Leaf Disease Detection and Recommendation of Pesticides using Convolution Neural Network

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Abstract—**Crop production problems are common in India which severely effect rural farmers, agriculture sector and the country's economy as a whole. In Crops leaf plays an important role as it gives information about the quantity and quality of agriculture yield in advance depending upon the condition of leaf. In this paper we proposed the system which works on preprocessing, feature extraction of leaf images from plant village dataset followed by convolution neural network for classification of disease and recommending Pesticides using Tensor flow technology. The main two processes that we use in our system is android application with Java Web Services and Deep Learning. We have use Convolution Neural Network with different layers five, four & three to train our model and android application as a user interface with JWS for interaction between these systems. Our results show that the highest accuracy achieved for 5-layer model with 95.05% for 15 epochs and highest validation accuracy achieved is for 5-layer model with 89.67% for 20 epochs using tensor flow.**

Keywords—CNN, Tensor flow, Leaf Disease, ANN.

I. INTRODUCTION

Technology helps human beings in increasing the production of food. However the production of food can be affected by number of factor such as climatic change, diseases, soil fertility etc. Out of these, disease plays major role to affect the production of food. Agriculture plays an important role in Indian economy. Leaf spot diseases weaken trees and shrubs by interrupting photosynthesis, the process by which plants create energy that sustains growth and defense systems and influences survival[1].Over 58% smallholder farmer depends on agriculture as their principal means of livelihood. In the developing world, more than 80 percent of the agricultural production is generated by smallholder farmers, and reports of yield loss of more than 50% due to pests and diseases are common[2].The production is decreasing day by day with various factors and one of them is diseases on plants which are not detected early stage. There is various work is done in previous years. Bacterial disease reduces plants growth very fastly so to detect this type of diseases ,Dheeb Al Bashish, Malik Braik, and Sulieman Bani-Ahmad [3] created system which detect the type of disease the plants have using image processing and color space transformation which creates device independent transformation. Identifying the disease at an early stage and suggesting the solution so that maximum harm can be avoided to increase the crop yield [4] have used ANN and K-means to classify the disease and grade the disease for. There is a need to design the automatic system to detect the leaf disease and recommend the proper pesticide. Pesticides on rice for controlling the disease damages the rice filed [5] created which will detect diseases at early stage. Which pesticides to use for which type of disease is the important task [6] gives the solution to which type of pesticides use. The paper is organized into following sections. Section 1 gives the introductory part and importance of automatic system design for early detection of leaf disease. Section 2 gives the current work done in this area. Third section include proposed methodology for leaf disease and recommending pesticide using CNN and Tensor flow tech. section 4 discuss the performance analysis and finally section 5th conclude the paper.

II. LITRARTURE SURVEY

The system by Xingchun Chen and Ron Roeber [7] focuses on Plant diseases like fungal diseases which reduces crop production. The wetness in leaf, environmental and soil data gathered from different sources. The site is connected to High plain regional climate center (HPRCC) weather server .The system is built in a zope web server with MYSQL relational databases support. Zope is as an open source web application server, is written in Python and built for content management systems. A model build by J. Duthie [8] and S. Pennypacker Et al. [9] is one of the most famous models for predicting infectiousness of disease. Both papers use a Weibull probability density function(PDF)and consider the effects of temperature and wetness duration. The proposed work is about automatic detection of diseases and diseased part present in the leaf images of plants of grape using SVM. This study contains a unique work that is it will calculate the % of infected area of plants[10]. Demonstration of the technical feasibility of a deep learning approach to enable automatic disease diagnosis through image recognition Classify Crop species & disease status of 38 different classes containing 14 crop species and 26 diseases achieving accuracy of over 99% using Deep Convolution Neural network AlexNet, GoogLeNet, Stochastic Gradian Descent[11]. The study compared the performance of PLSR, ν-SVR, and GPR with the PRI and NBNDVI. The experiment was conducted in the greenhouse under controlled conditions to study the different disease symptoms effects on reflectance of the leaves for Wheat leaf rust disease [12]. CNN based on the AlexNet architecture is able to significantly outperform the baseline MLP, showing comparable performance to that of a group experts and outperforming any single expert. They have used Dataset of 2539 images of Apple Tree Species: Maxigala, Fuji Suprema and Pink Lady for Diseases: nutritional imbalances leaves with potassium and magnesium deficiency, damage (apple tree scab and Glomerella's stains),(391,558),herbicide damage (glyphosate) 325,569 healthy leaves)[13]. Robotic

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detection system for combined detection of two major threats of greenhouse bell peppers: Powdery mildew (PM) and Tomato spotted wilt virus (TSWV).they have used the tech like Principal Component Analysis for PM ,Principal Component Analysis for TSWV,Coefficient of Variation of TSWV Symptom Pattern the result shows For TSWV, PCA-based classification with leaf vein removal, achieved the highest classification accuracy (90%) while the accuracy of the CV methods was also high (85% and 87%). For PM, PCA-based pixel-level classification was high (95.2%) while leaf condition classification accuracy was low (64.3%) since it was determined based on the upper side of the leaf while disease symptoms start on its lower side [14]. In the paper [15] an FCM clustering and neural network classification based approach is proposed to detect and quantify the severity for late blight disease of potato.[16] A survey on methods that use digital image processing techniques like ANN,SVM,SOM,Fuzzy Logic,Thresholding, color Analysis. to detect, quantify and classify plant diseases from digital images in the visible spectrum. [17]image analysis and classification techniques for extraction and classification of leaf diseases. Leaf image is captured and then processed to determine the status of each plant using GLCM texture feature and color textures features are extracted for further classification purpose. Finally classification based on SVM. Lucas G. Nachtigall, Ricardo M. Araujo and Gilmar R. Nachtigall [18] consider the apple plants for disease detection on the datasets of 2539 images and 6 known disorders using convolutional neural network. By detecting the different stages of plants disease, it helps to diagnoses and prevent further loss of yield and [19] proposes method which gives different stages of plants disease and for this they used spectral data. The spectral data is collected using ASD spectroradiometer (Analytical Spectral Device, Boulder, CO, USA).By using the wavelength the system is able to find out severity of disease for which they used different math's function. [20] used A Flash FPGA and a DSP in plant disease remote monitoring and control system. The FPGA is used to acquire and transmit the field plant image or video data for subsequent monitoring and diagnosis, the DSP TMS320DM642 to process and encode video or image data to get high transfer efficiency, the nRF24L01 single chip 2.4GHz radio transceiver is used for wireless data transfer.

III. PROPOSED METHODOLOGY

The main aim is to design a system which is efficient and which provide disease name and pesticides name as fast as possible. For that purpose we use two phase: 1st is training phase and 2nd is testing phase. In 1st phase: Image acquisition, Image Pre-processing and CNN based training. In 2nd phase Image acquisition, Image Pre-processing, Classification and disease identification and pesticides identification. For experimentation purpose we have used PlantVillage datasets. The data records contain 54,309 images. The images span 14 crop species: Apple, Blueberry, Cherry, Corn, Grape, Orange, Peach, Bell Pepper, Potato, Raspberry, Soybean, Squash, Strawberry, Tomato. It contains images of 17 fungal diseases, 4 bacterial diseases, 2 mold(oomycete) diseases, 2 viral disease, and 1 disease caused by a mite. 12 crop species also have images of healthy leaves that are not visibly affected by a disease. The following figures show the overall model of the system and sample images from dataset.

Fig. 1. sample images of leaves from dataset

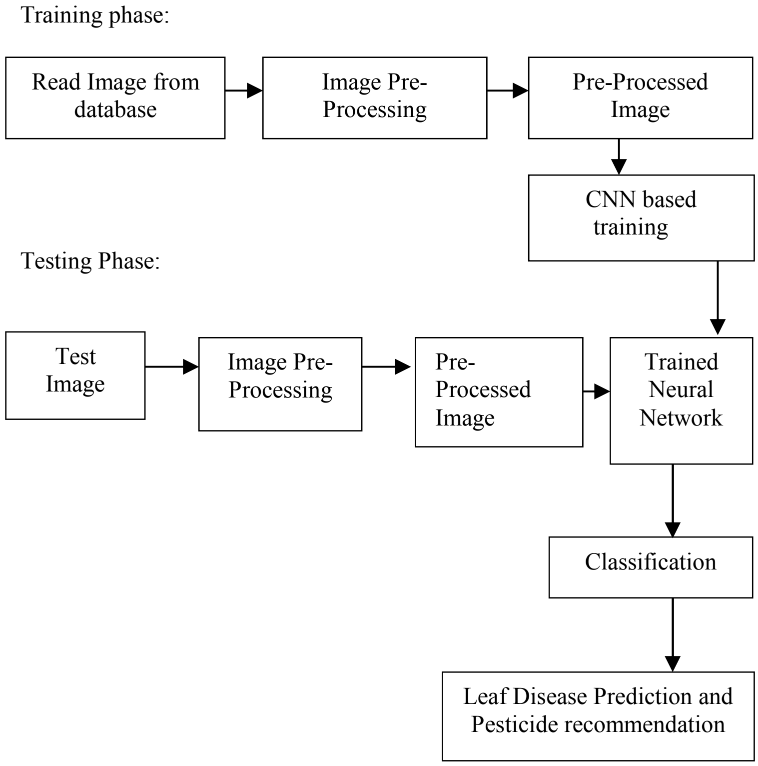

Fig. 2. System Architecture

A. *Image Acquisition:*

For training, Image is taken from database. And for testing, you can take image from camera at real time but in this project, we made a particular folder on mobile from that image will be fetched by android application and send through java web services i.e. tomcat server to server side system on which pre-processing is done and later on algorithm test that particular image.

B. *Image Pre-Processing:*

Image should be processed before sending to the algorithm for testing and training purpose. For that purpose, in this project image is scaled or resize into 150 x 150 dimension. As we used color image so that we don't need any color conversion techniques and that pre-processed image is directly passed to algorithm for training and testing purpose.

C. Convolutional Neural Network:

Once pre-processing is done, then CNN is used for training purpose and after that we get trained model. That CNN method is written with help of tensor flow. By using this model, we classify the image that system is getting after pre-processing of testing image. Then we get particular disease name or healthy leaf name if there is no disease on that leaf and that disease name is send to android application and with the help of that disease name we get particular pesticide name which help farmer to take respective action in order to decrease percentage of disease.

IV. Performance Analysis

The performance analysis of convolution neural network for classification & prediction of pesticide for leaf disease is performed on PlantVillage datasets. The data records contain 54,309 images. We have used 38 class labels and 16 class labels in which class C00 has 270 images, Class C01 has 280 images etc. for experiment purpose. We have divided the dataset in training data which include 18917 images and testing data which include 3000 images. The results are shown for accuracy for training data and validation accuracy for testing data for different epoch with different layer of CNN i.e. five layer, four layer & three layer CNN and class labels i.e. 38 classes & 16 classes using tensor flow. Loss (cost) function used is cross entropy function and optimizer used is ADAM with learning rate 0.001 in Tensor flow for CNN Model.

TABLE I. No of Epoch with Accuarcy and Validation Accuracy wrt 5,4,3 CNN Layer

No of Epoch	Five layer CNN		Four Layer CNN		Three Layer CNN	
	Accuracy	*Validation Accuracy*	*Accuracy*	*Validation Accuracy*	*Accuracy*	*Validation Accuracy*
1	0.5613	0.5920	0.6633	0.6520	0.5064	0.5083
2	0.7365	0.7170	0.7337	0.7477	0.6543	0.6310
3	0.8167	0.8033	0.8291	0.8120	0.7077	0.7127
4	0.8155	0.7997	0.8370	0.8233	0.7342	0.7070
5	0.8646	0.8300	0.8509	0.8333	0.7712	0.7487
6	0.8782	0.8453	0.8720	0.8413	0.8032	0.7860
7	0.8754	0.8670	0.9081	0.8587	0.8092	0.7583
8	0.9129	0.8797	0.9072	0.8487	0.8315	0.7963
9	0.9238	0.8647	0.8879	0.8680	0.8205	0.8153
10	0.9117	0.8640	0.9214	0.8503	0.8269	0.8230
11	0.9245	0.8780	0.9271	0.8507	0.8410	0.8260
12	0.9341	0.8710	0.9116	0.8453	0.8581	0.8200
13	0.9257	0.8950	0.9348	0.8507	0.8499	0.8310
14	0.9417	0.8740	0.9160	0.8700	0.8735	0.8453
15	0.9375	0.8763	0.9241	0.8713	0.8753	0.8287
16	0.9341	0.8797	0.9373	0.8817	0.8624	0.8173
17	0.9387	0.8870	0.9279	0.8603	0.8824	0.8260
18	0.9492	0.8843	0.9464	0.8900	0.8978	0.8440
19	0.9524	0.8850	0.9531	0.8673	0.8940	0.8447
20	0.9402	0.8967	0.9372	0.8643	0.8862	0.8477

Following graph shows the Accuracy and Validation Accuracy.

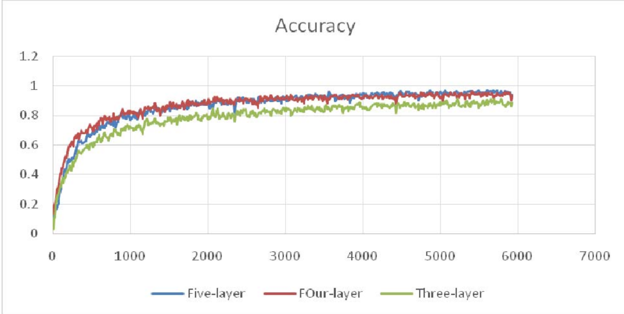

Fig. 3. Comparative graph of 5,4, 3 CNN layer wrt Epoch

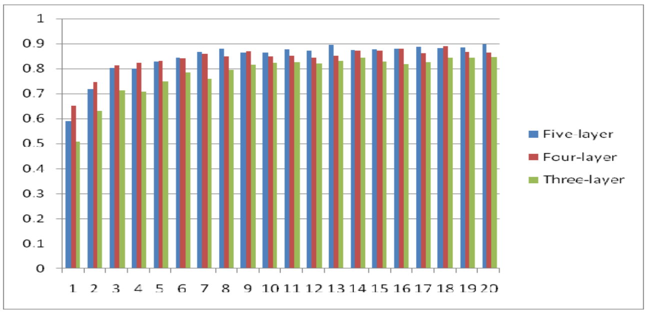

Fig. 4. Validation Accuracy Comparative graph of 5,4, 3 CNN layer wrt Epoch

Analysis of Graph: from the graph we can analyze that the validation accuracy gives best result for five layers with 89.67 as compared to three and four layer CNN.

TABLE II. Accuracy & Validation accuracy for 38 classes & 16 Classes

Epoch	38-Classes		16-Classes	
	Accuracy	*Validation Accuracy*	*Accuracy*	*Validation Accuracy*
10	92.19	87.17	94.78	91.43
15	92.35	86.77	95.57	91.73
20	93.72	86.43	95.32	90.33

Following graph shows the Accuracy and validation accuracy for 38 classes and 16 classes.

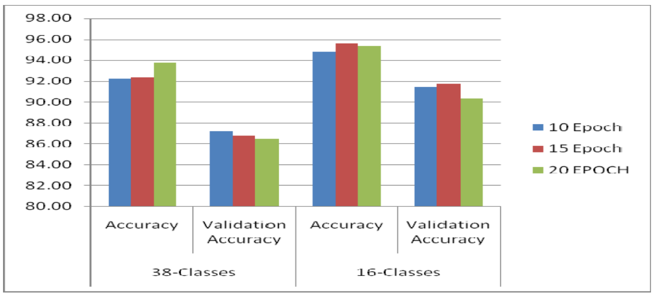

Fig. 5. Comparative graph ofAccuracy & Validation Accuracy for 38& 16 Classes wrt Epoch

Analysis of Graph: from the graph we can analyze that the Accuracy for CNN for 38 classes is 93.72 for 20 epoch and 86.43 for validation and for 16 classes accuracy is 95.32 & validation accuracy is 90.33.

TABLE III. OVERALL ACCURACY COMAPARISION

	3-layers		4-layers		5-layers	
Total Epoch	***Accur Acy***	***Validat ion***	***Accur acy***	***Validat ion***	***Accur acy***	***Validat ion***
10	88.24%	83.23%	92.19%	87.17%	91.01%	86.93%
15	91.11%	82.97%	92.35%	86.77%	95.05%	86.30%
20	88.62%	84.77%	93.72%	86.43%	94.02%	89.67%

Following graph shows the overall Accuracy for 3 layer CNN Model,4 Layer CNN model and 5 layer CNN model.

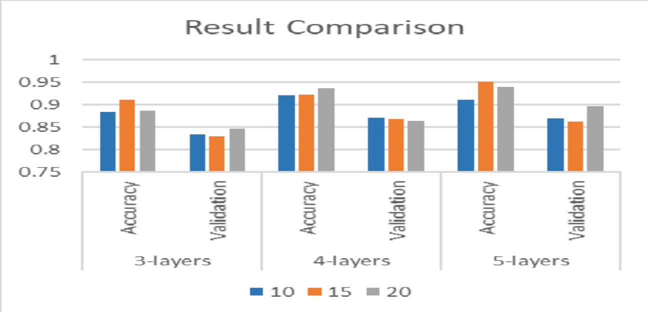

Fig. 6. Comparative analysis chart for overall Accuracy

Analysis of Graph: from the graph we can analyze that the highest Accuracy for CNN Model with 5 layers 95.05%, with 4 layers 93.72% and with 3 layers 81.11%. And highest validation accuracies for CNN model are 84.77%, 87.17% and 89.67% for 3,4 and 5-layer models respectively.

TABLE IV. SAMPLE OF PESTICIDE RECOOMENDATION WITH DISEASE NAME

Disease name	**Pesticide name**
Apple scab	Spray liquid copper soap
grape leaf blight	Inspire super
orange huanglongbing	Zinkicide
cherry powdery mildew	Lime sulpher

V. CONCLUSION

In this work the leaf disease images are classified using convolution neural network with five-layer model, four-layer model and three-layer model and recommend the Pesticides as per the leaf disease. Our result shows that CNN model having 3-convolution layer, 4-convolution layer and 5-convolution layer trained for 10, 15 and 20 epochs (cycles). As we can see from graphs that the highest accuracy achieved for 5-layer model with 95.05% for 15 epochs and highest validation accuracy achieved is for 5-layer model with 89.67% for 20 epochs using tensor flow.

REFERENCES

[1] Mangement of leaf spot diseasea of trees and shrubs:Trees & Shrubs:Yard & Garden:Garden:University of Minnesota Extension,4/22/2007.

[2] Monzurul Islam, Anh Dinh, Khan Wahid ,Pankaj Bhowmik "Detection of Potato Diseases Using Image Segmentation and Multiclass Support Vector Machine", IEEE 30th Canadian Conference on Electrical and Computer Engineering (CCECE),2017

[3] Dheeb Al Bashish, Malik Braik, and Sulieman Bani-Ahmad,"A framework for detection and classification of plant and stem diseases", International Conference on Signal and Image Processing,2010.

[4] Aakansha Rastogi,Ritika Arora,Shanu Sharma,"Leaf Disease Detection and garding using computer vision Technology & fuzzy logic",IEEE-IC on Signal processing and Integrated network,2015

[5] Santanu Phadik ar and Jaya Sil, "Rice Disease Identification using Pattern Recognition", Proceedings of 11th International Conference on Computer and Information Technology,2008

[6] Neethu K.S1 , P .Vijay ganesh2 , "Leaf Disease Detection and Selection of Pesticides using Artificial Neural Network", International Research Journal of Engineering and Technology (IRJET),2017

[7] Xingchun Chen and Ron, "Monitoring Soybean Disease and Insect Infection Patterns in Nebraska", International Conference on Granular Computing, IEEE 2015

[8] J. A. Duthie , "Models of the Response of Foliar Parasites to the Combined Effects of Temperature and Duration of Wetness", Phytopathology, 87–11, 1088/1095 (1997)

[9] S.P. Pennypacker, H.D. Knoble, C.E. Antle, and L.V. Madden: "A Flexible Model for Studying Plant Disease Progression, Phytopathology", 70–3, 232/235 (1980)

[10] Rajleen Kaur,Dr. Sandeep Singh Kang,"An Enhancement in Classifier Support Vector Machine to Improve Plant Disease Detection",IEEE 3rd International Conference on MOOCs, Innovation and Technology in Education (MITE),2015

[11] Sharada Prasanna Mohanty,David Hughes and Marcel Salathé,"Using Deep Learning for Image-Based Plant Disease Detection,"April 15, 2016

[12] Davoud Ashourloo, Hossein Aghighi, Ali Akbar Matkan, Mohammad Reza Mobasheri, and Amir Moeini Rad,"An Investigation Into Machine Learning Regression Techniques for the Leaf Rust Disease Detection Using Hyperspectral Measurement,"IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, VOL. 9, NO. 9, SEPTEMBER 2016

[13] Vijai Singh A.K. Misra ,"Detection of plant leaf diseases using image segmentation and soft computing techniques",INFORMATION PROCESSING IN AGRICULTURE 4 (2017) 41–49,Elsevier.

[14] Noa Schor, Avital Bechar,Timea Ignat, Aviv Dombrovsky, Yigal Elad,and Sigal Berman,"Robotic Disease Detection in Greenhouses: Combined Detection of Powdery Mildew and Tomato Spotted Wilt Virus",IEEE ROBOTICS AND AUTOMATION LETTERS, VOL. 1, NO. 1, JANUARY 2016

[15] Sandika Biswas , Bhushan Jagyasi , Bir Pal Singhy and Mehi Lalz,"Severity Identification of Potato Late Blight Disease from Crop Images Captured under Uncontrolled Environment",IEEE Canada International Humanitarian Technology Conference - (IHTC) 2014

[16] Jayme Garcia Arnal Barbedo,"Digital image processing techniques for detecting, quantifying and classifying plant diseases,Sprinjer plus,2013

[17] Ms. Kiran R. Gavhale,Prof. Ujwalla Gawande,Mr. Kamal O. Hajari,"Unhealthy Region of Citrus Leaf Detection Using Image Processing Techniques",International Conference for Convergence of Technology - 2014,IEEE

[18] Lucas G. Nachtigall and Ricardo M. Araujo ,"Classification of Apple Tree Disorders Using Convolutional Neural Networks", IEEE 28th International Conference on Tools with Artificial Intelligence, 2016

[19] Davoud Ashourloo, Ali Akbar Matkan , Alfredo Huete, Hossein Aghighi, and Mohammad Reza Mobasheri,"Developing an Index for Detection and Identification of Disease Stages" , IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, 2016

[20] Chunxia Zhang,Xiuqing Wang, Xudong Li,"Design of Monitoring and Control Plant Disease System Based on DSP&FPGA",2010 Second International Conference on Networks Security, Wireless Communications and Trusted Computing.