ESTIMATE ACCURACY IN IMAGE PLANT DISEASES DETECTION USING CONVOLUTIONAL NEURAL NETWORK COMPARED WITH PULSE-COUPLED NEURAL NETWORK

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Abstract

Aim: The main aim of the research work is to estimate accuracy in Image plant disease detection using Convolutional Neural Network over Pulse-Coupled Neural Network.
Materials and Methods: Convolutional Neural Network and Pulsed-Coupled 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 88.21% compared to Pulse-Coupled Neural Network with 83.95% in predicting plant disease in plant diseases detection. There are statistically significant differences between study groups with p = 0.045 ($p<0.05$) Independent T-test value states that the results in the study are insignificant.
Conclusion: Convolutional Neural Network gives better accuracy then Pulse-Coupled Neural Network.

Keywords: Plant Disease Detection, Novel Convolutional Neural Network, Pulse-Coupled Neural Network, Accuracy, Image Processing

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1. Introduction

The aim of this research work is to estimate the accuracy in image plant disease detection using a convolutional neural network over a Pulse-Coupled Neural Network. To predict plant disease, the current study employs the Image Processing technique(Genaev et al. 2021). When the image is accumulated and processed, the values of the image are as compared to the dataset, and the end result is proven relying on the comparison. The old approach of human analysis by visual inspection is no longer viable for categorizing agricultural diseases. Plant diseases have an impact on plant development and agricultural yield, as well as on agriculture's societal impact. There are many instances where farmers lack a thorough understanding of the crops and the diseases that can impact them(Mrisho et al. 2020; P. Wang et al. 2021). Farmers suffer financial losses as a result of plant leaf diseases(Gumber and Chand 2019).

The first stage in disease management is to detect the ailment. Plant disease causes a considerable decrease in the quality and quantity of agricultural goods(Li, Zhang, and Wang 2021).Time consumption, manpower consumption, are disadvantages of manual monitoring.(Liu and Wang 2021). Leaves are the most vulnerable portion of the plant, they show disease symptoms first. From the beginning of their life cycle until they are ready to be harvested, the crops must be monitored for illnesses.(Almadhor et al. 2021; P. Wang et al. 2021)(Taterwal 2021).

Plant Disease Detection can be carried out by many researchers. There are 157 articles which were published in IEEE Xplore digital library, 97 articles published in Science direct and 182 articles from Google Scholar. Among all the articles and journals the most cited papers are (Almadhor et al. 2021; Mrisho et al. 2020) and (Saleem et al. 2020)(X. Wang, Liu, and Liu 2021).

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). The majority of plant illnesses are detected by their symptoms, which include color, texture, and shape(Genaev et al. 2021; Aglave 2018). Plant diseases can be detected using images of leaves and other components of the plant. Diseases that are easily disseminated can have a significant negative impact on plant production, even destroying entire crops. The main aim of this research work is to detect plant diseases using Image Processing techniques.(Saleem et al. 2020; Mrisho et al. 2020).

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 Pulsed-Coupled 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 Pulsed-Coupled Neural Network algorithm is group 2 with the sample size of 10 and it was compared for more accuracy in neural network 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 = 3.88 and Pulsed-Coupled Neural Network = 3.73.

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;

Pulse-Coupled Neural Network Algorithm

The Pulse-Coupled Neural Network was used for the analysis. Pulse-Coupled Neural Networks also require the required amount of input data to perform the assigned task. A PCNN is a two-dimensional neural network. Each neuron in the network corresponds to a pixel in an input image.

Pseudocode for PCNN Algorithm

```
Import Pulse-Coupled Network Classifier
Import Pulse-Coupled Neural Network as PCNN
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 Pulse-Coupled 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 PCNN. Table 2 represents the Group statistics results which depicts CNN with Mean Accuracy of 90.71%, and standard deviation is 2.90. PCNN has an Mean Accuracy of 83.32% and Standard Deviation is 3.82. Proposed Innovative CNN algorithm provides better performance compared to the PCNN algorithm. Table 3 describes the independent samples t-test value for CNN and PCNN with Mean difference as 7.398, standard Error Difference as 1.519. Significance value is observed as 0.410. Fig. 1 describes the average accuracy of CNN and PCNN algorithms. CNN's average accuracy is 90.71% and PCNN is 83.32%.

4. Discussion

The Novel Convolutional Neural Network dominated the Pulse-Coupled 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(Liu and Wang 2021)(. 2021).The level of accuracy of neural network consolidation is determined by various parameters, including the stage of the disease, the type of disease, and the composition of the subject (Kumar and Kaur 2015) As a consequence of the study's findings, both experimental and statistical analysis reveal clarity in performance, although the presented Innovative model has some limitations, such as threshold and precision (Chen et al. 2021)**.** 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. This proposed Innovative model will provide the most

accurate information on plant diseases(Halder, Sarkar, and Bahar 2018). Research results, experimental and statistical analyzes demonstrate the clarity of performance. However, the presented Innovative model has some limitations, such as threshold and precision. When compared to existing machine learning techniques, the accuracy level of diagnosing Plant Diseases using Images can still be enhanced by using artificial intelligence techniques to predict and analyze better outcomes (Mrisho et al. 2020) (Zhongzhi 2019). 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 using Novel Convolutional Neural Network Compared with Pulse-Coupled Neural Network. The current study focused on algorithms such as, Novel Convolutional Neural Network over Pulse-Coupled Neural Network for higher classification in detecting Plant Diseases. The outcome of the study Convolutional Neural Network 88.21% higher accuracy than Neural Network 83.95%.

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

Aglave, Balaji. 2018. Handbook of Plant Disease Identification and Management. CRC Press.

Almadhor, Ahmad, Hafiz Tayyab Rauf, Muhammad Ikram Ullah Lali, Robertas Damaševičius, Bader Alouffi, and Abdullah Alharbi. 2021. "AI-Driven Framework for Recognition of Guava Plant Diseases through Machine Learning from DSLR Camera Sensor Based High Resolution Imagery." Sensors 21 (11). https://doi.org/10.3390/s21113830.

Chen, Junde, Jinxiu Chen, Defu Zhang, Y. A. Nanehkaran, and Yuandong Sun. 2021. "A Cognitive Vision Method for the Detection of Plant Disease Images." Machine Vision and Applications. https://doi.org/10.1007/s00138-020-01150-w.

Genaev, Mikhail A., Ekaterina S. Skolotneva, Elena I. Gultyaeva, Elena A. Orlova, Nina P. Bechtold, and Dmitry A. Afonnikov. 2021. "Image-Based Wheat Fungi Diseases Identification by Deep Learning." Plants 10 (8). https://doi.org/10.3390/plants10081500.

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.

Halder, Monishanker, Ananya Sarkar, and Habibullah Bahar. 2018. "PLANT DISEASE DETECTION BY IMAGE PROCESSING: A LITERATURE REVIEW." SDRP Journal of Food Science & Technology. https://doi.org/10.25177/jfst.3.6.6.

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.

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.

Li, Lili, Shujuan Zhang, and Bin Wang. 2021. "Apple Leaf Disease Identification with a Small and Imbalanced Dataset Based on Lightweight Convolutional Networks." Sensors 22 (1). https://doi.org/10.3390/s22010173.

Liu, Jun, and Xuewei Wang. 2021. "Plant Diseases and Pests Detection Based on Deep Learning: A Review." Plant Methods 17 (1): 22.

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.

Mrisho, Latifa M., Neema A. Mbilinyi, Mathias Ndalahwa, Amanda M. Ramcharan, Annalyse K. Kehs, Peter C. McCloskey, Harun Murithi, David P. Hughes, and James P. Legg. 2020. "Accuracy of a Smartphone-Based Object Detection Model, PlantVillage Nuru, in Identifying the Foliar Symptoms of the Viral Diseases of Cassava-CMD and CBSD." Frontiers in Plant Science 11 (December): 590889.

Saleem, Muhammad Hammad, Sapna Khanchi, Johan Potgieter, and Khalid Mahmood Arif. 2020. "Image-Based Plant Disease Identification by Deep Learning Meta-Architectures." Plants 9 (11). https://doi.org/10.3390/plants9111451.

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.

. Shishira. 2021. "Plant Disease Detection Using Leaf Images." International Journal for Research in Applied Science and Engineering Technology. https://doi.org/10.22214/ijraset.2021.37429.

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

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.

Wang, Peng, Tong Niu, Yanru Mao, Bin Liu, Shuqin Yang, Dongjian He, and Qiang Gao. 2021. "Fine-Grained Grape Leaf Diseases Recognition Method Based on Improved Lightweight Attention Network." Frontiers in Plant Science 12 (October): 738042.

Wang, Xuewei, Jun Liu, and Guoxu Liu. 2021. "Diseases Detection of Occlusion and Overlapping Tomato Leaves Based on Deep Learning." Frontiers in Plant Science 12 (December): 792244.

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. "Computer Vision-Based Agriculture Engineering." https://doi.org/10.1201/9780429289460.

Tables and Figures

Table 1. Accuracy Values of Image Plant Disease Detection using CNN and PCNN. The efficiency of CNN algorithm (88.21) is more than PCNN algorithm (83.95).

S.NO	CNN	PCNN
1	92.80	84.20
2	88.60	79.80
3	83.50	90.50
4	90.50	83.20
5	85.40	84.00
6	82.50	89.70
7	93.80	78.60
8	87.00	84.00
9	86.50	82.50
10	91.50	83.00

Table 2. Group Statistics Results-CNN has an mean accuracy (88.21%), std.deviation (3.88), whereas for PCNN has mean accuracy (83.95%), std.deviation (3.73).

Group Statistics					
	Groups	**N**	**Mean**	**Standard deviation**	**Standard Error Mean**
Accuracy	CNN	10	88.21	3.88	1.22

	PCNN	10	83.95	3.73	1.18

Table 3. Independent Sample T- test Result is done with confidence interval as 95% and level of significance as 0.499 (Convolution Neural Networks seems to be significantly better than Pulse-Coupled Neural Networks with these value of $p < 0.05$)

Accuracy	**Independent Sample Test**									
	Levene's Test for Equality of Variances						**T-test for Equality of Means**			
	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	0.476	0.045	2.501	18	0.011	0.022	4.260	1.703	0.681	7.838
Equal variances not assumed			2.501	17.973	0.011	0.022	4.260	1.703	0.681	7.838

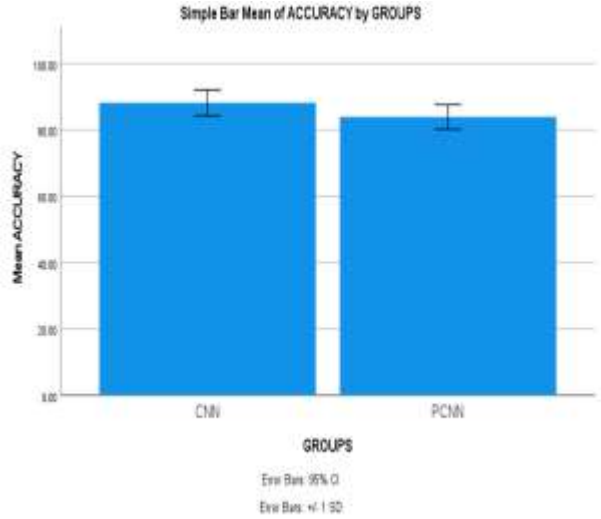

Fig. 1. Examination of CNN set of rules along with PCNN set of rules in phrases of mean accuracy Std.Deviation of CNN (88.21%) is somewhat higher than PCNN (83.95%). X Axis: CNN vs ANN.Y Axis: Mean accuracy of detection ± 1 SD.