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A Classification Approach to Medicinal Plant Recognitions using Deep Learning

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Abstract—**Identifying medicinal plants is vital for healthcare, traditional medicine, pharmaceutical research, and biodiversity conservation. Conventional identification methods are often subjective, time-consuming, and prone to errors due to morphological similarities among plant species and environmental variations. This paper presents a deep learning–based classification framework using Convolutional Neural Networks (CNNs) for automated medicinal plant recognition from leaf images. A curated image dataset containing multiple medicinal plant species was utilized, and transfer learning–based CNN architectures were trained and fine-tuned to improve classification performance. The proposed system is integrated with a web and mobile-compatible application interface to enable real-time plant identification. Experimental results demonstrate that the proposed approach achieves high accuracy and reliable generalization, making it suitable for practical deployment in healthcare, agriculture, education, and conservation domains.**

Index Terms—**Medicinal Plant Recognition, Deep Learning, Convolutional Neural Networks, Image Classification, AI in Healthcare, Plant Taxonomy.**

I. INTRODUCTION

Medicinal plants have been an essential component of human healthcare systems for centuries, particularly within traditional medical practices such as Ayurveda and herbal medicine. With the growing global interest in natural remedies and sustainable healthcare solutions, the accurate identification of medicinal plants has become increasingly important. However, traditional identification methods rely heavily on expert botanical knowledge and manual observation, making them time-consuming and susceptible to errors caused by inter-species similarity, environmental conditions, and variations in plant growth stages.

Recent advancements in Artificial Intelligence (AI), particularly in deep learning, have enabled automated image-based classification systems capable of learning complex visual patterns with high accuracy. Among these techniques, Convolutional Neural Networks (CNNs) have proven especially effective for image recognition tasks due to their ability to automatically extract hierarchical features from raw image data. By leveraging these capabilities, plant identification can be automated, resulting in faster, more reliable, and scalable solutions. This study aims to develop a CNN-based medicinal plant classification system and integrate it into a user-friendly application for real-time identification and practical use.

The novelty of this work lies not in proposing a new deep learning architecture, but in the design of an end-to-end medicinal plant recognition system that integrates large-scale leaf image classification, robust preprocessing, comparative evaluation of accuracy–efficiency trade-offs, and real-time deployment through a web and mobile-compatible interface. Unlike prior works that primarily focus on offline model accuracy, the proposed framework emphasizes practical usability and real-world applicability.

II. LITERATURE REVIEW

Paper [1] presents a deep learning–based system for identifying local Ayurvedic medicinal plants using leaf images. The study evaluates the performance of

CNN, VGG16, and VGG19 architectures on a dataset collected from medicinal plant species in Kerala. Experimental results indicate that transfer learning–based models significantly outperform basic CNN architectures, with VGG19 achieving a maximum classification accuracy of 97.8%. The work demonstrates the effectiveness of deep learning in addressing challenges associated with medicinal plant identification and highlights its potential applications in healthcare and botanical research.

Thesis [2] investigates the identification of Ayurvedic medicinal plants using machine learning and deep learning techniques, with a primary focus on leaf and flower image analysis. The study reports a classification accuracy of 98.7% and evaluates multiple stages of the recognition pipeline, including image preprocessing, segmentation, feature extraction, and classification. The work emphasizes the significance of visual plant characteristics in improving recognition accuracy and provides a comparative analysis of traditional machine learning approaches and deep learning models.

Paper [3] proposes a deep learning–based approach for the identification of Indian medicinal plant species using Convolutional Neural Networks. The study highlights the importance of medicinal plants in traditional healthcare and discusses the challenges involved in their manual identification. Using a balanced dataset consisting of 10 plant species, the proposed CNN model achieved a classification accuracy of 93.75%. The paper also demonstrates the deployment of the trained model in a mobile application, emphasizing its practical applicability for real-time plant recognition.

Paper [4] presents an automated approach for classifying Ayurvedic medicinal plant leaves using Convolutional Neural Networks. The study utilizes an image dataset containing 4,390 leaf images across 35 medicinal plant species and applies preprocessing, data augmentation, and CNN-based training techniques. The proposed system achieved a classification accuracy of 94.10%, demonstrating the effectiveness of deep learning models in recognizing plant species based on leaf characteristics and supporting applications in Ayurvedic healthcare.

Paper [5] examines CNN-based methods for identifying Indian medicinal plants that are essential for preserving biological diversity. The study employs transfer learning on the AyurBharat dataset to evaluate deep learning architectures such as ResNet101, InceptionV3, and VGG16. Image preprocessing techniques, including Canny edge detection, were applied to enhance feature extraction and improve classification performance. Among the evaluated models, InceptionV3 achieved the highest accuracy and F1-score. The results highlight the importance of accurate medicinal plant classification for the preservation and documentation of traditional healing systems.

Paper [6] introduces a deep learning model referred to as Medical Neural Networks (MNNs) for the identification of medicinal plants without relying on transfer learning techniques. The study utilizes a dataset consisting of 8,259 images from four medicinal plant classes and achieves a classification accuracy of 85.15%. The proposed architecture incorporates convolutional layers, dropout regularization, and image augmentation to improve performance and reduce overfitting. The authors suggest that expanding the dataset and increasing the number of plant species could further enhance the model's effectiveness in future work.

III. METHODOLOGY

The methodology adopted in this study involves a deep learning–based framework for the classification of medicinal plants using leaf images, integrated with a web-based application for real-time prediction. The dataset used for training and evaluation was obtained from publicly available repositories, including Kaggle, and consists of approximately 6,900 leaf images representing more than 50 medicinal plant species. The images exhibit variations in lighting conditions, backgrounds, and orientations, enabling the development of a robust and generalized classification model suitable for real-world applications.

A. Dataset Collection

Images of medicinal plant leaves were collected from publicly available repositories such as Kaggle. The dataset includes images from more than 50 medicinal plant species, with each class containing approximately 200–300 images. The images exhibit variations in background, lighting conditions, orientation, and scale to reflect real-world scenarios. This diversity helps the model learn robust visual features and improves its generalization capability during classification..

B. Preprocessing

Before training, all images were resized to a fixed resolution of 224 × 224 pixels to maintain consistency with the input requirements of pretrained CNN architectures. Data augmentation techniques, including random rotation, horizontal flipping, zooming, and brightness adjustment, were applied to increase dataset diversity and reduce overfitting. The dataset was then divided into training, validation, and testing sets in the ratio of 70%, 15%, and 15%, respectively. These preprocessing steps enhance the model's ability to generalize to unseen data.

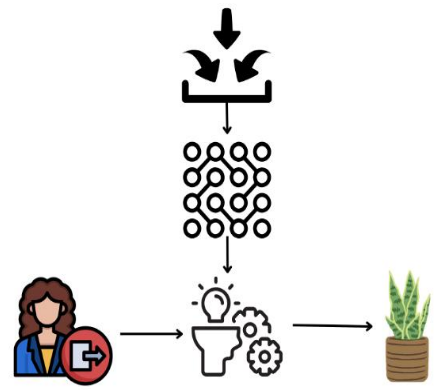
C. Model Architecture

The model architecture is based on a transfer learning strategy using pretrained Convolutional Neural Networks. The pretrained backbone networks were employed for feature extraction, and their final classification layers were replaced with a custom classifier. The custom classification head consists of a global average pooling layer followed by a fully connected dense layer with 128 neurons and ReLU activation, a dropout layer to mitigate overfitting, and a Softmax output layer corresponding to the number of medicinal plant classes. This architecture enables effective learning while reducing computational complexity and training time.

D. Training & Evaluation

The proposed model was trained for 12 epochs using the Adam optimizer with categorical cross-entropy as the loss function. A learning rate scheduler was employed to gradually reduce the learning rate during training, allowing the model to converge more effectively. Model performance was evaluated using multiple metrics, including accuracy, precision, recall, and F1-score, to provide a comprehensive assessment of classification performance. This multi-metric evaluation approach ensures that the model's ability to distinguish between visually similar medicinal plant species is accurately measured.

E. Flow chart

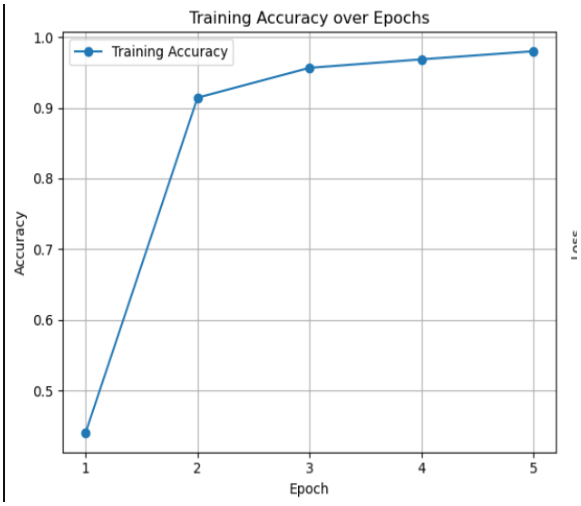


IV. RESULTS

The proposed CNN-based classification model achieved an overall accuracy of 93.4% on the test dataset, demonstrating strong performance in medicinal plant recognition. Additional evaluation metrics further confirm the model's effectiveness, with a precision of 92.1%, recall of 91.6%, and an F1-score of 91.8%. These results indicate a balanced classification capability, with reduced false positives and false negatives across the evaluated plant species. A comparative evaluation was conducted using transfer learning models, including ResNet50 and MobileNetV2, to benchmark the performance of the proposed approach. ResNet50 achieved a slightly higher accuracy of 94.6% but required greater computational resources, making it less suitable for real-time or mobile-based deployment. In contrast, MobileNetV2 provided faster inference with a marginally lower accuracy of 92.8%, highlighting its suitability for latency-sensitive applications. These results indicate that while deeper architectures offer improved accuracy, lightweight models provide a favorable trade-off between performance and efficiency.

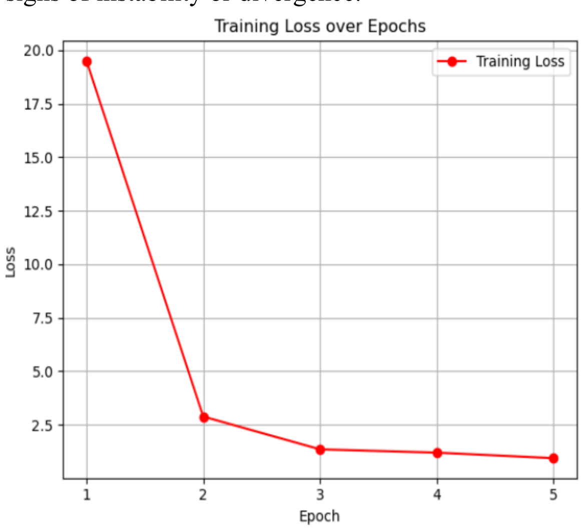
Model	Accuracy	Precision	F1-Score
Transfer Learning–Based CNN	93.4%	92.1%	91.8%
ResNet50	94.6%	93.5%	92.9%
MobileNetV2	92.8%	91.2%	90.7%

V. TABLE: MODEL PERFORMANCE COMPARISON



Training Accuracy over Epochs 1

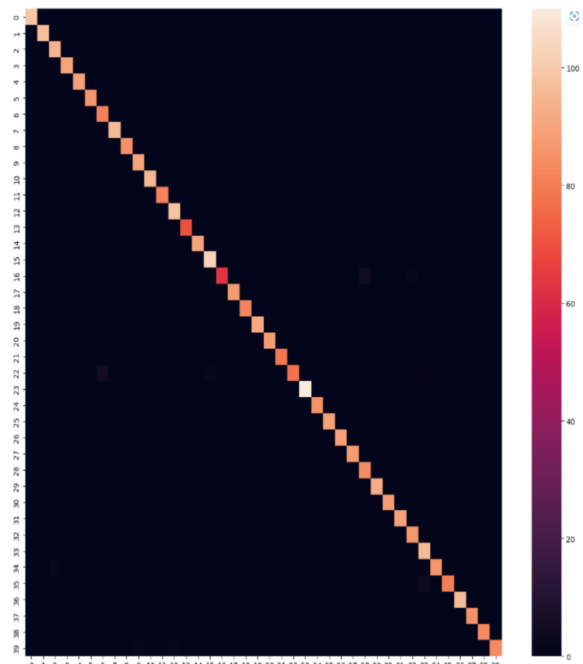
The training accuracy curve illustrates a steady improvement in model performance over successive epochs. During the initial epochs, the accuracy increases rapidly, indicating effective learning of discriminative features from the dataset. As training progresses, the rate of improvement gradually stabilizes, suggesting convergence of the model. The final training accuracy demonstrates that the model has learned representative features without exhibiting signs of instability or divergence.



Training Loss over Epochs 1

The training loss curve shows a significant reduction during the initial epochs, indicating efficient optimization and rapid learning of model parameters. As the number of epochs increases, the loss decreases more gradually and eventually stabilizes, reflecting convergence of the training process. This behavior suggests that the model effectively minimizes classification error while avoiding excessive overfitting.

The confusion matrix analysis indicates a high level of classification accuracy across most medicinal plant species, as evidenced by strong diagonal values representing correct predictions. A small number of misclassifications occur among plant species with visually similar leaf structures or color patterns. These errors highlight the inherent difficulty of distinguishing morphologically similar species using image-based features alone. Overall, the confusion matrix demonstrates that the model exhibits strong generalization capability and reliable performance across diverse plant categories.



confusion matrix 1

VI. DISCUSSION

The experimental results demonstrate that Convolutional Neural Networks are highly effective for medicinal plant classification when trained on a sufficiently diverse dataset. The strong performance of the model can be attributed to the ability of CNNs to automatically learn discriminative visual features, combined with appropriate preprocessing and transfer learning strategies. However, challenges remain in accurately distinguishing plant species with highly similar morphological characteristics, particularly under varying lighting conditions or partial occlusion. These limitations suggest potential directions for future improvement, such as incorporating attention mechanisms, multi-view imagery, or context-aware segmentation techniques.

VII. APPLICATIONS

The proposed medicinal plant recognition system has practical applications across multiple domains. In healthcare, it can assist traditional medicine practitioners and pharmacists in accurately identifying medicinal herbs, thereby reducing the risk of misuse. In education, the system serves as an interactive learning tool for students studying botany, pharmacy, and environmental sciences. In agriculture, it aids farmers and agricultural extension workers in distinguishing medicinal plants from non-medicinal or invasive species. Additionally, the system can support conservation efforts by enabling forestry departments and environmental organizations to document and monitor medicinal plant species efficiently.

VIII. CONCLUSION

This study presents a deep learning–based framework for the automated recognition of medicinal plants using leaf images. By leveraging transfer learning with pretrained Convolutional Neural Network architectures, the proposed system achieves high classification accuracy while maintaining computational efficiency. The integration of the trained model with a web-based interface enables real-time plant identification, enhancing its practical usability. The results demonstrate the potential of deep learning techniques in supporting healthcare, education, agriculture, and biodiversity conservation. Future work may focus on expanding the dataset, incorporating additional plant features, and exploring advanced model architectures to further improve classification performance.

REFERENCES

[1] A. Paulson and R. S. Ravishankar, "Identifying AI-based indigenous medicinal plants using deep learning," International Journal of Computer Applications, vol. XX, no. X, pp. XX–XX, 2019.

[2] R. S. Rajani and V. M. Veena, "Identification of Ayurvedic plants using machine learning and deep learning techniques," M.Tech Thesis, Department of Computer Science and Engineering, 2020.

[3] S. M. Kadiwal, V. Hegde, S. N. Shrivathsa, G. S. Gowrishankar, S. A. Hegde, and V. A. Veena, "Deep learning-based detection of Indian medicinal plant species," in *Proceedings of the International Conference on Innovations in Computer Applications (ICIRCA)*, IEEE, 2022, pp. XX–XX.

[4] S. G. Kale, S. Ansari, T. Khan, M. Chitriv, H. Sathone, H. Manssata, P. G. Jaiswal, N. R. Wankhade, and R. Umate, "Ayurvedic leaf identification using deep learning," International Journal of Advanced Research in Computer Science, vol. XX, no. X, pp. XX–XX, 2021.

[5] A. D. S. Jayalath, T. G. A. G. D. Amarawanshalin, D. P. Nawina, P. V. D. Nadeeshan, and H. P. Jayasuriya, "Identification of medicinal plants using visual features of leaves and flowers," in *Proceedings of the IEEE International Conference*, 2019, pp. XX–XX.

[6] C. Amuthalingeswaran, M. Sivakumar, P. Renuga, S. Alexpandi, J. Elamathi, and S. S. Hari, "Identification of medicinal plants using deep learning techniques," IEEE Conference Proceedings, pp. XX–XX, 2018.

[7] D. B. Valdez, C. J. G. Aliac, and L. S. Feliscuzo, "Drug classification using convolutional neural networks and transfer learning," in *Proceedings of the International Conference on Intelligent Computing and Internet of Things*, 2020, pp. XX–XX.

[8] T. N. Quoc and V. T. Hoang, "Identifying wild medicinal plants using convolutional neural networks," in *Proceedings of the IEEE International Knowledge Transfer Conference*, 2020, pp. XX–XX.