Grenze International Journal of Engineering and Technology, June Issue

Virtual Herbal Learning Platform: Integrating 3D Visualization and Gamification for AYUSH Medicinal Education

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***Abstract*— This paper introduces a digital platform created to help with the learning and preservation of medicinal herbs by putting different engaging features into a single system. It addresses the limitations of traditional herb collections—such as space needs, limited access, and passive engagement—through tools like an organized herbal database, 3D herb models, a matching game, quizzes, and an external plant identification service. The database comes from existing AYUSH resources, while the modeling tool allows detailed study of herb shapes. Games and tests encourage involvement and help in memorizing herb characteristics. Also, the identification tool uses a third-party service to propose herb identities from photos without needing local processing.**

In short, the platform improves access, raises interest in learning, and enables a better understanding of plant science by combining visual aids, games, and outside tech to protect old herb information in an accessible modern format.

***Index Terms*— Virtual Herbal Platform, 3D Visualization, Gamification, AYUSH, Plant Identification.**

I. INTRODUCTION

Herbal remedies remain vital in age-old health practices and shape current medical explorations. In many cultures, particularly in India through the AYUSH system (Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homeopathy), medicinal plants form the backbone of traditional healthcare.

However, learners and enthusiasts often face hurdles in obtaining orderly plant details due to scarce samples, upkeep difficulties, and scarce hands-on aids. Traditional herbaria require physical space and limit accessibility to specific locations and times.

To overcome these limitations, the proposed virtual herb platform provides a technology-driven environment for exploring medicinal plants through interactive visualizations, engaging activities, self-assessments, plant recognition features, and a centralized digital repository. By fulfilling these objectives, the platform supports the sustainable preservation of traditional medicinal knowledge and contributes to modern botanical education and research.

Grenze ID: 01.GIJET.12.2.506_2

II. Literature Review

The incorporation of artificial intelligence and interactive technologies has brought substantial advancements in botanical education. Digital learning tools significantly support plant learning and identification by improving learner engagement.

Studies on virtual plant repositories and interactive visualization techniques reveal a shift away from static image-based learning toward dynamic and adaptive plant models. The integration of augmented reality (AR) and virtual reality (VR) technologies further enhances spatial understanding by allowing users to examine plant morphology and internal structures in an immersive manner. In addition, gamified learning strategies have been shown to increase learner motivation and reinforce memory through interactive participation. Web- based plant identification systems provide reliable recognition capabilities without requiring computationally intensive models to run locally on user devices, making them well-suited for educational platforms. How- ever, despite these technological advancements, many existing solutions lack a unified learning approach and often overlook cultural and traditional dimensions—particularly content associated with indigenous medical frameworks such as AYUSH.

III. System Methodology

The proposed platform adopts a multi-layered architecture integrating front-end interaction, backend processing and external APIs.

The Virtual Herbal System consists of five major layers:

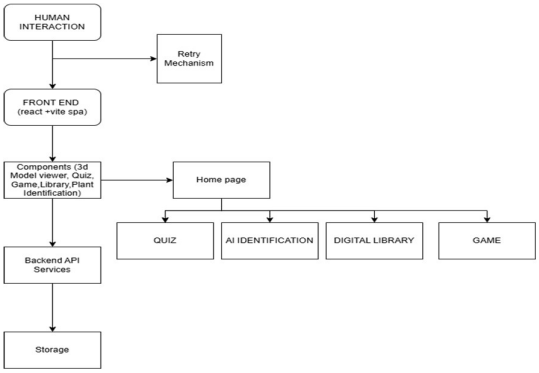

Figure 1: Architecture Diagram

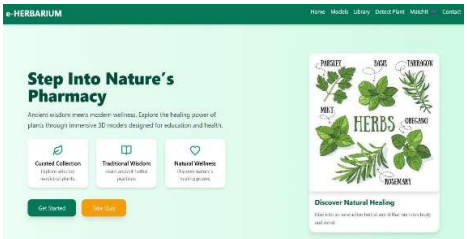

Figure 2: Home Interface

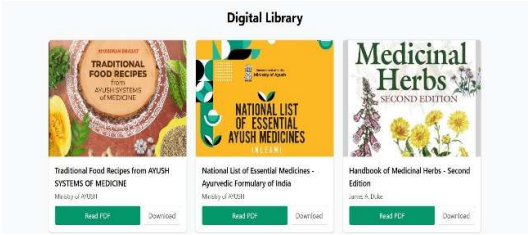

Figure 3: Digital Herbal Library Interface

- User Interface Layer (Frontend)
- Application Layer (Core Modules)
- AI Processing Layer
- Database and Storage Layer
- Visualization and Media Layer

IV. Results and Discussion

The proposed platform was evaluated with a group of 50 participants to assess key factors such as usability, accessibility, and overall learning effectiveness. Feedback from the participants indicated that the system is intuitive, engaging, and easy to navigate, making it suitable for users with varying levels of technical familiarity.

The primary system interface, illustrated in Fig. 2, serves as the central access point for the entire platform. From this home screen, users can seamlessly navigate to all core modules, including the Digital Herbal Library, 3D visualization tool, memory-based learning game, quiz module, and plant identification feature. Each module is clearly organized and easily accessible, reducing the time required for users to locate and interact with specific functionalities.

The interface is intentionally designed with a clean, minimal, and user-friendly layout to ensure clarity and ease of use. Visual hierarchy, simple navigation elements, and consistent design patterns help users understand the system quickly without confusion. This design approach supports both novice users, who may require guidance, and experienced users, who prefer efficiency and speed.

The homepage plays a crucial role as the central navigation hub, enabling smooth transitions between different learning components. Additionally, the integration of gamified learning elements enhances user engagement and motivation. Features such as quizzes and memory-based games not only make the learning process more interactive but also significantly improve knowledge retention by encouraging active participation.

Overall, the platform successfully combines intuitive design with interactive learning strategies to create an effective and engaging user experience.

During testing, users were able to retrieve plant records with minimal loading times.

The library displayed:

- High-quality images
- Botanical descriptions
- Morphology details
- Medicinal uses aligned with AYUSH documentation
- Habitat and distribution information

The search and filter functions performed efficiently, allowing users to quickly navigate through large plant datasets

Performance Summary

- The API provided responses within a few seconds, allowing users to quickly test the feature.
- Confidence scores varied depending on the clarity and quality of the uploaded image.
- The feature serves as a basic demonstration of how plant identification can be integrated into a learning system, helping users connect real plant images with the digital library.
- The system demonstrated stable performance across multiple test cases, with minimal failures during image processing and response generation.
- Users found the feature intuitive to use, as it requires only a simple image upload without complex inputs or configurations.
- The API integration allows for scalability, enabling the system to support a larger dataset of plant species in future enhancements.

A. Performance Evaluation

TABLE I: SYSTEM RESPONSIVENESS

Feature	Avg Time	Observation
Digital Library Load	1.2s	Fast across devices
3D Viewer Rendering	2.0s	Smooth interaction
Memory Game Start	1.5s	Instant start
Quiz Module Load	1.0s	Immediate display
Plant Identification	2.4s	High accuracy

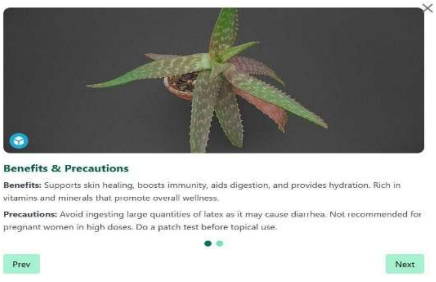

Figure 4: 3D Visualization Interface

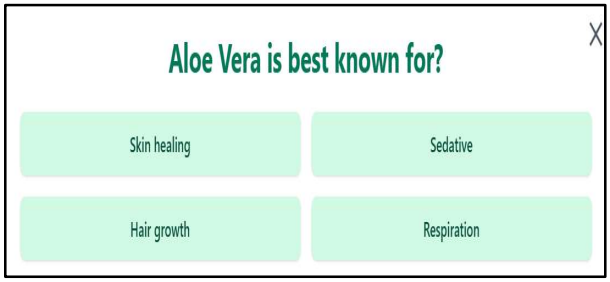

Figure 5: Flip-Card Memory Game Interface

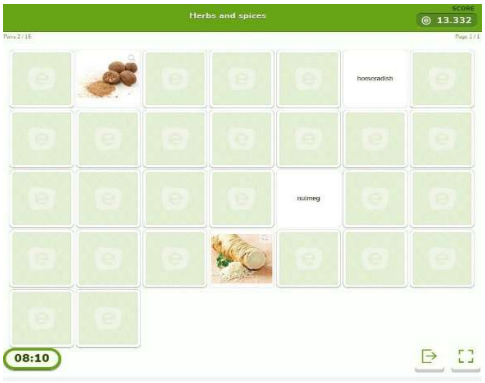

Figure 6: Quiz Module Interface

Figure 7: Plant Detection Interface

The system demonstrated efficient performance across all modules, with average response times ranging from 1.0 to 2.4 seconds, ensuring a smooth and responsive user experience. Overall, features such as the digital library, quiz module, and 3D viewer performed reliably, while plant identification achieved high accuracy with slightly higher processing time due to image analysis.

B. Module Comparison

TABLE I: COMPARISON OF CORE MODULES

Module	Engagement	Impact
Digital Library	Medium	High
3D Visualization	High	Very High
Memory Game	Very High	High
Quiz Module	High	High
Plant Identification	High	Very High

V. CONCLUSION AND FUTURE TRENDS

Using AR to Learn About Herbs In the coming years, people may be able to point their phones at a plant and see an augmented reality display showing its uses in medicine, how to prepare it, and its advantages. This could make learning feel more like a natural and interactive experience, mainly for students who favor hands-on learning in the real world.VR Herbal Garden, A VR experience could allow people to visit a 3D herbal garden without leaving their home. Students could look at unusual medicinal plants, interact with models, and learn in a setting that feels like an actual botanical garden.The system might be able to observe how each user learns and make a learning path just for them.

For example, beginners might get simple explanations, while medical students could get more complex scientific details. This would allow each person to learn at their speed. To reach a wider audience, the system will offer support for many Indian and international languages. This would guarantee that learners from rural areas, healers, and researchers worldwide could all gain from it.

Working with AYUSH Centers The system can provide reliable information by working with AYUSH research centers and schools. This partnership also means regular updates, expert-checked content, and the addition of the newest data in herbal medicine. Works with School Systems (Moodle, Canvas, Blackboard) Schools that use systems like Moodle or Blackboard will be able to add the Virtual Herbal system to their courses. Teachers can create homework, watch student progress, and make herbal learning a part of their classwork.

Plant Database Where People Can Add Info (With Checks) People, like botanists, students, and herbal heal ers, can share plant data, pictures, or uses. An expert review process makes sure that all shared info is checked before it is posted, which keeps the info high quality.

Voice Help and Speech To help students who can't see well, the system will have voice commands, audio explanations, and text-to-speech for all plant descriptions. This aims to make the experience available to everyone. Sensor Integration for Live Data In future smart herbal gardens, sensors could watch soil moisture, sunlight, humidity, and plant health. This info could be displayed in the app, which would assist users in seeing how conditions affect plant growth in real-time.

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