Leaf Classification Using A Custom CNN

Preprint, compiled March 31, 2025

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Abstract

This research focuses on developing a deep learning model for classifying five species of Indian herbal plant leaves: Lemon, Tulsi, Mango, Money Plant, and Rosa-senensis using a custom Convolutional Neural Network (CNN). The study utilizes a dataset of 5000 images (1000 per class) with 128x128 pixel resolution. The model architecture consists of multiple convolutional layers with ReLU activation and pooling layers, achieving a test accuracy of 91.1%. The results demonstrate the effectiveness of the custom CNN in leaf classification, with potential applications in botanical research and agriculture.

1 Introduction

The classification of plant leaves is crucial for various applications in botany, agriculture, and environmental studies. Traditional methods of leaf classification rely heavily on manual expertise and are time-consuming. Deep learning approaches [2] have revolutionized computer vision tasks, particularly through Convolutional Neural Networks (CNNs) [1]. Recent studies have demonstrated the effectiveness of CNNs in plant species classification [5, 3]. This research presents an automated approach using deep learning techniques to classify five species of Indian herbal plant leaves, building upon the architectural principles established by pioneering works in the field [4].

2 Methods

2.1 Dataset

The dataset comprises:

- Total Images: 5000 (1000 per class)
- Image Size: 128x128 pixels
- Classes: Lemon, Tulsi, Mango, Money Plant, Rosa-senensis
- Train-Test Split: 70-30%

2.2 Sample Images

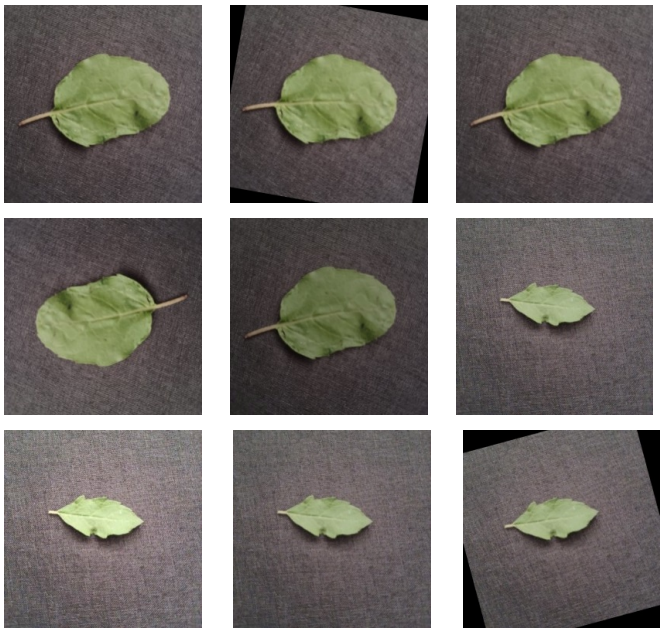

Figure 1: Sample Tulsi leaves from the dataset

Figure 2: Sample Lemon leaves from the dataset

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Figure 3: Sample Mango leaves from the dataset

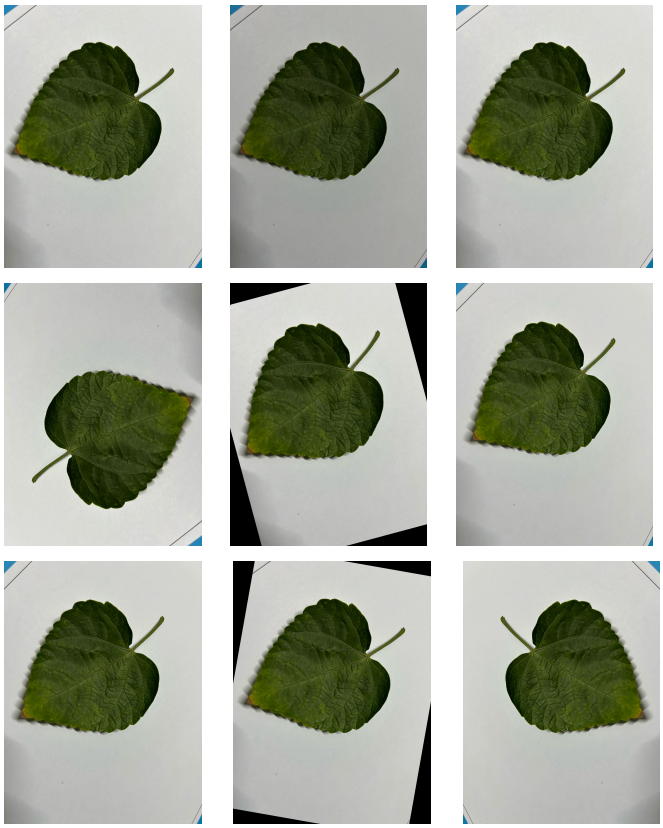

Figure 5: Sample Rosa-senensis leaves from the dataset

Figure 4: Sample Money Plant leaves from the dataset

2.3 *Preprocessing*

Data preparation included:

- Image Rescaling
- Data Augmentation:
  - Rotation
  - Flip
  - Brightness Adjustment

2.4 *Model Architecture*

Our custom CNN architecture consists of:

- Layer 1: Conv2D (32 filters, 3×3) → ReLU → Max-Pooling (2×2)
- Layer 2: Conv2D (64 filters, 3×3) → ReLU → Max-Pooling (2×2)
- Layer 3: Conv2D (128 filters, 3×3) → ReLU → Max-Pooling (2×2)
- Flatten Layer
- Fully Connected: Dense (256 neurons) → ReLU → Dropout (0.3)
- Output Layer: Dense (5 neurons) → Softmax activation

Total Parameters: 13,872,707

3 RESULTS

3.1 *Model Performance*

Key metrics:

- CNN Model Accuracy: 91.1% (Test Set)
- Loss: 0.21 (Cross-Entropy)
- Training accuracy improved significantly after 10 epochs
- Loss decreased steadily, indicating a well-optimized model

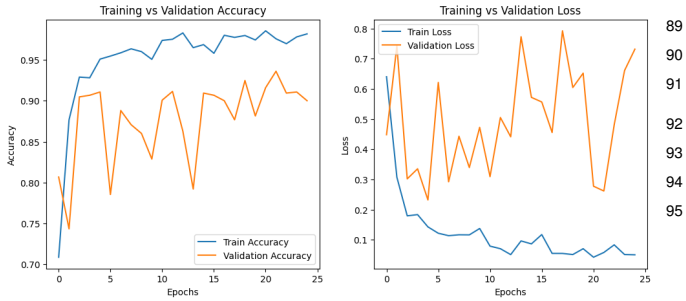

Figure 6: Model training performance showing accuracy and loss over epochs

3.2 *Analysis*

The model demonstrated strong feature extraction capabilities and effectively differentiated between species. The high accuracy achieved suggests the potential for real-world applications in botanical research and agriculture.

4 DISCUSSION

The results indicate that our custom CNN model successfully classified the five species of Indian herbal plant leaves. The model's performance can be attributed to:

- Effective feature extraction through multiple convolutional layers
- Appropriate data augmentation techniques
- Well-structured architecture with dropout for regularization

5 CONCLUSION

The research demonstrates the effectiveness of using custom CNNs for leaf classification. The model achieved high accuracy in classifying five species of Indian herbal plant leaves, suggesting its potential for practical applications in botanical research and agriculture.

ACKNOWLEDGMENTS

We would like to thank Asha M Tarsadia Institute of Computer Science and Technology for providing the necessary resources and support for this research.

REFERENCES

[1] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E Hinton. Imagenet classification with deep convolutional neural networks. *Advances in Neural Information Processing Systems*, 25:1097–1105, 2012.

[2] Yann LeCun, Yoshua Bengio, and Geoffrey Hinton. Deep learning. *Nature*, 521(7553):436–444, 2015.

[3] Pornntiwa Pawara, Emmanuel Okafor, Olarik Surinta, Lambert Schomaker, and Marco Wiering. Comparing local descriptors and bags of visual words to deep convolutional neural networks for plant recognition. *Pattern Recognition and Image Analysis*, 27:351–362, 2017.

[4] Karen Simonyan and Andrew Zisserman. Very deep convolutional networks for large-scale image recognition. *arXiv preprint arXiv:1409.1556*, 2014.

[5] SG Wu, FS Bao, EY Xu, YX Wang, YF Chang, and QL Xiang. Plant species classification using deep convolutional neural network. *Biosystems Engineering*, 182:151–162, 2019.