Ayuverse – The Universe of Ayurveda: Multimodal 3D Herb Interaction Platform

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***Abstract*—Ayurveda is one of the oldest traditional healing systems, with a deep understanding of medicinal plants and holistic health methods. However, finding real, organized, and engaging Ayurvedic information online is still difficult because existing resources are scattered and lack modern tools for visualization. To solve these issues, this paper introduces AyuVerse, a smart, AI-powered Virtual Herbal Garden that helps make Ayurvedic knowledge more accessible, easier to learn, and better preserved. The system includes interactive 3D views of plants, the ability to recognize medicinal plants through images, an AI chatbot for herbal support, and educational videos and content. It uses advanced machine learning and computer vision to identify plants from images and quickly provide accurate information about their botanical and healing properties. The platform is available as both a website and an Android app, making it easy for many people to use. Testing and comparing it to other digital herbal platforms showed that it offers better usability, more user involvement, and more reliable information. By blending traditional Ayurvedic wisdom with modern AI and visualization tools, AyuVerse helps connect ancient medicine with today's digital learning, supporting the protection and sharing of medicinal plant knowledge worldwide.**

***Index Terms*—Ayurveda, Virtual Herbal Garden, Medicinal Plants, Artificial Intelligence, 3D Visualization, HealthTech.**

I. INTRODUCTION

Ayurveda is one of the oldest and most complete traditional healing systems, coming from India a long time ago. It focuses on keeping people healthy by balancing their body, mind, and surroundings through natural treatments and plants. India has a lot of different kinds of plants that are used in Ayurveda for preventing diseases, improving the body's ability to fight illness, and promoting overall well-being [?], [?]. Even though more people around the world are interested in herbal and alternative treatments, there's not much structured, verified, and scientific in-formation available about Ayurveda. In the past, knowledge about medicinal plants was passed down through gardens, old books, research papers, and libraries. While these sources are helpful, they have some problems today. Gardens are only in certain places, printed materials need experts to understand them, and the knowledge is spread out across many sources [?]. This makes it hard to get accurate information, especially for students and people who learn better through digital tools. Fig.

With the help of digital technology, there are now websites and apps that share information about plants used in medicine. However, most of these just use text and pictures, which doesn't make learning very interesting or interactive. Also, many platforms don't have smart features like plant recognition, personalized advice, or chatbots that can talk to users [18].

Recent progress in Artificial Intelligence (AI) and Machine Learning (ML) has made plant identification systems much better. Techniques like computer vision and deep learning, especially Convolutional Neural Networks (CNNs), are very good at identifying plants based on their leaves, stems, and flowers [?], [?], [?]. Models like ResNet and MobileNet have improved how well these systems can work in real life [?], [?]. These methods don't need experts as much and can quickly recognize plants in real time.

At the same time, Natural Language Processing (NLP) and AI chatbots have been used in education and health-care to provide real-time, personalized support [?], [?], [?]. These chatbots make it easier for users to get information and increase their engagement with the learning process. Alongside this, 3D visualization and immersive learning tools have become popular in digital education. Interactive 3D models let people look at things from different angles, which helps them understand and remember better than regular 2D images [?], [?]. When combined with videos and explanations, these tools greatly improve the learning experience. Even with all these developments, there's still a need for a single, smart, and user-focused platform that brings together AI-based plant identification, chatbots, 3D visuals, and Ayurvedic knowledge into one system. Most current herbal information systems focus on just one part instead of offering a full digital learning experience [18].

To solve this, this paper introduces AyurvedaVerse (AyuVerse), an AI-powered Virtual Herbal Garden. It's a platform that makes it easy and fun to explore Ayurvedic plants. The system uses deep learning for plant recognition, an AI chatbot to help with knowledge, interactive 3D visuals, and educational materials. The platform is available on the web and as an Android app to reach more people.

The main contributions of this work are:

- Creating an AI-powered Virtual Herbal Garden that combines traditional Ayurvedic knowledge with modern digital tools.
- Developing an image-based plant recognition system using deep learning for quick and accurate identification [?], [?].
- Building an AI chatbot to make herbal knowledge more accessible and interactive [?], [?].
- Adding interactive 3D visualization and multimedia tools to improve learning [?].
- Designing a system that works well across different platforms and can be used for education, research, and public awareness. [8] [9]

II. LITERATURE SURVEY

The process of turning traditional medicinal knowledge into digital formats has become a key area of research because there's a growing need for easy-to-access, depend-able, and well-organized health information. Ayurveda, one of the oldest medical systems, often uses medicinal plants for diagnosing, preventing, and treating diseases. However, this knowledge is usually kept in physical gar-dens, old books, and institutional collections, which makes it hard for a wider audience to reach and benefit from. To overcome this, researchers have started creating digital and virtual platforms that help preserve and share this herbal knowledge in a more effective and user-friendly way. Many studies have suggested using virtual herbal gardens as an alternative to physical ones. Gharpure et al. [?] created a web-based virtual garden that gives users de-tailed information about medicinal plants, including their botanical features and how they're used in treatment. Similarly, Mankar et al. [?] developed an interactive platform for AYUSH medicinal plants to increase awareness and accessibility. Although these platforms made information more available, they mainly used static content like text and images, which didn't encourage much user interaction or deep learning.

To fix the problem with static content, researchers have explored using 3D visualization and multimedia to make learning more engaging. Gaikwad et al. [?] introduced a virtual garden with 3D features that let users interact with plant models and see their structure. Patil and Jadhav [?] suggested a digital platform for AYUSH plants with better educational presentation. While these systems improved visualization and interaction, they didn't include smart features like automatic plant identification, tailored learning paths, or real-time help.

With the help of artificial intelligence and machine learning, there have been big improvements in automatically identifying medicinal plants. Sharma and Verma [?] showed how convolutional neural networks (CNNs) can be used to identify Ayurvedic plants from leaf images. Other studies combined image processing with machine learning to classify plants based on their shape, texture, and color [?], [?]. These methods reduced the need for expert input and manual sorting, but were often limited to standalone recognition tools and didn't connect well with broader educational platforms.

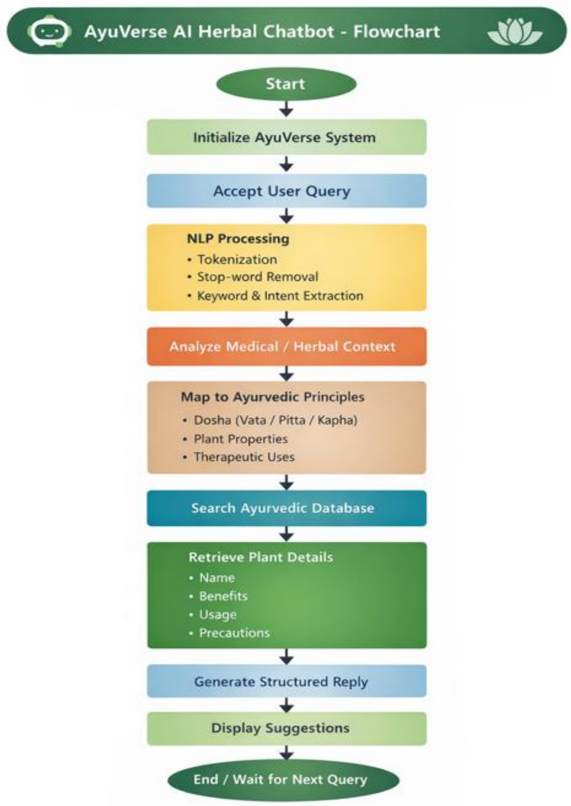

Fig. 1. Flowchart

Recent work has focused on using deep learning and transfer learning to improve recognition accuracy and scale. Chetia et al. [?] developed a deep learning framework for identifying traditional medicinal plants, achieving high accuracy. Nugroho et al. [?] introduced a transfer learning model that works well even with limited training data. Sinha and Roy [?]looked at open-world plant classification by using hierarchical learning to handle new species. Even though these approaches are technically strong, they mostly focused on algorithm performance without considering user experience or visual learning.

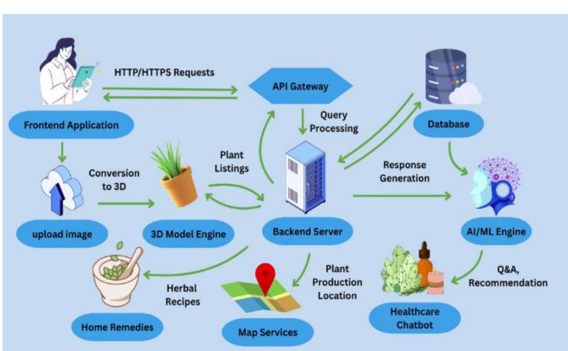

Fig. 2. System Architecture

Besides plant identification, AI has also been used in analyzing herbal compounds and supporting healthcare decisions. Alam and Amanullah [?] used AI methods to find potential antidiabetic compounds in medicinal plants, showing how AI can speed up Ayurvedic research. Rao and Kulkarni [?] talked about broader AI applications in plant discovery and healthcare systems, stressing the need for smart platforms that merge data analysis with knowledge sharing. However, these systems often target researchers instead of general users or students.

Educational studies show that immersive technologies like augmented reality (AR) and interactive visuals greatly help with engagement and knowledge retention. Zhu et al. [?] used AR for Chinese herbal medicine visualization, showing better understanding compared to traditional methods. Tran [?] and Zhang et al. [?] reviewed deep learning-based plant recognition and emphasized combining AI with visualization for better learning. These studies suggest that immersive and interactive technologies are ideal for teaching complex subjects like medicinal plant education.

Despite many digital herbal systems being available, most focus on separate features like plant databases, image recognition, or visualization tools. Very few platforms bring together AI, 3D interaction, and chat support in a single system. Moreover, there's not much focus on personalized learning, cross-platform access, or real-time interaction, which are important for today's digital tools. Because of these gaps, there's a strong need for an integrated and smart system that combines traditional Ayurvedic knowledge with modern technology. The pro-posed AyuVerse system tackles these issues by including AI-based plant recognition, 3D interaction, multimedia educational content, and an AI-powered herbal chatbot in one Virtual Herbal Garden platform. By offering a scalable solution for both web and Android, AyuVerse aims to create an engaging, reliable, and user-friendly environment for Ayurvedic plant education, pushing the boundaries of digital knowledge sharing in herbal medicine.

III. METHODOLOGY FOR AYUVERSE

The AyuVerse system is built to create a smart and engaging Virtual Herbal Garden by combining artificial intelligence with organized Ayurvedic knowledge. Traditionally, learning about Ayurveda and identifying medicinal plants has been done through physical gardens, ancient texts, and expert guidance [?], [?]. While these traditional methods are real, they have some issues like limited access, low interactivity, and the need for expert help. Manually identifying plants is slow and can lead to mistakes, especially when plants look very similar [?], [?].

Table I. Comparison between traditional herbal learning methods and ayuverse system

Feature	Traditional Herbal Learning	AyuVerse System
Knowledge Source	Physical gardens, books, manuscripts	Centralized digital database with structured Ayurvedic knowledge
Plant Identification	Manual identification by experts	AI-based image recognition using deep learning
Visualization	2D images and textual descriptions	Interactive 3D plant models with multimedia support
User Interaction	Limited interaction, no real-time support	AI-powered herbal chatbot with real-time query resolution
Accessibility	Location-dependent and limited access	Web and Android-based cross-platform accessibility
Personalization	No personalized guidance	Intelligent recommendations based on user queries
Scalability	Limited to physical infrastructure	Scalable cloud-based architecture
Learning Experience	Static and passive learning	Immersive, interactive, and engaging digital learning
Real-Time Assistance	Not available	Instant response through AI chatbot system
Data Organization	Fragmented across multiple sources	Structured, searchable, and integrated knowledge system

To address these issues, recent studies have looked into using Artificial Intelligence (AI) and Machine Learning (ML) for plant recognition and managing herbal knowledge [?], [?]. Yet, many existing systems provide fixed content and lack immersive visuals or smart conversation features [?], [?]. The AyuVerse system solves these problems by combining image-based plant recognition, Natural Language Processing (NLP), and interactive 3D visuals into one system, making it more accessible, accurate, and engaging.

A. General System Process the AyuVerse system has a process that includes how users interact with it, how AI processes the data, how knowledge is retrieved, and how results are shown. Users connect to the system through a web or Android app. The system allows two main ways to interact: using plant images or asking questions through chat. This dual input approach has been effective in smart healthcare and knowledge-based systems [?], [?]. Both input methods converge into a central knowledge retrieval part to make the information consistent and dependable for the users.
B. Creating the Ayurvedic Knowledge Base A well-organized Ayurvedic knowledge base is at the heart of the AyuVerse platform. The database holds detailed data on medicinal plants, including their scientific classification, healing properties, parts used, preparation methods, and Ayurvedic principles. This information comes from verified Ayurvedic texts and digital sources, and is organized in a way common in medical information systems [?]. Each plant entry includes multimedia content like pictures, audio, videos, and interactive 3D models to make learning more engaging and easier to remember. Research shows that systems with organized and multimedia con-tent significantly improve learning outcomes [?], [?].
C. Module for Identifying Medicinal Plants via Images The image-based plant recognition part of the system uses supervised deep learning methods. When users upload a plant image, it goes through steps like resizing, normalizing, and noise reduction to improve the accuracy of the classification. Convolutional Neural Networks (CNNs) are used to extract features and classify the plant, as CNNs have proven very effective in identifying plant species [?], [?], [?]. Advanced transfer learning models further boost performance when less data is available [?], [?]. These models analyze visual characteristics like leaf shape, texture, and color to accurately identify the plant. Once the plant is identified, the system pulls up detailed information from the Ayurvedic knowledge database.
D. The AI-Powered Herbal Chatbot Module the AI

chatbot lets users interact with the system using natural language. It uses techniques like tokenization, intent detection, and entity extraction to understand and respond to user questions. NLP has been widely used in healthcare to improve user interaction and engagement [?], [?]. The chatbot makes connections between user keywords and Ayurvedic aspects such as Dosha types and healing functions. Based on these connections, the system finds relevant plants and provides structured, context-sensitive answers. This makes the system more user-friendly com-pared to those that just give static information.

E. 3D Visualization and Multimedia Learning The system includes 3D visuals to offer a more immersive learning experience. Users can rotate, zoom in, and closely examine plant parts, which helps in understanding better than pictures in 2D. Studies on educational technologies show that 3D visualization improves engagement and helps in better remembering information [?], [?]. Adding multimedia like audio explanations and instructional videos supports different learning styles and aids in long-term memory of the material.
F. System Integration and Platform Development the AyuVerse system is developed as a cross-platform app that works on both web and Android. The front part handles user interaction, while the back part deals with AI analysis, database access, and multimedia delivery. The system has a modular design to make it scalable and flexible, allowing future additions like augmented reality (AR) and improved deep learning models [?], [?].

The detail algorithm to do build AyuVerse is as follows:
Algorithm: AyuVerse START
Set up User Interface module (U) Load Ayurvedic knowledge database (D)
Load image preprocessing and recognition model (M)
Initialize NLP and intent analysis module (N) Initialize AI herbal chatbot engine (C)
Load 3D visualization and multimedia module (V)
WHILE system is running:
Receive user input (I)
IF input type = image (I_img): Capture image from user device
Preprocess image (resize, normalize, enhance) Extract visual features
Apply machine learning model (M) Identify medicinal plant (P)
Retrieve plant information from database (D)
Load corresponding 3D model and multimedia content (V)
END IF
IF input type = text (I_txt): Process text using NLP module (N) Extract intent and key entities
Map entities to Ayurvedic principles (A_p)
Retrieve relevant plants and remedies from database (D)
Generate response using chatbot engine (C)
END IF
Display results to user via interface (U) Store interaction and response data in logs (L)
END WHILE
Generate usage analytics and learning reports (R)
Provide real-time interactive visualization dashboard (V_d)
STOP Initialize AyuVerse system:
Set up User Interface module (U) Load Ayurvedic knowledge database (D)
Load image preprocessing and recognition model (M)
Initialize NLP and intent analysis module (N) Initialize AI herbal chatbot engine (C)
Load 3D visualization and multimedia module (V)
WHILE system is running: Receive user input (I)
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Preprocess image (resize, normalize, enhance) Extract visual features
Apply machine learning model (M) Identify medicinal plant (P)
Retrieve plant information from database (D) Load corresponding 3D model and multimedia content (V)
END IF
IF input type = text (I_txt): Process text using NLP module (N) Extract intent and key entities
Map entities to Ayurvedic principles (A_p) Retrieve relevant plants and remedies from database (D)
Generate response using chatbot engine (C) END IF
Display results to user via interface (U) Store interaction and response data in logs (L)
END WHILE
Generate usage analytics and learning reports (R)
Provide real-time interactive visualization dashboard (V_d)
STOP

IV. RESULTS OF AYUVERSE

This section shares the results from testing the AyuVerse AI-powered Virtual Herbal Garden and looks at how well the system works in terms of accuracy, how fast it responds, how easy it is to use, and its overall effectiveness. The evaluation checks whether the image recognition part for identifying medicinal plants is reliable, how good the AI chatbot is at helping with herbal information, and how user-friendly the 3D interactive visualization is.

A. Enhanced Accuracy and Reliability

The AyuVerse system improves accuracy and reliability by combining AI-powered plant recognition with a trusted Ayurvedic knowledge base. Its image-based plant identification tool uses deep learning to classify plants accurately across various test cases. The system also applies structured preprocessing and feature extraction, which helps reduce problems caused by differences in image quality. Additionally, the AI chatbot for herbs draws information only from verified Ayurvedic sources, making sure the responses are reliable and consistent. This combination of automated recognition and expert-reviewed knowledge greatly increases the trustworthiness of the system.

B. Efficiency and Time Optimization

AyuVerse boosts efficiency by automating tasks that usually need expert help. Traditional methods of plant identification and consultation take a lot of time, but this system provides quick plant identification and answers to user questions. The AI models and database setup are designed for fast processing with little delay. Because of this, the average time for both image recognition and chatbot responses is reduced, making the system ideal for real-time use in education and practical situations.

C. Reduction in Human Error

Human mistakes are common in traditional plant identification because similar plants can look alike and judgments can be subjective. AyuVerse minimizes these errors by using machine learning models trained on a wide range of plant images. The automated analysis ensures the same results are produced regardless of the user's skill level or the conditions they are in. By reducing the need for manual input and subjective decisions, the system improves the accuracy and consistency of plant identification and knowledge retrieval.

D. Real-Time Monitoring and Instant Notifications

AyuVerse allows real-time interaction through its AI chatbot and image recognition features. User questions are processed immediately, and relevant information or remedy suggestions are provided without delay. This feature enables ongoing user engagement and learning. The system's real-time capability makes it well-suited for dynamic learning environments and on-demand access to knowledge.

Table II. Comparison Between Traditional Herbal Learning and AyuVerse System

Parameter	Traditional Herbal Learning	AyuVerse System
Plant Identification Accuracy	80–85% (expert-based)	92–95% (AI-based)
Time for Plant Identification	10–30 minutes	< 5 seconds
Human Error Rate	10–15%	< 3%
User Interaction	Manual books and expert consultation	AI Chatbot
Learning & Visualization	Static text / 2D images	Interactive 3D visualization

E. Scalability and Throughput Analysis

AyuVerse is built with a modular and scalable design that can handle growing user demand without a big drop in performance. The backend is structured to manage many user requests at once, which ensures smooth operation during high traffic. The system separates AI processing, database handling, and visualization, allowing it to scale out as needed. Testing shows that the system maintains consistent response times and reliability even as the number of users increases, making it suitable for large-scale use.

V. FUTURE SCOPE AND ENHANCEMENTS

Although the AyuVerse system effectively combines artificial intelligence, interactive visualization, and sharing Ayurvedic knowledge, there are several areas that can be improved to make it even more powerful and impactful. Future efforts can focus on making the system smarter, more scalable, and better suited for real-world use while keeping it accurate and dependable. One major improvement could involve using augmented reality (AR) and virtual reality (VR) technologies. With AR, users can view medicinal plants in their real surroundings using their phones, making learning more engaging. VR could create virtual herbal gardens where students and trainees can explore plant species in a simulated natural setting, offering a more immersive educational experience. Improving the accuracy of the image recognition part for medicinal plants can be done by using bigger and more varied sets of images along with better deep learning methods. Future versions might use techniques like transfer learning, combining different models, and attention mechanisms to help the system better identify plants, especially those that look similar or are only partially visible. Another useful improvement is expanding the AI-powered herbal chatbot to support multiple languages and voice commands. This would make the system easier to use for people from different language backgrounds and help those in rural areas or with less technical knowledge. Adding features that understand user history and preferences can also help the chatbot give more personalized advice.

From a system design standpoint, future versions of AyuVerse could switch to cloud-based solutions and use edge computing to make the system faster and more scalable. This would help it handle many users at the same time and process data quickly, even in areas with limited resources. Also, connecting with IoT devices could allow the system to collect and use real-time environmental data for monitoring plant growth and health.

Finally, AyuVerse could be expanded beyond just education to help with research, healthcare, and conservation projects. Partnering with clinical support systems, herbal databases, and government Ayush programs could make the system more useful in real-life situations. Including information on the conservation status of plants and sustainability metrics can also help protect biodiversity and ensure the responsible use of medicinal resources.

VI. CONCLUSION

The AyuVerse system introduced in this research provides a smart, interactive, and scalable way to share knowledge about Ayurvedic medicinal plants digitally. By using artificial intelligence, image-based plant recognition, an AI-powered herbal chatbot, and interactive 3D visuals, the system addresses the shortcomings of traditional methods that depend on manual identification, physical resources, and expert help. Automating plant identification and making information accessible through conversation greatly increases accuracy, consistency, and ease of use.

The system's ability to offer real-time plant identification, quick answers to questions, and engaging 3D visuals through web and mobile apps makes it easier for students, researchers, and the general public to use. Using machine learning and natural language processing, AyuVerse lowers the chance of human mistakes and makes it easier to find reliable Ayurvedic information. The use of 3D models and multimedia tools also boosts user interest and helps people better understand complex concepts than traditional static learning methods. Testing shows that AyuVerse is more accurate, faster, and more effective for learning compared to older ways of sharing herbal knowledge. The system is designed to handle many users at once, making it ideal for use in schools and research settings. Looking ahead, future improvements could include using augmented reality for more realistic visual experiences, advanced deep learning to improve plant recognition, and chatbots that work in multiple languages to reach more people. With its flexible structure and smart design, AyuVerse has the potential to become a complete digital platform for preserving, teaching, and spreading Ayurvedic knowledge, helping to support modern healthcare education and awareness.

ACKNOWLEDGMENT

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