INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

ADVANCED NETWORK SURGERY TECHNIQUE PREDICTING PADDY LEAF DISEASES

Doniparthi Sai Charan, ECE,SSN College of Engineering Kalavakkam, Chennai,
Mettukuru Avinash Reddy, IT,SSN College of Engineering Kalavakkam, Chennai.

ABSTRACT

Agriculture plays a chiefly role in economy as well as it is considered to be the backbone of economic system for developing countries. For decades, agriculture has been related with the production of vital food crops. Paddy rice is a staple crop for much of the world's population. It is also a key source of the greenhouse gas methane, responsible for about 40 million tonnes, or 10% of global emissions, each year. Thus, the proposed research work aims to predict the type of disease in a paddy plant to help the farmer in deciding the fertilizer that shall be given to the plant for its healthy growth. Here the trending deep learning technology is used to achieve the proposed solution. An innovative modified VGGNet architecture is proposed which uses two different types of optimization technique to increase the accuracy is used for training the dataset. Then the trained model that is generated by this algorithm is given as an input to the next algorithm where resnet is used to further increase the accuracy of the model. The datasets were collected from UCI real time images as well as the GitHub datasets and the training are performed. The three different types of paddy disease such as bacterial leaf blight, blast, brown spot is used for prediction. The three different types of datasets used were UCI repository, Github images as well as images searched from internet. The experimental results of three diseases show that 97% of accuracy is achieved in predicting the type of disease in paddy plant.

Keywords : Paddy diseases, Deep learning, VGGNet, Network .

1. INTRODUCTION

In India, the farmer and his contribution towards the growth of the country makes a big difference in its GDP as the proposed work helps one in finding the paddy diseases with the current prevailing technologies. Usually in the agricultural productivity, the production depends on the types of plant grown and the proper usage of fertilizers and pesticides by the farmers. The type of fertilizer usage depends on the type of plant disease detected and the plant is infected by it. But, on the other hand, the farmers are quite inefficient in finding which type of disease the plant is infected with. There are several types of diseases in plants and each kind of disease in the plants has its own kind of fertilizer to be used. If the farmer fails to predict the type of disease, then the fertilizer given to the plant will also be wrong which will slow down the plant growth. This will reduce the nutritious value of the plant and sequentially affect the growth of the plant. The farmers whose only hope lies in their agricultural land are affected by this and it drastically reduces the financial condition of the farmer. In order to avoid this, the research work designs a system which can predict the type of plant disease. Making use of the efficient deep learning technology which is basically evolved to imitate the humans and perform all the tasks of human by replacing the humans. Here in this research, the proposed work will determine the type of plant disease by giving an input image to the model. As the type of paddy disease is predicted, the farmer can decide as which fertilizer to be used for what kind

of disease to increase the productivity. The disease prediction involves steps such as dataset collection, data augmentation, data preprocessing, training with the algorithm, optimization, loss minimization, validation and evaluation, report generation, model serialization and prediction. The architecture of Visual Geometric Group at University of Oxford (VGG) has around 16 layers in which there are thirteen hidden layers and three fully connected layers, and its name is derived from the number of layers.

Once the disease prediction model is trained using the above-mentioned methods, it will predict the type of disease successfully by which the farmer will have an idea of what type of fertilizer to use and in what order. Scientists are working in determining the paddy plant disease whereas all were found with less accuracy compared to the proposed model. The proposed work will implement a novel concept of modified VGGNet that uses two optimization techniques and using Resnet for fine tuning of the model and boosts the accuracy to the highest efficiency. The model generated is then tested with the real time dataset and it appeared to outperform all the existing techniques in terms of accuracy. The rest of the paper will discuss about the steps taken in accomplishing the proposed work such as to give a brief explanation on the related works did for the proposed research work, section 2 will describe about the existing system, section 3 will discuss about the overall process, section 4 will give the step by step working and section 5 will give the output results obtained, section 6 will discuss about the conclusion and section 7 will give the future work that can be carried out further in future and section 8 gives the references for the survey carried out for this research work.

2. RELATED WORK

(Rajmohan et al., 2018) [35], focused on determining the paddy diseases types. The research work is to find out the type of disease where it achieved an accuracy of about 87.05%. Here a dataset of 200 number was used for training purpose and 50 datasets were used for testing the model with the above-mentioned techniques to increase the efficiency.

Sukhvir Kaur et al., 2017 [38], discusses about the different types of diseases and the type of different techniques that can be used to identify the type of plant disease. It mainly focused on providing an overview of the plant diseases for further research as well as discusses about the different possible techniques that can achieve high accuracy.

Similarly, (J.G.A. Barbedo, 2017) [8], proposed a research work for collecting different types of datasets which can be helpful in finding the type of plant disease. They focused on collecting the dataset and it had a huge amount of about 2326 images of about 171 diseases occurring in the plants. Moreover, this paper focused on providing a public dataset which can be available for various research in the field of agriculture and help the researches achieve the best possible accuracy in predicting the disease present in crops.

On the other hand (Wenjiang Huang, 2014) [40] did a research on the types of diseases occurring on winter wheat plants. It deals with giving an effective treatment on identifying the type of disease. They achieve an accuracy of
93.5%. The main parameters that were considered for predicting the type of disease is environmental conditions such as humidity and temperature. The different techniques were applied with a motivation of providing a collection of datasets for disease prediction in wheat plant for further research which can then be analyzed with different possible techniques.

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

(G.J.A. Barbedo, 2016) [9], conducted experiment in collecting all the plant disease data that is been researched in the past four decades and provides a brief outcome of all techniques performed to detect the presence of plant diseases. It mainly focuses on comparing the existing research, the current scenario for detecting the disease that is the different techniques applied to find the presence of disease, and what kind of techniques can be applied in the future analysis to obtain the highest accuracy and lead a way to predict the plant diseases in the most possible and efficient way and to achieve the highest accuracy.

From the above researches conducted by different authors, at different conditions, and with different types of plants, it is evident that all have achieved a way of identifying the plant diseases from basic techniques of past to the current techniques of deep learning and have given a way for the present research and triggered researchers to further improve the accuracy of prediction to predict the proper disease and give an efficient way of providing proper fertilizers to the infected plants.

3. PROPOSED SYSTEM

From the above discussed methodologies, none of the methods achieve the accuracy which the proposed research obtained with the help of new techniques.

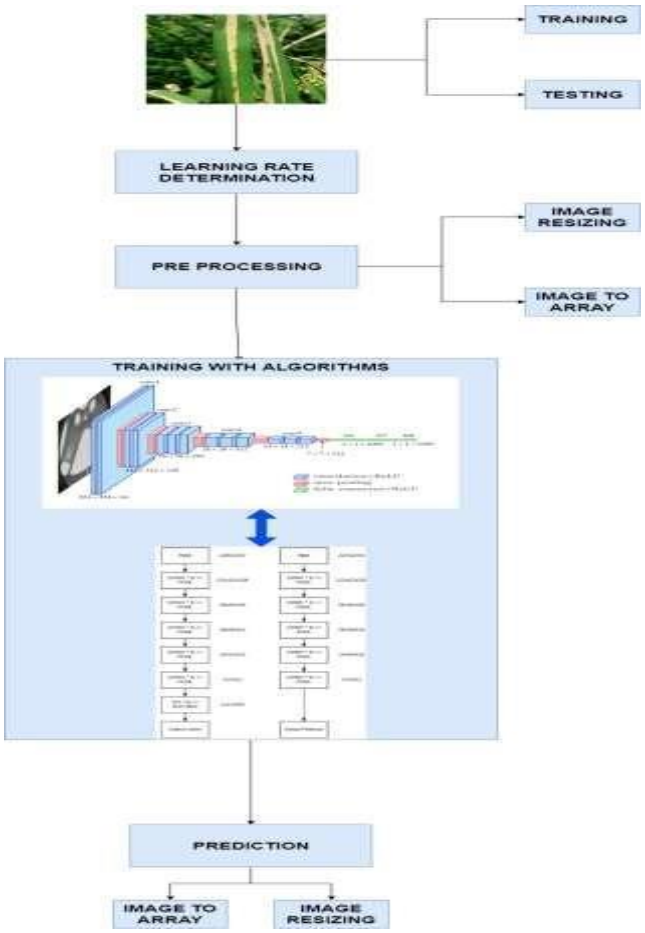

Fig. 1. Architecture Diagram

The overall working of the proposed work can be explained as follows. Hybrid methodology is performed to obtain more accurate results as well as promote real time implementation if it is been integrated in raspberry pi and streamed over the infected leaves. Thus, this proposed work provides an efficient way to determine the type of paddy disease. The architecture of the whole system can be seen in the below given figure which elaborates a step by step process applied.

4. WORKING

The objective of this research work is to determine the presence of different types of disease in the paddy plant. So that, one can provide necessary pesticides and fertilizers to the plant to help the growth of the plant in a proper way. Different methodology will be used for analysing three types of paddy diseases and helps the farmer to give the proper the infected plant and avoid the use of unnecessary pesticides. So, initially the first process will be dataset collection. Those datasets will be collected with the required parameters. These datasets will be separated as testing as well as training. The testing datasets will be used to test the model after generating the trained model with the deep learning algorithm. So, after collecting the datasets and generating a learning rate curve for training the model such that to predict the method of training the model in a particular way such that it can avoid overfitting and achieve accuracy to the maximum extent. Then based on the learning rate, the model is been trained. After generating learning rate, pre-processing the model is done which will convert all the different size image to a single size. Then it will undergo training with modified VGG16 architecture to generate an output accuracy. Then fine tuning is performed with the ResNet50 model architecture which will further improve the accuracy of predicting the disease. Then a process called optimization is done. The optimization method used will be Adam and stochastic gradient descent. Then the noises generated are eliminated during training process by using loss minimization. As the model gets generated it will be analysed by giving real time inputs and predicting the different types of paddy diseases. Thus, this research helps the farmers in predicting the type of disease and increasing the plant growth. In the next section, a detailed explanation of the technique involved in processing each module and increasing the accuracy is been discussed in detail.

PROCESSES INVOLVED

1. Dataset Collection

Dataset collection is a process of collecting different types of paddy disease datasets from various resources to train the architecture to obtain the accurate output. The dataset collection is a main process as the efficiency of the model depends on the type and the amount of dataset collected and processed. There are three different types of dataset collection. They are

I. Collecting from the google resources
II. Taking the own real time images
III. Using the third-party images

In the proposed research work, the datasets used are the real time UCI datasets collected from the UCI repository, the GitHub datasets and the images collected from the internet to process the output. These datasets are collected and pre- processed and given as an input to the model for further processing.

2. Dataset Augmentation

Dataset Augmentation is a process of duplicating the dataset into many numbers by applying the different possible ways of converting the images. It is considered as the number of ways the image can be converted such that the processor

can analyse it in any form and that it will increase the accuracy of the model. It will also help in increasing the number of datasets collected. The techniques which are applied for dataset augmentation can be listed as zooming, shifting, flipping, rotating in different angles, etc. The main purpose of dataset augmentation is that the accuracy of the model increases such that if an input image of any different form is given, the generated model will be able to predict it at any instance. Thus, it will not only increase the accuracy of the model but also it will help in training the architecture effectively. The efficiency on the other hand also depends on the amount of datasets present. One criterion that is to be taken into consideration is that the time required for training the dataset depends on the number of datasets i.e. more the number of datasets, more is the time consumed for its training.

3. Dataset Pre-processing

Dataset pre-processing technique is applied to pre- process the dataset to make it ready for undergoing the process of training. Pre-processing is nothing but making the data aligned to one format such that it will be easier for the model to get trained. Different types of pre-processing techniques such as aspect aware pre-processor and image to array pre- processor is applied.In aspect aware pre-processor, all the images of

different size will be converted to same size such that it can be easier for the model to analyse the dataset and process it accordingly. In image to array pre-processor, all the images are converted to array format from string format such that the architecture analyses it effectively. The huge amount of string data of the image is converted to array such that it will be easier for the model to get trained. As the pre-processing technique is applied successfully, the dataset is ready to get trained by the proposed algorithms such as modified VGG16 as well as Resnet50 such that the combination will give the output of higher accuracy.

4. Dataset Splitting

The collected dataset undergoes a process called dataset splitting where the datasets will be split into training dataset as well as testing dataset. Such that the training dataset will be used to train the model whereas the testing dataset will be used to test the model as it gets generated. From of the total amount of dataset collected, splitting of dataset is done in a 3:1 ratio such that 75% of the dataset will be used for training the model whereas 25% will be used for testing the model as it is generated. The training dataset will be initially trained by the modified VGG16 architecture whereas the output of the model will be given as an input to the Resnet50 architecture.

5. Training with Modified VGG16

The VGG16 is a famous architecture which proves to be the best in classification of images in any format. It is a type of convolutional neural network that was trained and used to win the ILSVR ImageNet competition. The architecture has 16 layers of which 13 form the convolutional layer and three are the fully connected layers. The convolutional layers are the process of applying different kind of filters to the dataset collected and learning each image. VGG16 uses 3x3 filters to learn the images. After all the 16 layers of training, the output obtained will be stored as a model which will be given as an input to the resnet architecture to train and increase the accuracy of the model which is called as finetuning. After applying different types of layers such as convolution, max pooling, etc the fully connected layer in the last segregates the classes of disease and allows the model to differentiate and generate the model file effectively. The flow of VGG16 can be explained as follows. It involves convolution layer which is the process of applying filters in each image and extracting the features of the image which is in terms of RGB value. Then, an activation layer is used which is ReLU. It is used for eliminating the unwanted pixels from the extracted features. It compares the pixel values of every learnt image and compares whether any pixel is matching with the previous tested image, if it matches then those pixel values are removed from the images such that it can be able to differentiate between those two. The next layer is fully connected layer that uses three different sized layers. The first two layers are of
4096 channels wide whereas the last layer is of 3 channels depth. After this the fully connected performs the clustering of data which is split into different categories and the next layer comes into action. This is the softmax layer which is a kind of activation function that is used in the last output node of VGG16. This function aligns the output obtained in between 0 and 1 by predicting the probability of the presence of type of paddy disease as well as it takes care that the sum of the output should give 1. This SoftMax layer is of 2 units dense. Now this model can be used to predict various diseases in paddy by giving an image input.

6. Training with ResNet50 performing Network Surgery

In this research work, network surgery is applied for increasing the accuracy to the much better level. The output obtained from VGG16 is given as an input to the ResNet architecture which is trained to further increase the accuracy of the generated model such that Resnet have proved to be
28% more efficient than the VGG16 architecture. Network
surgery is nothing but training an architecture and merging it with other architecture such that it will increase the accuracy. It can be said that the head of VGG16 is included with ResNet and the training is carried on merging the features of VGG with ResNet. Resnet has almost 50 layers such that it has 5 stages, in which each stage will have convolutional and identity block. Among these, each identity block is found to be with three convolutional layers. In this research, the input will be given by the output of the VGG16 architecture to further boost the accuracy and predict the paddy diseases more accurately. One main advantage of ResNet is that it has the skip connection methodology by which it can skip any step. The skip connection which is used here can be said as identity. This identity function allows to pass to the interested block without going through each weighted layer. This skip technique allows the ResNet to build more deeper network with more additional layers which will further increase the accuracy of the model. It can also take decisions to skip certain layers which it feels that are not more relevant or it can boost the accuracy. It is trained

using two different filters such as 1x1 and 3x3. The ResNet architecture has 4 different stages in which each stage has both convolution as well as the identity layer. First the convolution is performed using the 7x7 filter which then undergoes max pooling with a stride of two- unit length. The input to the ResNet is given with a size of 224x224x3. Then in the upcoming four stages the model undergoes training with 1x1 and 3x3 filters applying both convolution and identity blocks. Finally, the output obtained from these four stages undergoes a process of average pooling which gives an average output and then fully connected layer performs clustering and the outputs are obtained from the trained model. A layout of that technique can be seen in the above-mentioned architecture flow diagram.

7. Optimization

As the model undergoes certain number of epochs, it is necessary to take care of whether it is learning in a correct path as per the architecture. The optimization techniques play a very important role in taking care of the training process of any architecture. Certain techniques such as Stochastic Gradient Descent, Adam are used in this proposed work to align the training process in a way each architecture should learn. The accuracy of the model mostly depends on the selection of optimization technique. This application is trained using different optimization techniques and obtained different accuracies at different levels. After applying different techniques, Stochastic Gradient descent found to increase the accuracy to a much better level which can be seen in the results section.

8. Loss Minimization

As the model undergoes a lot of training in terms of number of epochs, it gives rise to many losses which will decrease the accuracy of the model. In order to eliminate those losses, loss minimization techniques such as cross categorical entropy is used. After applying this, the accuracy of the model increases. The categorical cross entropy works in a way such that the losses obtained during the training process are eliminated successfully by keeping a threshold value. The categorical cross entropy is also called as SoftMax loss. It is basically a combination of SoftMax activation and cross entropy loss. After applying different techniques, this categorical cross entropy is found to be best suited for increasing the accuracy. 9. Model Generation

After all the training process is completed, model serialization is performed which extracts all the features and saves the file as a binary file which is called as a model file. It can be generated in two types such as in pickle file format or a model file format. This model file is generated such that it can be used in the future to predict the presence of paddy disease by importing this model instead of unnecessarily undergoing all the processes. The aim of this model generation is that one may not need to undergo the whole process of generating a model which consumes more time unnecessarily. The time required for the model generation depends on the number of datasets. If the datasets are less, then the time taken will be less and on the other hand if the datasets are more then it may take days to learn and generate the model.

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

E. Result Obtained

This section will describe about the steps taken to obtain the expected results. Many different techniques were applied to increase the accuracy. The step by step processes can be seen below. Before undergoing the training process, learning rate is been found which helps in reducing the time consumed by using different techniques. The learning rate can be defined as a threshold point up-to which one should train the model as training further will lead to increase in loss and decrease in accuracy which is called as overfitting In order to avoid this overfitting, the learning rate is been found. The learning rate for the proposed work is found to be 0.001 which is the perfect learning rate obtained for the datasets used in this work. The graph generated for finding the learning rate can be seen in the below figure.

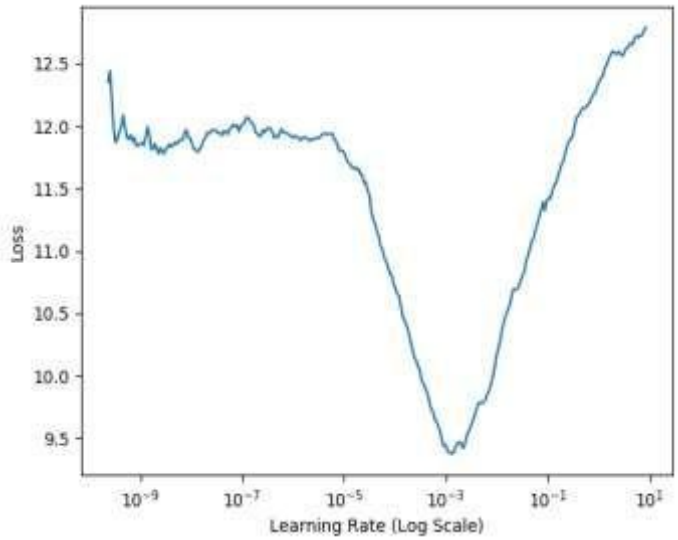

Fig 2 Learning Rate for the Proposed Work

Since, the proposed work also intends to prove that the learning rate other than the 0.001 is less accurate as overfitting and underfitting takes place, an analysis is done and the datasets are trained for 7 different types of learning rate whose accuracies can be seen in the below given table. It also gives a difference in the datasets used such as UCI, GitHub and images collected from internet experimented on 3 types of paddy diseases.

Learning Rate / Dataset used	10^{-3}	10^{-1}	0.5	10	10^{-7}	10^{-9}	0.005
GitHub images (3 diseases)	97	95	86	80	79	60	49
UCI images (3 diseases)	91	86	75	72	64	51	45

Table 1 Accuracies Obtained for Different Learning Rate

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

As this proposed work aims in determining only 3 types of disease, the results of it can be seen in detail further. Initially the optimization technique used was RMS prop and obtained an accuracy of about 76% and the results obtained can be seen as follows

TYPES OF DISEASE	PRECISION	RECALL	F1-SCORE
Bacterial leaf blight	0.80	0.75	0.77
Blast	0.79	0.70	0.74
Brown spot	0.70	0.79	0.74
avg / total	0.76	0.75	0.75

Table 2 Accuracy on RMSProp Optimization Technique

The RMSprop technique works on the magnitude of the gradient where the step sizes are decreased for the large gradients and step sizes of the small gradients are increased to avoid vanishing and exploding of the model accuracy.The graph plotted for the above technique is follows which is a plot of loss against accuracy.

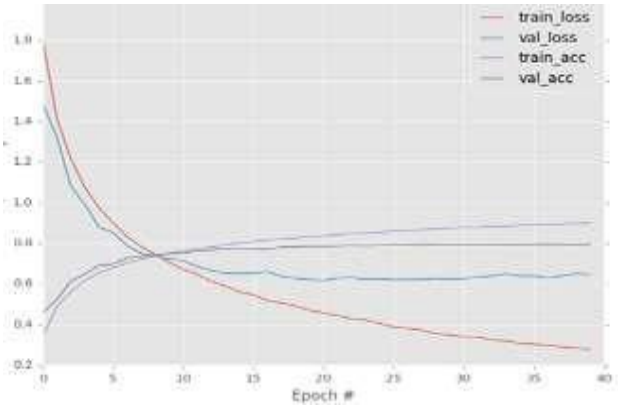

Fig. 3 Loss and Accuracy Plot Using RMSProp Optimize

Since the above-mentioned technique obtained a less accuracy and is unsuitable for the real time application, other different techniques are also applied such as Adam, SGD, etc to increase the accuracy. The results when we apply the Adam optimizer obtained an accuracy of about 80% which can be seen in the below mentioned outputs.

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

TYPES OF DISEASE	PRECISION	RECALL	F1-SCORE
Bacterial leaf blight	0.80	0.75	0.77
Blast	0.79	0.79	0.79
Brown spot	0.82	0.83	0.82
avg / total	0.80	0.79	0.80

Table 3 Accuracy on Adam Optimization Technique

The graph plot for the above-mentioned technique is follows

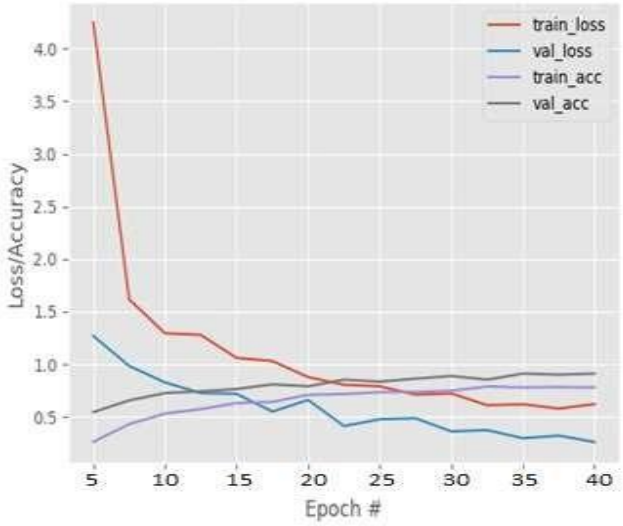

Fig. 4 Loss and Accuracy Plot Using Adam Optimizer

In order to improve the accuracy further the SGD optimizer was used which gave us an accuracy of about 85%. This can be seen in the below results.

TYPES OF	PRECISIO	RECAL	F1-
Bacterial leaf	0.84	0.85	0.84
Blast	0.84	0.83	0.83
Brown spot	0.86	0.84	0.85
avg / total	0.85	0.84	0.84

Table 4 Accuracy on SGD Optimization Technique

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

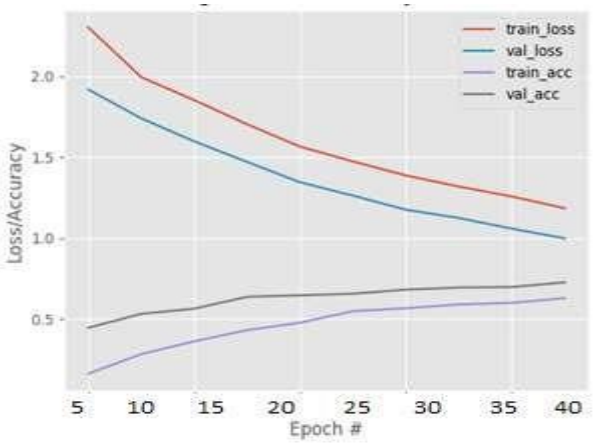

Fig. 5 Loss and Accuracy Plot Using SGD Optimizer

The above results are quite accurate, but the goal of this research lies in obtaining accuracy of above 95%. For this process different techniques are applied and the combination of Adam and SGD gave the results of nearly 93% that can be seen in the below results.

TYPES OF DISEASE	PRECISION	RECALL	F1-SCORE
Bacterial leaf blight	0.90	0.91	0.90
Blast	0.96	0.93	0.94
Brown spot	0.93	0.90	0.91
avg / total	0.93	0.91	0.92

Table 5 Accuracy on Combined Adam and SGD Optimization Technique

The graph for the above obtained accuracy in terms of loss vs accuracy can be seen in the below figure

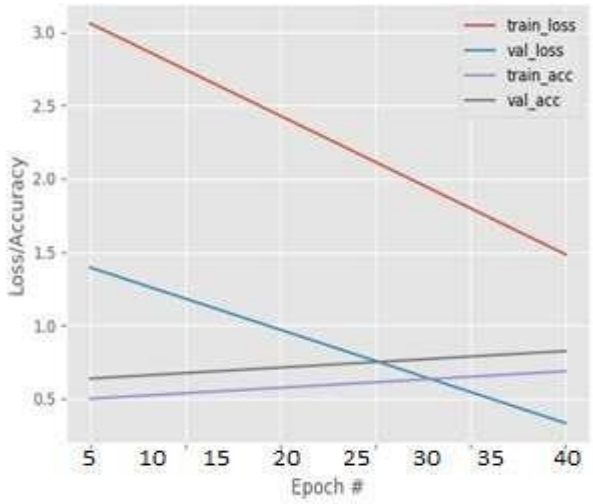

Fig. 6 Loss and Accuracy Plot Using Adam and SGD Optimizer

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

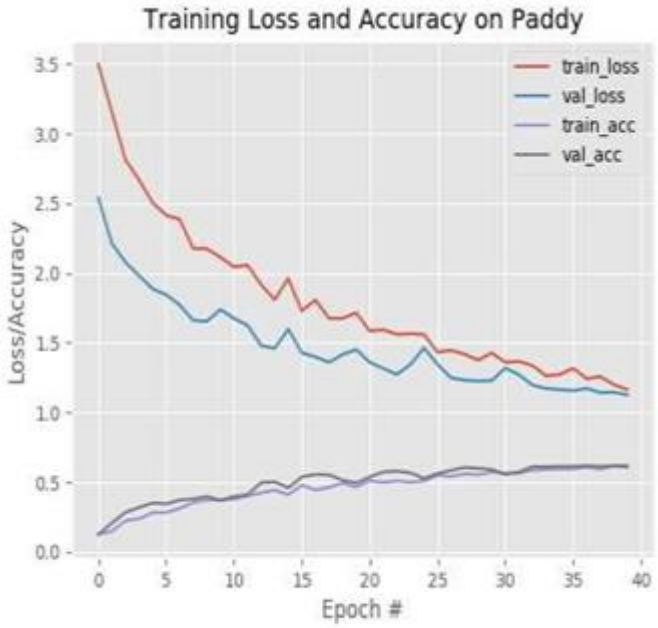

Fig. 7 Loss and Accuracy Plot After Network Surgery

After obtaining this accuracy the model undergoes network surgery with the Resnet architecture which further boosted the accuracy and obtained the results of about 97% accuracy which can be seen in the results shown

TYPES OF	PRECISIO	RECA	F1-
Bacterial leaf blight	0.97	0.95	0.96
Blast	0.94	0.96	0.95
Brown spot	1.00	1.00	1.00
avg / total	0.97	0.97	0.97

Accuracy on Combined Modified VGG16 and ResNetTechnique

The graph was plotted for the training and validation accuracy and losses at the end of the process and found that the accuracy of the model increases with decrease in the losses. This was the same case for both training as well as validation.

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 8 ISSUE 4 (2022) PAGES 1 – 16
RECEIVED : 25.05.2021 PUBLISHED : 04.07.2022
July 04.2022

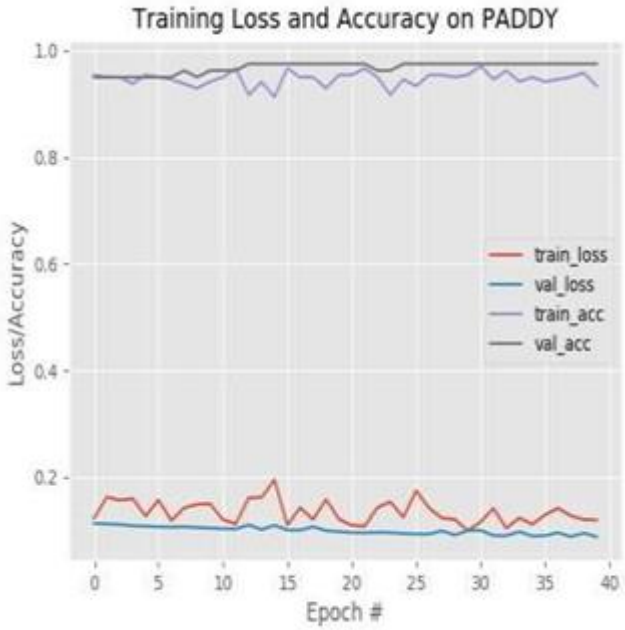

Fig. 8 Loss and Accuracy Plot Using Hybrid Algorithm

CONCLUSION

From this research work an accuracy of the model above 97% is obtained which is more than the existing techniques and prove to outperform all other existing methodologies. This research also introduces a concept of Network Surgery to further improve the accuracy of the model and predict the presence of disease in a more efficient manner. The experimental results were performed using the UCI real time dataset as well as the GitHub datasets which are publicly available. Thus, this model proves to be the efficient one among all others in obtaining the results in predicting the paddy disease presence and the type of disease.

FUTURE WORK

In the future these results can be further used for researching this topic with many emerging algorithms and improve the accuracy level to further boost the accuracy of prediction with nine types of diseases. Further, this can also be promoted to the farmers for test and trial and implement in future use. Thus, by this research the farmers can be promoted with disease effective prediction system.

REFERENCES

[1] Abirami Devaraj, Karunya Rathan, Sarvepalli Jaahnavi and K Indira, “Identification of Plant Disease using Image Processing Technique” International Conference on Communication and Signal Processing, April 4-6,
2019, India.

[2] Ali AlSuwaidi, Student Member, IEEE, Bruce Grieve, and Hujun Yin, Senior Member, IEEE, “Feature-Ensemble-Based Novelty Detection for Analyzing Plant Hyperspectral Datasets” IEEE journal of selected topics in applied earth observations and remote sensing.

[3] Andrea Cossettini1, Student Member, IEEE, and Luca Selmi1,2, Fellow, IEEE, “On the Response of Nanoelectrode Impedance Spectroscopy Measures to Plant, Animal, and Human Viruses” IEEE Transactions on NanoBioscience.

[4] Avinash Kumar, Sobhangi Sarkar and Chittaranjan Pradhan, "Recommendation System for Crop Identification and Pest Control Technique in Agriculture" International Conference on Communication and Signal Processing, April 4-6, 2019, India.
[5] K.R.Aravind1 and P.Raja2, "Design and Simulation of Crop Monitoring Robot for Green House" 2016 International Conference on Robotics: Current Trends and Future Challenges (RCTFC).
[6] R Amog Shetty, Rishab F Tated, Sunku Rohan, Triveni S Pujar, "CNN based Leaf Disease Identification and Remedy Recommendation System" Department of Information Science and Engineering, Dayananda Sagar College of Engineering, Kumaraswamy Layout, Bangalore-560078, India.
[7] Athula Ginige1, Anusha I. Walisadeera2,3, Tamara Ginige4,5, Lasanthi De Silva3, Pasquale Di Giovanni6, Maneesh Mathai1, Jeevani Goonetillake3, Gihan Wikramanayake3, Giuliana Vitiello6, Monica Sebillo6, Genoveffa Tortora6, Deborah Richards5, Ramesh Jain7, "Digital Knowledge Ecosystem for achieving Sustainable Agriculture Production: A Case Study from Sri Lanka" 2016 IEEE International Conference on Data Science and Advanced Analytics.
[8] J. G. A. Barbedo, L. V. Koenigkan, B. A. Halfeld-Vieira, R. V. Costa, K. L. Nechet, C. V. Godoy, M. Lobo Junior, F. R. A. Patrício, V. Talamini, L. G. Chitarra, S. A. S. Oliveira, A. K. N. Ishida, J. M. C. Fernandes, T. T. Santos, F. R. Cavalcanti, D. Terao, F. Angelotti, "Annotated Plant Pathology Databases for ImageBased Detection and Recognition of Diseases" IEEE latin america transactions, vol. 16, no. 6, june 2018.
[9] J. G. A. Barbedo, "Expert Systems Applied to Plant Disease Diagnosis: Survey and Critical View" IEEE latin america transactions, VOL. 14, NO. 4, april 2016.
[10] Cheng Hu , Senior Member, IEEE, Kai Cui , Rui Wang , Teng Long, Fellow, IEEE, Shuqing Ma, and Kongming Wu, "A Retrieval Method of Vertical Profiles of Reflectivity for Migratory Animals Using Weather Radar" IEEE transactions on geoscience and remote sensin.
[11] 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.
[12] G.Elavarasi1, G.Murugaboopathi2, S.Kathirvel3, "Fresh Fruit Supply Chain Sensing and Transaction Using IoT" Department of Computer Science and Engineering.
[13] FAWAD KHAN1,2, HUI LI2, "Owner Specified Excessive Access Control for Attribute Based Encryption" date of current version January 4, 2017.
[14] Fumiaki Mitsugi, "Practical Ozone Disinfection of Soil Via Surface Barrier Discharge to Control Scab Diseases on Radishes" IEEE Transactions On Plasma Science.
[15] Gayatri Kuricheti, Supriya P, "Computer Vision Based Turmeric Leaf Disease Detection and Classification" Department of Electrical and Electronics Engineering.
[16] Ganesan P1, G.Sajiv2, "CIELuv Color Space for Identification and Segmentation of Disease Affected Plant Leaves Using Fuzzy based Approach" 2017 Third International Conference on Science Technology Engineering & Management (ICONSTEM).
[17] Hailing Zhou, Ajmal Mian, Lei Wei, Doug Creighton, Mo Hossny, and Saeid Nahavandi, Senior Member, IEEE, "Recent Advances on Singlemodal and Multimodal Face Recognition: A Survey" IEEE transactions on human- machine systems, vol. 44, no. 6, december 2014.
[18] By Jeyavijayan Rajendran, Student Member IEEE, Ramesh Karri, James B. Wendt, Student Member IEEE, Miodrag Potkonjak, Nathan McDonald, Garrett S. Rose, and Bryant Wysocki,

"Nano Meets Security: Exploring Nanoelectronic Devices for Security Applications" Proceedings of the IEEE. [19] Jagadeesh D. Pujari Rajesh Yakkundimath Abdulmunaf S.Byadgi, "Identification and Classification of Fungal disease Affected on Agriculture/Horticulture Crops using Image Processing Techniques" 2014 IEEE International Conference on Computational Intelligence and Computing Research.

[20] Jagadish Kashinath Kamble, "Plant Disease Detector" 2018 International Conference On Advances in Communication and Computing Technology (ICACCT).

[21] S.M. Jaisakthi, P. Mirunalini, D. Thenmozhi, Vatsala Barclays Eon, "Grape Leaf Disease Identification using Machine Learning Techniques" second International Conference on Computational Intelligence in Data Science (ICCIDS-2019).

[22] Jobin Francis, Anto Sahaya Dhas D, Anoop B K, "Identification Of Leaf Diseases In Pepper Plants Using Soft Computing Techniques" Vimal Jyothi Engineering College, Kannur.

[23] KellieP. Burris, Tsai-Chin Wu, Milana Vasudev, MichaelA. Stroscio,Fellow,IEEE, ReginaldJ. Millwood, and C. Neal Stewart*, Jr., "Mega-Nano Detection of Foodborne Pathogens and Transgenes Using Molecular Beacon and Semiconductor Quantum DotTechnologies" ieee transaction son nano bioscience, vol.12, no.3, September 2013.

[24] N.krithika, dr.a.grace selvarani, "An Individual Grape Leaf Disease Identification Using Leaf Skeletons and KNN Classification" 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS).

[25] An Investigation Into Machine Learning Regression Techniques for the Leaf Rust Disease Detection Using Hyperspectral Measurement Davoud Ashourloo, Hossein Aghighi, Ali Akbar Matkan, Mohammad Reza Mobasheri, and Amir Moeini Rad, Vol No.: 1939-1404, 2016

[26] New Optimized Spectral Indices for Identifying and Monitoring Winter Wheat Diseases Wenjiang Huang, Qingsong Guan, Juhua Luo, Jingcheng Zhang, Jinling Zhao, Dong Liang, Linsheng Huang, and Dongyan Zhang, Vol No.: 1939-1404, 2014

[27] Smart Paddy Crop Disease Identification And Management Using Deep Convolution Neural Network And Svm Classifier,1R.Rajmohan, 2M.Pajany, 3R.Rajesh, 4D.Raghu Raman, 5U. Prabu 1,2,3,4 Department of Computer Science & Engineering, IFET College of Engineering, Tamil Nadu, India 5Department of CSE, Koneru Lakshmaiah Education Foundation, Andhra Pradesh, India , Volume 118 No. 15 2018.

[28] Mr. Ketan D, Mr. Himanshu V. Taiwade , Mr. Virendra P. Yadav, Mr. Nikesh V, "Implementation of Prototype for Detection & Diagnosis of Cotton Leaf Diseases using Rule Based System for Farmers" Proceedings of the international conference on Communication and Electronics Systems.

[29] Kamal KC, Zhendong Yin †, Bo Li, Bo Ma, Mingyang Wu, "Transfer learning for fine-Grained crop disease classification based On leaf images" School of Electronics and Information Engineering, Harbin Institute of Technology.

[30] Leninisha Shanmugam, Agasta Adline A. L .Aishwarya, N. Krithika G, "Disease Detection In Crops using Remote Sensing Images" 2017 IEEE International Conference on Technological Innovations in ICT For Agriculture and Rural Development (TIAR 2017).

[31] I. M. Mathias, L. A. Z. Junior, L. B. Matyak, A. H. Dias, R. F. Duda, G. M. S. Afonso, "BRNeural – Artificial Neural Networks Simulator with Topology Multilayer Perceptron Using the Encog Framework" IEEE latin america transactions, vol. 14, no. 1, jan. 2016.

[32] Omkar Kulkarni, "Crop Disease Detection Using Deep Learning" Dept. of Information Technology, Pune Institute of Computer Technology, Savitribai Phule Pune University.

[33] Prabira Kumar Sethy, Nalini Kanta Barpanda, Amiya Kumar Rath,

"Detection & Identification of Rice Leaf Diseases using Multiclass SVM and Particle Swarm Optimization Technique" International Journal of Innovative Technology and Exploring Engineering (IJITEE).

[34] Priyanka Soni I and Rekha Chahar2, "Segmentation Improved Robust PNN Model for Disease Identification in Different Leaf Images" 1st IEEE International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES-2016).

[35] R.Rajmohan, 2M.Pajany, 3R.Rajesh, 4D.Raghu Raman, 5U. Prabu "Smart Paddy Crop Disease Identification And Management Using Deep Convolution Neural Network And Svm Classifier" Volume 118 No. 15 2018,.

[36] Er. Rupinder Kaur, Raghu Garg, Dr. Himanshu Aggarwal, "Big Data Analytics Framework to Identify Crop Disease and Recommendation a Solution" Punjabi University.

[37] Rui Wang , Cheng Hu , Senior Member, IEEE, Changjiang Liu, Teng Long, Fellow, IEEE, Shaoyang Kong, Tianjiao Lang, Philip J. L. Gould, Jason Lim, and Kongming Wu, "Migratory Insect Multifrequency Radar Cross Sections for Morphological Parameter Estimation" IEEE transactions on geoscience and remote sensing.

[38] Sukhvir Kaur1 • Shreelekha Pandey1 • Shivani Goel2, "Plants Disease Identification and Classification Through Leaf Images: A Survey" Archives of Computational Methods in Engineering (2019) 26:507–530.

[39] Santanu Phadikar and Jaya Sil, "Rice Disease Identification using Pattern Recognition Techniques" Proceedings of 11th International Conference on Computer and Information Technology (ICCIT 2008).

[40] Wenjiang Huang, Qingsong Guan, Juhua Luo, Jingcheng Zhang, Jinling Zhao, Dong Liang, Linsheng Huang, and Dongyan Zhang, "New Optimized Spectral Indices for Identifying and Monitoring Winter Wheat Diseases" IEEE journal of selected topics in applied earth observations and remote sensing, vol. 7, no. 6, june 2014.

[41] Xiang Wang, Jia Ma, Xiaowei Li∗, Xiaodong Zhao, Zongli Lin∗, Member, IEEE, Jie Chen ∗, and Zhifeng Shao, "Optimization of Chemical Fungicide Combinations Targeting the Maize Fungal Pathogen, Bipolaris maydis: A Systematic Quantitative Approac" IEEE transactions on biomedical engineering, vol. 62, no. 1, january 2015.

[42] Zhinan Li and Zygmunt J. Haas, Fellow, IEEE, "On Residual Path Lifetime in Mobile Networks" IEEE communications letters, vol. 20, no. 3, march 2016.

[43] Zhi-Hua DIAO1, Chun-Ying DIAO2, Yuan-Yuan WU3, "Algorithms of Wheat Disease Identification In Spraying Robot System" 2017 9th International Conference on Intelligent Human-Machine Systems.