An Intelligent PlantMitra Framework for Medicinal Plant Recognition and Therapeutic Insight Modeling

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Abstract: The AYUSH sector plays a crucial role in India's healthcare system, with medicinal plants forming the foundation of traditional therapeutic practices. This paper presents PlantMitra, an intelligent platform developed to improve the identification, accessibility, and dissemination of medicinal plant knowledge. The system integrates deep learning–based plant classification with user-centric features such as multilingual support, text-to-speech, chatbot assistance, multimedia resources, and real-time image recognition. In addition to classification, the platform provides AYUSH-based remedy recommendations and contextual plant information to support informed usage. Advanced functionalities, including three-dimensional visualization, virtual reality integration, and location-aware personalized suggestions, are incorporated to enhance user engagement and experiential learning while supporting the preservation and promotion of traditional medicinal knowledge in alignment with the National AYUSH Mission. The experimental results demonstrate that the adopted Xception-based model achieves approximately 98% test accuracy on an extended dataset of Indian medicinal plant species, highlighting the effectiveness and reliability of the proposed approach.

Keywords: *Medicinal Plant Classification, Convolutional Neural Networks, Transfer Learning, Xception Architecture, AYUSH, ImageNet, Computer Vision, Healthcare AI Systems*

I. Introduction

Medicinal plants have long been integral to traditional healthcare systems, particularly within India's AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homeopathy) framework, where they form the basis of preventive and therapeutic treatments. In recent years, the global shift toward natural and holistic healthcare solutions has significantly increased interest in herbal medicine. However, the effective utilization of this knowledge remains limited due to the lack of accessible, reliable, and technology-enabled platforms that can seamlessly connect traditional practices with modern digital tools.

Despite the extensive availability of medicinal plant resources, most existing digital platforms suffer from fragmentation, limited interactivity, and inadequate user engagement. These systems primarily offer static textual information, lacking features such as real-time plant identification, multimedia integration, multilingual accessibility, and intelligent recommendation systems. Consequently, their ability to support education, awareness, and practical application of AYUSH-based knowledge is significantly constrained.

To overcome these limitations, this paper presents an enhanced version of *PlantMitra*, an intelligent and interactive platform designed for medicinal plant identification and knowledge dissemination. The proposed system integrates real-time image-based plant detection, enabling users to identify plants instantly through image uploads. It further incorporates immersive

technologies such as virtual reality (VR) for 3D visualization, along with multilingual support, including regional languages, to improve accessibility and inclusivity.

A core component of the platform is a deep learning-based image classification model built on the Xception architecture, pre-trained on ImageNet and fine-tuned on the Indian Medicinal Leaves Image Dataset. The enhanced model supports classification across 15 plant species and achieves a test accuracy of approximately 98%, indicating strong performance and generalization capability. Additionally, the platform offers location-based recommendations for region-specific medicinal insights and improved chatbot interactions for enhanced user experience.

By integrating advanced artificial intelligence techniques with culturally significant medicinal knowledge, *PlantMitra* addresses the shortcomings of existing systems while aligning with the objectives of the National AYUSH Mission. The platform demonstrates the potential of AI-driven, user-centric solutions in preserving traditional knowledge, enhancing public awareness, and enabling the practical application of medicinal plants within modern healthcare ecosystems.

The remainder of this paper is organized as follows: Section II reviews related work in medicinal plant classification and digital knowledge platforms. Section III outlines the proposed methodology, including dataset preparation, model development, and system architecture. Section IV presents experimental results and performance evaluation. Section V concludes the paper with key findings, applications, and directions for future research.

II. Literature Review

Medicinal plants form the cornerstone of the AYUSH system, and numerous digital initiatives have been undertaken globally to document, preserve, and disseminate ethnomedicinal knowledge. Sharma et al. (2019) developed a comprehensive medicinal plants database, demonstrating how structured digital repositories can significantly improve the accessibility, organization, and research value of ethnobotanical information. Similarly, Patwardhan et al. (2005) emphasized the importance of Ayurveda and natural product informatics in modern drug discovery, highlighting the relevance of digitizing medicinal plant knowledge to bridge traditional wisdom with contemporary biomedical research.

Despite these significant contributions, existing digital platforms exhibit several critical limitations that restrict their usability, accessibility, and educational value. The WHO Medicinal Plant Database, for instance, serves as a globally recognized repository of herbal information but lacks interactive features and multimedia integration. Similarly, official portals provided by the Ministry of AYUSH in India offer valuable information on medicinal plants but remain largely static, text-based, and difficult to navigate for general users. Several mobile applications for herbal remedies have emerged in recent years, focusing on herbal remedies and plant identification; however, many of these tools suffer from inadequate scientific validation, limited search functionality, and an absence of user-centered features that enhance engagement and learning.

Pathiranage et al. (2020) proposed an image-based plant recognition system using deep learning techniques, demonstrating the potential of artificial intelligence in medicinal plant identification. While such approaches achieve notable classification accuracy, they often operate as standalone

models without integration into broader knowledge dissemination platforms. Similarly, other studies, such as those studies reported by IRJMETS (2025), have explored the use of machine learning for herbal classification but lack features such as multilingual support, user interaction, or personalized health recommendations, which are essential for real-world healthcare applications.

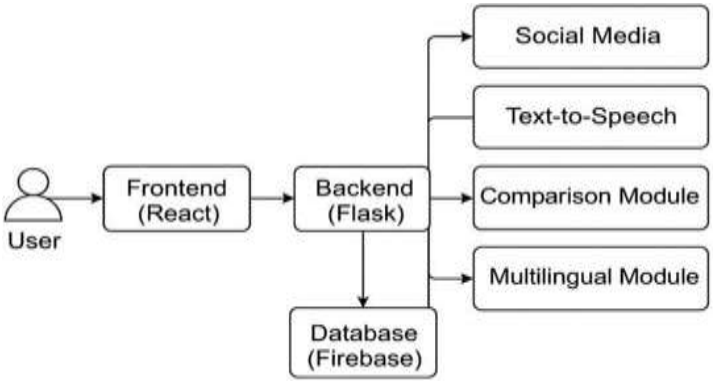
A critical review of existing systems indicates several persistent limitations. Most platforms predominantly rely on static textual content and lack interactive and immersive capabilities such as three-dimensional visualization, virtual reality (VR) integration, real-time image processing, and voice- or image-based query mechanisms. In addition, essential features including location-aware recommendations and accessibility support, such as text-to-speech, are often not incorporated. The available information is frequently fragmented across multiple sources, reducing its usability and hindering effective knowledge integration. Moreover, the dominance of English-only interfaces restricts accessibility for a significant portion of the Indian population. These challenges underscore the need for a unified, intelligent, and user-centric solution that bridges traditional ethnomedicinal knowledge with modern technological advancements. In this context, the proposed system, *PlantMitra*, offers an integrated approach by combining deep learning–based plant classification with interactive visualization, multilingual and regional language support, AYUSH-based therapeutic recommendations, real-time image analysis, and location-aware personalized services.

III. Methodology

The project follows an iterative, user-centered methodology, ensuring the system evolves through technical validation and user feedback. The approach included requirement analysis, system design, implementation, testing, deployment, and iterative refinement. Functional requirements encompassed a medicinal plant database, health remedy suggestions, multilingual and multimedia support, real-time image upload, search and filter functionality, bookmarking, comparison tools, and location-based recommendations. Non functional requirements focused on scalability, cross-device responsiveness, accessibility (e.g., text-to-speech), usability, and performance optimization.

System design involved architectural diagrams, data flow models, and UI/UX wireframes. As shown in Fig 1, the implementation used React (frontend), Flask (backend), and Firebase (database). Testing included unit, integration, and user acceptance testing. Deployment utilized Vercel (frontend) and Render (backend), followed by user feedback incorporation to enhance reliability and usability.

Fig 1: System Architecture Diagram of PlantMitra



The enhanced system also integrates a Virtual Reality (VR) module for immersive 3D visualization of medicinal plants, along with regional language support to improve accessibility for diverse users. Additionally, a location-aware recommendation system has been incorporated to provide personalized plant and remedy suggestions based on user geography. Key features include a search and filter algorithm for querying plants by symptoms, diseases, names, regions, or properties; a comparison module for side-by-side analysis; and a recommendation algorithm mapping symptoms to AYUSH remedies. Plant and remedy data were cross-verified with AYUSH and WHO sources, achieving approximately 97–98% accuracy.

For plant classification, a deep learning approach was used with an extended version of the Indian Medicinal Leaves Image Dataset, covering fifteen plant classes. Images were resized to 299×299 pixels, normalized, and split into training, validation, and testing sets in an 80–10– 10 ratio. The Xception convolutional neural network (CNN), pre-trained on ImageNet, was used as the base model. The base layers were frozen, and a custom classification head was added, consisting of a dense layer with 128 units (ReLU activation), a dropout layer (0.2) for regularization, and a final dense layer with 15 units (softmax activation) corresponding to the plant classes. The model was trained using the Adam optimizer and sparse categorical cross-entropy loss function for seven epochs with a batch size of 32.

The system supports real-time image input, allowing users to upload or capture leaf images for instant classification and corresponding AYUSH-based health suggestions. Evaluation showed strong performance, achieving approximately 98% test accuracy, consistent with the earlier version despite increased dataset complexity.

IV. Result

The enhanced PlantMitra platform demonstrates improved performance and scalability. The updated deep learning model, trained on 15 plant species, achieved an accuracy of approximately 98%, indicating strong generalization across a larger dataset. The integration of VR visualization and real-time image upload significantly improved user engagement. The inclusion of location-based recommendations and multilingual support further enhances usability and accessibility, making the platform more adaptable to diverse users. Performance evaluation further showed that the platform delivers fast responses, with an average API response time of less than two seconds, ensuring a smooth and responsive user experience. Performance testing showed efficient real-time prediction capabilities with minimal latency.

Table 1: A comparative table below highlights the advantages of PlantMitra over existing digital resources.

Platform	Interactivity	Multilingual and Regional Language Support	Remedy Suggestions	Comparison and Text-to-speech Tools	VR support	3D Models
WHO Medicinal Plant Database	+	+	+	+	+	+

Ministry of AYUSH Portal	+	Limited	+	+	+	+
Herbal Mobile Apps	Limited	Limited	Limited	+	+	+
AYUSH AAROGYA	■	■	■	■	■	■

The deep learning-based classification model was evaluated using the Indian Medicinal Leaves Image Dataset across fifteen plant species. Figure 2 presents the finalized model architecture, illustrating the Xception base network with the added fully connected and dropout layers for improved generalization.

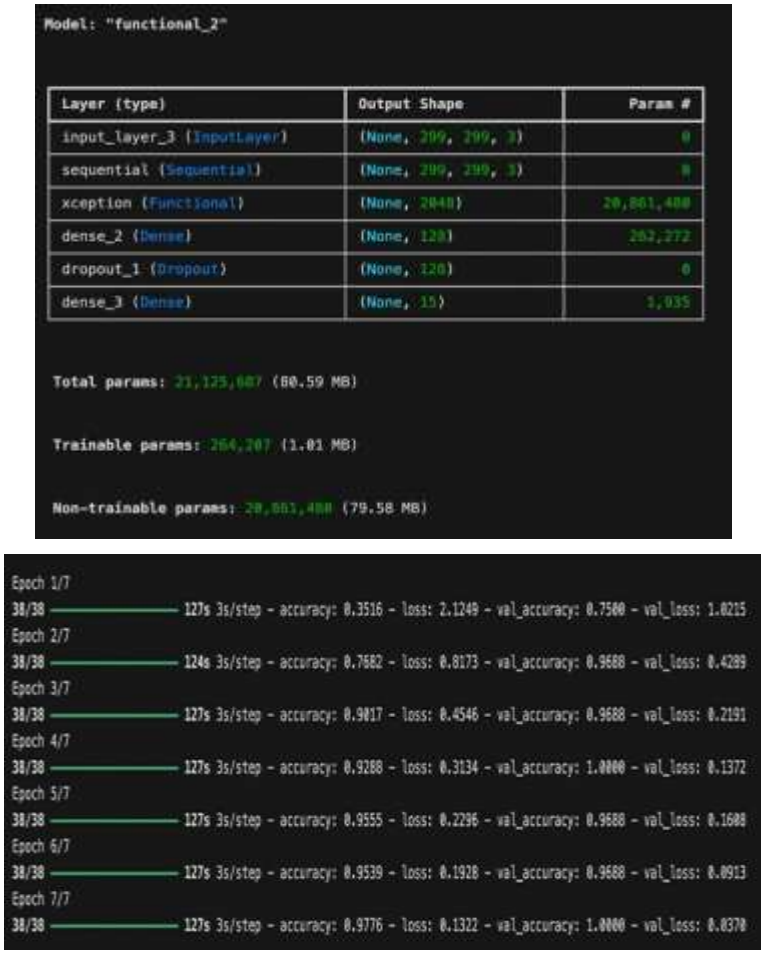


Fig 2: Finalized classification model summary

Figure 3 shows the training and validation accuracy over seven epochs, indicating stable convergence and strong performance on unseen test data, with the final test accuracy reaching approximately 98 percent.

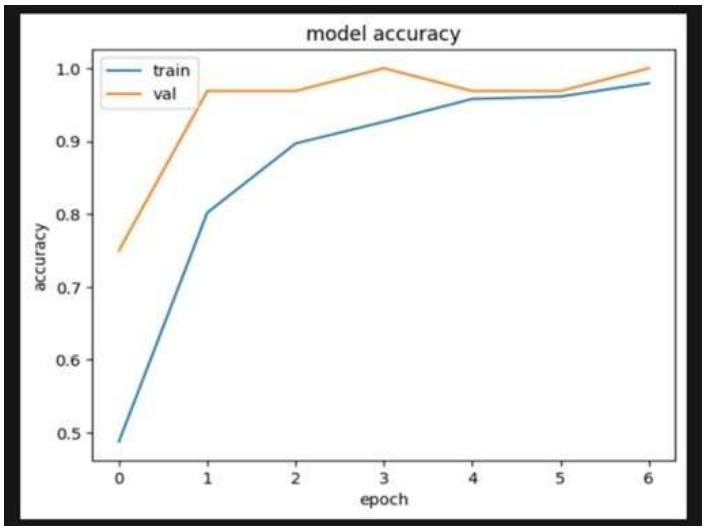


Fig 3: Training and Test value Accuracy over time

The classifier exhibits high confidence levels in predictions, accurately identifying Aloe Vera, Amla, Bhrami, Bringraja, Castor, Coriander, Curry, Ginger, Lemongrass, Mint, Neem, Pepper, Tamarind, Tulsi and Turmeric leaves in real-time.

Qualitative evaluation of the platform demonstrates its practical utility and engagement features. Fig 4-7 highlights the screenshots and features of the platform. These features collectively enhance accessibility, learning, and user engagement, addressing the limitations of existing static and fragmented resources.

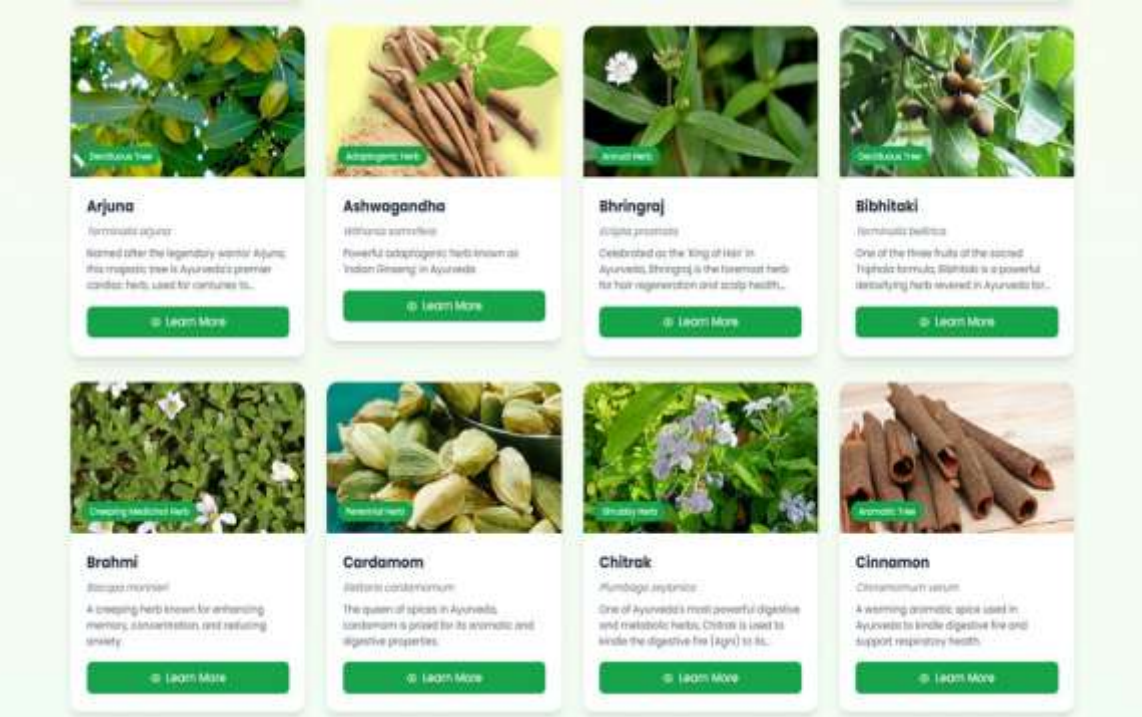


Fig 4: Plants Collection Page

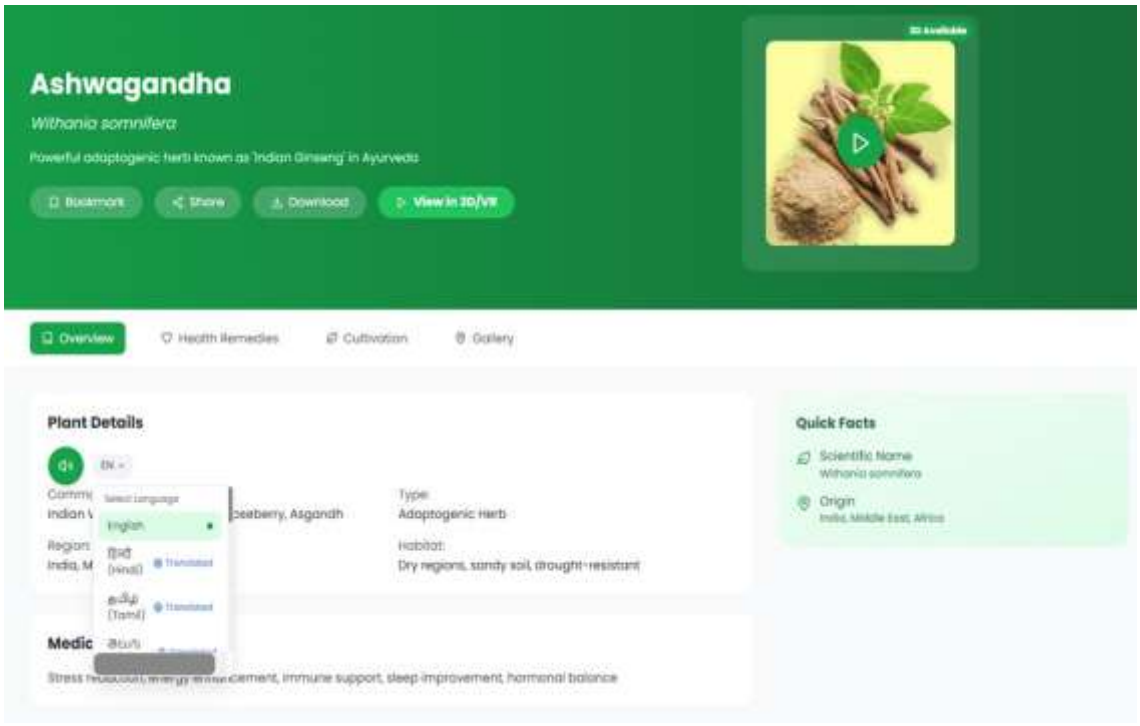


Fig 5: Detailed plant information with 3D models, VR support, multilingual and regional languages support, text-to-speech, bookmarking, social media sharing, and multimedia integration

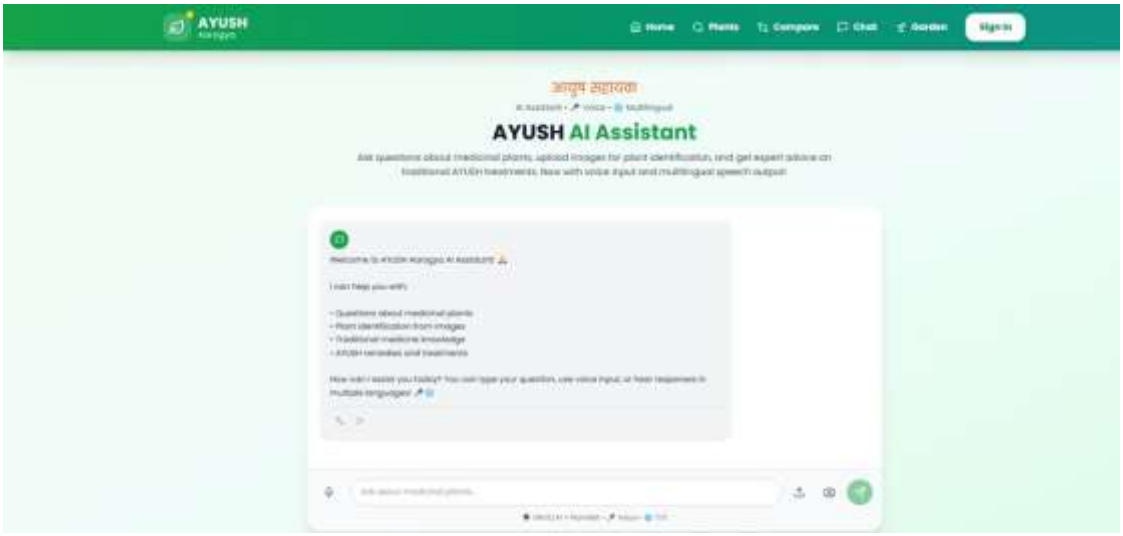


Fig 6: Chat Support with Plant Image Classification, Voice Input support, real time image upload, multilingual support

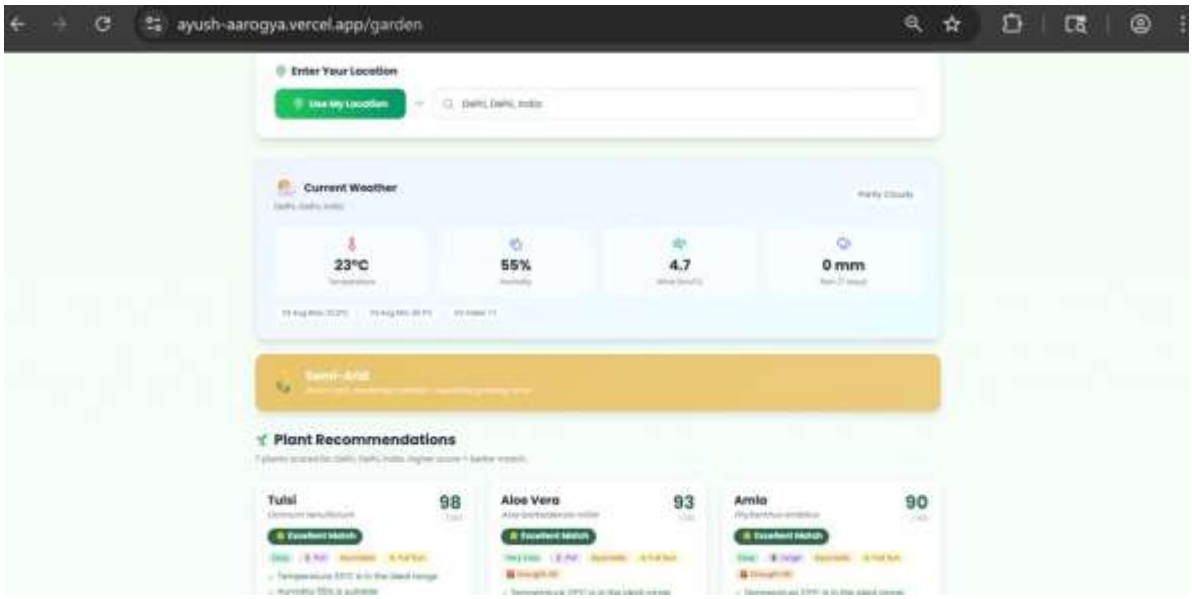


Fig 7: Location based Plant Recommendations

Overall, the results indicate that PlantMitra effectively combines high-accuracy AI-based plant classification with an interactive, culturally relevant platform, providing a comprehensive solution for digital AYUSH knowledge dissemination and practical herbal healthcare guidance.

V. Conclusion

The project, PlantMitra, successfully evolves into a comprehensive and intelligent platform for medicinal plant identification and knowledge dissemination. Unlike existing fragmented and static resources, the system integrates advanced features such as 3D plant visualization, multilingual and regional language support, AYUSH-based remedy recommendations, plant comparison tools, and text-to-speech functionality, significantly enhancing usability and learning. In its enhanced version, the platform incorporates real-time image upload for instant plant detection, virtual reality (VR) support for immersive interaction, and location-based recommendations to provide personalized and region-specific medicinal guidance. The database has been scaled to include 30 medicinal plants, and the deep learning model has been extended to classify 15 plant species while maintaining a high accuracy of approximately 98%. Aligned with the Government of India's National AYUSH Mission, the system demonstrates strong potential for applications in healthcare education, telemedicine, and personalized digital healthcare solutions. The integration of artificial intelligence with user-centric and immersive technologies highlights the platform's readiness for real-world deployment. These results demonstrate its potential for applications in healthcare education, telemedicine, and personalized health guidance. Future work will focus on further expanding the plant database, enhancing multilingual capabilities, and integrating emerging technologies such as augmented reality (AR) and IoT-based plant monitoring to build a more comprehensive smart healthcare ecosystem.

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