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Detection And Identification Of Plant Leaf Based On CNN (Convolutional Neural Network) Algorithm

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Abstract: Leaf detection is a critical task in agriculture, aiding in the early identification of plant leaf to ensure optimal benefits. This paper presents a comprehensive approach to automating leaf detection using advanced image processing and deep learning techniques in Python. The methodology involves pre-processing the input images to enhance features and extract meaningful information. Subsequently, a Convolutional Neural Network (CNN) model is trained on a curated dataset comprising healthy plant leaves. The CNN learns to classify leaves into respective categories, enabling automated detection. The trained model is evaluated based on various metrics such as accuracy, precision, assess its benefits.

In this paper, the performance of a pre-trained ResNet34 model in detecting disease is investigated. Additionally, a real-world application of the model is demonstrated through predictions on unseen leaf images. The results showcase the efficacy of the proposed approach in accurately identifying plant leaf, laying the foundation for further advancements and integration into agricultural practices.

Keywords: Leaf Detection. Image Processing, Convolutional Neural Networks (CNN)

1. Introduction

The most widely used method for plant leaf detection is simply naked eye observation by experts through which identification and detection of plant are done. For doing so, a large team of experts as well as continuous monitoring of experts is required, which costs very high when farms are large. At the same time, in some countries, farmers don't have proper facilities or even idea that they can contact to experts. Due to which consulting experts even cost high as well as time consuming too. In such a condition, the suggested technique proves to be beneficial in monitoring large fields of medical science. And automatic detection of the leaf by just seeing the benefits on the plant leaves. Plant identification by the visual way is a more laborious task and at the same time less accurate and can be done only in limited areas. Whereas if automatic detection technique is used it will take fewer efforts, less time and more accurately. Image segmentation is the process of separating or grouping an image into different parts. There are currently many different ways of performing image segmentation, ranging from the simple thresholding method to advanced colour image segmentation methods. The segmentation process is based on various features found in the image.

MATERIALS AND METHODS

We obtained the xPLNet dataset by filling up the Google form link available at Github, which is the primary GitHub repository for the same [3]. This dataset contains pictures of 9 different classes in which 8 different leaves have been included with 1 class of healthy plant leaves (see Table 1). This dataset has 65760 images in which 59184 images have been taken in training set and 6576 have been taken in test set. The further distribution of the images in respective classes can be found in Table 1. Initially, we used the model architecture that the authors have provided which has 901,653 trainable parameters in total. After testing their model, we moved to create our own and improved it thereafter by hyperparameter variation and using image data augmentation

Dataset for training

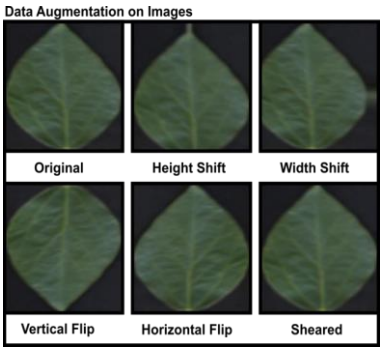


Figure 1: This figure shows the augmented images produced with the help of the image data generator

CNN stands for **Convolutional Neural Network**. It is a type of **deep learning algorithm** specifically designed to process and analyse **visual data**, such as images. CNNs are highly effective for tasks like **image classification**, **object detection**, and **image recognition**, which makes them perfect for applications like **plant leaf detection and identification**.

I. Detection:

- In this context, detection means recognizing that there is a leaf in the image and focusing on it.
- CNN implicitly detects the region of interest (ROI)—i.e., the leaf—by learning which pixels/features are relevant.

In more advanced systems, detection may involve bounding boxes, but for leaf classification, detection usually just means isolating the leaf (with or without segmentation).

II. Identification:

- Identification is the classification of the detected leaf.
- CNNs identify the plant species by learning from a large set of labelled training images.
- It distinguishes between classes based on patterns in shape, texture, vein arrangement, etc.

Machine Learning (ML) is a branch of artificial intelligence (AI) that enables computers to learn from data and make decisions or predictions without being explicitly programmed. In ML Support Vector Machine (SVM) – great for classification tasks, In ML leaf identification Detects patterns in leaf shape, color, and texture, learns from a dataset of labeled leaves, Predicts the species of a new leaf based on its features, continues to improve with more data (scalable).

Table 1: Types of leves available in the dataset for the prediction.

Class	Type of Leaves	Number of Leaves	
		Train Set	Test Set
Class 0	Azadirachta Indica (Neem)	5953	623
Class 1	Brassica Juncea (Indian Mustard)	5897	679
Class 2	Ocimum Tenuiflorum (Tulsi)	5934	642
Class 3	Syzygium Jambos (Rose Apple)	11850	1302
Class 4	Carissa Carandas (Karanda)	5918	658
Class 5	Citrus Limon (Lemon)	5937	639
Class 6	Mangifera Indica (Mango)	5872	704
Class 7	Mentha (Mint)	5906	670
Class 8	Psidium Guajava (Guava)	5917	659
Total		59184	6576
Grand Total		65760	

Hardware and Software All the preprocessing of the training and testing data was done using Python (v3.10.) 32 GB RAM memory for training the deep learning model TensorFlow GPU (v2.4.1) module in anaconda environment (v22.9.0) was used. To further simplify the process of modeling and training the neural network, Keras (v2.4.0) was used on top of Tensor Flow GPU.

2. Related Work

Paper [1] Extensive research has been conducted to explore various methods for automated identification of plant leaves. The leaves can manifest in various parts of the plant such as lemon, Neem, Indian mustard, as stated before, this work concentrates, particularly on leaves.

Paper [2] discussed a methodology for recognition of plant leaves and benefits. The proposed work is composed of K-Means segmentation technique and the segmented images are classified using a neural network. They developed a method for detecting the visual signs of plant leaves by using the image processing algorithm. The accuracy of the algorithm was tested by comparing the images, which were segmented manually with those automatically segmented.

Paper [3] discussed various techniques to segment part of the plant. This paper also discussed some Feature extraction and classification techniques to extract the features of leaf and the classification of plant leaves. The use of ANN methods for classification of plants leaves such as self-organizing feature map, back propagation algorithm, SVMs, etc. can be efficiently used. From these methods, we can accurately identify and classify various plant leaf using image processing techniques.

Paper [4] contain the study of detection of plant leaves and the identification of the leaf trained & tested Initially, input images are taken and then image processing is started. Background and Black pixels are both segmented in the first step. Then Hue and Saturation part of the image is also separated. And finally tested part and trained area % and a name of the leaves is acquired which is main work using our proposed methodology. The main aim of this work is to provide the advancement and enhancement in computing classifiers of a neural network approach and provide better results.

II. BLOCK DIAGRAM

The system consists of the following blocks:

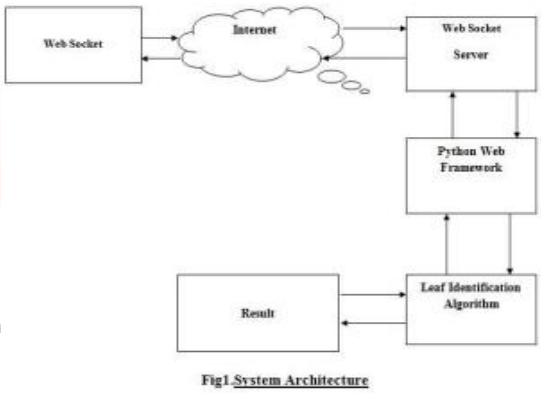
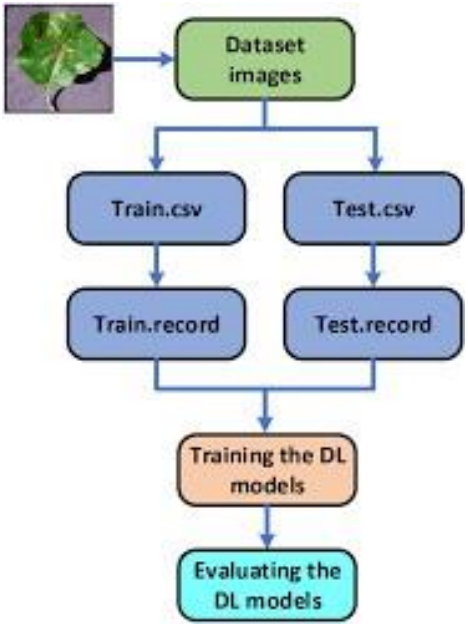


Fig1.System Architecture

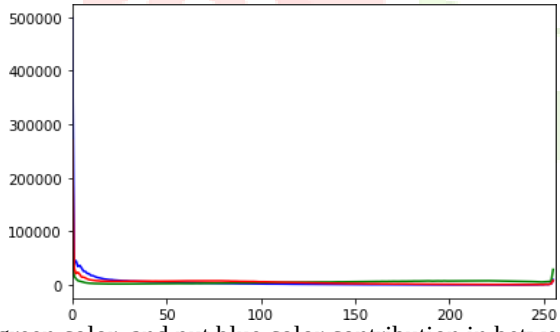
Web Socket: Web Socket is a computer communications protocol, providing full-duplex communication channels over a single TCP connection. Send the Acquired Image by using a mobile camera to the web socket Server. In Our Project, we used a Local Server.

Python:. In python, OpenCV is to be installed. 'Opensource computer vision library' initiated by some enthusiast coders in '1999' to incorporate Image Processing into a wide variety of coding languages. It has C++, C and Python interfaces running on Windows, Linux, Android, and Mac. It is one of the libraries used for the image processing in python on python web framework by using: leaf Identification algorithm it detects and identifies the Leaf benefits. By using Database, it sends the result back to the sender farmer.

3. Experimental Method/Procedure/Design



A. Image Acquisition- The images of the plant leaf are captured through the camera. This image is in RGB (Red, Green, and Blue) for color transformation structure for the RGB leaf image is created, and then, a device-independent color space transformation for the color transformation structure is applied.
B. Image Pre-processing To remove noise in the image or other object removals, different pre-processing techniques is considered. RGB to Gray Converter-Weighted method or luminosity method-You has seen the problem that occurs in the average method. The weighted method has a solution to that problem. Since red color has more wavelength of all the three colors, and green is the color that has not only less wavelength than red color but also green is the color that gives a more soothing effect to the eyes. It means that we have to decrease the contribution of red color, and increase the contribution of the



green color, and put blue color contribution in between

these two. So the new equation that form is: New grayscale image = ((0.3 * R) + (0.59 * G) + (0.11 * B)). According to this equation, Red has contributed 30%, Green has contributed 59% which is greater in all three colours and Blue has contributed 11%. Image Resize- The resolution of document images is typically higher than 2000 _ 2000, which is too large to be fed to a CNN with the current availability of resources. Large input dimension not only costs more computation resources but also leads to a greater chance of overfitting. After Converting RGB image into Gray it resizes into a standard format that is either 400 × 400 for better resolution.
The specific goals of this research are to:

i) Determine the model's overall effectiveness in classifying l e a v e s using both a validation and test dataset.
ii) Compare the model's accuracy when tested with various image sizes and the augmentation settings.
iii) Deploy the trained model to create an easy to use the web applications.

4. Results and Discussion

Image is captured through the mobile camera. • The captured image is uploaded to the local server using android application. • Image undergoes various image processing algorithms at the server to determine the disease. • The determined leaves are sent back as a result on the mobile application.

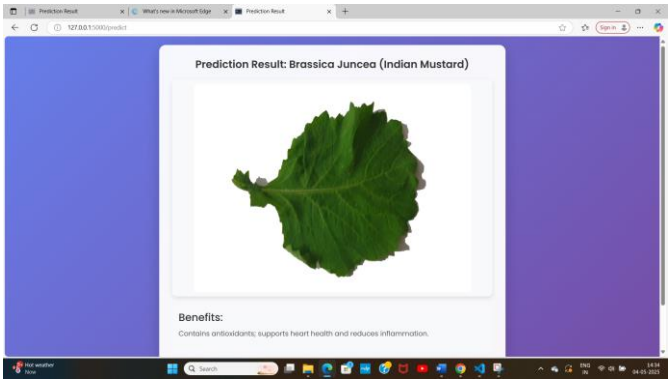
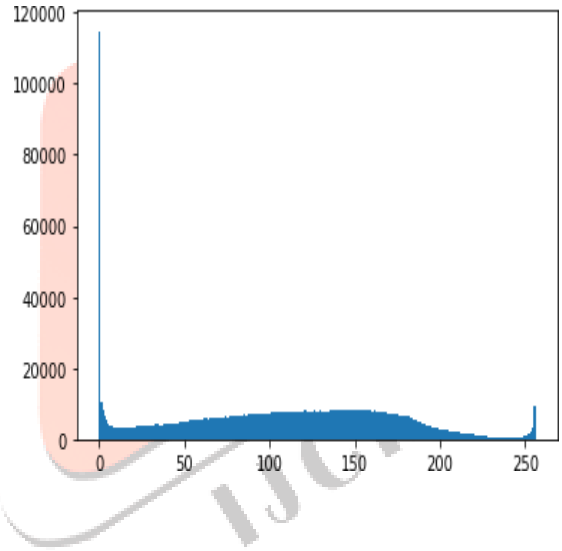


Fig. 4 Image Capture for Database

Training and Validation Accuracy



Training and Validation Loss

5. Conclusion and Future Scope

In conclusion, the leaf detection project using Python represents a significant step forward in leveraging advanced technologies to address crucial challenges in agriculture. The successful completion of this paper highlights the potential of machine learning, particularly deep learning through

Convolutional Neural Networks (CNNs), in revolutionizing detection & identification in plant leaves. By employing image processing techniques and training a CNN model on a curated dataset, we have demonstrated the ability to accurately classify plant leaves into healthy and benefits categories.

Future Scope: The scope of this paper on leaf detection using Python is broad and encompasses several crucial aspects. First and foremost, the paper aims to create a sophisticated detection system that leverages cutting-edge technologies, including machine learning and computer vision. The primary focus is on the development and implementation of robust algorithms and models that can accurately identify various leaves. The system will handle a diverse range of leaf images and differentiate

between healthy leaves and those afflicted, potentially including common ailments like powdery mildew, rust, and blight. In addition to disease detection, the paper may involve exploring and implementing mechanisms to determine the severity and type of leaf. This will provide a more detailed analysis and enable appropriate remedial measures. The paper may also encompass the development of a user-friendly interface, allowing users such as farmers and agricultural experts to interact with the system easily. This interface could facilitate image upload, disease prediction, and the presentation of results in an intuitive and accessible manner. The ultimate goal is to deliver a versatile and scalable solution that can be potentially integrated into agricultural practices. The project scope also includes documenting the methodologies, algorithms, and implementation details comprehensively, enabling not only its successful completion but also serving as a foundation for future research and advancements in the field of plant pathology and precision agriculture.

Data Availability

A dataset containing 8,685 leaf images, captured in a controlled environment, is established for training and validating the model. Validation result show that the proposed method can achieve an accuracy of 97.2% and an F1 score of greater than 96.5%. This demonstrates the technical feasibility of CNNs in classifying plant leaves and presents a path towards AI solutions.

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