ESTIMATE ACCURACY IN IMAGE PLANT DISEASES DETECTION USING CONVOLUTIONAL NEURAL NETWORK COMPARED WITH FULLY CONNECTED NEURAL NETWORK

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Abstract

Aim: To estimate accuracy in Image plant disease detection using Convolutional Neural Network over Fully Connected Neural Network.
Materials and Methods: Convolutional Neural Network and Fully Connected Neural Network are implemented in this research work. Sample size is calculated using G power software and determined as 10 per group with pretest power 80%.
Results and Discussion: Convolutional Neural Network provides a higher of 89.00 compared to Fully Connected Neural Network with 81.52 in predicting plant disease in plant diseases detection. There are statistically significant differences between study groups with $p = 0.035$ ($p<0.05$). Independent T-test value states that the results in the study are insignificant.
Conclusion: Convolutional Neural Network gives better accuracy then Fully Connected Neural Network.

Keywords: Plant Disease Detection, Novel Convolutional Neural Network, Fully Connected Neural Network, Accuracy in Neural Network, Image Processing, Innovative model

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1. Introduction

The goal of this study is to evaluate the accuracy of the diagnosis of plant diseases using Convolutional Neural Networks with Fully Connected Neural Networks. In this study, Image processing is used to predict plant diseases (Elaraby, Hamdy, and Alanazi 2022). When the image is collected and processed, the values in the input image are compared to the dataset and the relevant results for comparison are displayed (Tiwari, Joshi, and Dutta 2021). Rapid population growth requires an increase in food production. If the disease spreads easily, it can severely affect crop production and even destroy entire crops. Therefore, early detection, diagnosis and prevention of the disease are very important ((Razmjooy and Estrela 2019).

Images can be processed to detect and diagnose plant leaf diseases and then take appropriate preventive measures to treat diseases and increase crop yields. It is very difficult to monitor plant diseases with your own hands (Taterwal 2021; Choudhury et al. 2021). It requires a tremendous amount of work, expertise in the plant diseases, and also requires excessive processing time (Zhu et al. 2021; Jepkoech et al. 2021). Hence, Image Processing is used for the detection of plant diseases by the images of leaves compared with the data sets (Dhaka et al. 2021; Kumar and Kaur 2015). Plant disease causes a considerable decrease in the quantity of agricultural goods. The protection of plants and crops in agricultural fields is critical. The leaves can be utilized to identify and diagnose ailments when they are still in the early stages (Zhu et al. 2021; Thomas and Titus 2020). Plant leaves, which are the most vulnerable, display disease symptoms first. From the beginning of their life cycle until they are ready to be harvested, the crops must be monitored for illnesses (Gunarathna and Rathnayaka 2020). The use of technology in the detection and analysis process increases the accuracy and reliability of the process in neural networks. Many diseases are initially observed on the leaves of plants. If the disease is not detected at an early stage, it can cause a lot of damage (Gunarathna and Rathnayaka 2020; Menon, Ashwin, and Deepa 2021). The Image Processing models offer a quick, standardized and accurate solution to this issue. The major goal of this study is to use image processing techniques to detect plant diseases (Gumber and Chand 2019).

Our team has extensive knowledge and research experience that has translated into high quality publications (K. Mohan et al. 2022; Vivek et al. 2022; Sathish et al. 2022; Kotteeswaran et al. 2022; Yaashikaa, Keerthana Devi, and Senthil Kumar 2022; Yaashikaa, Senthil Kumar, and Karishma 2022; Saravanan et al. 2022; Jayabal et al. 2022; Krishnan et al. 2022; Jayakodi et al. 2022; H. Mohan et al. 2022). Plant Disease Detection can be carried out by many researchers. There are 164 articles which were published in IEEE Xplore digital library, 112 articles published in Science direct and 186 articles from Google Scholar. Among all the articles and journals the most cited papers are (Joshi, Mishra, and Ponmagal 2021; Roy and Sharan 2021; Radovanovic and Dukanovic 2020) and (Zhongzhi 2019). Many diseases are initially spotted on the leaves of the plants. It could lead to more harm if the disease is not identified in the first stage. The Image Processing models offer a quick, standardized and accurate solution to this issue (Gumber and Chand 2019). The main aim of this research work is to detect plant diseases using Image Processing techniques.

2. Materials and Methods

The research work was conducted in the Image Processing Lab, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences. Basically it is considered with two groups of classifiers namely Novel Convolutional Neural Network and Fully Connected Neural Network Algorithms, which is used to detect plant Diseases. Group 1 is the Novel Convolutional Neural Network algorithm with the sample size of 10 and the Fully Connected Network algorithm is group 2 with the sample size of 10 and it was compared for more accuracy score and Loss values for choosing the best algorithm to detect plant diseases. The sample size was calculated and determined as standard deviation for Convolutional Neural Network = 3.17 and Fully Connected Neural Network = 4.40.

Convolutional Neural Network Algorithm

The CNN was utilized for classifying and differentiating input data types. A Novel Convolutional Neural Network is a deep learning algorithm that can record an input image, focus on different aspects of the image, and distinguish them.

Pseudocode for CNN Algorithm

```
Import Convolutional Network Classifier
Import Convolutional Neural Network as CNN
filename, pathname = ui getfile({'*.jpg'; '*.gif'; '*.png'; '*.jpeg'}
Load Image;
if isequal(filename,0)||isequal(pathname,0)
warndlg('Press OK to continue', 'Warning');
else
image aqa = imread([pathname filename]);
imshow(image aqa);
```

```
title('Input');
image aqa = Preprocess( image aqa );
figure;
imshow(image aqa);
title('Preprocess');
image aqa = imresize(image aqa);
Compare images and  gives the accuracy;
Plot the graph for accuracy;
Plot  the graph for specificity;
Accuracy of the Convolutional Neural Network classifier;
```

Fully Connected Neural Network Algorithm

The Fully Connected Neural Network Algorithm model is a deep learning model with a fully connected first layer and combines expression similarities and prior-knowledge similarities as the input.

Pseudocode for FCNN Algorithm

```
Import Fully Connected Network Classifier
Import Fully Connected Neural Network as FCNN
filename, pathname = uigetfile({'*.jpg'; '*.gif'; '*.png'; '*.jpeg'}
Load Image;
if isequal(filename,0)||isequal(pathname,0)
warndlg('Press OK to continue', 'Warning');
else
image aqa = imread([pathname filename]);
imshow(image aqa);
title('Input');
image aqa = Preprocess( image aqa );
figure;
imshow(image aqa);
title('Preprocess');
image aqa = imresize(image aqa);
Compare images and  gives the accuracy;
Plot the graph for accuracy;
Plot  the graph for specificity;
Accuracy of the Fully Connected Neural Network classifier;
```

Recall that the testing setup includes both hardware and software configuration choices. The laptop has an Intel Core i5 11th generation CPU with 8GB of RAM, an x64-based processor, a 64-bit operating system, and a solid state drive. Currently, the software runs on Windows 10 and is programmed in Python. Once the program is finished, the accuracy in neural network value will appear. Procedure: Wi-Fi connected laptop with Google Collaboratory search to write the code in Python. Run the code. To save the file, upload it into the disc, and create a folder for it. Log in using the ID from the message. Run the code to output the accuracy in the neural network and graph.

Statistical Analysis

This analysis was performed with IBM SPSS 28. This is a statistical software used for data analysis. In the case of 10 repetitions of innovative models and existing algorithms, 10 repetitions were observed to analyze the accuracy with up to 20 samples, each iterated. Independent T-test values were performed. Plant leaf normal or diseased are independent variables and plant disease detection is dependent variable.

3. Results

Images selected from the dataset are framed to check the disease of plants Table 1 shows the accuracy in neural network value of iteration of CNN and FCNN. Table 2 represents the Group statistics results which depicts CNN with Mean Accuracy of 89.00%, and Standard Deviation is 3.17. FCNN has a mean accuracy of 81.52% and standard deviation is 4.40. Proposed Innovative CNN algorithm provides better performance compared to the FCNN algorithm. Table 3 describes the independent samples t-test value for CNN and FCNN with Mean difference as 7.480, std Error Difference as 1.717. Significance value is observed as 0.358. Fig. 1 describes the average accuracy of CNN and FCNN algorithm. CNN's is 89.00% and FCNN's is 81.52%.

4. Discussion

The Novel Convolutional Neural Network dominated the Fully Connected Neural Network in this study. The new convolutional neural network is a good choice for classifying images with relatively large data sets based on the simplicity of the approach and the accuracy obtained from the neural network. This technique identifies the disease, percentage of affected regions with good accuracy in the neural network for identification of different diseases (Abbas et al. 2021). The level of accuracy in neural network gain is determined by the variety of parameters, including disease stage, disease kind and object composition (Tiwari, Joshi, and Dutta 2021). Descriptions of leaves before and after disease infestation are part of the data sets used in this project. As a result of the study results, the experimental and statistical analysis shows a clear performance, although the presented innovative model has some limitations, such a threshold and precision (Tiwari, Joshi, and Dutta 2021; Zhongzhi 2019). The successive issues encountered in the process of detecting Plant Diseases were observed. The plants that are more diseased can be easily identified using old-

fashioned procedures. However, those who are affected by diseases in their early stages are unable to detect them using traditional procedures ("Plant Leaf Disease Detection Using Advanced Image Processing and Neural Network" 2018). This proposed Innovative model will provide the most accurate information on plant diseases. As a consequence of the study's findings, both experimental and statistical analysis reveal clarity in performance. When compared to existing machine learning techniques, the accuracy in neural network level of diagnosing Plant Diseases using Images can still be enhanced by using artificial intelligence techniques to predict and analyze better outcomes. The vast dataset for Plant Diseases can be used in the future to validate our proposed Innovative model in terms of scenarios.

5. Conclusion

The Image Plant Diseases Detection by using Novel Convolutional Neural Network Compared with Fully Connected Neural Network. The current study focused on algorithms such as, Convolutional Neural Network over Fully Connected Neural Network for higher classification in detecting Plant Diseases. The outcome of the study Convolutional Neural Network 89.00% higher accuracy than Fully Connected Neural Network 81.52%.

Declarations

Conflict of Interests

No conflict of interest

Authors Contribution

Author VG was involved in data collection, data analysis, manuscript writing. Author AG was involved in the Action process, Data verification and validation, and Critical review of manuscript.

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6. References

Abbas, Amreen, Sweta Jain, Mahesh Gour, and Swetha Vankudothu. 2021. "Tomato Plant Disease Detection Using Transfer Learning with C-GAN Synthetic Images." Computers and Electronics in Agriculture. https://doi.org/10.1016/j.compag.2021.106279.

Choudhury, Amitava, Arindam Biswas, Manish Prateek, and Amlan Chakrabarti. 2021. Agricultural Informatics: Automation Using the IoT and Machine Learning. John Wiley & Sons.

Dhaka, Vijaypal Singh, Sangeeta Vaibhav Meena, Geeta Rani, Deepak Sinwar, Kavita, Muhammad Fazal Ijaz, and Marcin Woźniak. 2021. "A Survey of Deep Convolutional Neural Networks Applied for Prediction of Plant Leaf Diseases." Sensors 21 (14). https://doi.org/10.3390/s21144749.

Elaraby, Ahmed, Walid Hamdy, and Saad Alanazi. 2022. "Classification of Citrus Diseases Using Optimization Deep Learning Approach." Computational Intelligence and Neuroscience 2022 (February): 9153207.

Gumber, Pankaj, and Lal Chand. 2019. "Plant Disease Detection Methods Using Image Processing." International Journal of Computer Sciences and Engineering. https://doi.org/10.26438/ijcse/v7i7.391395.

Gunarathna, M. M., and R. M. K. Rathnayaka. 2020. "Experimental Determination of CNN Hyper-Parameters for Tomato Disease Detection Using Leaf Images." 2020 2nd International Conference on Advancements in Computing (ICAC). https://doi.org/10.1109/icac51239.2020.9357284.

Jayabal, Ravikumar, Sekar Subramani, Damodharan Dillikannan, Yuvarajan Devarajan, Lakshmanan Thangavelu, Mukilarasan Nedunchezhiyan, Gopal Kaliyaperumal, and Melvin Victor De Poures. 2022. "Multi-Objective Optimization of Performance and Emission Characteristics of a CRDI Diesel Engine Fueled with Sapota Methyl Ester/diesel Blends." Energy. https://doi.org/10.1016/j.energy.2022.123709.

Jayakodi, Santhoshkumar, Rajeshkumar Shanmugam, Bader O. Almutairi, Mikhlid H. Almutairi, Shahid Mahboob, M. R. Kavipriya, Ramesh Gandusekar, Marcello Nicoletti, and Marimuthu Govindarajan. 2022. "Azadirachta Indica-Wrapped Copper Oxide Nanoparticles as a Novel Functional Material in Cardiomyocyte Cells: An Ecotoxicity Assessment on the Embryonic Development of Danio Rerio." Environmental Research 212 (Pt A): 113153.

Jepkoech, Jennifer, David Muchangi Mugo, Benson K. Kenduiywo, and Edna Chebet Too.

2021. "Arabica Coffee Leaf Images Dataset for Coffee Leaf Disease Detection and Classification." Data in Brief 36 (June): 107142.

Joshi, Yash, Sachit Mishra, and R. S. Ponmagal. 2021. "17 Using Deep Learning for Image-Based Plant Disease Detection." Internet of Things and Machine Learning in Agriculture. https://doi.org/10.1515/9783110691276-017.

Kotteeswaran, C., Indrajit Patra, Regonda Nagaraju, D. Sungeetha, Bapayya Naidu Kommula, Yousef Methkal Abd Algani, S. Murugavalli, and B. Kiran Bala. 2022. "Autonomous Detection of Malevolent Nodes Using Secure Heterogeneous Cluster Protocol." Computers and Electrical Engineering. https://doi.org/10.1016/j.compeleceng.2022.107902.

Krishnan, Anbarasu, Duraisami Dhamodharan, Thanigaivel Sundaram, Vickram Sundaram, and Hun-Soo Byun. 2022. "Computational Discovery of Novel Human LMTK3 Inhibitors by High Throughput Virtual Screening Using NCI Database." Korean Journal of Chemical Engineering. https://doi.org/10.1007/s11814-022-1120-5.

Kumar, Surender, and Rupinder Kaur. 2015. "Plant Disease Detection Using Image Processing- A Review." International Journal of Computer Applications. https://doi.org/10.5120/ijca2015905789.

Menon, Vishal, V. Ashwin, and Raj K. Deepa. 2021. "Plant Disease Detection Using CNN and Transfer Learning." 2021 International Conference on Communication, Control and Information Sciences (ICCISc). https://doi.org/10.1109/iccisc52257.2021.9484957.

Mohan, Harshavardhan, Sethumathavan Vadivel, Se-Won Lee, Jeong-Muk Lim, Nanh Lovanh, Yool-Jin Park, Taeho Shin, Kamala-Kannan Seralathan, and Byung-Taek Oh. 2022. "Improved Visible-Light-Driven Photocatalytic Removal of Bisphenol A Using V2O5/WO3 Decorated over Zeolite: Degradation Mechanism and Toxicity." Environmental Research. https://doi.org/10.1016/j.envres.2022.113136.

Mohan, Kannan, Abirami Ramu Ganesan, P. N. Ezhilarasi, Kiran Kumar Kondamareddy, Durairaj Karthick Rajan, Palanivel Sathishkumar, Jayakumar Rajarajeswaran, and Lorenza Conterno. 2022. "Green and Eco-Friendly Approaches for the Extraction of Chitin and Chitosan: A Review." Carbohydrate Polymers 287 (July): 119349.

"Plant Leaf Disease Detection Using Advanced Image Processing and Neural Network." 2018. International Journal of Recent Trends in Engineering and Research 4 (4): 138–43.

Radovanovic, Drasko, and Slobodan Dukanovic. 2020. "Image-Based Plant Disease Detection: A Comparison of Deep Learning and Classical Machine Learning Algorithms." 2020 24th International Conference on Information Technology (IT). https://doi.org/10.1109/it48810.2020.9070664.

Razmjooy, Navid, and Vania Vieira Estrela. 2019. Applications of Image Processing and Soft Computing Systems in Agriculture. IGI Global.

Roy, Sandip Kumar, and Preeta Sharan. 2021. "13 Image-Based Hibiscus Plant Disease Detection Using Deep Learning." Internet of Things and Machine Learning in Agriculture. https://doi.org/10.1515/9783110691276-013.

Saravanan, A., P. Senthil Kumar, B. Ramesh, and S. Srinivasan. 2022. "Removal of Toxic Heavy Metals Using Genetically Engineered Microbes: Molecular Tools, Risk Assessment and Management Strategies." Chemosphere 298 (July): 134341.

Sathish, T., R. Saravanan, V. Vijayan, and S. Dinesh Kumar. 2022. "Investigations on Influences of MWCNT Composite Membranes in Oil Refineries Waste Water Treatment with Taguchi Route." Chemosphere 298 (July): 134265.

Taterwal, Deepit. 2021. Detection of Pepper Leaves Diseases Using CNN and Machine Learning Algorithms.

Thomas, Siji A., and Geevarghese Titus. 2020. "A Comparative Analysis on PNN and CNN Classifiers for Retinal Disease Detection Using Fundus Images." Emerging Technologies for Sustainability. https://doi.org/10.1201/9780429353628-34.

Tiwari, Vaibhav, Rakesh Chandra Joshi, and Malay Kishore Dutta. 2021. "Dense Convolutional Neural Networks Based Multiclass Plant Disease Detection and Classification Using Leaf Images." Ecological Informatics. https://doi.org/10.1016/j.ecoinf.2021.101289.

Vivek, J., T. Maridurai, K. Anton Savio Lewise, R. Pandiyarajan, and K. Chandrasekaran. 2022. "Recast Layer Thickness and Residual Stress Analysis for EDD AA8011/h-BN/B4C Composites Using Cryogenically Treated SiC and CFRP Powder-Added Kerosene." Arabian Journal for Science and Engineering. https://doi.org/10.1007/s13369-022-06636-5.

Yaashikaa, P. R., M. Keerthana Devi, and P. Senthil Kumar. 2022. "Algal Biofuels: Technological Perspective on Cultivation, Fuel Extraction and Engineering Genetic Pathway for Enhancing Productivity." Fuel. https://doi.org/10.1016/j.fuel.2022.123814.

Yaashikaa, P. R., P. Senthil Kumar, and S. Karishma. 2022. "Review on Biopolymers and Composites – Evolving Material as Adsorbents in Removal of Environmental Pollutants." Environmental Research. https://doi.org/10.1016/j.envres.2022.113114.

Zhongzhi, Han. 2019. "Using Deep Learning for Image-Based Plant Disease Detection." Computer Vision-Based Agriculture Engineering. https://doi.org/10.1201/9780429289460-24.

Zhu, Jiajun, Man Cheng, Qifan Wang, Hongbo Yuan, and Zhenjiang Cai. 2021. "Grape Leaf Black Rot Detection Based on Super-Resolution Image Enhancement and Deep Learning." Frontiers in Plant Science 12 (June): 695749.

Tables and Figures

Table 1. Accuracy Values of Image Plant Disease Detection using CNN and FCNN. The efficiency of CNN algorithm(89.00) is more than FCNN algorithm(81.52).

S.NO	CNN	FCNN
1	86.50	85.50
2	92.50	78.80
3	89.20	76.50
4	90.00	83.20
5	87.50	77.00
6	83.50	84.20
7	85.60	77.80
8	90.50	90.50
9	91.20	81.20
10	93.50	80.50

Table 2. Group Statistics Results-CNN has an mean accuracy (89.00%), std.deviation (3.17), whereas FCNN has mean accuracy (81.52%), std.deviation (4.40).

Group Statistics					
	Groups	**N**	**Mean**	**Standard deviation**	**Standard Error Mean**
Accuracy	CNN	10	89.00	3.17	1.005
	FCNN	10	81.52	4.40	1.392

Table 3. Independent Sample T- test Result is done with confidence interval as 95% and level of significance as 0.358 (Convolution Neural Networks seems to be significantly better than Fully Connected Neural Network with these value of $p < 0.05$)

	Independent Sample Test									
	Levene's Test for Equality of Variances						**T-test for Equality of Means**			
Accuracy	**F**	**Sig**	**t**	**df**	**Significance**		**Mean Difference**	**Std.Error Difference**	**95% Confidence Interval of the Difference**	
					One-Sided p	**Two-Sided p**			**Lower**	**Upper**
Equal variances assumed	0.892	0.035	4.356	18	0.001	0.001	7.480	1.717	3.871	11.088
Equal variances not assumed			4.356	16.377	0.001	0.001	7.480	1.717	3.846	11.113

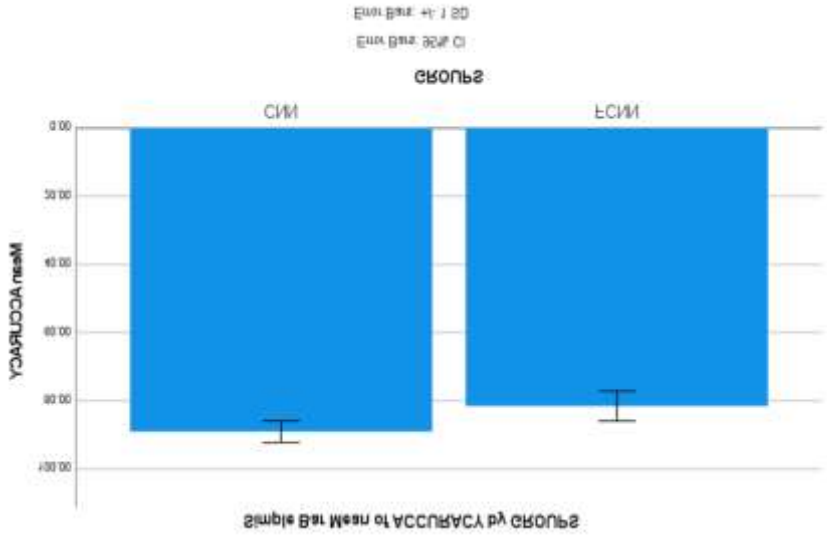

Fig. 1. Examination of CNN set of rules along with FCNN set of rules in phrases of mean accuracy Std.Deviation of CNN (89.00%) is somewhat higher than FCNN (81.52%). X Axis: CNN vs FCNN. Y Axis: Mean accuracy of detection ± 1 SD.