AN ENHANCED CONVOLUTIONAL NEURAL NETWORKS (E-CNN) MODEL FOR GRAPE LEAF DISEASE DETECTION AND CLASSIFICATION

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Abstract

The severity of grape leaf disease damage to a grape may be estimated by analysing the condition of the grape leaves, which are a reliable indication of the grape plant's overall health. In order to speed up the process of grape leaf disease detection in grape leaf samples, this proposed research work suggests using deep learning based classification and image processing techniques. To achieve this goal, this proposed research work use a technique for extracting relevant features from images. We present an Enhanced CNN Model for Grape Leaf Disease Detection. We found that E-CNN provided the most consistent results with an accuracy of **98.81%**.

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1. INTRODUCTION

Grapes are widely consumed in the Mediterranean, Central Europe, and Southwest Asia. Leaves from this plant may be used in place of spinach or other leafy greens in salads. The grape leaves are used in the production of many dishes, thus it is essential that they be of high quality. One indicator of grape leaf selection in cooking is the absence of grooves and intact surface area of the leaves. In this study, we use image processing methods to extract the grape leaf's geometrical properties, such as its area and perimeter, and we then provide a numerical value based on the aforementioned index. Grapes are widely consumed in the Mediterranean, Central Europe, and Southwest Asia. Leaves from this plant may be used in place of spinach or other leafy greens in salads. The grape leaves are used in the production of many dishes, thus it is essential that they be of high quality. One indicator of grape leaf selection in cooking is the absence of grooves and intact surface area of the leaves. To quantify the aforementioned indicator, this study used image processing methods to extract the geometrical properties of a grape leaf, such as its area and perimeter.

A grape plant's response to a disease, whether a virus, bacterium, or fungus, may result in changes in colour, function, and form. The model's performance degrades while dealing with a smaller dataset. Training on a big dataset increases a model's accuracy and efficiency by decreasing the chance of overfitting. The kind and quality of the training dataset have a significant influence on the model's performance. Due to noise in the training data, the classifier's efficiency will alter depending on its internal structure. We've just scratched the surface of the issue so far since there aren't enough datasets devoted to exploring early detection. This proposed research work can diagnose grape plant illnesses using current grape leaf images and metadata, eliminating the need to collect more grape leaf inputs for laboratory investigation.provides a realistic strategy that can be implemented without breaking the bank or needing a lot of work. The proposed research work employs a Enhanced Convolutional Neural Network (CNN) to identify leaf infection, classify the infection (fungus, virus, bacterium, black spot, powdery mildew, downy mildew, blight, canker, and so on), and offer a treatment strategy.

2. LITERATURE REVIEW

The model for implementation was developed using a more complex computer setup.
In this approach, users are required to provide images of leaves, as well as to install a number of programmes, including TensorFlow, OpenCV, Keras, and others. Using the existing user-based technologies, plant leaf diseases have been found. It does not, however, provide any suggestions on how to end the shortfall.

Several methods for the automatic diagnosis of plant diseases were provided in the cited study [1]. The plant's root, stem, fruit, or leaves might all be affected by the illness. As was said before, the emphasis of this investigation is on leaves.

Paper [2] demonstrates how to identify damaged and healthy leaves using collected data. The histogram of an oriented gradient (HOG) is one example of a feature extraction approach that is used to build these.

Paper [3] Mr. Ashish Nage and Prof. V.R. Raut looked into the possibility of identifying diseases in leaves. They suggest a mobile app for Android that would help farmers with plant disease diagnosis by allowing them to send pictures of affected plants to a computer. Disease classification techniques were used in the development of this software. The Android app runs the user's input through a series of analyses to determine the illness, and then returns the results to the user.

In paper [4], image processing is used to spot blemishes on tomato leaves with photographic evidence. Take into account detecting elements like colour, binding, and texture to provide the swift and decrease losses for farmers while guaranteeing output. For this task, we use the categorization strategy known as KNN (K-nearest neighbours). This is directed and carried out to resolve classification and regression issues.

The goal of paper [5] is to help farmers better detect and control plant diseases. Faster region basis convolution neural network (Faster R-CNN), region-based fully convolutional neural network (R-CNN), and single-shot multibook detector (SSD) are only a few of the fundamental neural networks employed in this model's development, along with other deep learning techniques for leaf identification. After being checked, the results it produces with an accuracy of 94.6% prove the usefulness of the CNN and point to the effectiveness of deep learning strategies.

Using machine learning techniques, this [6] aims to create a rice leaf identification model. Algorithms like KNN (K Nearest Neighbour), J48 (decision tree), Nave Bayes and Decision tree, and Logistic Regression are used for this. This work's accuracy was improved because to the use of time-saving methods.

3. PROPOSED FRAMEWORK

The framework is widely accepted that the feature selection approach is meant for its effectiveness in choosing the best features and forecasting the model based on the features selected. The proposed work provides a robust classification model for home health care data by guessing the finest result based on the selected features. It also advocates a novel methodology for classification using machine learning models that include a feature selection model and a feature importance model. Figure 4.1 depicts the proposed framework. After reading the data with Python libraries, the data is preprocessed by deleting missing values and formatting the data with the filter method.

The feature importance is used to achieve robust prediction based on the model assessed. Subsequently, ML classifier is employed to choose the premium approach after obtaining unique features.

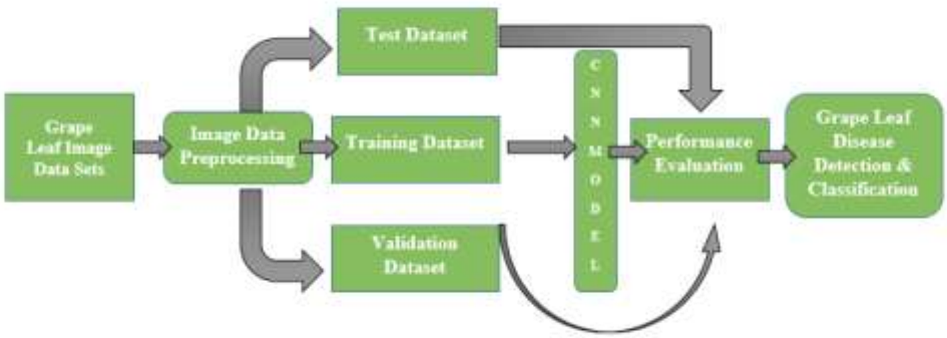

Figure 1.: Proposed Framework

Training and testing Algorithm
Input: Grape Leaf Image Dataset
Output: categorization of a review as healthy or unhealthy, with diseased providing recommendations for resolving the defect.
Step 1: Begin
Step 2: Create a database (healthy or ill)
Step 3: Image Data Preprocessing normalization
Step 4: Split the dataset into Train, Test and Validation Datasets
Step 5: Build the Proposed Model using Deep Learning CNN
Step 6: Train the Model with Training Dataset
Step 7: Apply the Model with Test Dataset
Step 8: If the chance of healthy is greater than the probability of unhealthy, show a healthy leaf; otherwise, display a sick leaf.
Step 9: Proceed to the Step 4
Step 10: End

4. IMPLEMENTATION

Implementation of the proposed framework is explained below for home health care prediction using a filter-based feature selection process, along with the proposed procedure for implementing the methodology mentioned above.

The sequence of procedural steps

1. Image acquisition: Sample photographs of both damaged and healthy leaves are

collected for use in training the system to acquire the necessary image from the dataset or a real-time source supplied by Google.

Data Set

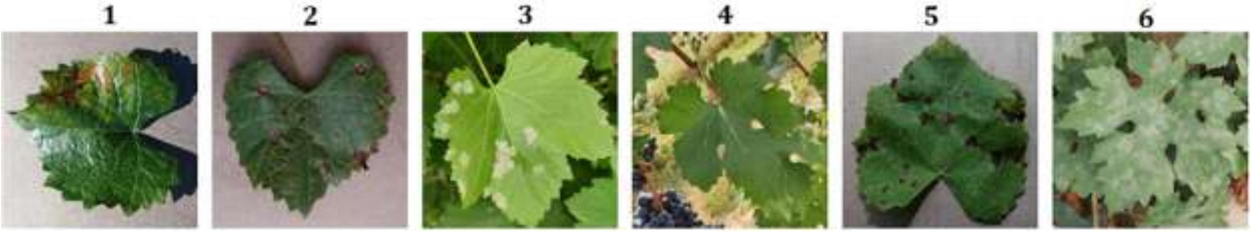

Fig. 2 : Grape Leaf Images. **(1)** Black measles, **(2)** Black rot, **(3)** Downy mildew, **(4)** Healthy, **(5)** Leaf blight, and **(6)** Powdery mildew.

2. Preprocessing a picture entails reducing its size to a standard, such as 50 by 50 pixels, before it is used in the analysis. The goal of this process is to clean up the picture by getting rid of any background noise or distracting features.
3. In this step of image processing, known as "segmentation," the leaves are broken down into their constituent components so that relevant insights may be drawn from the collected data. The leaf information is derived using the leaf's perimeter, shape, region edge, threshold, feature, and model. Here, we use a neural network-based approach to segmentation, although there are more methods out there.
4. Features are extracted from pictures using CNN's several layers for feature extraction and subsequent categorization. The primary function of feature extraction in plant disease detection is the automated learning of the characteristics. In this stage, the fundamental geometrical properties are obtained. diameter, breadth, leaf area, leaf perimeter, morphological traits, form, texture, rectangular, etc. used to extract features.
5. The photos must be classified in order to organise them into groups for further analysis. In order to develop efficient relation analysts employ data, the next stage is classification, which involves comparing the different values acquired after feature extraction and determining whether or not the input leaf is sick. In this article, we establish a taxonomy of four groups within the realm of leaf imagery. In the event that the leaf's final condition is one of illness, it offers cures for curing the ailment.

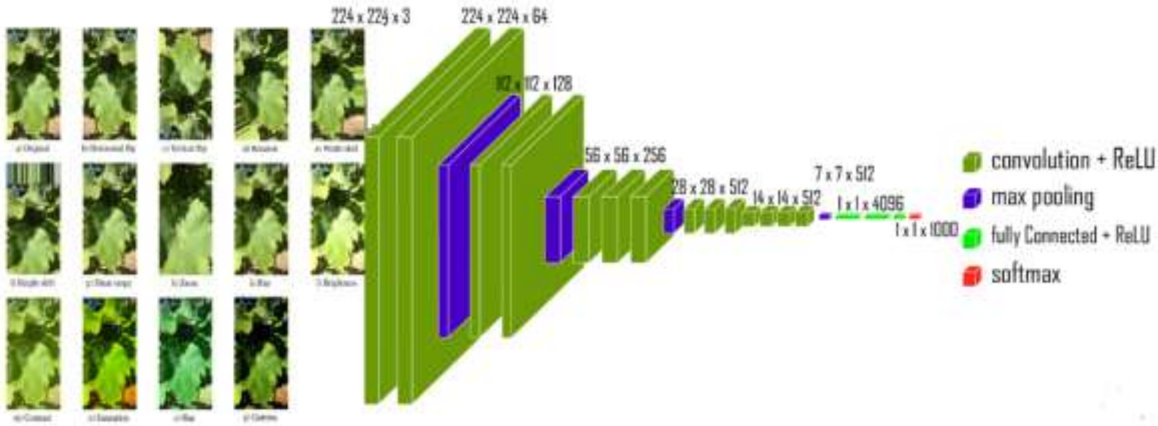

Figure 3: Deep Learning based E-CNN Model

6. The last part of our leaf processing is testing multiple photographs and detecting ailments. The classifier programme use the CNN algorithm. CNN is composed of a large number of linked networks that can detect and extract text from images. An input layer, a convolutional layer, an output layer, and a fully connected layer comprise multilayered neural networks. Additional layers may be stacked on top of the

Convolutional layer. First, the convolution layer is constructed, and the input data is loaded. Each succeeding layer has activation functions. The convolutional neural network also has a pooling mechanism. In this scenario, we build five convolutional layers and add pooling at various depths. Apply a softmax activation function to the totally connected layer after finishing each layer. The optimizer and its output are then sent to the regression layer. The learning rate (LR) is a variable that measures the rate at which a model is taught. In this scenario, a learning rate of 1.e-3 is employed. When you've completed building the model, include the data into it. Converted instructional information x and y. A thousand words (y) are worth a thousand pictures (x).

7. A variable represents well and ill in the model. Finally, you must supply data to the model so that it can assess whether or not it is healthy. CNN is gaining popularity due to its supremacy as a data-splitting tool and its usefulness as a machine-learning approach. Because it is broadening ways for identifying identities and classes. It can learn new characters automatically based on the data. This strategy accelerates the examination of visual leaves. An algorithm of this kind experiences substantial structural alterations. A range of variables, including the quality and diversity of training data, impact the model's performance. The classifier's quality was determined by the information provided. The primary agent causing the ailment is utilised to determine if it is infectious or healthy.

5. RESULTS AND DISCUSSION

The acquired results are system specific. The results may differ significantly due to different combinations of neural network CNN library versions and NVIDIA driver library versions.

Table 1 . Accuracy of Proposed Model

Classification Models	Accuracy
Random Forest	75.42
SVM	83.12
CNN – VGG16	94.22
Ensemble – Majority Voting	98.10
E-CNN	98.81

Proper detection of leaf diseases and subsequent derivation are essential for optimising crop output. An image processing strategy based on an automatic model for identifying leaf diseases might help with this. The goal of this research was to identify features in individual photographs and classify them as either healthy or unhealthy. Based on the classification it provides, the leaf is either ill or there are treatments available to help with the shortcoming.

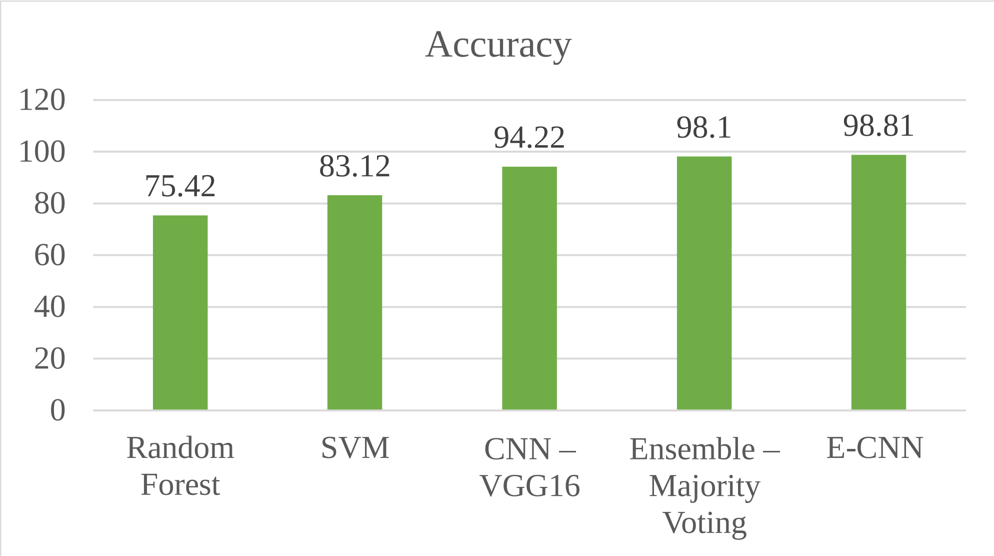

Fig 4. Accuracy of Proposed Approach

In this scenario, we use a method based on convolutional neural networks (CNNs). Its multi-layered design facilitates accurate detection. Starting with the huge collection of datasets needed for training and testing, the process is broken down into its component parts, such as the preprocessing phase, training the algorithm for CNN, and optimisation. We present an Enhanced CNN Model for Grape Leaf Disease Detection. We found that E-CNN provided the most consistent results with an accuracy of **98.81%**.

These image processing methods allow for the accurate recognition and identification of a broad variety of leaf diseases. In this case, the images needed for identification are provided in two forms: in real time through Google and as trained datasets. The model was created in this project with the help of appropriate methods and implementation steps. The proposed method simplifies and expedites the output for the input image, and it is computationally more accurate than the prior method.It's a way of helping farmers out while keeping their costs down.

5.1 COMPARISON OF RESULTS

Table 2 . Comparison of Proposed vs Existing Models

Model	Accuracy
Huang et.al [2018]	77.10
Lauguico et.al [2020]	95.65
Hasan et.al [2020]	91.37
Ansari et.al [2021]	97
Lin et.al [2022]	86.29
Jaisakthi et.al [2019]	93
Proposed Approach [2023]	98.81

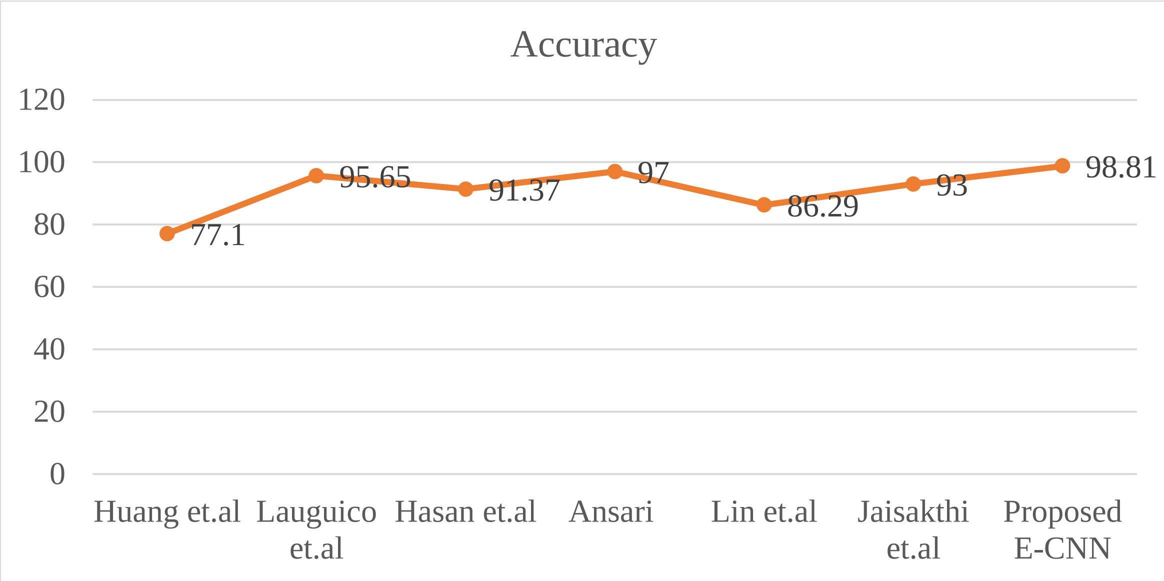

Fig 5 .Comparison of Proposed vs Existing Models

6. CONCLUSION

Grapes are extremely vulnerable to disease-inflicted damage, which can be caused by insects or fungi. The impact of this damage is worsened by increasingly frequent events caused by global warming, such as unusually high temperatures and severe storms. With these elements together, as well as global uncertainty and rising prices, the importance of plant disease prevention cannot be overstated. To that goal, this study looked at how deep-learning convolutional neural networks adapt to classifying grape illnesses from photos of infected leaves. Technology has infiltrated all facets of daily life, with various degrees of success and impact. Artificial intelligence is one of the most promising and prevalent fields of progress in this regard. Many research challenges can be solved with deep-learning algorithms. For image-based applications, convolutional neural networks are the ideal choice. The findings in this research show that the transfer-learning strategy has the ability to produce consistent performance. These findings show that it is possible to classify grape illnesses in a way that meets field deployment performance requirements. Furthermore, the approach used in this work has no overhead, requires no preparation or image processing, and does not require intentional feature extraction.

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