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**Research Article**

# Identification of potato plant diseases using CNN model

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| ARTICLE INFO | ABSTRACT |
|---|---|
| | India is an agriculturally intensive country and the level of crop production is a major concern. We have developed strategies to improve the quality of agricultural products and prevent plant diseases, making the work of farmers easier. Using deep neural networks and artificial intelligence, it can detect damaged plants without human intervention and repair them before it is too late |

## I. INTRODUCTION

- Covid19 impacts all organisms. It's widely understood that health entails more than just theabsence of illness or disease. Agriculture stands as a cornerstone of prosperous business ventures and plays a pivotal role in every nation, including India, where a significant portion of thepopulation is involved in agricultural pursuits. During the agricultural season, a diverse array of crops is cultivated, with potatoes reigning supreme, constituting Potatoes account for 28.9% of India's total agricultural production . Known as the "king of vegetables," potatoes are incrediblyversatile and can be easily combined with other produce. Research highlights that white potatoes are the richest and most affordable source of potassium among all vegetables and fruits.Considering the crucial role of potatoes, it is a shared responsibility to ensure ample access to fresh tubers. To meet the demand for potatoes, it's imperative to adopt meticulous planting practices and diligently combat plant diseases, yielding optimal outcomes for farmers. However, manual disease management procedures are time-consuming. Embracing artificial intelligence, particularly deep neural networks (DNNs), offers a promising solution. The identification of leaf diseases hinges on two key principles: object recognition and image classification.


**Fig. 1: Sample image of each class**

1. The aim of this work is to identify and describe plant diseases; Potato leas get affected by the early and late blight . [2]. The difference between healthy leaves and damaged leaves is shown in the picture below.
2. CNN is a type of deep neural network (DNN) algorithm. CNNs effectively convert input images into vector representations and can perform various visual tasks. By processing the image, CNNs function as image

"encoders.".

3. Recent research indicates that CNN excels in object recognition and image classification. The structure of this work is as follows: Chapter 1 provides an overview of the study, Chapter 3 outlines the methodology, and Chapters 4 and 5 analyze the results and potential future directions.
4. Abyss tests and pattern recognition show that although the learned features appear distinctive enough, the system does not need real insect-related features and is separated from health.
5. The article is structured as follows: Chapter 2 focuses on automatic plant disease detection using machine learning. Chapters 3 and 4 discuss the analysis and experimental procedures, respectively.

Chapter 5 presents the study's findings.

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## II. RELATED WORK

1. The investigation into leaf diseases reveals that Convolutional Neural Networks (CNNs) yield the high accuracy in disease detection.
2. Researchers employed diverse leaf images to construct a deep learning model, amalgamating classical architectures, for plant disease identification.
3. [2] developed an autonomous system for identifying and classifying potato diseases,resulting in a classification accuracy of around 98% across various testing datasets. This technology holds promise for farmers seeking to augment crop yields.
4. It helps detect potato diseases using CNN [3]. Classification of potato leaf blight with 99% accura cy using data consisting of 700- 800 images. Disadvantages of the information and visuals mentioned above
5. [4] It is considered efficient, fast, accurate, and highly predictable. It can detect and treat diseases. To improve plant health and productivity, we need to better understand diseases and their treatments.

The framework is powered by CNN and Python algorithms with 80% accuracy.

7. DenseNet has been deployed for the identification and detection of numerous foliar diseases [5], focusing specifically on three plant species: tomatoes, potatoes, and bell peppers. Data collection in rural areas involved the utilization of mobile phone cameras, enabling direct detection. The overarching aim of this endeavor, and future endeavors, is to enhance model accuracy, reduce computational demands for resource-constrained devices like mobile phones, and facilitate the development of mobile applications for immediate usage.
8. The article utilized several machine learning algorithms, such as Bayesian, K-Nearest Neighbors (KNN), and Support Vector Machine (SVM), achieving accuracies of 88.67%, 94.00%, and 96.83%, respectively.
6. [7] examined how a convolutional neural network model can identify diseases using images associated with specific location data and historical contexts.
7. Adopt a method of control and control [8]. KMeans are used to complete patient segmentation. According to the article, deep learning algorithms can be used to identify various diseases in the futu re.
8. Learn how to correctly classify potato leaf blight using RGB images. Based on the results of this study, it is recommended to create access to big data. It analyzes all the features learned by the model to ascertain if they represent the texture of the entire image, rather than focusing solely on the leaves and affected areas.. Compare model performance:

Table 2 shows some algorithms used for potato detection and the accuracy achieved by each algorith m.

| S.No | Algorithm | Ref No. | Accuracy |
|---|---|---|---|
| 1 | Ann | [17] | 85-91% |
| 2 | NN | [38] | 93% |
| 3 | BPNN | [10] | 92% |
| 4 | Naive Bayes | [6] | 88.67% |
| 5 | KNN | [6] | 94.00% |
| 6 | SVM | [6] | 96.83% |
| 7 | SSD &RCNN | [1] | 94.60% |
| 8 | CNN | [3] | 99.09% |

Table 1 performance comparison of model

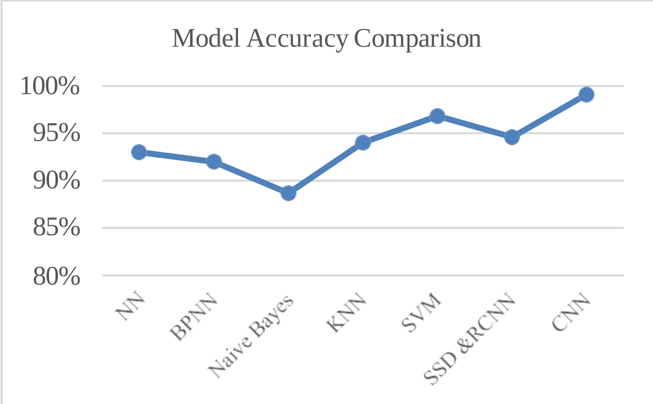


Fig. 2: Accuracy comparison of model

Based on the literature review findings, CNN surpasses other classification algorithms in performance.

## III. PROPOSED METHODOLOGY

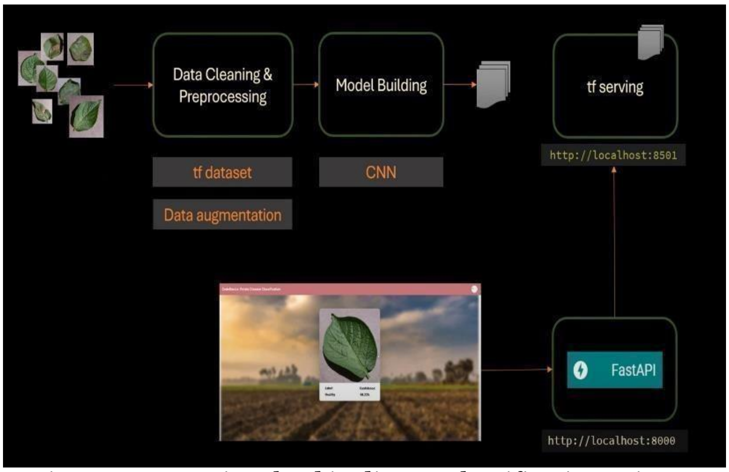


Fig. 3: - Process involved in disease classification using CNN

Data Acquisition: The commencement of algorithm assessment and deployment hinges on this initial stage. Enhanced prediction accuracy is directly proportional to the volume of data gathered. Data collection serves as the foundational step in the planning trajectory. This repository encompasses over 2,150 images showcasing various manifestations of leaf blights, including early blight, late blight, and healthy leaves.

Table 2 presents details pertaining to the classification of potato leaf ailments, categorized into three distinct groups. These categories encompass early-stage disease, progressed disease, and healthy foliage. The document segregates organisms into respective groups and tabulates the corresponding image counts for each.

The comparison accuracy of several algorithms is shown in Figure 2 below. As seen in the image below, CNN has the most accurate results.

Table 2: Diseases & Number of images

| Disease | Type of Disease | No. of Image |
|---|---|---|
| Early Blight | Fungal | 1000 |
| Late Blight | Fungal | 1000 |
| Healthy | No Disease | 150 |

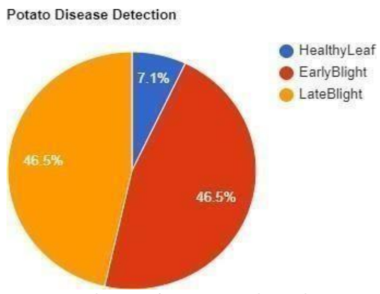

Fig. 4: Number of images level giant chart

Data Preprocessing: Preprocessing plays a vital role in ensuring the accuracy of results obtained from any data input. In the case of leaf images, it's imperative to standardize the size of potato leaves to mitigate potential classification discrepancies arising from diverse leaf patterns.
Noise Reduction: Prior to advancing to subsequent stages, only pertinent features crucial for the classification task are retained within the image. Extraneous elements are systematically eliminated, streamlining the image for optimal processing. Filtering techniques are employed to smoothen the image and diminish contrast, thereby accentuating the salient features essential for accurate classification


Fig. 5: - Dataset of potato leaf

Figure 5 shows the exact shape of the leaf; Unless the page is the same size as the other object, nothing appears in the image.
FeatureExtraction: After removing the sound from the image, we need to extract the features. Feature e xtraction is used to reduce image size without sacrificing important features. It also removes normal feat ures.

## Classification:-

Any classification technique or deep learning architecture like ANN, CNN, or SVM can be utilized to categorize the image into specific classes. CNN is a neural network specialized for image classification owing to its superior accuracy compared to alternative algorithms.
Convolutional neural networks (CNNs) signify a significant progression in deep learning neural network technology, especially within the domain of image recognition. Specialized within the family of neural networks, CNNs excel in tasks such as image classification and visual analysis. Operating on two- dimensional inputs, CNNs are adept at processing image data by extracting relevant features.
In the context of image analysis, where images may exhibit similarities, CNNs offer a practical solution. By filtering input data, CNNs generate distinctive feature maps that accentuate relevant image features. During the training phase, these networks autonomously learn filters tailored to the specific prediction task at hand.
The process entails iteratively applying filter arrays to the input data, yielding two-dimensional feature vectors. These features, once extracted, undergo further processing before being forwarded to subsequent layers within the network architecture.
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linear report (e.g. Re LU) as the output of the entire process. The CNN architecture is shown in Figure 1 . The CNN architecture is as follows:

1. Convolutional (known) layer
2. Re LU (Inverse Linear Unit)
3. Swimming pool layer
4. A pair of layers is fully connected (FC).

The majority of computations occur within the convolutional layer. These layers serve to extract object-specific characteristics by identifying features within the input image and generating feature- specific maps. This layer uses image featurebased kernels to perform convolution operations and kernels to extract image features. Reluchi layer.

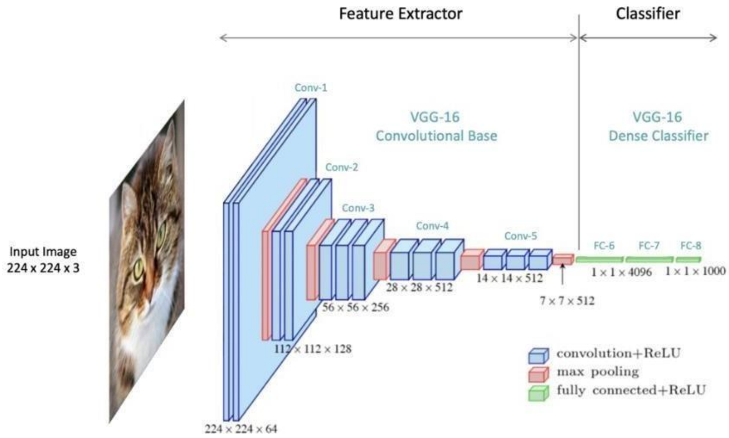


Fig. 6: Convolutional Neural Network Architecture

Rectified Linear Unit (ReLU) layer: ReLU serves as a pivotal component within the model architecture, enhancing its robustness. The ReLU function, defined as max(0, x), introduces nonlinearity to the network, facilitating the completion of convolutional operations. By transforming all negative values to zero, the ReLU layer expedites the training process. Additionally, it aids in reducing the spatial extent of the feature map by distributing weights among neurons within the layer.
Pooling layer: Various pooling techniques such as average pooling, maximum pooling, multiresolution unordered pooling, and random pooling are employed in this layer. These pooling operations condense the information within the feature maps, facilitating dimensionality reduction.
Smoothing layer: This layer is instrumental in transforming the 2D dataset into a compact vector representation.
Dense layer: Neurons within this layer form connections with neurons from the preceding layer. Using the uniform maximum approach, the dense layer analyzes input vectors to extract significant features from the image data. Resampling techniques like remarrying are implemented to mitigate errors within this layer.

The convolutional neural network (CNN) architecture utilized in leaf detection, as depicted in Figure 4, begins by accepting a 2D vector representation of the image as input. Subsequently, it undergoes a series of aforementioned operations before ultimately classifying the image

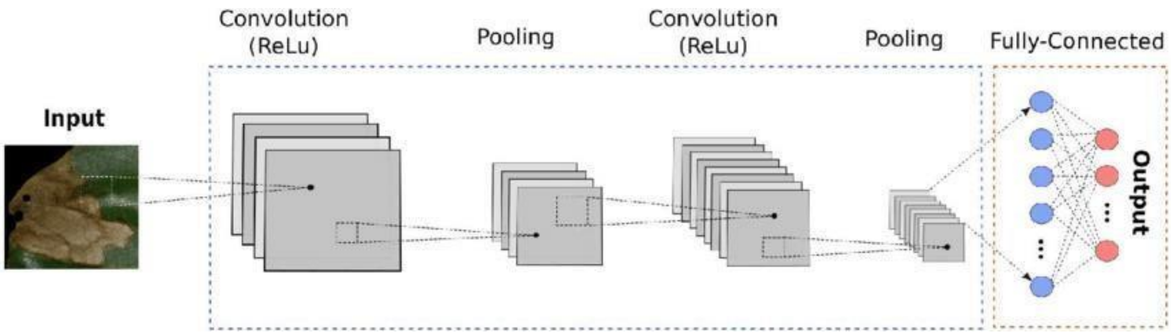


Fig. 7: CNN illustration in plant leaf detection

The following diagram illustrates the numerous phases involved in image classification.

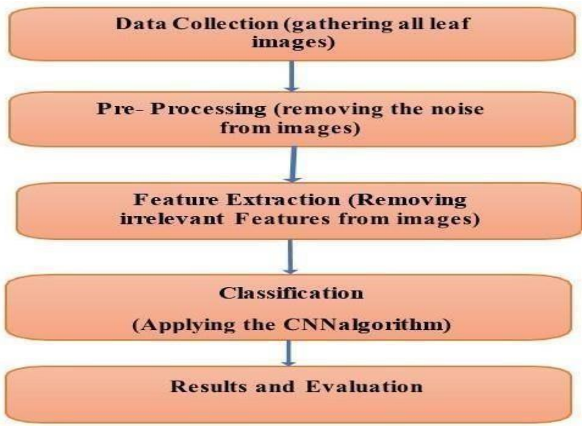

Fig 8: Some basic algorithm for Image Classification

## IV. Results and comparisons:

Utilizing the leaf classification model, we can distinguish between diseased and healthy leaves based on the image input. Evaluating the model's accuracy involves generating a confusion matrix, where the diagonal elements represent the count of correct classifications. This matrix serves as a robust measure of the model's performance in accurately identifying leaf health status.

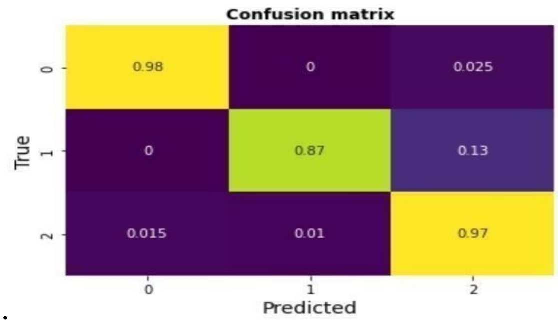


Fig. 9: Confusion Matrix

Our models outperform their competitors in all categories. Night blight affects 13% of leaf health. We c an solve this problem by adding more images to the health category. But now 87% is actually not scary. So the result is more than predicted (farmer estimate).


Fig. 10: End result of model

Finally, we can create a nervous system model, apply it and get results. It can be clearly seen from abov e that the image is captured in the image page interface, and the result shows that the data of the infected virus is displayed.

## V. Conclusion

The leaf analysis system incorporates a convolutional neural network (CNN) encoder/decoder to aid in classifying leaf health status, distinguishing between healthy and diseased leaves. A comprehensive study was conducted on a substantial dataset utilizing deep neural networks to detect potato aphids.
Two forms of potato blight are recognized: early blight and late blight. Among different deep neural network structures, CNN demonstrates the highest precision in distinguishing and classifying potato leaves into early blight, late blight, and disease-free groups. The study results show that the artificial neural network (ANN) achieves an accuracy of 85%, the support vector machine (SVM) reaches 88.89% accuracy, whereas CNN achieves a remarkable accuracy of 99.07%s. Ultimately, convolutional neural networks stand out for their superior performance, providing a more effective approach in image recognition and discrimination within the realm of deep learning.

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