

Virtual Herbal Garden for AYUSH Medicinal Plants

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Abstract: *The AYUSH Medicinal Plants Virtual Herbal Garden is a new groundbreaking online platform that will help to preserve, promote and popularize the Indian heritage of the knowledge of medicinal plants of the AYUSH systems Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy [5],[7]. Informative, however, the traditional herbal gardens have the limitations of physical access and geography. This project fills that gap creating an interactive and educative virtual herbal garden which recreates a real world setting of a herbal garden in cyberspace. The site provides 3D models of the medicinal plants, which are of high quality,[1],[5] and the users have an opportunity to rotate, zoom in and out as well as explore each component of the plant with very detailed and hoverable information points that indicate the medicinal properties of the plant. Individual plant profiles contain all the data, including botanical description, habitat, medicinal application using AYUSH, preparation and cultivation techniques and guides and multimedia features like images, videos and audio manuals in various languages to make the learning process more inclusive. It has a sophisticated search and filter system that allows the user to search the plants based on ailment, part of the plant, region, or AYUSH discipline. The platform also presents one Disease-to-Plant Recommendation Engine that is capable of suggesting disease-specific herbal recommendations as well as pharmacological actions, preparing methods, dosages, and safety measures[3]. They also allow the users to engage in thematic virtual tours, bookmark their favorites, add personal notes, and share the information about the plants easily. The desired result will be a mobile application that will provide an interactive, immersive, scientifically validated knowledge base with more than 200 medicinal plants. It also strives to benefit the students, researchers, health care practitioners and general population through the greater awareness, access and conservation of traditional medicinal resources. In the end, this project will close the divide between the traditional knowledge of herbs and new digital technology to promote better healthcare and heritage conservation[2][5].*

Keywords: Virtual Herbal Garden, AYUSH, Medicinal Plants, Ayurveda, Siddha, Unani, Homeopathy, Naturopathy, 3D Visualization, Interactive Learning, Digital Heritage Preservation, Virtual Reality, Mobile Application

I. INTRODUCTION

The AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy) traditional knowledge of medicinal plants of nature is a centuries-old system of natural healing and holistic well being[5]. Nevertheless, this traditional knowledge is still constrained to the accessibility of books, research articles, and physical herbal gardens, and it is not accessible and participatory by contemporary scholars. In the digital age, there is a rising necessity of conserving and presenting this priceless heritage in the form of interactive and user-friendly websites that could recreate the experience of exploration and learning mentioned in real life[2],[7]. Traditional methods of learning medicinal plants have been very dependent on textual or two dimensional information, which is not good enough to reflect the structural diversity, visual diversity and functional diversity of the plant species. Consequently, there has been a decline in the level of the education and use of AYUSH knowledge by the people. Moreover, students, scholars, and the overall population cannot learn about the medicinal and ecological value of these species due to the absence of digital integration and real-time



exploration tools[1],[4]. Conversely, the innovative 3D visualization, artificial intelligence (AI), and mobile technologies can be used to develop immersive virtual experiences that could be used to increase user comprehension and participation[1],[3][5]. The Virtual Herbal Garden proposes something new as it integrates the advanced modeling of the plant in 3D, multimedia content, and smart search and recommendation processes. With such a system, users can also virtually browse through medicinal plants, retrieve verified botanical and AYUSH data and get plant recommendations depending on the disease or health condition[1][3][5]. This project will be aimed at creating and deploying an AI-powered Virtual Herbal Garden that could virtually guide the exploration of herbs in reality and inspire people to think more about the need to preserve traditional medicinal resources. [5] The system combines 3D display, intelligent disease to plant recommendation system and multimedia learning tools to provide real and educational user experience. It is an attempt to fill the existing gap between the conventional knowledge of plants and digital technologies by ensuring that the study of AYUSH medicinal plants can be more accessible, interactive, and engaging. here are different technologies and frameworks that aid in the creation of this system. 3D modeling tools are applied to develop realistic images of plants whereas the authenticity of data is made possible by validated botanical and AYUSH databases[4][7]. Artificial intelligence boosts the recommending system, whereas multimedia integration (sound, video and interactivity through animation) adds the teaching experience. The design of the platform is scalable, performance-driven and user-friendly to serve various categories of users, such as students, researchers, and the general population [6]. The general objective of this project is to create a digital ecosystem that is self-sustainable, interactive, and educational and reinvigorates traditional knowledge of plants in a new context [2][5][7]. The Virtual Herbal Garden is expected to create awareness, education, and appreciation of the traditional herbal heritage of India using the latest technology as a tool of knowledge saving and accessibility by providing the data about AYUSH medicinal plants with the immersive visualization and smart interaction[1].

II. LITERATURE SURVEY

The fast development of digital technologies has altered the process of traditional knowledge preservation, access and sharing [4][6]. There has been a major transition in the area of ethnobotany and AYUSH-based medicinal research with regard to virtual and interactive knowledge systems replacing the traditional herbariums and printed compendiums. One of the new innovations has been the creation of Virtual Herbal Gardens and digital herbariums with the purpose of sharing medicinal plant knowledge with a broader audience as well as preserving and creating awareness on the same [2][5][7].

Early efforts in this area were mainly on digital herbarium, in which physical specimens of plants had been scanned and provided with a catalogue [7]. (metadata) including taxonomy, collection locality, and specimen images. The Indian Virtual Herbarium (IVH) by the Botanical Survey of India is an example of a project that has been on the front line in digitizing thousands of authenticated plant specimens nationally [2]. Although these systems are highly valid in data and taxonomic terms, they are two-dimensional mainly and specimen-focused, allowing a low level of interactivity and educational interaction to the general user.

Trying to be more accessible and reach out to more regions, localized projects like the Virtual Herbarium with Bilingual Description of Medicinal Plants of Chhattisgarh (2019) showed the prospects of using bilingual interfaces to popularize traditional knowledge [2]. The given project demonstrated that the gap between scientific communities and local practitioners can be narrowed with the help of language inclusivity and descriptive metadata, and the significance of digital herbarium accessibility in terms of cultural and linguistic inclusivity [1].

Along the lines of digitization, studies on virtual plant visualization and modeling have been increasing. Plant modelling with L-systems (2014) has demonstrated how a mathematical and procedural modeling can be used to create realistic plant structures that can be used in visualization of education and interactive exploration. The publications provided the basis of modeling realistic plant morphologies in computer-based 3D settings by the use of computer graphics and botanical data.

More recent scholarship and institutional projects like the Virtual Herbal Garden (AYUSH) applications published at the time of writing (2023-2025) (IJARSCT, IRJMETS, IJIRT) have tried to develop interactive web platforms or mobile platforms by which users can explore medicinal plants in the form of textual profiles, still images, and



minimalist 3D models [5]. Despite these systems being a significant improvement, they are not always dynamic, interactive, and backed with well-enforced botanical databases.

In addition to visualization-based systems, the work on plant disease prescription and recommendation engines, including the publication of Plant Disease Prescription Recommendation (PRSER) model in 2023, shows that semantic retrieval and sentence-embedding strategies can be effectively used to match the query made by the user with the relevant treatment data. This kind of research will be very insightful to develop disease-to-plant recommendation systems to AYUSH, where natural language processing (NLP) and domain-specific embeddings may be used to match health symptoms with medicinal plants [3].

Moreover, according to recent reviews on herbarium digitization and data-driven plant informatics (2023), there is the phenomenon of next-generation herbariums, which are characterized by the focus on interoperability, image-based identification, and AI-assisted data curation. ScienceDirect, 2023, Herbarium of the Future review explains how AI and machine learning can be used to automatize taxonomical classification and make botanical datasets of large scale more practical [5]. All these studies imply that it is necessary to consider visualization, AI-based recommendations, and verified taxonomic data that will be incorporated into future digital herbal systems to guarantee scientific reliability and user friendliness.

Whilst these advances have been made, the current systems are limited to a great extent. The majority of existing virtual herbariums have limited capabilities of immersive 3D viewing or augmented reality and only provide static data. Most of the academic models emphasize aesthetic appeal, however, based on nonverified data of the plants and result in inconsistent or inaccurate medicinal information. In addition, the incorporation of smart recommendation systems has not been fully investigated in the AYUSH sphere, which restricts an individual learning/discovery experience. Such accessibility features as multilingual support, audio guides, and interactive narration are also commonly not provided, making these systems less inclusive to a variety of users [3].

The combination of artificial intelligence, three-dimensional visualization, and the knowledge graph technologies opens new prospects of modernizing the traditional education on medicinal plants. The proposed future systems are seen to be a combination of image-based plant recognition, recommendation of an NLP disease-to-plant, and AR/VR exploration systems, anchored on verified AYUSH and botanical databases. Through this kind of multidisciplinary practices, the digital herbal platforms could go beyond being mere repositories and become smart interactive ecosystems that not only allow the conservation of culture but also improve scientific knowledge [4].

This is the reason that the current study is based on this review; the creation of an AI-based Virtual Herbal Garden as a part of AYUSH Medicinal Plants development. It seeks to combine validated sources of data, 3D representation, multimedia content and smart recommendation systems into one platform. The proposed system will help add to the development of the comprehensive, interactive, and user-friendly digital ecosystem of traditional medicinal plant knowledge by eliminating the identified limitations in interactivity, data reliability, and personalization [3].

III. SYSTEM ARCHITECTURE

A. Overview

Virtual Herbal Garden of AYUSH Medicinal Plants is developed as a three tier smart system enabling the user to explore, learn, and visualize medicinal plants in a virtual world [5]. The architecture brings together three significant layers namely the Presentation layer, Application layer and Database Layer that mutually provide a smooth data flow, scalability and real time interaction. Fig. 1 shows the entire architecture.

The interaction and visualization of the user interface!— human—.Presentation Layer A. User Interaction and Visualization

The process starts at the user interface which is the point of contact. This layer is created in the Unity 3D, React Native or the latest web frameworks and offers a highly interactive and educational process [1][5].

Users can:

Simulate in the 3D virtual herbal garden, See specifications of medicinal plants, hear voice messages and see educational movies, Search the name, disease or AYUSH category etc. of search plants. Favorite plants may be



bookmarked or shared to be used in the future. The tasks of this layer include the interactive visual presentation, cross platform accessibility, and realistic garden-like feel

• **Application Logic and Processing (Application Layer):**

Application Layer performs as the smart processing unit of the system. It deals with user inputs, logic-based operations and control of communication between the front end and the database [3][5].

In the case of a search by a user on a plant that is associated with a specific disease (e.g., “diabetes”), this layer:

Accepts the search query on the frontend, Recommends the Disease-to-Plant Recommendation Algorithm through, Retrieves the database results that are relevant, and Forces the processed data to be sent back to the user interface to be visualized. Other processes that are managed by this layer are user authentication, customized recommendations, messages, and feedback reactions. It will be implemented with Python (Flask/Django), and its Firebase API-based or cloud-provided high scalability and real-time response will be integrated.

• **Data storage and management (Database Layer)**

Database Layer: This provides a foundation to the system by providing effective storage, retrieval and control of data [4][7]. It keeps systematic documentations as:

Description of medicinal plants (scientific name, habitat, parts used and medicinal value), mappings between diseases and plants, User account profiles, likes and dislikes, Multimedia materials (images, video and audio files), and Feedback and ratings data. The layer provides the support of Firebase Realtime Database, MySQL, or MongoDB to process the structured and unstructured data. It guarantees consistency, security and high speed of data access by indexing, caching and efficient execution of queries.

• **Multimedia and Integration Recommendation:**

The application layer contains a Recommendation Engine that uses AI/ML methods to match the diseases to the appropriate medicinal plants. It utilizes existing AYUSH data and user feedback to narrow down on its suggestions. The inclusion of multimedia helps to provide real-time audio narration, image rendering, and video display to increase the value of the educational platform [5].

• **System Workflow:**

The general workflow of the system is structured in the following way:

User Login: The user has a personal access to the application. Search Query: This search query involves the name of a plant or disease that is searched by a user.

Processing: The back-end is used to validate and process the query through recommendation algorithms. Data Retrieval: Data in the database is retrieved.

Display of Results: The front end will display the results in 3D visualization form with text and multimedia.

User Interaction: User browses, adds bookmarks and gives comments to enhance suggestions. This cyclical process guarantees the real time flow of data, interactive learning and free flow of data amongst

IV. METHODOLOGY

Virtual herbal garden of ayush medicinal plants was created based on the waterfall model that is a sequential and systematic process of developing a software. This model guarantees the transparency of every stage and the orderly process of requirements acquisition to deployment [5].

Requirement analysis: during this stage, specific data regarding the ayush medicinal plants and the needs of the users were gathered using validated and authentic sources, which meant that the information utilized in the system would be accurate and relevant [5][7].

System design: in accordance with the examined requirements, the system architecture and main modules were developed. These were the user authentication interface, plant information interface, 3d visualization interface and the disease to- plant recommendation engine [1][3].



Development: android studio was chosen as the development environment to develop the application. The database performed the data management of the firebase realtime database, whereas unity 3d was incorporated to have in interactive 3d plant visualization and engage the user experiences [1][5].

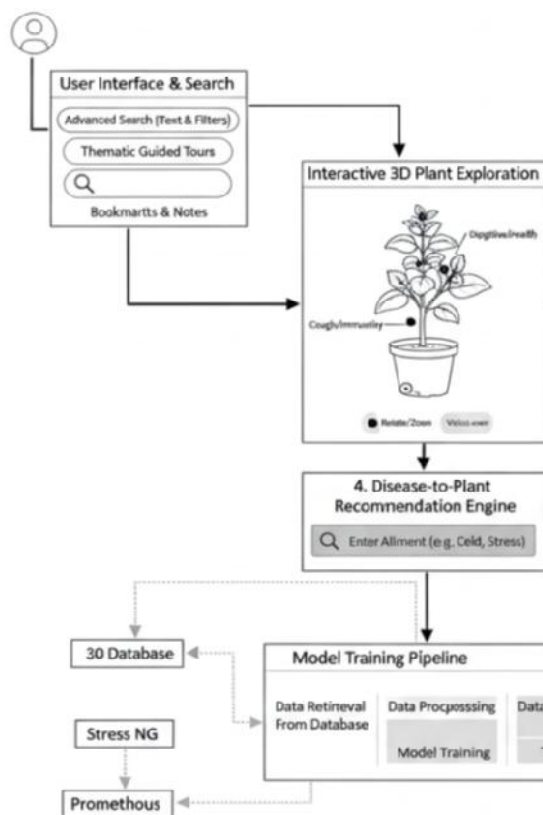


Figure 1: Virtual AYUSH Herb

Testing: Unit and integration testing was done to ensure that all modules were functioning, reliable and accurate. The system was tested in terms of performance, speed of data retrieval and accuracy of recommendation [1][5].

Deployment: Upon passing the tests, it was implemented on the Android devices. The feedback mechanism was used to measure the usability, interactivity and the general satisfaction of the system performance. This systematic solution has made the system developed interactive, precise and user friendly, which will be useful in the digital learning and awareness about herbal medicine [5][7].

V. IMPLEMENTATION AND RESULTS

The suggested Virtual Herbal Garden of AYUSH Medicinal Plants was developed as a mobile application based on Android Studio, Firebase and Unity 3D environment [5]. Several functional modules are incorporated within the system architecture, such as user authentication, plant search and retrieval, 3D visualization of medicinal plants and a disease-to-plant recommendation engine [1][3][5]. Firebase Realtime Database is used as a repository to store and manage the



information about plants, user credentials, and feedbacks and therefore guarantees secure and uninterrupted real-time syncing of data among devices [3][5].

The app allows the end-user to view a wide variety of AYUSH medicinal plants in an interactive manner. Every plant record contains all the necessary information, such as botanical descriptions, medicine, and visuals that can be viewed as pictures and 3D images [1][5][7]. Video and audio materials also improve the level of user interaction and learning. Unity 3D provides the opportunity to use immersive visualization, which allows the observer to watch plant models in various angles.

The system exhibited high performance in terms of quick response during testing as well as searching the plant accurately and recommending with high precision with disease based results [3] [5]. The level of user satisfaction was high according to the usability tests, which is explained by the intuitiveness and flexibility of the interface and by the fact that the app is easy to navigate. In general, the created system is effective in providing a digital, convenient, and informative platform that would contribute to increased awareness of AYUSH medicinal plants and facilitate the preservation of ancient knowledge of herbs using the latest technology [5][7].

VI. SECURITY AND PRIVACY CONSIDERATIONS

The system ensures user privacy through end-to-end encryption and anonymized data storage in Firebase. Only derived features, not raw audio or video files, are stored. User consent is obtained before continuous monitoring. The design complies with basic GDPR and IT Act (India) privacy guidelines [6][7].

VII. CONCLUSION AND FUTURE SCOPE

Virtue Herbal Garden of AYUSH Medicinal Plants is a new online application that will save and enhance the traditional medicinal background of India by the use of modern technology [5] [7]. It provides users with an interactive platform to navigate on different medicinal plants in 3D, detailed information about plants, audio-visual and AI-driven disease-to-plant suggestions [1][3][5]. The application fills the dark side of the physical herbal gardens and the digital availability so that all people have the access to the abundance of knowledge on Ayurveda, Yoga, Unani, Siddha and Homeopathy. The system could be further extended in future with Augmented Reality (AR), Virtual Reality (VR), and AI-driven chat assistants to have immersive learning experiences [4][6]. The application could be even more truthful and convenient to use with the support of multiple languages and connection to the proven AYUSH research databases. With the combination of the traditional knowledge and technology, this project not just improves learning and research but also promotes sustainable living and natural knowledge of healthcare [2][5][7]. It is one of the major milestones to conserve the Indian heritage of herbs and to accept the digital era.

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