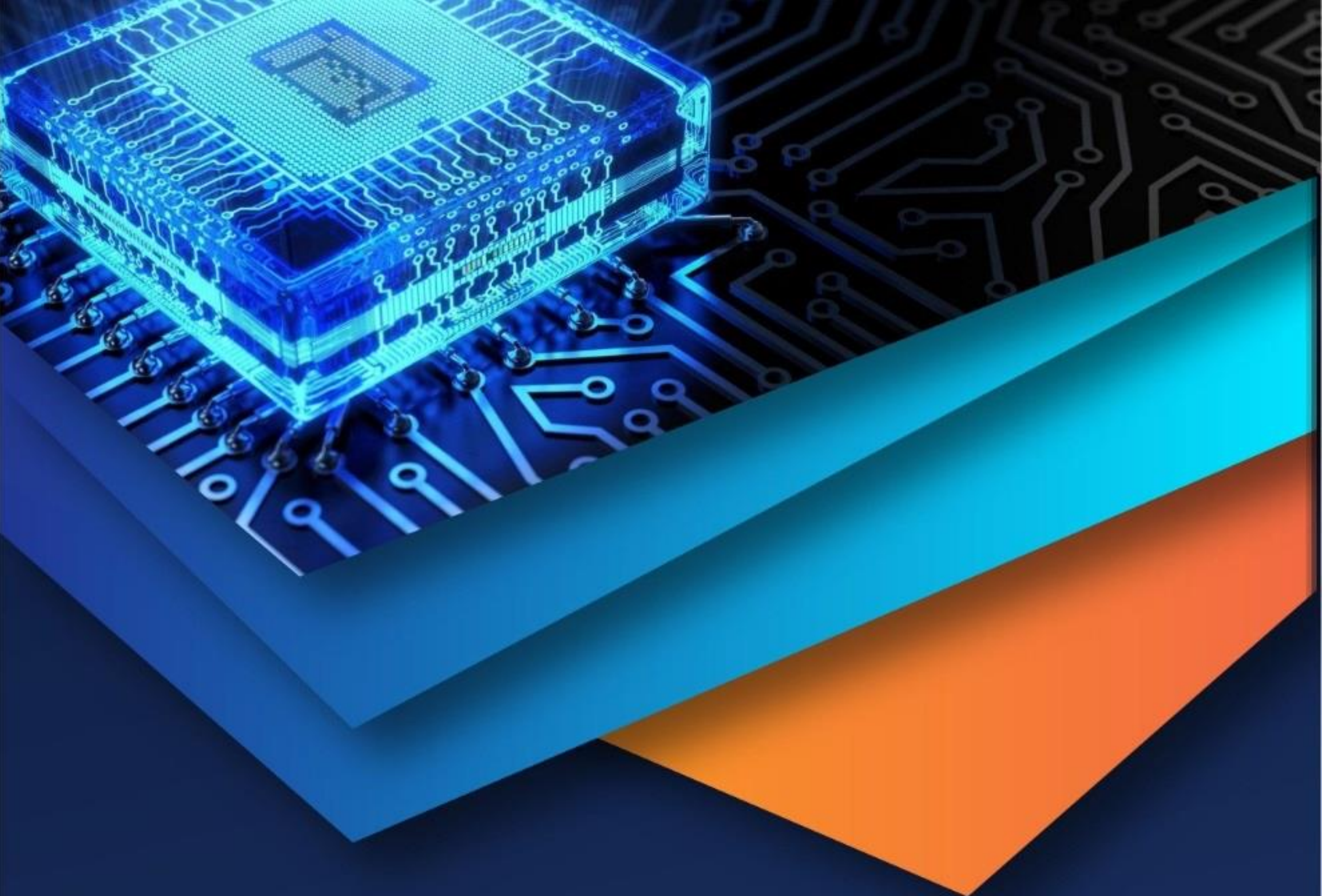

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