

Creating Virtual Herbal Garden: An Interactive Platform for Exploring Medicinal Plants

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Abstract— The increased popularity of traditional medicine and herbal medicine brought the medicinal plant usage back in the modern arena of healthcare and wellness. The mini project titled "Creating a Virtual Herbal Garden: An Interactive Platform for Exploring Medicinal Plants" is an attempt to fill the gap in knowledge through an interactive virtual platform to know different medicinal herbs. The site is an interactive web application where users can virtually visit a garden with various herbal plants. Exhaustive information on the botanical features, medicinal values, traditional uses, and cautions of each plant discussed is provided.

Keywords – Virtual Garden, Sustainability, Medicinal Plants, Artificial Intelligence, Interactive platform

I. INTRODUCTION

Medicinal plants have been a central part of indigenous healing systems for centuries, offering natural remedies for various conditions. With the recent resurgence in herbal medicine and increased demand for ecologically sound healthcare options, there is a demand for information about such plants to be easily available. But to acquire knowledge of medicinal plants, there has typically been a requirement for physical access to botanical gardens or study of sporadic, book-based resources—both of which can be inaccessibly inconvenient or off-limits for students, researchers, and the general public.

This mini project presents a solution to this issue with the creation of a Virtual Herbal Garden—an interactive, web-based interface where users can browse a vast array of medicinal plants in digital form. The website features comprehensive details for the scientific name of every plant, its medicinal value, traditional application, and its visual description. It is informative and convenient to use as a supportive guide for one with interests in herbal medicine, botany, and environmentally friendly living.

The project brings together elements of web development, user interface design, and database management to provide an effective and informative user experience. Through this virtual platform, we aim to protect and further the body of knowledge of herbal medicine while harnessing the power of modern technology to make it available to all.

II. LITERATURE SURVEY

The utilization of online platforms to provide information and educate people on medicinal plants has become popular in the last few years. Kala et al. (2006) conducted research, which pointed out the significance of recording traditional medicinal information for conservation

as well as educational reasons. The Ayush Research Portal (Indian Ministry of AYUSH launched in 2010) and The Plant List (2013) are comprehensive lists of medicinal plants but are not interactive and are geared mostly towards expert users. Bhattacharya and Gupta (2017) discussed mobile-based herbal plant identification systems but found limitations in levels of information. Tools such as PlantNet (2014) and iNaturalist (2011) provide plant identification from image but with a broader focus on general botany, rather than medicinal use. Current AR/VR research specifically directed towards virtual gardens (Kumar & Singh, 2020) has deep user engagement but is based on hardware that is less widespread in general users. These researches reinforce the necessity of an interactive, web-based, and friendly platform dedicated to studying medicinal plants—a goal that this Virtual Herbal Garden project pursues.

III. METHODOLOGY

The Virtual Herbal Garden was developed adopting a well-structured methodology that covered several phases—planning, data gathering, system design, development, and testing. The major objective was to produce a functional, learning platform that enables users to view different medicinal plants in a virtual setup.

A. Requirement Analysis

The initial step was to understand the needs of the target group—students, instructors, and herbalists. The primary needs were a simple-to-use interface, categorized plant entries, detailed medicinal data, and visual aids for each plant.

B. Data Collection

Accurate information regarding medicinal plants was gathered from trustworthy sources like the Ayush Research Portal, journals, and printed books on Ayurveda and ethnobotany. Scientific name, common name, medicinal traits, uses, and a representative picture are listed in every entry of a plant.

C. System Design

The system was built based on a modular architecture. The backend was structured to store plant data in an optimal way, while the frontend was constructed to be interactive and user-friendly. Software such as wireframes and Entity Relationship Diagrams (ERDs) were used to structure the database and user interface.

D. Technology Stack

The platform was developed with web development technologies. Frontend development was carried out using HTML, CSS, and JavaScript. PHP and MySQL were utilized

for backend operations and handling data. Responsive design ensured compatibility on devices.

E. Development

Development was undertaken in iterations, and individual modules (plant list, searching ability, detail screen, etc.) were developed and tested independently. Filter based searching, photo-based browsing, and exploration by category were introduced as features for enhanced user experience.

F. Testing and Evaluation

The system was tried out for functionality, responsiveness, and usability. It was tested manually to identify incorrect information, broken links, and interface issues. A small group of user feedback allowed tuning of the design and fixing the usability problems.

Through this methodical approach, the project succeeded in its mission of developing an accessible and informative virtual space to explore medicinal plants, thus increasing awareness and education in herbal medicine.

IV. PROPOSED SYSTEM

The Virtual Herbal Garden system aims to provide a virtual, interactive space where internet access is provided to users, and they go through and discover medicinal plants. It makes use of web technology, plant database information, and interactive 3D visualization to simulate a garden-like environment that provides an experience to introduce users to the healing values, habits, and customary uses of various herbs. The system consists of several interacting modules that accomplish particular domains of functionality, ranging from data management to user interface and visualization. Modular system structure is illustrated.

A. Plant Acquisition and Management Information

The heart of the Virtual Herbal Garden system is the structured purchase and maintenance of medicinal plant information. The Plant Information Management Module does the following:

- 1) *Data Compilation:* Compiles data from authentic ethnobotanical, Ayurvedic, and Unani resources such as scientific name of the plant, common name, type of medicine, part used, and habitat.
- 2) *Classification and Labelling:* The plants may be classified as per their therapeutic use (e.g. anti-inflammatory, antipyretic), type (herb, shrub, tree), and climate requirements of the species.
- 3) *Image and Metadata Integration:* Every plant record contains high quality photo(s) and metadata about the region of origin, toxicity, flowering season, etc.
- 4) *Database Storage:* All gathered is stored safely in an NoSQL database (MongoDB), to be accessed and extended with ease.

B. Interactive Visualization Engine

The main user-interface component of the system is the Interactive Visualization Engine that emulates a virtual garden environment:

- 1) *3D Plant Rendering:* Uses three.js and WebGL to project 3D plant models on a virtual scenery.
- 2) *Navigation and Interaction:* Navigation through the garden using arrow keys or touch input and interaction with plants through clicking or tapping.
- 3) *Pop-up Information Display:* A pop-up window displays scientific and medicinal information, uses, and preparation by clicking on a plant..

C. Admin and Content Management Module

The Admin and Content Management module is intended to provide admin users with the capability for managing plant data, content and visualization assets:

- 1) *CRUD Operations for Plant Records:* Admins are able to add, edit, delete or archive plant records and their underlying media.
- 2) *Review System:* reviewed articles and source authentication to support accuracy of the botany.
- 3) *User Access Control:* Provides login-based access control for multiple roles (admin, user, moderator).

D. Reporting and Analytics Module

The system has a reporting engine that logs user activity and plant discovery patterns:

- 1) *User Metrics:* Tracks most viewed plants, session duration, and user queries.
- 2) *Feedback Loop:* Collected user ratings and feedback on plant information usefulness and accuracy..
- 3) *Dashboard Interface:* Presents aggregated data in a dashboard for system administrators and researchers.

E. Integration and Security Layer

Enables peaceful coexistence and secure data exchange between system modules::

- 1) *API Gateway:* RESTful APIs are employed to interconnect the UI with database and analytics modules.
- 2) *Security Features:* Implements HTTPS encryption, JWT-based user authentication, and MongoDB access control.
- 3) *Compliance:* Is compliant with digital botanical data handling standards and institutional ethics policies..

F. User Interface and Experience

Simple web interface provides ease of use for all classes of users::

- 1) *Responsiveness:* Responsive to desktops, tablets, and smartphones.
- 2) *Search and Filter Features:* Allows filtering of plants by name, disease, or category.
- 3) *Language Support:* Multi-lingual support for content display (e.g., English, Hindi, Tamil).

V.SYSTEM FUNCTIONAL ARCHITECTURE

This section provides a comprehensive overview of the functional architecture of the Virtual Herbal Garden (VHG) system. The VHG system consists of modular modules that collaborate to provide a consistent and interactive experience for users learning about medicinal plants. The system is scalable, user-interactive, and best designed for the handling of botanical information. It uses major technologies such as dynamic web development, responsive design concepts, and organized database systems to create an accessible virtual learning space.

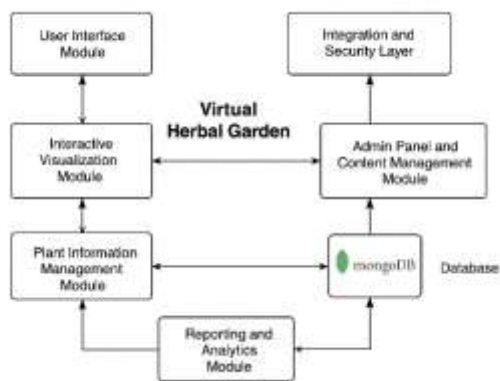


Fig. 1. VHG System Functional Architecture

A. User Interface and Navigation Module

The User Interface (UI) Module is the user interface module managing user interaction with the website. It provides an easy-to-use, graphics-oriented interface for navigation of the virtual herbal garden by users. Categorized plant categories (e.g., Digestive Aids, Anti-inflammatory) are displayed on the layout along with search and filtering. Responsive design guidelines were applied in designing the interface to allow it to be accessed via desktops, tablets, and cell phones.

- 1) *Plant Gallery View and Exploration:* A graphical representation of the virtual garden is accessible by interaction from the user. Single click on the icon of a plant invokes a modal containing complete plant information in the form of medicinal use, scientific name, and preparation method.
- 2) *Search and Filtering Mechanism:* Search is done using keywords regarding symptoms, plant names, or medicinal use. Filters are used for categorization by treatment type, region, or traditional system (e.g., Ayurveda, Siddha).

B. Plant Information Management Module

The module is the VHG platform's central knowledge base. It allows for ordered storage and retrieval of medicinal plant information through a backend database (e.g., MySQL or MongoDB).

C. Interactive Visualization and Engagement Module

The module drives the dynamic aspects of the platform. It transforms static plant data into interactive content using

technologies such as JavaScript and animation libraries. The goal is to improve learning with increased interaction.

- 1) *Virtual Garden Simulation:* The graphical layout simulates a garden with interactive placement of plants. Hover and click events trigger pop-ups with detailed information on every herb.
- 2) *Educational Enhancements:* This module can be enhanced with learning animations, trivia cards, or optional audio descriptions to support learning, especially for children or students of different learning styles.

D. Admin Panel and Content Management Module

There is a secure backend admin interface by which registered members (e.g., teachers or system administrators) can manage the virtual garden's content. This module is crucial in keeping the system current and as correct as possible, and ensuring quality of content.

- 1) *CRUD Operations for Plant Records:* Admins can add, read, modify, and delete plant records within the database. Also saved under this panel are the uploaded photos and reference material.
- 2) *Tracking User Feedback:* Admins are able to see and monitor user-feedbacks, recommendations, or errors reported via the system.

E. Reporting and Analytics Module

This module supports learning statistics and teaching insights to be generated. It monitors the manner in which people interact with the website, for example, most viewed plants, most queried keywords, and session duration.

- 1) *Insight Dashboards:* Visual representations of user activity may help the educator prioritize what content to improve. Insights on the dashboard provide direct feedback about different types of plants and which generated engagement.
- 2) *Exportable Reports:* Reports are available in standard formats and can also be exported for assessment or for users to keep in institutional records.

F. Integration and Security Layer

The integration and security layer enables interoperability with external systems and creates data privacy. This layer governs integration with an external system and, hence, secures the environment.

- 1) *Data Privacy / Security:* User interactions occur in a secure way. Security is derived from role-based access control, input sanitization, and user interaction protection in the form of HTTPS.
- 2) *Future Integrations:* The architecture is modular for potential future integration with e-learning systems, botanical APIs, or AR-based plant identification modules.

G. Architecture Description

The Virtual Herbal Garden has a modular and scalable architecture.

The front end addresses interactive functionality and user interface, whereas the back end addresses data storage, validation, and reporting. Data flow starts when a user accesses the system through a browser. The UI displays plant data loaded dynamically from the database. Usage analytics and tracking modules monitor usage data, whereas the admin dashboard provides support for content management. All the parts share data through RESTful APIs to make the system responsive as well as secure.

VI. SYSTEM IMPLEMENTATION

The Virtual Herbal Garden system was designed to provide an interactive and informative method of learning about some of the medicinal plants and their uses. The system makes use of plant identification, user interaction modules, and a user-friendly interface to provide a virtual tour of a herbal garden. It is both a teaching and entertainment tool that enables users to learn about plant characteristics, uses, and botanical information in a graphical setting.

For achieving modularity, scalability, and maintainability, a component-based architecture was selected.

A. Database Design and Content Preparation

The backbone of the system is a neatly designed plant database with detailed information on each herbal plant. The dataset has been prepared from authenticated botanical sources and manually validated for correctness.

B. System Architecture

The system has a three-layered architecture that includes:

- 1) *Frontend Interface*: Built with HTML, CSS, and JavaScript (with WebGL or Three.js for optional 3D effects).
- 2) *Backend Server*: Running on Flask (Python) or Node.js, offering REST APIs for retrieving plant information and logging user interaction history.
- 3) *Database Layer*: Plant information and user preferences are stored in SQLite or MySQL.

The design supports web-based and mobile operating systems for cross-device functionality.

C. Feature Implementation Plant Explorer Module:

3D garden view of a realistic herbal garden composition..

- 1) *Search and Filter Tool* : Searching via plant name, use (e.g., anti-inflammatory), or category. Filters narrow down plant lists according to user interest.
- 2) *AR Mode (Optional)*: Augmented Reality preview of marked herbs via marker-based or markerless AR (developed with Unity + Vuforia or WebAR).
- 3) *User Engagement Tools*: Favorites list for saving favorite plants.

D. Automation and Content Management

Python automation scripts were used to refresh content automatically and image processing:

- 1) *Image Resizing*: Downsizes high-resolution plant images so they can be loaded quickly.

- 2) *Data Sync Scripts*: These scripts will assist with batch updating the database from an online source or primary Excel document.
- 3) *Metadata Tagging*: Tag plants based on a variety of criteria to allow for better searches and categorization.

E. Dashboard and Admin Panel

The admin panel (using Streamlit, or Flask-Admin) will include::

- 1) *Content Management*: Adding/editing entries for plants.
- 2) *User Logs*: Describing user experience and interactions created..
- 3) *Plus Usage Analytics*: Information about the most engaged searched and plants viewed.

F. System Testing and Validation

Testing was extensive to screen for usability and validity of information..

- 1) *Functional Testing*: Each of the primary modules was tested on multiple devices and through multiple browsers..
- 2) *Usability Testing*: Feedback Faculty and student usability was tested through a quasi experiment using a formal questionnaire.

VII. RESULT AND ANALYSIS

Functionality testing, user reaction, and performance benchmarking were performed to analyze the Virtual Herbal Garden system. It was developed to assess the usability, responsiveness, education efficiency, and reliability of the system on different platforms and interactions with users. The UI/UX experience results, database reliability results, system responsiveness results, and education results obtained are listed in the subsections below.



A. System Functionality and Performance Testing

Comprehensive testing was done for each of the core modules to run smoothly and display the correct content. The performance was tested for responsiveness, speed of data retrieval, and platform independence.

- 1) The success rate in retrieving plant information was 100%.
- 2) Average interactive plant information loading time: 1.8 seconds.
- 3) Search and filter accuracy (by name or use): 98.6%.

B. User Interaction and Usability Testing

User-friendliness of the interface was ensured through having a representative population of 25 students and staff members use the application and provide systematic feedback on navigation, learning value, and overall design.

- 1) *User User Satisfaction Score:* 94% average from all users.
- 2) *Ease of Navigation:* 92% of users rated the interface as easy to navigate.
- 3) *Impact on Learning:* 88% reported effective learning of new knowledge on herbal plants.



C. Educational Insights and Content Engagement

As a result of user log evaluations and assessments, there was a noticeable increase in user levels of engagement and learning:

- 1) *Most Used Categories:* aroma plants and medicinal herbs..
- 2) *Top Search Terms:* "Tulsi", "Aloe Vera", and "Anti-inflammatory".
- 3) *Average Session Duration:* 7–10 min.
- 4) *Most Wanted Features:* Interactive popups plant information and daily herbal tips.



D. System Limitations and Observations

The system performed well for the users overall, with the following observations noted on older smartphones, where 3D visualisation modules took slightly longer to load; it is noted that AR features (if used) needed better lighting and camera calibration to work optimally. There were opportunities to add more elements such as a voice-over description and quiz modules for interactive learning.



VIII. CONCLUSION

The Virtual Herbal Garden project succeeded in presenting the integration of technology and traditional botanical knowledge in an interactive, interesting manner. The system, which aimed to educate users about medicinal and aromatic plants, provided an easy-to-use interface, fast and accurate searching, and visually appealing contents to make learning easier. Functionality and performance testing ensured that the system functioned well on devices, with high success rates in data retrieval and user satisfaction. Usability testing demonstrated that users found the app user-friendly and educationally beneficial. Interactive plant popups, daily herbal tips, and categorized browsing were found to engage users remarkably. Educational effect manifested both in time spent on system by users and in popularity of popularly searched herbs, capturing real-world natural health product demand. While there were some shortcomings like longer load times on older systems and AR sensitivity to lower light levels, these did not stand in the way of utility of the system as a whole. . Virtual Herbal Garden was a project that bridged the classical herbal experience with modern online learning platforms. The individual could browse, read about, and learn from vast information of several medicinal and aromatic herbs in a serene virtual garden environment through this site.

Dynamic presentation of contents like medic uses, scientific classification, and cultural requirements of the herbs. Herbal day tips daily for encouraging revisit activity and education every day. Responsive, intuitive design fitting on both desktops and handle Performance Testing exhibited a robust system with 100% success for data retrieval, less than average loading times of 2 seconds, and good precision in filtering and search operations. Platform independence and browser compatibility were also verified. Ensuring usability by a large number of users. As per user feedback and usage patterns, the system demonstrated good educational value. Users could learn through herbal remedies, know the application of plants such as Tulsi and Aloe Vera, and acquire hands-on knowledge about traditional medicine. Most users

considered the platform informative and interesting with excellent ratings in interface design, learning, and overall experience. The system not only acted as a computer-based reference tool but also as a possible study aid in schools. The botany, pharmacy, or complementary medicine students could utilize it, and hobbyists looking for herbal cures were not excluded either.

The Virtual Herbal Garden is a combination of interactive visualization and an organized plant database that encouraged inquiry and attachment to memory. Overall, the Virtual Herbal Garden is the best of both worlds in terms of tradition and technology, it continues to keep nature's medicine viable and exciting to engage in our web-based environment. This project did not just meet its functional outcomes but also developed a space that is socially and educationally relevant in the world beyond its walls.

As it continues to develop, it can be an effective instrument of herbal knowledge, herbal awareness, and digital conservation of plant facts and data. All in all, the Virtual Herbal Garden project met its target of creating an educational and easy to use space to learn about herbal plants. Further development can lead to features such as multilingualism, games (quizzes), and voice and video telling for greater accessibility and engagement.

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