Original Article

Prediction of Plant Diseases using Simple Novel Image Detection Technique with Improved Accuracy and Compared with Convolutional Neural Network

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Abstract

Aim: The aim of this research is to compare the performance of Simple Novel Image Detection Technique (SNIDT) with the Convolutional Neural Network (CNN) to improve the accuracy of Plant Disease Detection for Plant Protection.
Materials and Methods: The implementation of research is done using SNIDT, is a Machine Learning algorithm which calculates the RGB pixel density using the input images of plant leaves which are affected by diseases. The obtained pixel density is used for the summation of pixel density, the image gets converted to gray scale and then the normalization and brightness are measured. The algorithm classifies the output based on the grayscale of the given input image. Simple Novel Image Detection Technique and Convolutional Neural Network performance was compared with the samples of N=50 per group during the implementation. The research work uses 100 sample images for comparing both algorithms' performance. The sample size was calculated using the G Power statistical tool using G power with Pretest power 0.8.
Results: The comparison shows that Simple Novel Image Detection Technique has better mean accuracy of 81.13%, compared with Convolutional Neural Network the mean accuracy produces 75.09% with the significant value of .025 for $p<0.05$ provides significance.
Conclusion: The results show that the Simple Novel Image Detection technique has better accuracy than the Convolutional Neural Network algorithm and has significance.

Keywords: Convolutional Neural Network, Machine Learning, Plant leaf Diseases, Image Processing, Plant Protection, Simple Novel Image Detection Technique.

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INTRODUCTION

The plants are a major resource for producing food, this research study is to prevent growing diseases by classifying in the earlier stages. The Plant protection is an important factor for human life (Narayanasamy 2001). The plants are suffering from different types of diseases to prevent or for plant protection from the unidentified diseases by using the plant disease detection technique which detects the plant diseases by using the image as an input and gives the disease as an output ("DETECTION OF PLANT LEAF DISEASES USING IMAGE PROCESSING" 2020)The importance of the study is to protect the plants, since every living thing on the Earth leads using the food chain cycle. Since the plants have many unidentified diseases the detection technique this research will be useful to identify and solve the problems (Huang 1980). The application of this technique is very helpful in identifying different diseases and this analysis can be further referred for a solution which helps for plant protection for farmers crops (Indhu 2020), food production and development sectors (Mahlein 2016).
The articles published on Plant protection from unidentified diseases from the last five years in two different databases are as follows: IEEE- 93 and Science Direct-114. The most cited articles are referred from the databases, where the articles are detection of unhealthy regions of plant leaves using image processing and genetic algorithms (Singh, Varsha, and Misra 2015). Identifying leaf diseases in plants using Image classification methods discussed in this article (Oo et al. 2018). Plant leaf diseases detection and classification based on CNN with LVQ algorithm were performed in this article (Sardogan, Tuncer, and Ozen 2018). The most cited study is detection of plant leaf

diseases using neural networks (Dhaka et al. 2021), unhealthy regions of plant leaves using image processing and genetic algorithms.Our team has extensive knowledge and research experience that has translate into high quality publications(Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)
The existing algorithm used is CNN, has a poor accuracy of 75.09% for plant leaf disease identification and also it requires more computational power. The aim of this research is to improve the accuracy more than the existing research and to compare their performance using statistical tools.

MATERIALS AND METHODS

The Data Analytics Laboratory in the Department of CSE, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (SIMATS) has been used for developing and executing this research. The research mainly concentrated on two algorithms, one is the proposed system and another for comparing the result. Two groups were defined as, group 1 as SNIDT (Simple Novel Image Detection Technique) and group 2 as CNN (Convolutional Neural Network) with two sample size of 50 and 50 which is total of 100 which is performed under pretest power of 0.8 (Dhaka et al. 2021).
The dataset of sample images of plant leaf diseases has been downloaded from Kaggle, which has been used for analyzing the algorithm. The dataset contains different types of attributes like name, type, size, date. The dataset also contains 4000 image records of different plants and diseases. In the output, the proposed model will classify the type of plant, type of disease, information about the disease, their cause and cure techniques.

Simple Novel Image Detection Technique

In sample preparation group 1, Simple Novel Image Detection Technique of Machine Learning algorithm calculates the RGB pixel density and the summation of the pixel density and then it converts the image into a grayscale format. The converted format of image extracts the features from the image by converting the image into the grayscale format, normalizing the values. The brightness has been calculated after the conversion of image into grayscale, it takes an image of Plant Leaf Diseases as an input and gives the output as disease classification (Dhaka et al. 2021).

Steps for SNIDT algorithm

- The algorithm is calculated based on color RGB and Scale where change in appearance for the Shift is (u, v) where u, v indicates the variables.
- $E(U, V) = \sum [W(x,y) [I(x+y, y+v) - I(x, y)]^2$ which defines the mathematical representation of the algorithm the Image scale is taken in format of I(x,y).
- In SNIDT an input image is pre-processed to normalize contrast and brightness effects.
- Then the feature extraction is done to extract the important features of the image.
- The algorithm is applied for classification and the output is given based on the classification and comparison of images.

Convolutional Neural Network

In sample preparation group 2, the Convolutional Neural Network of Deep Learning based algorithm takes image as an input and classifies the image using various filters in the neural networks. A ConvNet is able to successfully capture the Spatial and Temporal dependencies in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and reusability of weights. In other words, the network can be trained to understand the sophistication of the image better (Sardogan, Tuncer, and Ozen 2018).

Steps for Convolutional Neural Network algorithm

- Mathematical representation of algorithm
- To compute the pre-nonlinearity $xlij=m-1\sum a=0m-1\sum b=0\omega abyl-1(i+a)(j+b)$
- For nonlinearity: $ylij=\sigma(xlij)$
- The representation of the algorithm Conv => Relu => Pool first.
- Our Conv layer has 36 filters with 3 x 3 core and Relu activation (linear correction module)
- By applying batch normalization, maximum aggregation, and a 27% reduction (0.26).
- Then create two sets (Conv => Relu) * 2 => Pool blocks.
- Then just a series of fully connected layers (fully connected layers) => Relu.
- which gives the output based on the image classification.

The model is tested on the setup with the hardware platform of i5 processor, 8GB RAM and 1TB Hard disk in DELL system. The used softwares was configured in Windows 10 OS, compilation software used was jupyter, pre-installed chrome, and MS Excel for recording the experiments behavioral data. The implementation of this research uses jupyter notebook editor, imported the basic required scikit learn, ggplot, seaborn libraries, loading the plant leaf disease dataset from data repository, various summarization of the data into statistical data and recording all the values obtained from the model as the output.

STATISTICAL ANALYSIS

The statistical software which is used for doing analysis is IBM SPSS version 22 (64 bit). The variables such as name, image type, number, ratio are known as independent variables. The dependent variables are types of disease such as seasonal disease, infectious disease, and non infectious disease. The independent sample T-test with significance of $p<0.05$ and confidence interval of 95% were taken to perform the result comparison between SNIDT and CNN (Dhaka et al. 2021).

Result

Table 1 explains about the group statistics of the model by comparing the algorithm and accuracy using sample samples=50 for SNIDT and samples=50 for CNN, the obtained Mean=81.1322 for SNIDT and 75.0900 for CNN, Std.Deviation=3.44258 for SNIDT and Std.Deviation=3.66524 for CNN, Std.Error Mean=.48685 for SNIDT and Std.Error Mean=.51834 for CNN.

Table 2 explains about the independent sample T-test analysis, which defines the Equality of the Variances and Equality of Means with the sig.=.025 for both assumed and non assumed variances and mean difference of 12.04220 for both assumed and non assumed variances and std.error difference .71113 for both assumed and non assumed variances and have 95% of confidence value respectively.

Figure 1 explains the comparison of the accuracy with error bars using a bar chart. The bar chart is generated with +/-1 SD and Confidence Interval of 95%. The X-axis carries the values obtained from the algorithms SNIDT (simple novel image detection technique) and CNN(Convolutional Neural Network). The Y-axis carries the mean accuracy rate of SNIDT is 81.1322% and CNN is 75.0900%.

Discussion

The comparison of both the algorithms have been done and the outputs have been represented in the results section. The two algorithms accuracy percentages are as follows: SNIDT is 81% and CNN is 75%. Also, the sig significance gets the value of 0.025 of $p<0.05$. So, from the accuracy and the significance values represented above states that SNIDT has better significance than CNN.

There are many studies related to Plant protection from unidentified diseases available. The similar findings to the proposed model in an article, plant disease identification system using machine learning techniques improves the prediction level (Alagumariappan et al. 2020). Image based detection of plant diseases from classical machine learning techniques uses more reliable prediction (Chatterjee et al. 2021). A modern way of approach for plant leaf image pre-processing for classification and disease detection uses hybrid models for disease identification (Dhaware and Wanjale 2017). A hybrid approach for plant leaf disease detection and classification using digital and classification using digital image processing methods (Rao and Kulkarni 2020). The opposing algorithm for the proposed study, was implemented using CNN and stated performs well compared to Machine Learning for Plant leaf detection technique (Sardogan, Tuncer, and Ozen 2018).

The model has some limitations such as wrong prediction in case of toxic side effects on leaf, cannot work with multiple recognition of images at once. Only one image can be used for processing at a time, it is only familiar with the leaf diseases of a plant which works only with leaf images. The future of the experiment can be improvised for classifying the plant diseases based on plant pathogens during seasonal carry-over with better and improved performance.

Conclusion

The accuracy of SNIDT algorithm has been improved to 81.13% and CNN has 75.09%, this proves SNIDT is an efficient algorithm when compared to CNN. The accuracy and output shows the efficient and better performance of the algorithm than CNN. Hence, it is proven that SNIDT performs better than CNN algorithm with respect to statistical analysis and related supporting articles.

Declarations

Conflict of Interest

No conflicts of interest in this manuscript.

Author Contribution

Author RM was involved in conceptualization, data collection, data analysis, manuscript writing. Author KJS was involved in conceptualization, guidance, and critical review of the manuscript.

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TABLES AND FIGURES

Table 1. The table gives the values of group statistics with the comparison of algorithms with the accuracy SNIDT=81.13% and CNN=75.09%.

Algorithm		**N**	**Mean**	**Std.Deviation**	**Std.Error Mean**
Accuracy	SNIDT	50	81.1322	3.44258	.48685
	CNN	50	75.0900	3.66524	.51834

Table 2. The table gives the output of independent variables like F,SIG,Mean difference,Std error difference, the significance is 0.025 ($p<0.05$).

	Levene's Test for Equality of Variance		**T-test for Equality of Means**						
	F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean diff.**	**Std error diff.**	**95% Confidence of the Differences**	
								Lower	**Upper**

Accuracy Equal variances assumed	.874	.025	16.924	98.147	.000	13.047	.71112	10.63098	13.45342
Accuracy Equal variances not assumed			16.014	97.4123	.000	13.041	.71112	10.63964	13.35648

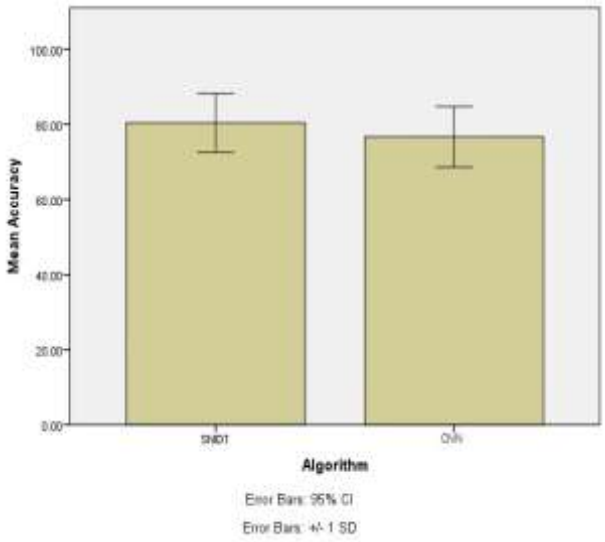

Fig. 1. Bar graph represents the comparison of Simple Novel Image detection Technique and Convolutional Neural Network. X- axis of the graph represents algorithm results of SNIDT and CNN with error bars, Y-axis represents the mean accuracy for plotted error bars with confidence interval 95% and +/- 1 SD.