Deep Learning-Based Medicinal Plant Identification Using Mobile Net and Res Net Algorithms

[1]Ms. Surya S, [2] Dr. Kiruba Nesamalar E

[1]Post Graduate, Department of Information Technology, Women's Christian College, Chennai.

[2]Assistant Professor, Department of Information Technology, Women's Christian College, Chennai.

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ABSTRACT

Deep Learning-Based Plant Identification Using Mobile Net and Res Net for identifying medicinal plants. In order to improve model generalization, ImageDataGenerator is used for image preprocessing and augmentation. The Adam optimizer is used to optimize both models after they have been compiled with categorical cross-entropy loss. Accuracy measurement is part of performance evaluation, and it is shown using bar charts and graphs. While both MobileNetV2 and ResNet50 achieve high accuracy, a comparison of the two models shows that MobileNetV2's lightweight architecture makes it more effective for real-time applications. The web-based interface of the system was created with HTML, CSS, and JavaScript. Users can upload images to the frontend, and the Flask-implemented backend processes the image and returns the predicted medicinal plant class and confidence score. Bohera, Devilback bone, Haritoki, Lemongrass, Nayontara, Neem, Pathaorkuchi, Thankuni, Tulsi, and Zenora are the ten classes of medicinal plants that make up the dataset. Through smooth user interaction made possible by this integration, medicinal plant identification is now quick and easy. By automating plant identification, this research provides a useful tool for conservation, agriculture, and healthcare. The suggested system offers a precise and effective way to identify medicinal plants by utilizing deep learning. Future research can look into improving model robustness and incorporating more plant species.

Keywords: Deep Learning, MobileNet, ResNet, Medicinal Plant Identification, Image Recognition, Flask, Image Augmentation, Web Application

INTRODUCTION

The therapeutic qualities of medicinal plants have made them essential to both conventional and modern medicine. Herbal medicine, the pharmaceutical industry, and drug discovery research all make extensive use of them. However, it is still very difficult to accurately identify medicinal plants, particularly for those who are not familiar with botanical classification. Conventional identification techniques frequently require a thorough understanding of plant morphology and taxonomy, which adds time and increases the possibility of human error. Deep learning-based image recognition provides a viable solution for the automatic and precise identification of medicinal plants in order to overcome these difficulties.

The goal of this research is to create an effective system for identifying medicinal plants by utilizing two cutting-edge deep learning models: MobileNetV2 and ResNet50. Because of their clear advantages in image classification tasks, these models were chosen. Because of its deeper architecture and residual learning framework, the deep residual network ResNet50 is renowned or its exceptional accuracy in challenging image recognition tasks. MobileNetV2, on the other hand, is a lightweight neural network that was created especially for real-time and mobile applications. As such, it has a lower computational requirement and is very efficient.

Ten species of medicinal plants—Bohera, Devilbackbone, Haritoki, Lemongrass, Nayontara, Neem, Pathaorkuchi, Thankuni, Tulsi, and Zenora—make up the dataset used in this study. Several preprocessing methods, such as image augmentation with ImageDataGenerator, were used to guarantee better model performance and generalization. By creating altered versions of the images through transformations like rotation, flipping, and zooming, this augmentation process improves the dataset and enables the models to learn more reliable features.

During the training phase, the models were optimized using the Adam optimizer, which guarantees effective convergence, and categorical cross-entropy loss. The classification accuracy of the trained models was then assessed using test images. The efficacy of the two models was evaluated using a range of performance metrics, such as confusion matrices, bar charts, accuracy scores, and loss curves. Because of its lower computational cost and deployment efficiency, MobileNetV2 turned out to be more appropriate for real-time applications, even though ResNet50 achieved high accuracy.

A web-based application was created to help users identify medicinal plants. Users can upload photos of medicinal plants for identification through the frontend, which is made with HTML, CSS, and JavaScript. The Flask-implemented backend analyzes the uploaded photos and uses the deep learning model that has been trained to identify the type of plant. The user is then presented with the prediction results, which include the identified plant name and confidence score. For researchers, herbalists, and enthusiasts looking to precisely identify medicinal plants, this system offers a smooth and intuitive experience.

By providing an automated, quick, and precise solution, this research aims to improve accessibility to medicinal plant identification. The suggested system reduces errors and increases efficiency by doing away with the need for manual identification through the use of deep learning. The study offers insightful information about the efficiency and accuracy trade-offs associated with classifying medicinal plants using MobileNetV2 and ResNet50. The Flask-based implementation is a reliable tool for plant identification because it closes the gap between deep learning research and useful real-world applications. More plant species may be added to the dataset in future research, the models may be further optimized, and the system may be integrated with mobile applications for wider accessibility.

Problem Definition

Identifying medicinal plants can be difficult because many plant species share physical traits. Traditional identification methods require information, which isn't always available. Ineffective or dangerous medications are administered as a result of misidentification. By developing an automated deep learning-based system that can identify medicinal plants from photographs, this study seeks to address this issue.

Objective of the Research

The project uses MobileNetV2 and ResNet50, two cutting-edge architectures, to create a deep learning model for identifying medicinal plants. Preprocessing and enhancement of the dataset will improve model performance and ensure reliable training and evaluation. To find the best method for this task, the accuracy and efficiency of MobileNetV2 and ResNet50 will be compared. After training, users will be able to quickly identify medicinal plants using an intuitive interface thanks to the models' integration into an online platform. This technology will help close the gap between deep learning and real-world botany and medical applications.

Scope of the Research

This project uses deep learning algorithms to classify ten different types of medicinal plants. In this work, images are preprocessed, evaluated, and trained using the MobileNetV2 and ResNet50 models. Using uploaded photos as input through a web application created with HTML, CSS, JavaScript, and Flask, the system is suggested to generate predictions. The system does not cover therapeutic qualities other than categorization; it only covers the categorized plant classes. Additional plant species, scope expansion to a larger dataset, and model interpretability for wider applications are possible future improvements.

LITERATURE SURVEY

Paulson Joseph and Ravishankar M. [1] "AI-Based Indigenous Medicinal Plant Identification," published in 2020 as part of the IEEE Calcutta Conference (CALCON). The study focuses on identifying indigenous

Ayurvedic medicinal plant species through deep learning techniques, comparing pretrained models like GoogLeNet and AlexNet with a basic Convolutional Neural Network (CNN) for effective leaf recognition. Dileep M. R. and P. N. Pournami. [2] The 2019 Proceedings of the International Conference on Communication and Signal Processing (ICCSP) article, "AyurLeaf: A Deep Learning Approach for Classification of Medicinal Plants," This paper presents 'AyurLeaf,' a deep learning-based CNN model for classifying medicinal plants based on leaf attributes such as size, shape, color, and texture. A dataset of leaf samples from 40 medicinal plants that are frequently found in Kerala, India, is presented at the outset.

S. K. Gupta and R. K. Sharma. [3] This was exactly what the 2021 International Journal of Computer Applications article "Ayurvedic Plant Identification Using Image Processing and Artificial Intelligence" accomplished. The study shows the high accuracy and reliability of deep learning algorithms in medicinal plant identification by classifying Ayurvedic plants using advanced image processing techniques. Gornale, S. S., and Bhoi, S. S. [4] In 2023, the paper "Ayurvedic Plants Identification Based on Machine Learning and Deep Learning Techniques" was published by IEEE Xplore. This study uses leaf photos to identify readily available medicinal plants in the area using 100 samples from 15 different species. Machine learning and deep learning techniques are used to achieve accurate identification.

M. A. Khan and P. D. Deshpande. [5] "Recognition and Classification of Indian Medicinal Plants Using Deep Learning," in 2020. The study demonstrates the model's ability to recognize Ayurvedic herbs from different regions of India by classifying Indian medicinal plants using images of their leaves using a Convolutional Neural Network (CNN). A. Sharma and R. Mishra. [6] The paper "Deep Learning-Based Classification of Indian Medicinal Plants Using Leaf Images" was published in 2022 by the Journal of Computer Science and Applications. This work presents a deep learning framework designed specifically for identifying Indian medicinal plants and demonstrates impressive classification accuracy using a dataset of commonly occurring Ayurvedic species.

S. P. Patil and K. H. Sane. [7] "Identification of Medicinal Plants Native to India Using Machine Learning Techniques," in 2021. The study aims to identify Indian medicinal plants by classifying data such as leaf texture, shape, and size using machine learning techniques like Random Forest and Support Vector Machines (SVM). Muhammad Salman Ikrar Musyaffa, Novanto Yudistira, Muhammad Arif Rahman, and Jati Batoro. [8] "IndoHerb: Indonesia Medicinal Plants Recognition using Transfer Learning and Deep Learning," was released in 2023. This study employs Convolutional Neural Networks (CNN) and transfer learning to classify Indonesian herbal plants with 92.5% accuracy using the ConvNeXt model.

Jianping Yao, Son N. Tran, Saurabh Garg, and Samantha Sawyer. [9] This paper, "Deep Learning for Plant Identification and Disease Classification from Leaf Images: Multi-prediction Approaches," was published in 2023. This research investigates several deep learning methods for plant identification and disease classification. It recommends a brand-new model that outperforms reference datasets: GSMo-CNN, or generalized stacking multi-output CNN. Alfreds Lapkovskis, Natalia Nefedova, and Ali Beikmohammadi. [10] The paper "Automatic Fused Multimodal Deep Learning for Plant Identification" was published in 2024. This work presents a multimodal deep learning approach for plant classification that achieves an accuracy of 83.48% on the PlantCLEF2015 dataset by integrating images of different plant organs, such as flowers, leaves, fruits, and stems, into a coherent model.

Dataset Used

The three main folders that comprise the dataset are Test, Train, and Validation. A specific plant species is represented by each of the ten subfolders that make up each of these main folders. Multiple photos of the corresponding plant species are stored in these subfolders. For each of the three main folders, the plant names in the subfolders are identical. Additionally, the dataset has columns for Image Path, which provides the path of the image file, and Label, which is the name of the plant species. For training, testing, and validation, this format offers a well-structured dataset.

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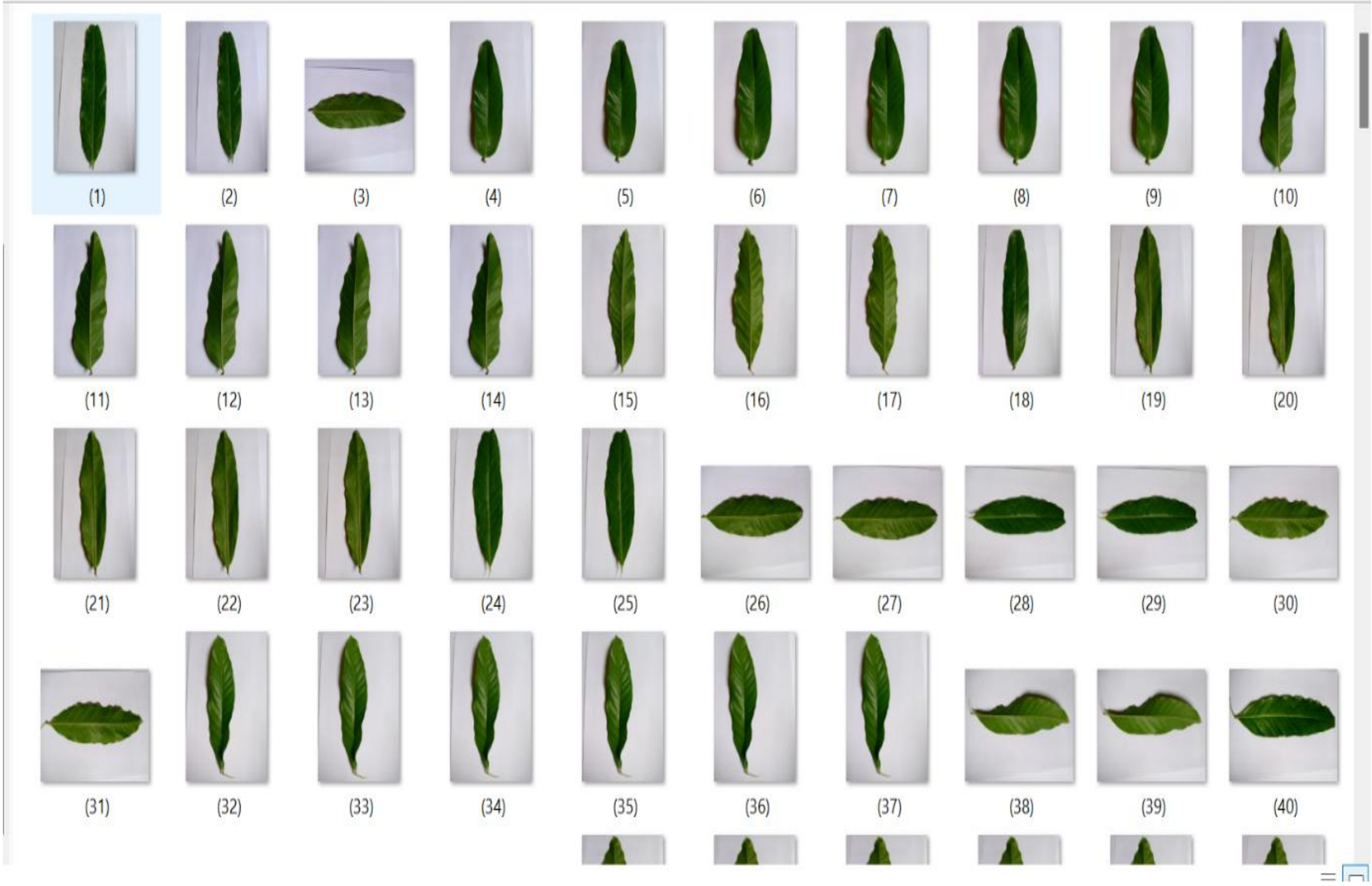
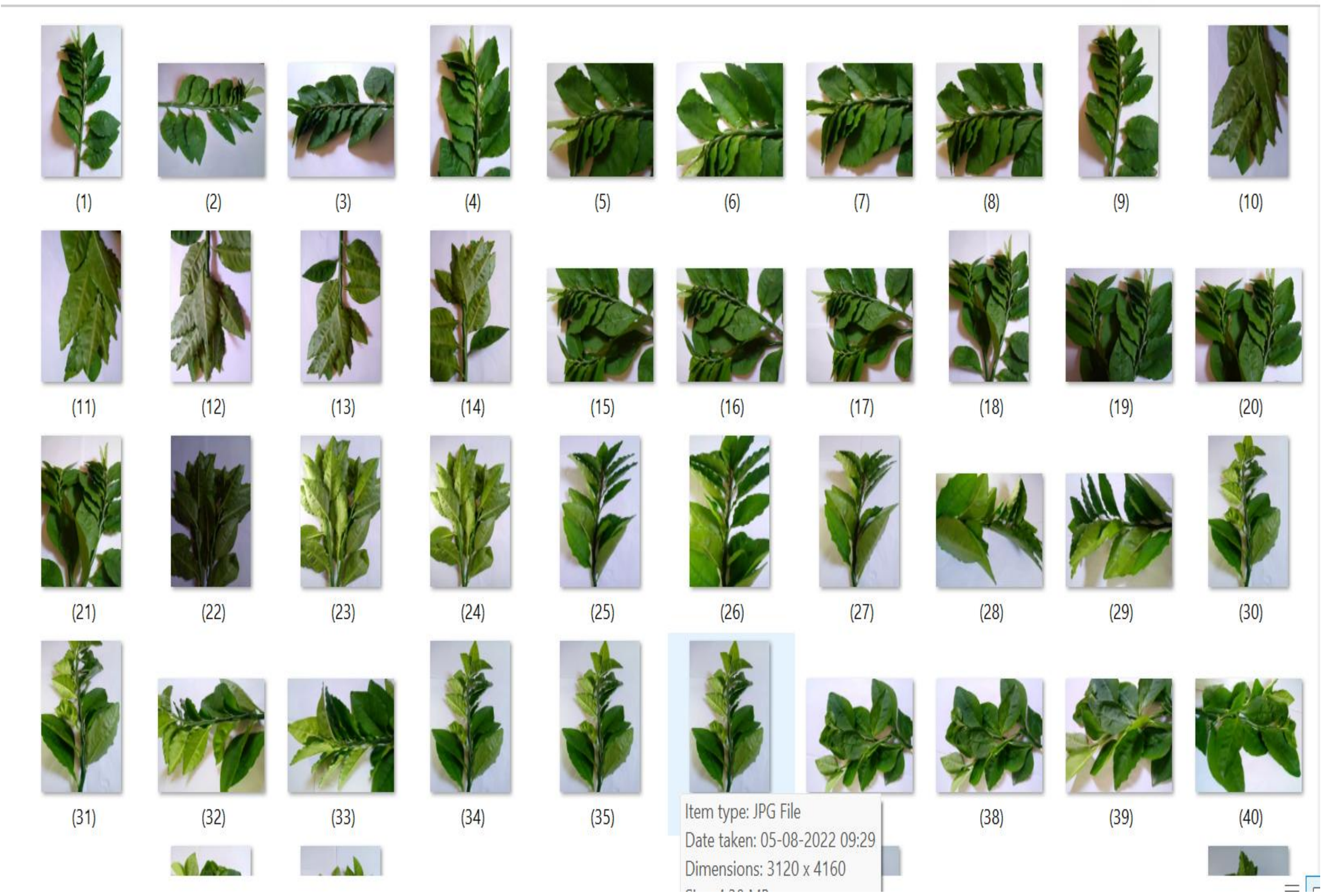
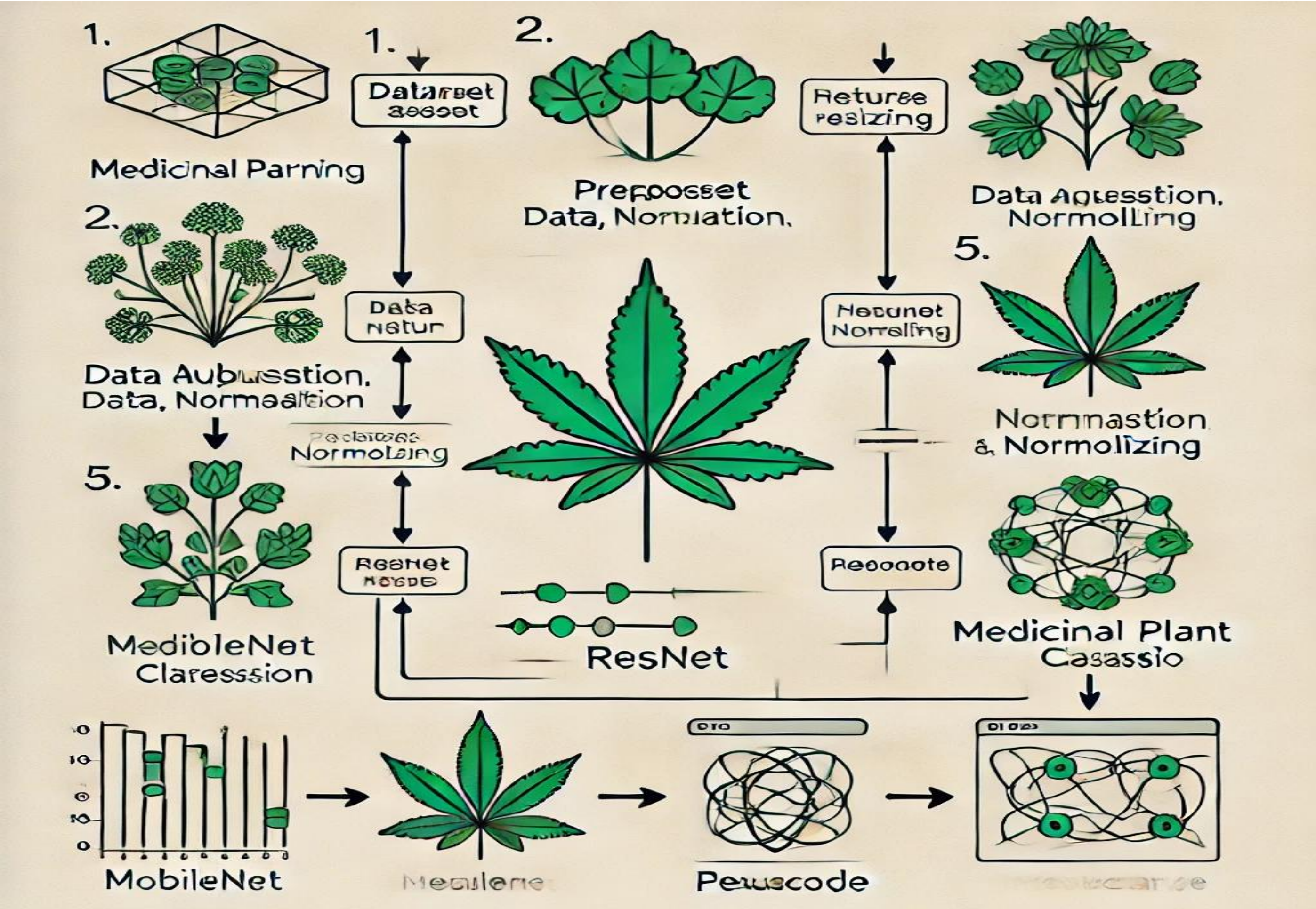
Sample Data





METHODOLOGY



Dataset

Images of therapeutic plants that were gathered for classification make up the dataset. Deep learning models are trained and assessed using these pictures. Every picture has a label that describes the type of plant it depicts. The accuracy and generalization of the model are enhanced by a well-structured dataset. It is crucial to separate the data into sets for testing, validation, and training.

Preprocessing

Methods such as data augmentation, normalization, and resizing are used. For consistency, resizing guarantees consistent image dimensions. To improve model efficiency, normalization scales pixel values. To avoid overfitting, variations are introduced through data augmentation. Preprocessing increases the robustness of the model and training performance.

Algorithms

MobileNet and ResNet are used to categorize medicinal plants. These deep learning models use images to extract key features. ResNet uses residual learning to increase the accuracy of deep networks. MobileNet is lightweight and was designed with mobile applications in mind. Both models aid in the accurate identification of species of medicinal plants.

MobileNet & ResNet

MobileNet is a lightweight, deep learning model designed for embedded and mobile applications. Depthwise separable convolutions reduce computation without compromising accuracy. As a result, it is a viable choice for real-time medicinal plant identification.

In order to solve the vanishing gradient problem in deep neural networks, a deep learning model known as ResNet was developed. It permits deeper architectures without compromising accuracy by utilizing residual learning and skip connections. ResNet is an efficient way to extract detailed features from images of medicinal plants.

Algorithm

- The MobileNetV2 model's top layer should be removed, and pre-trained weights (ImageNet) should be loaded.
- Use pre-trained weights (ImageNet) and load the ResNet50 model without the top layer.
- Preprocess dataset: Resize images, normalize pixel values, and apply augmentation.
- Add a GlobalAveragePooling2D layer to reduce feature map size.
- Add a fully connected Dense layer.
- Add the output Dense layer for classification.
- Compile model using Adam optimizer and categorical cross-entropy loss.
- Train the model on the training dataset and validate on the validation set.
- Evaluate model performance on the test dataset to obtain accuracy.

Classification

The class of the medicinal plant is predicted by the trained model. The name of the plant and its therapeutic qualities are included in the output. Users are given pertinent details about the species they have identified. Researchers and medical professionals benefit from this when it comes to plant-based therapies. Research and medical applications are supported by accurate classification.

Evaluation

Model performance is assessed using accuracy and loss metrics. Accuracy measures the percentage of correct predictions. Loss quantifies the difference between actual and predicted values. Evaluation is performed on validation and test datasets. Performance visualization is done through accuracy and loss plots.

Pseudocode

A structured approach to model training and prediction is outlined. It includes dataset loading, preprocessing, and model definition. The training phase updates model parameters based on input images. The prediction phase classifies new images using learned features. Pseudocode ensures a clear implementation of the identification process.`

RESULT AND DISCUSSION

To ensure successful identification of medicinal plants, the performance of the deep learning models is evaluated using accuracy, precision, recall, and F1-score. Loss and accuracy curves are analyzed in order to understand model convergence and prevent overfitting. A comparison between MobileNet and ResNet illustrates the trade-off between inference time and accuracy, with MobileNet providing faster processing and ResNet providing higher precision due to its deeper architecture. Inference time analysis indicates that MobileNet is better suited for real-time applications, while ResNet is better for detailed feature extraction. When visualization tools like bar charts and confusion matrices are used to assess classification performance, the results are simpler to understand. Model optimization methods like data augmentation, dropout layers, and hyperparameter tuning further increase accuracy and generalization. Figure 1. Shows the Loss and accuracy curves of proposed methodology

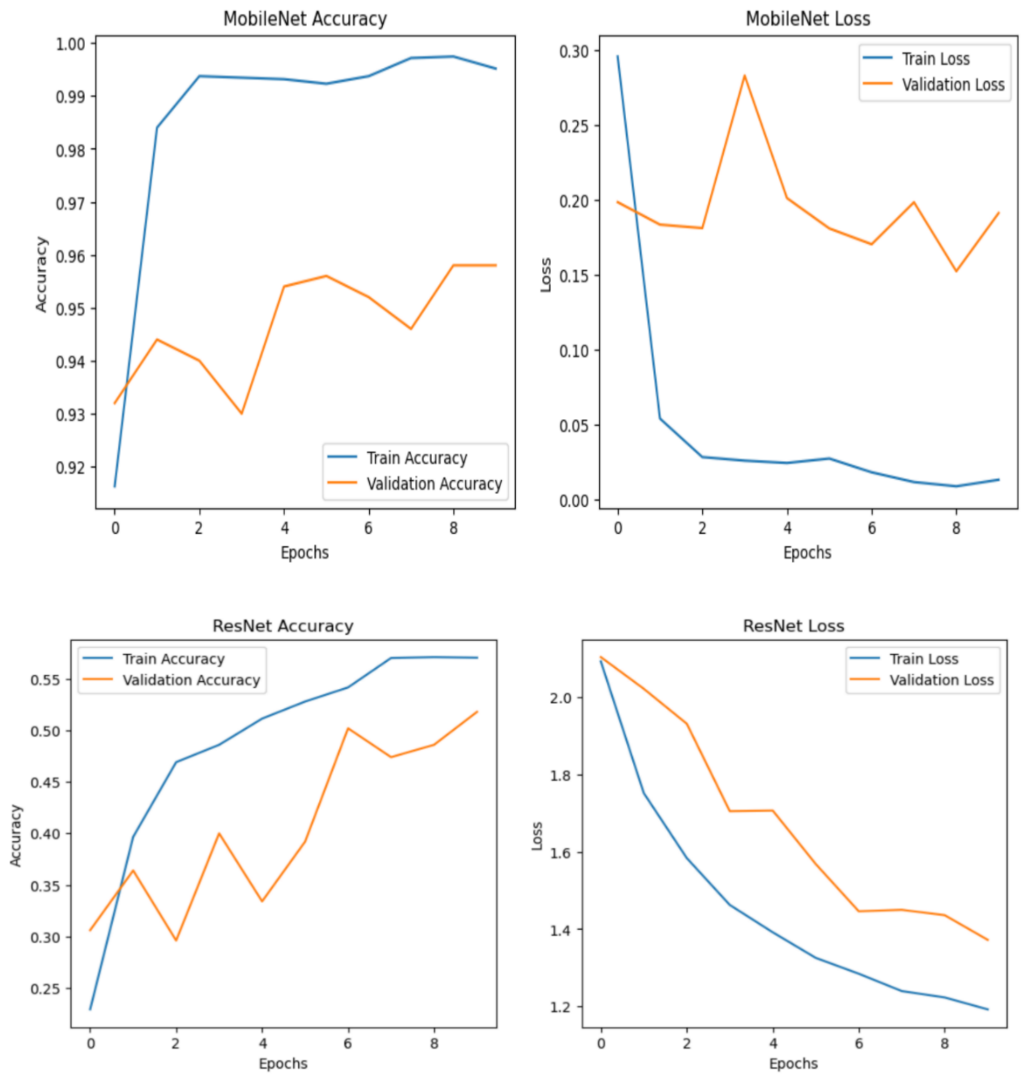


Figure 1. Loss and accuracy curves of proposed methodology

CONCLUSION

This study effectively shows the use of MobileNetV2 and ResNet50, two deep learning techniques, for the identification of medicinal plants. The report states that ResNet is more appropriate for fine-grained, high-accuracy identification, while MobileNet's efficiency makes it a good choice for real-time applications. Researchers, herbalists, and amateurs can easily and conveniently identify medicinal plants using the developed method. An efficient tool for both academic and practical objectives, the web-based application guarantees smooth interaction with the models. The findings open the door for further developments in automatic plant identification and confirm the effectiveness of deep learning in the identification of therapeutic plants.

Future Enhancements

- Dataset Expansion: To increase the model's accuracy and generalizability, the dataset's size and diversity should be increased.
- Real-time Mobile App: Establishing a mobile app that enables users to recognize therapeutic plants right from their phones.

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- Improved Model Training: Use transfer learning and other optimization strategies to improve the models' performance.

- Hybrid Model Approach: Investigating ensemble methods to enhance identification accuracy by combining the advantages of ResNet and MobileNet.

- Edge AI Deployment: Models for offline recognition are used by edge devices in situations where internet connectivity is not available.

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