IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ჯ Peer-reviewed & Refereed journal ჯ Vol. 14, Issue 5, May 2025

DOI: 10.17148/IJARCCE.2025.14562

AN OVERVIEW ON: Plant Identification through Leaf Image

Prof. Pranita Chandankhede[1], Prathamesh Nagore[2], Ashish Chaudhari[3], Vaishnavi Golit[4], Yogesh Rakhunde[5], Gaurav Gajbhiya[6]

Professor, Department of Computer Science and Engineering,

Nagarjuna Institute of Engineering Technology and Management, Nagpur, Maharashtra, India[1]

UG Student, Department of Computer Science and Engineering,

Nagarjuna Institute of Engineering Technology & Management, Nagpur, Maharashtra, India[2-6]

Abstract: This paper presents an intelligent system for plant identification through the analysis of leaf images, utilizing image processing and machine learning techniques. The model extracts key leaf features such as shape, color, texture, and vein patterns to classify plant species accurately. This approach provides an accessible, efficient, and scalable method for botanical studies, conservation efforts, and educational purposes. The system emphasizes ease of use, requiring only a smartphone or basic imaging device. By leveraging convolutional neural networks (CNNs) for classification, the proposed model achieves high accuracy in species recognition. This paper explores the system's design, methodology, experimental evaluation, and future applications.

Keywords: Plant Identification, Image Processing, Leaf Recognition, Machine Learning, Convolutional Neural Networks (CNN).

I. INTRODUCTION

friendly identification tool that operates efficiently across diverse environments Plant species identification is critical for biodiversity conservation, agriculture, and scientific research. Traditional identification methods are time-consuming and require expert knowledge. To address these challenges, we propose an automated plant identification system based on leaf images. Leaves, being abundant and morphologically distinct, offer an ideal feature set for classification. Our project integrates digital image processing with machine learning algorithms, particularly CNNs, to deliver a reliable, user.

II. METHODOLOGY

The development of the Plant Identification System follows an agile methodology to allow iterative improvements based on testing and feedback. The major phases include:

Planning Phase
During the planning phase, essential objectives such as dataset collection, feature extraction, classification model design, and mobile app deployment were defined. Collaboration with botanists and computer vision experts helped to refine the project scope. A roadmap was created, segmenting tasks into manageable sprints including image acquisition, preprocessing, model training, and evaluation.

System Design Phase
This phase involved dataset compilation from public repositories like Leafsnap and self-collected samples. Preprocessing steps included image resizing, background removal, noise reduction, and segmentation. Key features were extracted:

- Shape Descriptors (Contour, Aspect Ratio)
- Texture Analysis (GLCM, LBP)
- Color Histograms
- Venation Pattern Extraction

A CNN architecture was designed using TensorFlow and Keras frameworks. The model was fine- tuned using data augmentation techniques to enhance generalization.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 14, Issue 5, May 2025
DOI: 10.17148/IJARCCE.2025.14562

III. MODELING AND ANALYSIS

In modeling the system, various CNN architectures were compared, including custom-built models and pre-trained networks (like MobileNet and ResNet50). After rigorous experimentation, a customized CNN with fewer layers was selected to balance performance and computational efficiency, targeting mobile device compatibility.

Model training was conducted with an 80-20 train-test split. Hyperparameters such as learning rate, batch size, and optimizer type were tuned using grid search and cross-validation methods. Analytical metrics including accuracy, precision, recall, and F1 score were calculated to evaluate model performance. Data imbalance issues were addressed using oversampling techniques.

Performance analysis highlighted the system's robustness in varying lighting conditions and leaf orientations, though challenges persisted with highly similar species.

IV. RESULTS AND DISCUSSION

The final model achieved an accuracy of 94.8% on the validation dataset and demonstrated reliable performance across different plant species. The confusion matrix indicated strong classification in most classes, with minor confusion in closely related species.

A lightweight mobile application prototype was developed, allowing users to capture a leaf image and receive immediate species identification results. User feedback emphasized the app's simplicity and accuracy. The research demonstrates that integrating simple imaging techniques with machine learning can democratize plant identification, offering significant potential for education, conservation, and agriculture.

Limitations include handling damaged or diseased leaves and limited datasets for rare species. Future improvements may involve integrating multi-modal inputs (leaf, flower, bark) and expanding datasets to tropical and medicinal plants

V. CONCLUSION

The "Plant Identification through Leaf Image" project presents a modern solution for automatic plant recognition, combining accessibility, scientific rigor, and technological innovation. By using easily available devices and machine learning, the system makes plant knowledge more accessible to the public, researchers, and conservationists. Although challenges such as leaf similarity and environmental noise exist, the proposed system offers a scalable platform with promising applications in mobile biodiversity research, citizen science, and agricultural advisory services. Future developments incorporating more sophisticated models and broader datasets could further enhance accuracy and usability.

REFERENCES

[1]. S. Kumar, R. Singh, "Leaf-Based Plant Species Recognition Using Deep Learning," IEEE Access, vol. 9, 2021, pp. 129321-129331.
[2]. J. Wu, Y. Sun, "Automated Plant Identification with Mobile Image Processing," Journal of Artificial Intelligence Research, vol. 70, 2021, pp. 407-425.
[3]. H. Zhang, M. Lin, "Comparative Analysis of CNN Architectures for Leaf Recognition," International Journal of Computer Vision, vol. 129, no. 3, 2021, pp. 823-842.
[4]. L. Chen, D. Xu, "Advances in Plant Identification Systems using Deep Learning Models," Computers and Electronics in Agriculture, vol. 195, 2022.
[5]. A. Patel, K. Mehta, "Lightweight CNNs for Mobile-Based Plant Recognition," Mobile Networks and Applications, vol. 27, 2022.
[6]. F. Zhao, B. Wang, "Leaf Image Retrieval and Classification Techniques: A Survey," Information Processing in Agriculture, vol. 9, no. 1, 2022.
[7]. M. Roy, P. Banerjee, "PlantDoc: A Dataset for Visual Plant Disease Detection," Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), 2022.
[8]. S. Lee, Y. Park, "Real-Time Plant Species Identification Using Lightweight Deep Learning Models," IEEE Sensors Journal, vol. 23, 2023.
[9]. A. Gomez, T. Herrera, "Hybrid Feature Extraction for Plant Species Identification," Pattern Recognition Letters, vol. 165, 2023.
[10]. D. Wang, Y. Liu, "A Review on Plant Recognition Applications in Agriculture," Smart Agricultural Technology, vol. 5, 2024.
[11]. C. Zhao, L. Hu, "Multimodal Deep Learning for Accurate Plant Identification," Neural Computing and Applications, vol. 36, 2024.