PLANT DISEASE DETECTION USING NEURAL NETWORK: A REVIEW

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Abstract: Agricultural productivity depends heavily on the economy. This is one of the reasons why plant disease detection plays a major role in agriculture. As plant disease is quite natural and if proper care is not taken in this area, it has serious effects on plants and affects the quality, quantity or productivity of the respective products. Detection of plant disease using some automatic technique is beneficial because it reduces a large monitoring work in large crop farms and detects the symptoms of diseases at a very early stage, i.e. when they appear on plant leaves. This paper covers survey on different methodologies to detect plant leaf and fruit diseases using neural network.

Keywords: **plant disease, neural networks, neural network models, Image Processing**

I. Introduction

Many people in India are farmers and depend on agricultural production. There are several diseases which are going to affect the production of crops. The disease results in irregular shaped black patches which appear over the leaf surface or early grown fruits. Also, the fungus may occur under damp situations in these patches. These patches start in small shape but soon they cover the entire area of the fruit or leaf and finally result in rotten leaves or rotten fruits. It is necessary to detect and control such types of diseases in a specific time period which is at their initial state. So it is important to destroy such diseases before it will affect on some basic operation of plant body such as photosynthesis, transpiration, pollination, fertilization, germination etc. These diseases created due to the pathogens such as fungi, bacteria and viruses. For that farmers require continuous monitor the plant body which is time consuming process. There is a need of some method to detect diseases on the plant in early stages. The detection and classification of leaf disease accurately is the key to prevent the agriculture loss. For this purpose, neural network is used. Neural network provides list of methods and classifiers to detect plant diseases. This paper includes neural network in image processing, major types of neural networks, neural network models, plant diseases and literature review of plant diseases using artificial neural network.

II. Neural Network in Image Processing

A computational model that works in a way similar to the human brain 's neurons. Each neuron takes an input, carries out certain operations and passes the output to the next neuron. The main objective of any neural network is to eliminate the need to design feature vectors by hand. The neural network attempts to mimic the working of a brain, where we only present the “raw” input - the image and get the output directly. The various applications in image processing could be the classification of images, automatic annotation of images etc. There are two common ways to do image processing in neural network i.e. using gray scale and using RGB values.

i. **Using Gray Scale:** Here the image is converted to gray scale (range of gray shades from white to black) and each pixel is assigned a value according to how dark it is. All numbers are placed in an array and the computer calculates the array.
ii. **Using RGB Values :** Colors can be represented as RGB values (a blend of red, green and blue between 0 and 255). Computers could then extract each pixel's RGB value and set the result to an array for interpretation.

III. Major types of Neural Networks

The major types of neural networks (NN)which are Single-Layer Perceptron (SLP), Multi-Layer Perceptron (MLP), Radial-Basis Function (RBF) networks, Kohonen’s Self-Organising Map (SOM) networks, Probabilistic Neural Network (PNN) and Convolutional Neural Network (CNN).

IV.Neural Network Models

Various types of neural networks are implemented using specific neural architectures and learning algorithms known as NN models in combination.

i)Feed-Forward Neural Network (FFNN)

- Perceptrons are arranged in layers, with the first layer taking inputs and the last layer producing outputs. The middle layers have no connection with the external world, and hence are called hidden layers.
- Each perceptron in one layer is connected to every perceptron on the next layer. Hence information is constantly "fed forward" from one layer to the next, and this explains why these networks are called feed-forward networks

- There is no connection among perceptrons in the same layer.

ii)Back-Propagation Neural Network (BPNN)

- Back-propagation is a method used in artificial neural networks to calculate a gradient that is needed in the calculation of the weights to be used in the network.
- Back-propagation is shorthand for "the backward propagation of errors," since an error is computed at the output and distributed backwards throughout the network's layers
- It is commonly used to train deep neural networks

iii)Generalized regression Neural Network (GRNN)

- A memory-based network that provides estimates of continuous variables and converges to the underlying (linear or nonlinear) regression surface is described.
- The general regression neural network (GRNN) is a one-pass learning algorithm with a highly parallel structure. It is shown that, even with sparse data in a multidimensional measurement space
- The algorithm provides smooth transitions from one observed value to another
- The algorithmic form can be used for any regression problem in which an assumption of linearity is not justified.

V. Plant Diseases

The most common plant diseases occur in India are classified as per their features available on the leaf or fruit. The color, the texture and the morphological features are used to train a neural network model.

Table No. 1 : Characteristics of Diseases in Different Plant

Disease	Host	Symptoms and signs
Late Blight of potato	Potato	dark green to black or purplish lesions with pale green margins on lower leaves,
chestnut blight	chestnut tree	yellowish to reddish brown patches appear on bark
black stem rust of wheat	wheat; many grasses	rust-colored pustules with spores, followed by development of black teliospore
coffee rust	coffee	orange-yellow powdery spots on lower side of leaves; centers turn brown
loose smut	barley, oats, wheat	infected heads are covered with masses of olive-green spores
powdery mildew	many types of plants: grasses, vegetables, shrubs, and trees	spots of powdery mildew growth that enlarge to cover leaves or other plant organs
anthracnose	many types of plants: grasses, vegetables, shrubs, and trees	large circular black lesions on leaves; leaves turn yellow
brown rot	stone fruits	small sunken brown cankers; fruit develops brown spots

VI. Literature Review

In **classification of Diseased plant leaves using Neural Network Algorithms et al.** K. Muthukannan detected spot diseases in leaves and that are classified based on the diseased leaf types using various neural network algorithms. The methodology used to classify the diseased plant leaves using Feed Forward Neural Network (FFNN), Learning Vector Quantization (LVQ) and Radial Basis Function Networks (RBF) by processing the set of shape and texture features from the affected leaf image. The simulation results show the effectiveness of the proposed scheme. With the help of this work, a machine learning based system can be formed for the improvement of the crop quality in the Indian Economy.[1]

Et. al Malvika Ranjan in the paper **Detection and Classification of Leaf Disease using Artificial Neural Network** begins with capturing the images. Color feature like HSV features are extracted from the result of segmentation and Artificial neural network (ANN) is then trained by choosing the feature values that could distinguish the healthy and diseased samples appropriately. Experimental results showed that classification performance by ANN taking feature set is better with an accuracy of 80%. The present work proposes a methodology for detecting cotton leaf diseases early and accurately, using diverse image processing techniques and artificial neural network (ANN).[2]

The objective of the paper **Leaf Disease Classification using Artificial Neural Network** written by et al. Syafiqah Ishakais is to capture and analysis data from leaf images for classify healthy or unhealthy of the leaves of medicine plants was achieved using image processing method. From image processing method, algorithm of adjusted contrast, segmentation and features extraction is used to extract image and to get dataThe experiment results have been done using Artificial Neural Network. Multi-layer feed forward Neural Network which are multi-layer perceptron and radial basis function RBF are the structures of the network used to class healthy or unhealthy of leaves. In the final experiment, the result shows that the RBF network performs better than MLP network.[3]

In **Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification** et al. Srdjan Sladojevic concerned with a new approach to the development of plant disease recognition model, based on leaf image classification, by the use of deep convolutional networks. Novel way of training and them ethodology used facilitate a quick and easy system implementation in practice. The developed model is able to recognize thirteen different types of plant diseases out of healthy leaves, with the ability to distinguish plant leaves from their surroundings. All essential steps required for implementing this disease recognition model are fully described throughout the paper, starting from gathering images in order to create a database, assessed by agricultural experts. Caffe, a deep learning framework developed by Berkley Vision and Learning Centre, was used to perform the deep CNN training. The experimental results on the developed model achieved precision between 91% and 98%, for separate class tests, on average 96.3%.[4]

In Plant Disease Classification Using Convolutional Networks and Generative Adverserial Networks et al. Emanuel Cortes Using a public dataset of 86,147 images of diseased and healthy plants, a deep convolutional network and semi supervised methods are trained to classify crop species and disease status of 57 different classes. The experiment that performed well on the unsupervised data was rsnet. It was able to score above 80% in the training phrase under 5 epochs with the learning rate of 1e-5.[5]

Deep learning models for plant disease detection and diagnosis In this paper, et al. Konstantinos P. Ferentinos convolutional neural network models were developed to perform plant disease detection and diagnosis using simple leaves images of healthy and diseased plants, through deep learning methodologies. Training of the models was performed with the use of an open database of 87,848 images, containing 25 different plants in a set of 58 distinct classes of [plant, disease] combinations, including healthy plants. Several model architectures were trained, with the best performance reaching a 99.53% success rate in identifying the corresponding [plant, disease] combination (or healthy plant). The significantly high success rate makes the model a very useful advisory or early warning tool, and an approach that could be further expanded to support an integrated plant disease identification system to operate in real cultivation conditions.[6]

Et al. Serawork Wallelign in the paper **Soybean Plant Disease Identification Using Convolutional Neural Network** This paper describes the feasibility of CNN for plant disease classification for leaf images taken under the natural environment.The model is designed based on the LeNet architecture to perform the soybean plant disease classification. 12,673 samples containing leaf images of four classes, including the healthy leaf images, were obtained from the PlantVillage database. The images were taken under uncontrolled environment. The implemented model achieves 99.32% classification accuracy which show clearly that CNN can extract important features and classify plant diseases from images taken in the natural environment[7].

A Robust Deep-Learning-Based Detector for Real-Time Tomato Plant Diseases and Pests Recognition et al. Alvaro Fuentes we consider three main families of detectors: Faster Region-based Convolutional Neural Network (Faster R-CNN), Region-based Fully Convolutional Network (R-FCN), and Single Shot Multibox Detector (SSD), which for the purpose of this work are called “deep learning meta-architectures”. We combine each of these meta-architectures with “deep feature extractors” such as VGG net and Residual Network (ResNet). We demonstrate the performance of deep meta-architectures and feature extractors, and additionally propose a method for local and global class annotation and data augmentation to increase the accuracy and reduce the number of false positives during training. We train and test our systems end-to-end on our large Tomato Diseases and Pests Dataset, which contains challenging images with diseases and pests, including several inter- and extra-class variations, such as infection status and location in the plant.[8]

Identification of Apple Leaf Diseases Based on Deep Convolutional Neural Networks This paper proposes an accurate identifying approach for apple leaf diseases based on deep convolutional neural networks. It includes generating sufficient pathological images and designing a novel architecture of a deep convolutional neural network based on AlexNet to detect apple leaf diseases. Using a dataset of 13,689 images of diseased apple leaves, the proposed deep convolutional neural network model is trained to identify the four common apple leaf diseases. Under the hold-out test set, the experimental results show that the proposed disease identification approach based on the convolutional neural network achieves an overall accuracy of 97.62%, the model parameters are reduced by 51,206,928 compared with those in the standard AlexNet model, and the accuracy of the proposed model with generated pathological images obtains an improvement of 10.83%. This research indicates that the proposed deep learning model provides a better solution in disease control for apple leaf diseases with high accuracy and a faster convergence rate, and that the image generation technique proposed in this paper can enhance the robustness of the convolutional neural network model.[9]

In **Using Deep Learning for Image-Based Plant Disease Detection et al.** Prasanna Mohanty train a deep convolutional neural network to identify 14 crop species and 26 diseases (or absence thereof). The trained model achieves an accuracy of 99.35% on a held-out test set, demonstrating the feasibility of this approach. When testing the model on a set of images collected from trusted online sources - i.e. taken under conditions different from the images used for training - the model still achieves an accuracy of 31.4%. While this accuracy is much higher than the one based on random selection (2.6%), a more diverse set of training data is needed to improve the general accuracy. Overall, the approach of training deep learning models on increasingly large and publicly available image datasets presents a clear path towards smartphone-assisted crop disease diagnosis on a massive global scale[10].

In **Image-Based Plant Disease Detection with Deep Learning** et al. Ashwin Dhakal developed a model which is followed with feature extraction, segmentation and the classification of patterns of captured leaves in order to identify plant leaf diseases. Four classifier labels are used as Bacterial Spot, Yellow Leaf Curl Virus, Late Blight and Healthy Leaf. The features extracted are fit into the neural network with 20 epochs. Several artificial neural network architectures are implemented with the best performance of 98.59% accuracy in determining the plant disease.[11]

In **Deep Learning for Image-Based Cassava Disease Detection** et al. Amanda Ramcharan Using a dataset of cassava disease images taken in the field in Tanzania, we applied transfer learning to train a deep convolutional neural network to identify three diseases and two types of pest damage (or lack thereof). The best trained model accuracies were 98% for brown leaf spot (BLS), 96% for red mite damage (RMD), 95% for green mite damage (GMD), 98% for cassava brown streak disease (CBSD), and 96% for cassava mosaic disease (CMD). The best model achieved an overall accuracy of 93% for data not used in the training process.

Our results show that the transfer learning approach for image recognition of field images offers a fast, affordable, and easily deployable strategy for digital plant disease detection[12].

Table No. 2 : Comparative Study of Neural Network Models used by researchers

Sr. No	Name of Paper	Author	Accuracy	NN Model & Classifiers used	Year
1	Detection and Classification of leaf disease using Artificial Neural Network	K. Muthukannan P. Latha R. Pon Selvi and P. Nisha1	56.87%	Feed Forward Neural Network (FFNN), Learning Vection(LVQ) and Radial Basic Function Networks(RBF)tor Quantiz	2015
2	Detection and Classification using Artificial Neural Network	Malvika Ranjan1, Manasi Rajiv Weginwar2, Neha Joshi3, Prof. A.B. Ingole4	80%	Artificial Neural Network(ANN), Hue Saturation value features , Back Propogation Algorithm	2015
3	Leaf Disease Classification using Artificial Neural Network	Syafiqah Ishaka, Mohd Hafiz Fazalul Rahimana*, Siti	90.30%	Multi-layer feed forward Neural Network which are multi-layer perceptron and radial basis function RBF are the structures of the network used	2015
4	Plant Disease Classification Using Convolutional Networks and Generative Adversial Networks	Emanuel Cortes	80% in 5 epochs	segmentation with Mask RCNN	2015
5	Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification	Srdjan Sladojevic, Marko Arsenovic, Andras Anderla,Dubravko Culibrk, and Dark Stefanovic	96.3%.	a deep learning framework developed by Berkley Vision and Learning Centre, was used to perform the deep CNN training	2016
6	Using Deep Learning for Image-Based Plant Disease Detection	Sharada Prasanna Mohanty, David Hughes, and Marcel Salathé	99.35%	deep convolutional neural network with Alexnet & googlenet with transfer learning training mechanism	2016
7	A Robust Deep-Learning-Based Detector for Real-Time Tomato Plant Diseases and Pests Recognition	Alvaro Fuentes ID , Sook Yoon, Sang Cheol Kim and Dong Sun Park	85.98%	Faster Region-based Convolutional Neural Network (Faster R-CNN), Region-based Fully Convolutional Network (R-FCN), and Single Shot Multibox Detector (SSD),	2017
8	Identification of Apple Leaf Diseases Based on Deep Convolutional Neural Networks	Bin Liu ID , Yun Zhang ,†, DongJian He and Yuxiang Li	97.62%,	a novel architecture of a deep convolutional neural network based on AlexNet	2017
9	Deep Learning for Image-Based Cassava Disease Detection	Amanda Ramcharan Kelsee Baranowski, Peter McCloskey , Babuali Ahmed,	93%	a deep convolutional neural network	2017
10	Deep learning models for plant disease detection and diagnosis	Konstantinos P. Ferentinos Hellenic	99.53%	Convolutional deep learning model with deep learning methodologies	2018
11	Soybean Plant Disease Identification using convolutional Neural Netwotk	Serawork Wallelign,Mihai Polceanu,C´edric Buche	99.32%	Convolutional Neural Network Model on based on Lenet Architecture	2018
12	Image-Based Plant Disease Detection with Deep Learning	Ashwin Dhakal, Prof. Dr. Subarna Shakya	98.59%	Artificial Neural Network Architecture	2018

VII. Conclusion

Neural Networks provided us the first step towards AI by generating a model based on how our own human body learns. Through mimicking neuron interaction within the body, researchers about 20 years ago were actually able to conquer something that had never been done before. Before neural nets, there were very few, if at all, models that were actually trained on how our body learned. In this paper we present a review of the use of neural network models in the field of plant disease detection. The literature shows that color, texture and morphological characteristics are best suited to the identification and classification of diseases in plants. Most commonly used network models are artificial neural networks (ANN) and convolutional neural network (CNN). Automatic detection of plant diseases would solve the problem of expensive domain expert. Detection of plant diseases in early stage would help farmers to improve the crop yield, which in turn improves Indian gross domestic product.

REFERENCES:

[1] Diseased plant leaves using Neural Network Algorithms K. Muthukannan1, P. Latha2, R. Pon Selvi1 and P. Nisha1 1Department of ECE, Einstein College of Engineering, Anna University, Tirunelveli, India 2Department of CSE, Government College of Engineering, Anna University, Tirunelveli, India ARPN Journal of Engineering and Applied Sciences , VOL. 10, NO. 4, MARCH 2015 , ISSN 1819-6608

[2] Detection and Classification of Leaf Disease using Artificial Neural Network Malvika Ranjan1, Manasi Rajiv Weginwar2, Neha Joshi3, Prof. A.B. Ingole4 International Journal of Technical Research and Applications e-ISSN: 2320-8163, www.ijtra.com Volume 3, Issue 3 (May-June 2015), PP. 331-333

[3] Leaf Disease Classification using Artificial Neural Network Syafiqah Ishaka, Mohd Hafiz Fazalul Rahimana*, Siti Nurul Aqmariah Mohd Kanafiahb, Hashim *Saadc Syafiqah Ishak et al. / Jurnal Teknologi (Sciences & Engineering) 77:17 (2015) 109–114*

[4] Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification Dubravko Culibrk,2 and Darko Stefanovic1 Hindawi Publishing Corporation Computational Intelligence and Neuroscience Volume 2016, Article ID 3289801, 11 pages http://dx.doi.org/10.1155/2016/3289801

[5] Plant Disease Classification Using Convolutional Networks and Generative Adverserial Networks Emanuel Cortes Stanford University ecortes@stanford.edu

[6] Soybean Plant Disease Identification Using Convolutional Neural Network Serawork Wallelign Jimma Institute of Technology, Ethiopia LAB-STICC, ENIB, France wallelign@enib.fr Mihai Polceanu LAB-STICC, ENIB, France polceanu@enib.fr C´edric Buche LAB-STICC, ENIB,France buche@enib.fr Copyright _c 2018, Association for the Advancement of Artificial Intelligence (www.aaai.org).

[7] A Robust Deep-Learning-Based Detector for Real-Time Tomato Plant Diseases and Pests Recognition , Alvaro Fuentes 1, Sook Yoon 2,3, Sang Cheol Kim 4 and Dong Sun Park Sensors 2017, 17, 2022; doi:10.3390/s17092022

[8] Identification of Apple Leaf Diseases Based on Deep Convolutional Neural Networks, Bin Liu 1,2,*,† Yun Zhang 1,†, DongJian He 2,3 and Yuxiang Li 4, Symmetry 2018, 10, 11; doi:10.3390/sym10010011

[9] Using Deep Learning for Image-Based Plant Disease Detection Sharada Prasanna Mohanty1,2, David Hughes3,4,5, and Marcel Salathé1,2,6 April 15, 2016 | 1 https://arxiv.org/pdf/1604.03169

[10] Image-Based Plant Disease Detection with Deep Learning Ashwin Dhakal1, Prof. Dr. Subarna Shakya2 ISSN: 2231 – 2803 http://www.ijcttjournal.org

[11] Deep Learning for Image-Based Cassava Disease Detection Amanda Ramcharan1, Kelsee Baranowski 1, Peter McCloskey 2, Babuali Ahmed3, James Legg3 and David P. Hughes Frontiers in Plant Science | www.frontiersin.org 1 October 2017 | Volume 8 | Article 1852