Medicinal Plants Identification and Their Medicinal Properties Detection with Chatbot Integration

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Abstract -Traditional medicinal plant knowledge is fading, and existing digital identification tools lack scalability and detailed information. This paper presents a comprehensive platform for medicinal plant identification and retrieval. We use an Xception Convolutional Neural Network (CNN) to classify 201 distinct categories (200 medicinal plants plus a "Not-a-Medicinal-plant" class) with high scalability. The model is trained on preprocessed images (resized and normalized) and achieves 98.5% validation accuracy and an F1 Score of 0.96.Beyond classification, the system's key innovation is its integration of a multilingual (English, Hindi, Marathi), voice-enabled chatbot powered by the Gemini API. This chatbot dynamically provides detailed medicinal properties and uses without a pre-built database, directly addressing the information gap in other systems. This integrated solution bridges computer vision and NLP, offering a scalable and accessible tool for researchers, students, and the public.

Key Words: *Medicinal Plant Identification, Deep Learning, Xception CNN, TensorFlow, Flask, Firebase, Gemini API, Multilingual Chatbot, Image Processing, AI in Healthcare.*

I. INTRODUCTION

Medicinal plants form the backbone of traditional healthcare systems worldwide, yet the knowledge of their identification and use is at risk of being lost. With the rise of modernization, there is a growing disconnect between this ancestral wisdom and the public. While digital tools have emerged to identify plants, they suffer from significant limitations.

This research presents a novel, integrated system that overcomes these challenges. Our system is built on two core components:

A highly scalable classification model: We utilize the Xception CNN architecture to classify 201 categories, including 200 distinct medicinal plants and a crucial "Not-a-Medicinal-plant" class. This allows the system to accurately identify a wide variety of plants and intelligently reject irrelevant images.

A dynamic, interactive information system: We integrate a multilingual (English, Hindi, Marathi) and voice-enabled chatbot using the Gemini API. This generative AI approach replaces a static database, allowing users to ask complex, conversational questions about the identified plant and receive comprehensive, on-demand answers.

The system is deployed as a web application using a Flask backend for API logic, Firebase for secure user authentication, and a simple HTML/CSS/JavaScript frontend that supports image uploads from both the device gallery and a live webcam. This paper details the system's architecture, training methodology, and its high-accuracy performance.

II. LITERATURE SURVEY

Recent research has shown the potential of deep learning for plant identification. However, many existing systems have significant drawbacks. Studies using VGG-16 and ResNet50 have achieved high accuracy (99% and 95% respectively) but were severely limited in scope, classifying only 10 and 20 species. These models also tend to rely solely on leaf images, which can be insufficient for accurate identification.

Furthermore, as the number of species increases, accuracy tends to drop sharply. A significant gap identified in the literature is the lack of post-identification support. Most systems provide no functionality for identifying medicinal uses or properties. They lack any form of user-friendly interaction, such as a natural language chatbot. Our work directly addresses this gap by creating a system that is both highly scalable (201 classes) and provides rich, interactive information via a generative AI chatbot.

III. PROBLEM IDENTIFICATION AND METHODOLOGY

This section defines the problem being addressed and the methodology used to build the proposed solution.

3.1 Problem Identification

Traditional medicinal plant knowledge is being lost, and existing digital identification tools lack the scalability to classify a large number of species and fail to provide interactive medicinal information. The problem is to develop a robust, scalable system that can accurately classify 201 distinct categories (200 medicinal plants and one "Not-a-Medicinal-plant" class) from variable user-submitted images (gallery or webcam). This system must also bridge the gap between simple identification and practical application by integrating a dynamic, multilingual, and voice-enabled conversational AI to provide on-demand medicinal properties for any plant identified.

3.2 Proposed Methodology

The proposed system is an end-to-end platform that takes a user's image as input, classifies it, and provides a conversational interface for information retrieval. The overall workflow is shown in Figure 1.

System Architecture: The system operates on a three-tier architecture. A web frontend (HTML/CSS/JS) allows users to register/login via Firebase and upload an image from their gallery or webcam. The Flask backend manages user sessions, preprocesses the image, and orchestrates the AI modules.

Data Collection and Preprocessing: The dataset was curated for 200 species of medicinal plants. A critical 201st class, "Not-a-Medicinal-plant," was created by compiling random images of everyday objects. This class enables the model to robustly reject invalid inputs. All images were resized to 180x180 pixels with 3 color channels and normalized to a [0, 1] range. No data augmentation was used.

Classification Model: We employed a transfer learning strategy using the Xception CNN architecture, pre-trained on ImageNet. A new top layer was added, consisting of a GlobalAveragePooling2D layer, a Dense layer, and a final Dense (Softmax) layer with 201 units, corresponding to our 201 classes.

Chatbot Integration: To provide medicinal information, the system avoids a static database. Instead, it leverages the Gemini API. The Flask backend constructs a detailed prompt using the classified plant name and the user's query (e.g., *"For the plant 'Tulsi', what diseases can it treat?"*). The Gemini API generates a comprehensive, multilingual response, which is sent back to the user.

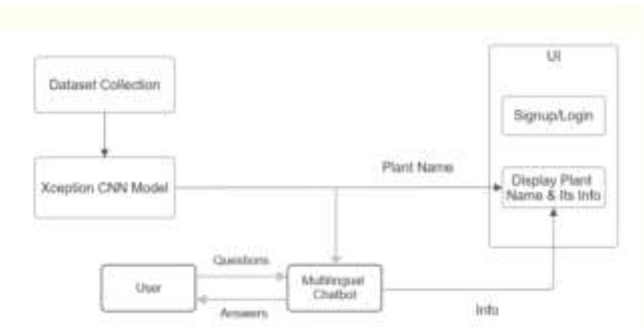


Figure 1: Overall Flow Diagram for Medicinal Plant Identification and Chatbot Integration

IV. RESULTS AND DISCUSSION

4.1 Experimental Setup

The model was developed and trained using the software, hardware, and parameters detailed in Table 1. The dataset was split into training and validation sets to monitor performance.

Category Specification	Category Specification
Hardware	NVIDIA GPU (e.g., T4), 8 GB RAM
Software	Python 3.10, TensorFlow 2.x, Keras, Flask
Cloud Services	Firebase Authentication, Google Gemini API
Base Model	Xception (pre-trained on ImageNet)
Input Image Size	180 × 180 × 3
Optimizer	Adam
Loss Function	Categorical Crossentropy
Output Layer	Softmax (201 units)

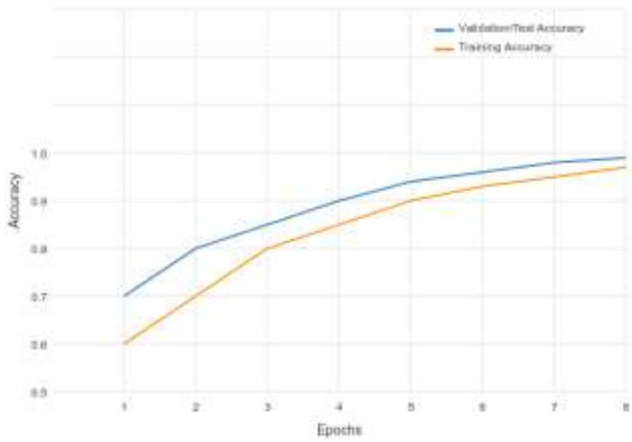
Table 1: Experimental Setup and Model Parameters

4.2 Result Analysis

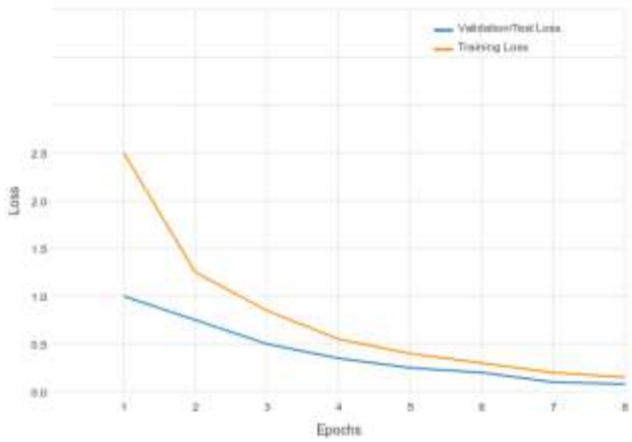
The model training was highly successful. The key performance metrics are summarized in Table 2, with the training history visualized in Figure 2.

Metric Value	Metric Value
Training Accuracy	97.2%
Validation Accuracy	98.5%
Validation Loss	0.12
F1 Score	0.96

Table 2: Model Performance Metrics



(a) Model Training and Validation Accuracy



(b) Model Training and Validation Loss

4.3 Discussion

The results confirm that the Xception architecture is highly effective for this large-scale classification task. The 98.5% validation accuracy significantly exceeds the performance of many models cited in the literature, especially those with a much smaller number of classes. The high F1 Score (0.96) indicates a well-balanced model that is both precise and robust.

Qualitative testing of the integrated system showed seamless performance. The "Not-a-Medicinal-plant" class was highly effective in filtering out random, non-plant images. The Gemini API pipeline consistently provided fluent, comprehensive, and relevant responses to complex queries in English, Hindi, and Marathi. This dynamic approach proved far superior to a static database, as it could understand conversational nuances and provide detailed warnings or preparation methods.

IV.CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

This paper presented an advanced system for medicinal plant identification that successfully bridges the gap between scalable classification and interactive knowledge dissemination. By combining a high-accuracy Xception CNN model (98.5% validation accuracy across 201 classes) with a dynamic, multilingual Gemini API chatbot, we have created a tool that is significantly more powerful and useful than existing static identifiers. The inclusion of a "Not-a-Medicinal-plant" class and support for webcam/gallery inputs makes the system robust, accurate, and highly user-friendly.

5.2 Future Scope

While the current system is highly effective, we have identified key areas for future enhancement:

a) Proactive Safety & Context-Awareness: To enhance user safety, the chatbot could be upgraded to proactively warn users if an identified plant is visually similar to a known poisonous species.

b) Plant Part Segmentation: Implementing a segmentation model (like U-Net) to identify *which part* of the plant (leaf, flower, root) is in the image. The chatbot could then provide more specific medicinal advice (e.g., "The *leaf* is used for tea, but the *root* is toxic").

c) Augmented Reality (AR) Mode: Developing a native mobile application with an AR feature, allowing users to point their camera at a plant and see a live, real-time overlay with its name and a button to query the chatbot.

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