**IMAGE PROCESSING OF MEDICINAL PLANTS USING CONVOLUTIONAL NEURAL NETWORK**

## A PROJECT REPORT

***Submitted by***

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***in partial fulfillment for the award of the degree of***

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# RAJALAKSHMI ENGINEERING COLLEGE ANNA UNIVERSITY, CHENNAI

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# BONAFIDE CERTIFICATE

Certified that this Thesis titled **“Image Processing of Medicinal Plants Using Convolution Neural Network**” is the bonafide work of “**NEHA MU (2116210701178)”** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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## ABSTRACT

The use of convolutional neural networks (CNNs) for processing medicinal plant images is suggested by this study. The goal is to create a reliable system that can recognize and categorize different species of medicinal plants from photos. Preprocessing picture data, training CNN models, and assessing classification accuracy are all part of the implementation process. The outcomes show how well CNNs work at automating the identification procedure, which supports studies on medicinal plants and efforts to conserve them. During training, the CNN learns to extract discriminative features from plant images, enabling it to accurately classify them into different categories based on their medicinal properties or taxonomic characteristics. Transfer learning techniques may also be employed to enhance the model's performance, especially when dealing with limited training data.

**Keywords:** Feature extraction, Classification, Morphological Traits, Medicine, Convolutional Neural Network.

**INTRODUCTION**

Throughout all cultures and eras, medicinal plants have been valued for their healing abilities, and they are the basis of traditional medical systems all around the world. These plants contain an abundance of bioactive substances, including flavonoids and alkaloids, each having specific therapeutic potential. The use of medicinal plants has been essential to human health and well-being from ancient treatments to contemporary medications. This study suggests using convolutional neural networks (CNNs) to process medicinal plant images as a solution to this problem. CNNs, a subclass of deep neural networks, have outperformed humans across a range of disciplines with unmatched success in image recognition tests.

There are several crucial elements in the application of this system, and each one adds to its total efficacy. First, photos are preprocessed to improve quality and standardize format, guaranteeing best input for further processing steps. By utilizing methods like augmentation, normalization, and scaling, the images are prepared for the CNN models to analyze them efficiently.

TensorFlow's strong features enable the CNN models to be trained on a wide range of datasets containing photos of medicinal plants. The models acquire the ability to identify pertinent features from the photos and classify objects accurately by applying learnt patterns through an iterative training process. It is also possible to use transfer learning approaches, which allow the models to use pre-trained networks and modify them for the particular job at hand.

Analyzing categorization performance is a crucial step in determining how effective the system that was designed is. The model's performance is quantitatively measured using metrics like accuracy and precision, which shed light on the model's dependability and applicability for practical uses.

This project aims to automate the identification process by utilizing CNNs and TensorFlow, which will save researchers a great deal of time and money while giving them access to accurate and thorough data on plant species. Furthermore, the application of cutting-edge technologies to medicinal plant research has the potential to completely transform the area and introduce breakthroughs that will improve environmental sustainability, human health, and conservation efforts.

**LITERATURE SURVEY**

## OVERVIEW

Plant identification and classification have been transformed by the use of Convolutional Neural Networks (CNNs) and TensorFlow in image processing of medicinal plants. This method uses deep learning to precisely assess leaf characteristics like form, size, color, and texture, allowing for highly accurate automated species recognition.

Additionally, TensorFlow, a popular deep learning framework, provides an extensive set of resources and tools for creating, honing, and implementing CNN models. Image processing practitioners and scholars can utilize it because of its comprehensive documentation and user-friendly interface.

CNN models must be trained on standardized datasets in order to function properly. Through the collection of varied leaf samples from different kinds of medicinal plants, researchers can make sure that the models accurately learn to identify and distinguish between distinct plant types. This improves the classification accuracy of the model and, by making it easier to identify therapeutic plants, helps to preserve traditional medical knowledge.

The first step in the procedure is usually to create standardized datasets with leaf samples from different types of medicinal plants. These datasets are essential for efficiently training CNN models. Next, using the gathered leaf images, the CNN models are implemented and trained using TensorFlow, a well-known deep learning framework.

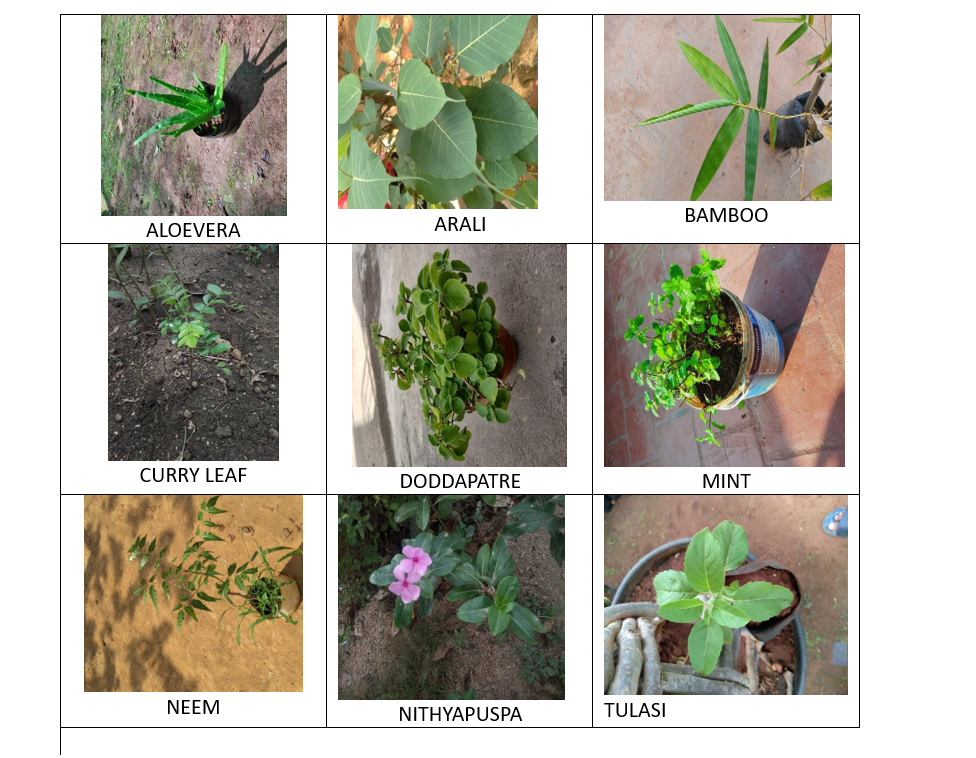
During the training phase, the CNN models are built to recognize complex patterns and characteristics from the images. These models, which draw inspiration from custom-designed networks or architectures and extract useful information from the leaf photos and allow them to distinguish between various plant species based on their visual traits.   
  
With little assistance from humans, CNN models that have been trained can reliably identify species of therapeutic plants. The Medicinal plants collection, which includes leaf samples from several medicinal plants found in Kerala, a state on India's southern coast, is one notable illustration of this methodology. Plant identification procedures have been made simpler and old medical knowledge has been preserved thanks to the remarkable classification accuracy of models trained on the Medicinal plant dataset, which was made possible by the use of CNNs and TensorFlow.   
  
All things considered, CNNs and TensorFlow image processing of medicinal plants is a state-of-the-art method with enormous potential for furthering study in plant biology, conservation, and traditional medicine. This technique saves time, improves workflows, and gives researchers important insights into the great biodiversity of medicinal plants by automating the identification procedure.

**METHODOLOGY**

## DATA COLLECTION

The study's use of a medicinal plant collection consists of 5000 photos that have been painstakingly categorized into 40 different categories, each of which represents a different species of plant. These photos feature the plant's leaves as well as its flowers, guaranteeing a thorough portrayal of the visual traits unique to each species. Plant specimens were carefully collected from their native habitats, with special attention paid to finding uncommon and unusual species, which added a variety of plant characteristics to the dataset. Color images were taken and stored in JPEG format to efficiently preserve their visual content. The photos were divided into three subsets, training, validation, and testing, with a distribution ratio of 80:20 each, in order to prepare the dataset for training and testing.

To improve dataset resilience and diversity, random augmentation was used to the training and validation subsets. Methods like cropping and horizontal flipping were used to get a consistent 256 x 256 pixel size. To maintain consistency throughout the dataset, the enhanced photos were then further cropped to a final size of 224 by 224 pixels. The processed photos varied in size from 200KB to 500KB, which could be attributed to differences in image complexity and quality. Strict quality control procedures were followed during the preprocessing and data gathering phases to guarantee the accuracy and dependability of the dataset. These procedures included standardizing picture capture techniques and carefully choosing plant specimens.



## ANALYSING

Manually analyzing massive amounts of data can be a difficult and time-consuming process that takes a lot of time and energy. Machine learning approaches have surfaced as a more effective solution to this problem. Among these methods, TensorFlow is a particularly effective one. TensorFlow is an open-source machine learning library that offers academics a wide range of resources and tools necessary for data classification jobs. Users can automate and expedite the classification process by utilizing.

Convolutional Neural Networks (CNNs) for the image processing of medicinal plants are a major breakthrough in the study of plants and medicine. CNNs provide a reliable and automated method for recognizing and categorizing different species of medicinal plants based on pictures of their leaves, blossoms, or other distinguishing characteristics by utilizing the power of deep learning algorithms.

In this context, CNNs' capacity to automatically identify and extract pertinent features from input images is one of their main advantages. Handcrafted feature extraction is frequently necessary for traditional image processing approaches, which can be labor-intensive and may not capture all pertinent information. On the other hand, more precise and effective categorization is made possible by CNNs, which can automatically learn hierarchical representations of features straight from raw pixel data.

CNNs are also ideally adapted to handle the intricacies and variances found in botanical imagery. The varied physical traits of medicinal plants, such as differences in leaf size, shape, color, and texture, might make it difficult to classify them using conventional techniques. Accurate classification is made possible even in the face of changes within and between plant species thanks to CNNs' exceptional ability to capture these intricate patterns as well as variations.

CNNs also have the benefit of being scalable and flexible enough to handle big datasets. As more picture datasets with thousands of tagged photos of medicinal plants become available, CNNs can analyze and learn from these massive datasets more quickly, which improves classification performance.

## CONVOLUTIONAL NEURAL NETWORK

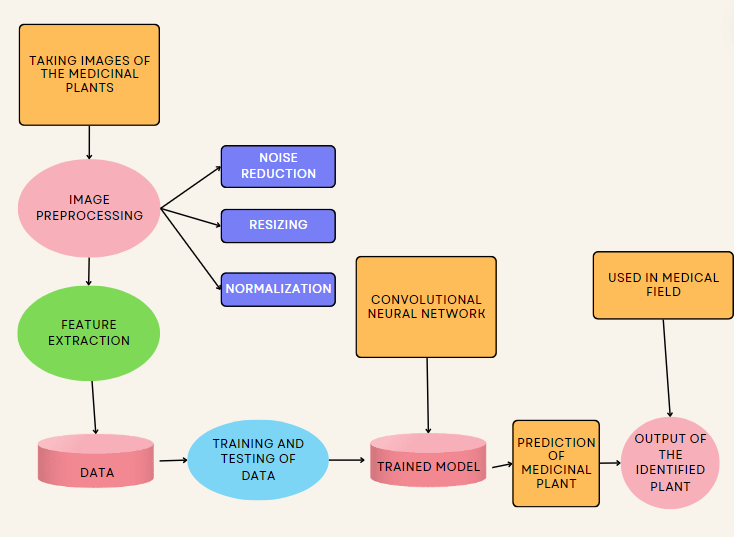
Convolutional Neural Networks (CNNs) have emerged as a effective device in photograph processing, mainly because of their awesome effectiveness in automated function mastering and category duties. CNNs are designed to routinely study and extract capabilities from enter photographs, allowing them to research and classify visible records with excessive accuracy. At the middle of a CNN structure are numerous layers, every with unique functions. The convolutional layers are answerable for mastering the traits of enter photographs with the aid of using making use of filters that discover numerous capabilities including edges, textures, and patterns. These filters slide throughout the enter photograph, generating function maps that spotlight applicable capabilities. Following the convolutional layers, pooling layers lessen the spatial dimensions of the function maps, supporting manipulate overfitting and computational complexity. Pooling operations like max pooling and common pooling down pattern the function maps with the aid of using choosing the most or common cost inside every pooling region. Finally, the absolutely linked layers carry out the category task, taking the found out capabilities and translating them into output classes. Through a chain of weighted connections and activation functions, the absolutely linked layers assign chances to every class, in the long run figuring out the category of the enter photograph. In summary, CNNs excel in photograph processing duties with the aid of using routinely mastering and extracting applicable capabilities from enter photographs, making them worthwhile gear for a extensive variety of programs in laptop imaginative and prescient and beyond.

## THE PROPOSED SYSTEM MODEL

A number of crucial processes are included in the suggested system model for processing medicinal plant images using TensorFlow and Convolutional Neural Networks (CNN). To assure uniformity and improve variability, a broad array of high-resolution photos of medicinal plants is first gathered and preprocessed. A CNN architecture is then created with the proper layers and approaches to avoid overfitting for tasks like object identification, segmentation, or classification. The CNN model is then trained using TensorFlow, perhaps utilizing transfer learning for better generalization, once the dataset has been divided into training, validation, and testing sets. Performance indicators including accuracy,

precision, recall, and F1-score are used to assess the trained model. Similarly, TensorFlow Object

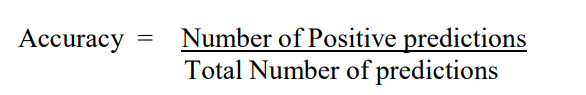
Detection API is utilized to create object detection models, and bounding boxes with annotations are used for training and assessment. In order to ensure adaptability and efficacy in supporting medicinal plant research, agriculture, or healthcare, the models are deployed using TensorFlow Serving or TensorFlow Lite for inference after training, integrated into pertinent applications or systems, and continuously improved based on new data and user feedback.

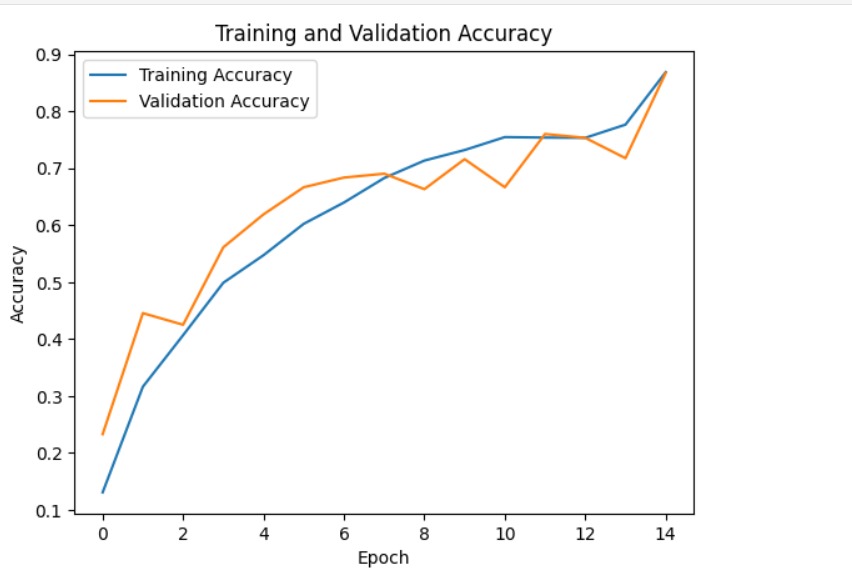


The CNN architecture's learning rate and batch size are two hyperparameters that can be optimized using methods like grid search or random search to enhance performance. It is possible to investigate ensemble learning techniques to merge predictions from various CNN models, improving overall resilience and performance. The model's ability to handle challenging tasks like segmentation, object detection, and classification can be further enhanced by looking into different transfer learning techniques, multi-task learning frameworks, and attention mechanisms.

## ACCURACY GRAPH FOR TRAINING AND VALIDATION

Once the training is completed, a graph depicting the training accuracy, validation accuracy, and 50 epochs is created. The validation accuracy is represented by the blue line, while the red line represents the training accuracy. The formula used to calculate accuracy is provided below.





Accuracy Graph on Training Set

and Validation

Especially in classification tasks, accuracy is an essential performance indicator in machine learning models. It calculates the percentage of accurate predictions the model has produced out of all of its forecasts.

The model's accuracy in properly identifying medicinal plants from photos of their leaves is measured by this formula. While a lower accuracy score implies that the model might be making more mistakes in its predictions, a higher accuracy value shows that the model is making more accurate predictions.

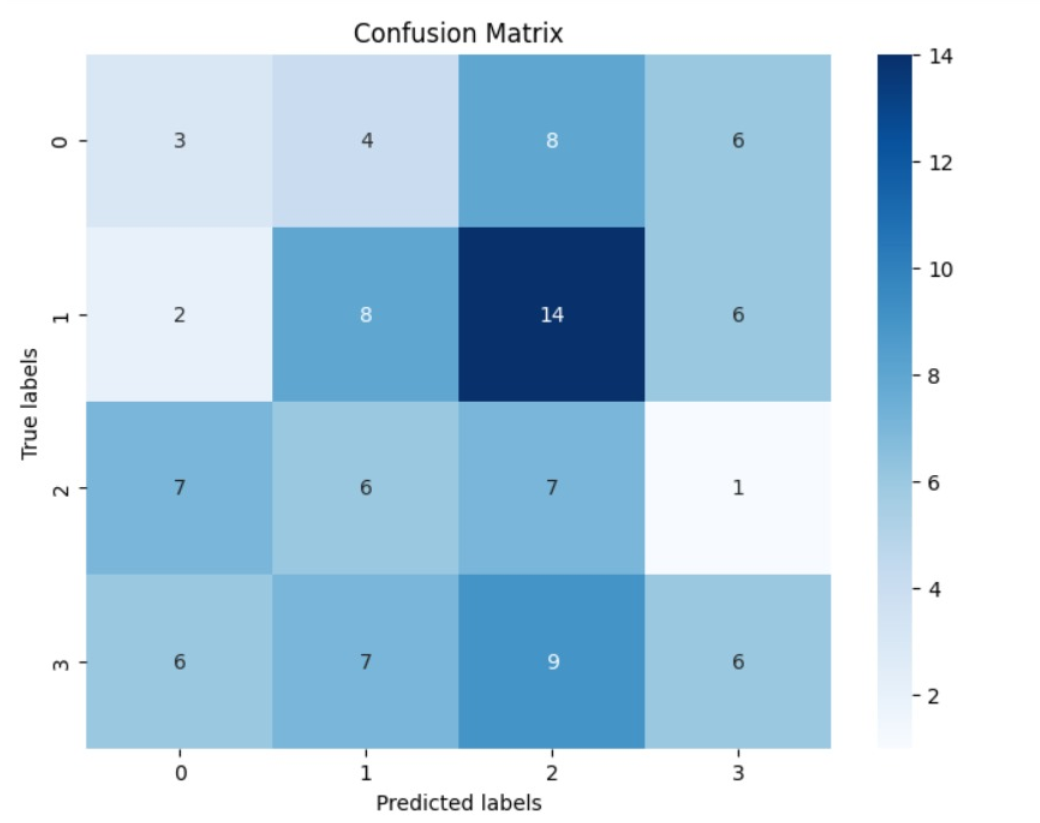
A Convolutional Neural Network (CNN) model's accuracy graph, which is produced during the training and validation stages, offers important insights into the functionality and learning dynamics of the model. Typically, this graph shows the accuracy of training and validation over a number of training epochs, or iterations.

The model iteratively modifies its parameters depending on the training examples as it gains the ability to identify patterns and characteristics in the training data, thus increasing its accuracy. The graph's blue line, or training accuracy, indicates how well the model performs on the training set as training goes on. It displays how well the model was able to categorize or forecast labels for the training set.

## CONFUSION MATRIX

A table used to assess a classification model's performance is called a confusion matrix. It offers a synopsis of the model's predictions in relation to the dataset's real labels. The matrix comes in very handy when handling jobs that fall under several classes or categories.

The actual class or label is represented by each row in a confusion matrix, while the anticipated class or label is represented by each column. The counts of the cases when the predicted class and the actual class match are contained in the cells of the matrix.



By offering a thorough overview of the predictions made by classification models in relation to the actual labels in the dataset, a confusion matrix is a vital tool for evaluating the effectiveness of these models. This analytical table is very helpful for assignments involving several classes or categories. In the confusion matrix, the actual class or label is represented by each row, and the anticipated class or label is represented by each column. The numbers in the matrix's cells represent the number of times the actual class and the anticipated class coincide. The confusion matrix allows for a more thorough examination of the model's behavior across several classes in addition to its primary purpose of summarizing predictions.

Within the field of medicinal plant image processing, a confusion matrix is a crucial instrument for evaluating the performance of classification models designed to recognise and group different plant

species according to their visible characteristics, like leaves or flowers. It offers crucial information about how well the model works with various kinds of medicinal plants, illuminating any persistent misunderstandings or misclassifications of diverse species. This knowledge is essential for identifying particular classes that could require more information or model modifications in order to improve classification accuracy.

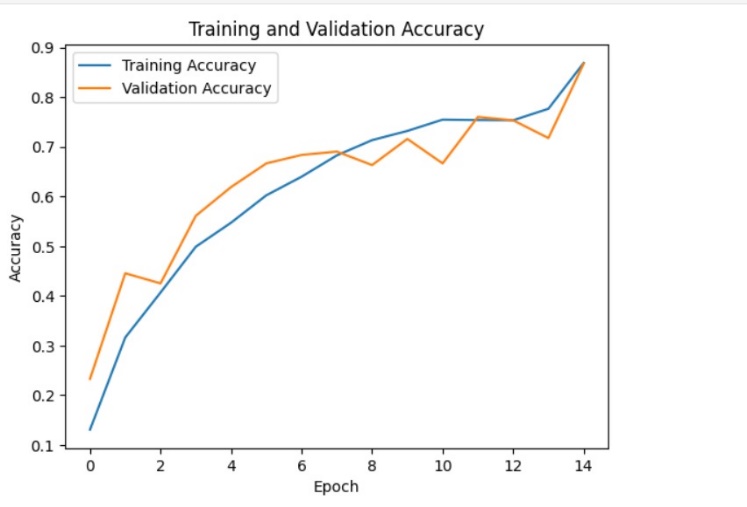
**RESULT**

Identification and classification of medicinal plants have advanced significantly as a result of the combination of TensorFlow and Convolutional Neural Networks (CNNs). This method allows for accurate automated species recognition by precisely evaluating leaf features like form, size, colour, and texture by utilising deep learning algorithms.

CNN models are trained more efficiently when standardised datasets, which include leaf samples from a variety of medicinal plants, are employed. These models are implemented and trained using TensorFlow, a well-known deep learning framework, allowing them to identify intricate patterns and attributes from the input photos.

Furthermore, CNNs are excellent in classifying and automatically identifying different types of therapeutic plants, with little human involvement. The Medicinal plants collection dataset serves as an example of how CNNs are being used to simplify plant identification procedures, preserve traditional medical knowledge, and achieve impressive classification accuracy.

In order to identify between various plant species based on visual characteristics, CNN models must first learn how to extract relevant features from leaf pictures during the training phase. By training them extensively, these models reach excellent accuracies—above 90% on training and testing sets—proving to be effective for automated species identification.



Accuracy Graph on Training Set

and Validation

When evaluating the effectiveness of machine learning models, like Convolutional Neural Networks (CNNs), in image processing tasks, training loss and testing loss are essential measures. The difference between the actual labels in the training dataset and the anticipated outputs of the model is measured by the training loss, also called the training error. During training, the model learns to minimise this loss by iteratively adjusting its parameters, which helps it generate accurate predictions and generalise effectively to new data. On the other hand, the testing loss, also known as the validation loss, assesses how well the model performs using a different dataset known as the validation set.



Loss Graph on Training Set

And validation

**CONCLUSION**

In summary, a novel method for plant identification and classification is provided by the combination of Convolutional Neural Networks (CNNs) with TensorFlow in the visual processing of medicinal plants. These algorithms employ deep learning approaches to precisely assess leaf features, hence enabling highly precise automated species recognition. The utilization of TensorFlow training and standardized datasets has proven to be crucial in attaining exceptional classification accuracy, streamlining plant identification procedures, and conserving traditional medical expertise. This technique offers time-saving solutions and important insights into the biodiversity of medicinal plants, which has great promise for furthering study in plant biology, conservation, and traditional medicine.

Additionally, the combination of CNNs and TensorFlow has made sophisticated machine learning tools more accessible to a wider range of researchers and practitioners, facilitating the identification and preservation of plants. The democratization of technology encourages cooperation, the exchange of knowledge, and the democratization of knowledge itself, enabling people all over the world to take part in the conservation of biodiversity and traditional medical expertise.

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