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Virtual Herbal Garden Interactive Platform for Exploring Medicinal Plants in Ayush

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Abstract: *An increased interest in natural medicine and the traditional systems of health care has made it necessary to develop digital platforms where knowledge of medicinal plants can be accessed easily. The "Virtual Herbal Garden: An Interactive Platform for Exploring Medicinal Plants in AYUSH" goes a step further in creating an online environment for users to explore species used in Ayurveda, Yoga, and Naturopathy, Unani, Siddha, and Homoeopathy (AYUSH). The system presents a virtual garden with detailed plant profiles, botanical information, therapeutic properties, cultivation methods, and their traditional uses. The system is equipped with features such as interactive browsing, an advanced plantsearch tool, guided learning modules, and visual representations to educate and engage the users. conservation of medicinal plant resources through sustainable means.*

Keywords: Herbal knowledge system, virtual plant exploration, traditional healing herbs, AYUSH medicinal species, digital herbal garden, natural therapy education, ethnomedicinal database, botanical learning platform, interactive herbal study tool, indigenous health practices, plant-based wellness, herbal resource conservation, online guide to medicinal plants, holistic health learning, nature-based healthcare technology.

I. INTRODUCTION

Traditional medicine has played an important role in maintaining health for many centuries. India's AYUSH systems, consisting of Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homoeopathy, are based on natural healing principles and greatly depend on medicinal plants for therapeutic use and preventive purposes. Such plants have not only therapeutic importance but also cultural, historical, and scientific values.

Over the last few years, interest in natural healthcare and plant-based remedies has increased globally. However, access to authentic and structured information about medicinal plants remains limited, especially for students, researchers, and individuals interested in traditional medicine. Physical herbal gardens and academic sources form a very important resource, but are not always accessible.

The Virtual Herbal Garden project fills this lacuna by creating an electronic learning platform where one can learn about the medicinal plants used in AYUSH systems. The portal gives information on the characteristics of a plant, its traditional uses, its cultivation practices, and its medicinal value in an interactive and visually appealing manner. It serves as an educational resource that supports self-learning, research, and awareness of natural healthcare practices.

The project integrates traditional knowledge with modern digital technology in support of the preservation of herbal heritage, while promoting sustainable awareness of medicinal plant resources. It also contributes to expanding the availability of credible herbal information in a convenient and user-friendly manner, supporting both academic and personal learning needs.

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Fig 1.1 Image Of Different plants

Problem Statement

Create a Virtual Herbal Garden that would be an interactive, educative, and immersive encounter for users to demonstrate the diversity of medicinal plants in the AYUSH system: Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy. The medicinal plants and herbs are of great importance to the AYUSH sector, which is fundamentally based on traditional healing practices, and still, not everybody can access their physical gardens. A Virtual Herbal Garden will be the digital platform that allows patients and even the casual public to explore, learn and understand the importance of various medicinal plants at home. Description: Participants have to create a Virtual Herbal Garden that is appealing, informative, and easy to navigate. The virtual garden should have: Interactive 3D Models: Life-like 3D models of medicinal plants that the users can rotate, zoom in and out, and view from various angles. Detailed Information: Thorough information regarding each plant, such as its scientific name, common names, where it grows, how it is used, and how it is cultivated. Multimedia Integration: Adding high-quality images, videos, and audio descriptions to improve the learning experience. Search and Filter Options: A Powerful search feature that makes it possible to quickly find specific plants and sift through them by criteria such as medicinal uses, geographical area, and kind. Virtual Tours: Online guided tours with an emphasis on certain topics, like plants for the digestive system, boosting immunity, skin care, etc. User Interaction: Options that let users mark their favourite plants, jot down notes, and disseminate the information through social media. Expected Outcome: The expected outcome is a complete Virtual Herbal Garden that is a useful educational tool for students, practitioners, and enthusiasts.

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II. OBJECTIVES

- To create awareness and knowledge about the significance and applications of medicinal plants used in traditional healing systems.
- To provide a virtual platform for students, researchers, and the general public who do not have access to physical herbal gardens.
- To provide an interactive learning experience that uses 3D models, videos, and interactive features to make studying medicinal plants more interesting and realistic.
- To present organised, detailed information about each plant with scientific classification, medicinal properties, cultivation methods, etc.
- To enable personalised exploration through search, filter, and bookmark features in addition to virtual tours based on health benefits or the type of plant.
- To blend technology with traditional knowledge by preserving India's vast heritage of herbal medicine while adapting it into digital education for the modern era

Fig: Interactive 3D Virtual herbal Garden Interface

III. LITERATURE REVIEW

[1] Recent studies point out how virtual and immersive technologies are becoming more common in herbal and botanical education. Early models of virtual gardens mostly let people explore digitally. But they usually missed clear details on plants and ways to interact for learning. Later setups improved things by letting users click on plants to see their medicinal uses. Research has looked into realistic ways to place plants to mimic natural settings. It has also covered IoT systems that monitor herbal gardens for better maintenance and growing. Plus, tools using machine learning and AR help spot medicinal plants and show 3D info to aid learning. In general, past work shows a clear push toward digital education for herbs. Still, many systems do not combine immersive interaction, learning tasks, and knowledge rooted in AYUSH culture. That is a gap the Virtual Herbal Garden plans to fill

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[2] Recent research points to the rising importance of digital platforms for keeping and teaching traditional herbal knowledge. Old sources like books and herbaria are often not easy to access. They also lack interactive parts, so they do not work well for today's learners. Studies indicate that virtual tools, such as 3D models of plants and virtual tours, make it simpler for users to grasp medicinal plants. These tools boost interest in learning, too. Cloud systems allow steady access to updated information from any place. The Virtual Herbal Garden builds on this by mixing real-time data, interactive visuals, and immersive learning. It aims to build stronger awareness and grasp of AYUSH medicinal plants in a fresh, engaging manner.

[3] Recent studies stress how digital visualisation tools improve learning about medicinal and culinary herbs. Traditional resources based on text often do not draw in users. They also fail to give a real sense of plants. This has pushed researchers toward 3D environments and interactive setups. The work reviewed shows how tech like Three.js and WebGL can create virtual herb gardens. Users can click on plants there to get info on medicinal value, culinary uses, and images. Other studies cover methods like deep learning for classifying plants, AR for spotting herbs, and platforms with herb databases that hold medicinal details. While early projects stuck to recognition or just showing data, this paper focuses on user interaction and immersive learning. It seeks to raise public awareness and appreciation of medicinal plants. Interactive digital solutions like these help close the divide between botanical knowledge and how users can access it

[4] Studies on digital systems for herbal learning underline the push for modern, interactive methods to explore medicinal plants. Traditional books and herbaria often cannot hold user interest. Recent projects turn to 3D models, multimedia, and virtual spaces to simplify plant info and make it more engaging. This works especially well for AYUSH-based plants. Research indicates that interactive visuals and immersive platforms boost learning a lot over static materials. Virtual herbal gardens made with Unity let users see plants in lifelike settings. They can explore medicinal uses and pick up cultivation tips through hands-on visual experiences. This move to immersive digital tools shows a bigger focus on making traditional medicinal knowledge reachable, attractive, and fitting for current learners.

[5] Recent research reveals more use of virtual reality and multimodal sensing to figure out how natural settings affect human emotions and attention. Old methods like surveys offer some insights. But they tend to overlook real-time shifts in feelings. To fix that, current studies blend physiological data, eye-tracking, and feedback from users to examine reactions in virtual green areas. Results show that natural features like water and herb plants generally lift mood and focus. Artificial items, on the other hand, often lower emotional ease in these virtual spaces. This backs the trend of using immersive tech to assess how various landscape parts impact mental health. It also guides strategies for digital designs based on nature.

[6] Recent research stresses the worth of digital platforms in raising awareness of medicinal plants and traditional healing. Studies indicate that mobile and virtual apps let users learn about herbs in interactive ways. They provide real-time info, visuals, and guided content that books from the past cannot match. Researchers have created mobile apps and VR systems for exploring plant details, identifying herbs, and getting rich multimedia descriptions to aid learning. Tools for plant recognition based on machine learning and smart herbal gardens with IoT have seen exploration too. These make herbal education more reachable and useful. The AYUSH Virtual Herbal Garden fits this pattern by offering a simple digital space. Users can move through 3D plant models, check medicinal info, and dive into herbal knowledge via an Android setup. This matches worldwide tech pushes to safeguard traditional medicine and better public access to herbal learning

[7] Recent studies point to the need for modern digital platforms to keep and share knowledge on medicinal plants. Traditional sources like books and herbaria tend to be full of text. They are not always easy for everyone to get,

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particularly younger people who like interactive formats. To fill this space, researchers have built virtual herbal garden systems. These show medicinal plant info via visual and interactive interfaces. Virtual herbal platforms let users check out plant species and grasp their medicinal traits. They also teach about traditional AYUSH systems in an engaging style. Studies highlight the key role of gathering plant info in one place and using multimedia modules for learning. This improves retention of knowledge and keeps users involved. Newer methods add easy-to-use features, real-time searches, and organised herbal databases too. These make learning smoother and more open. Such tech work helps preserve traditional medicinal knowledge. It also grows public awareness of natural healing ways.

IV. METHODOLOGY

In this section, we delve into the methodology behind our AI-Based Virtual Herbal Garden, outlining the entire development lifecycle that guides the design, implementation, and deployment of an engaging educational platform focused on medicinal plants. Our main goal is to craft a lifelike virtual space where users can navigate through three-dimensional representations of medicinal plants and learn about their uses in a hands-on, interactive way. Typically, traditional virtual herbal garden systems depend on painstakingly crafted 3D models made with specialized software like Blender, Maya, or 3ds Max. While these tools can create precise models, they demand a lot of expertise, time, and computing power. To tackle these challenges, our proposed system leverages Artificial Intelligence for 3D reconstruction, allowing us to automatically generate plant models from 2D images. These models are then exported in GLB format, fine-tuned, and integrated into the Unity Engine for real-time visualization and user interaction. We structured the entire development process into three main epics, following the Agile Software Development methodology. Each epic corresponds to a distinct phase of the project and was executed through separate sprints. The development journey encompasses image collection, AI-driven model creation, model optimization, crafting the virtual environment, designing interactions, implementing educational modules, and finally, deploying the platform. Before kicking off the development, we carefully selected the right software tools and technologies to meet our project needs. These include Meshy AI for generating 3D models, Blender for optimizing those models, Unity Engine for building the virtual environment, Android Studio for scripting and application logic, and Firebase Database for managing and storing information.

• Meshy AI

Meshy AI is an innovative platform that harnesses the power of Artificial Intelligence to turn flat, two-dimensional images into stunningly realistic three-dimensional models. By leveraging deep learning algorithms, computer vision techniques, and neural reconstruction models, it effectively grasps the structure of objects and creates corresponding 3D geometries. In this system, images of medicinal plants are gathered and uploaded into Meshy AI. As the processing unfolds, the AI meticulously extracts features to pinpoint key visual traits like leaf shapes, stem patterns, flower arrangements, texture details, color distributions, and object boundaries. These features are then used to gauge depth information and reconstruct the plant into a detailed three-dimensional mesh. The resulting model is rich with geometry, texture maps, material properties, and surface details that are essential for a lifelike visualization. Ultimately, the finished asset is exported in GLB format, a popular choice in modern real-time rendering applications thanks to its compact size and efficient performance. One of the standout benefits of Meshy AI is how it dramatically cuts down on the manual effort needed for modeling. While traditional methods might take hours or even days to create intricate medicinal plant assets, AI-driven reconstruction can whip up similar models in just a few minutes. This efficiency paves the way for the rapid creation of extensive medicinal plant datasets, perfect for educational purposes.

• Blender

Blender is a fantastic tool for refining AI-generated models before they make their way into real-time applications. We chose Blender because it's packed with powerful features for 3D modeling and mesh processing. As an open-source software, Blender is a go-to choice for a variety of fields, including game development, animation, virtual reality,

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architectural visualization, and simulation systems. It offers a wide range of functionalities like mesh editing, texturing, UV mapping, rigging, rendering, animation, and model optimization. Once we received the GLB files from Meshy AI, we brought each model into Blender for a thorough inspection and optimization. We carefully analyzed the polygon counts and made reductions where needed to boost rendering performance. While high-polygon models can create stunning visuals, they can also slow down frame rates and hog memory during execution. During the optimization phase, we tackled texture mapping issues, fixed material inconsistencies, resolved mesh overlaps, and corrected scaling errors. We applied uniform scaling to ensure that all the plants in our virtual herbal garden looked proportionate. This optimization process helped us strike the right balance between visual appeal and computational efficiency for all the generated medicinal plants.

• Unity Engine

Unity Engine served as the primary development environment for constructing the Virtual Herbal Garden application. Unity is a real-time development platform extensively used for game development, virtual reality systems, simulation software, educational applications, and interactive experiences. The optimized GLB models generated during previous stages were imported into Unity using GLTF-compatible import frameworks. Unity's terrain system was utilized to design a realistic herbal garden environment consisting of pathways, vegetation areas, plant zones, decorative structures, environmental objects, and navigation spaces. Environmental realism was enhanced through the application of advanced lighting techniques, shadow rendering, skybox systems, and material shaders. These components collectively contribute to the immersive nature of the virtual environment. Unity's component-based architecture enables modular development by attaching functionality directly to game objects. This architecture greatly simplified the implementation of interaction mechanisms, information systems, educational modules, search functionality, and user interface management. The major Unity components utilized in this project include Terrain System, Lighting System, Animation Components, Canvas User Interface, Event Handling System, Physics Colliders, and GLTFast Import Framework.

• Android Studio

I used Android Studio as the go-to integrated development environment for crafting and managing C# scripts within the Unity Engine. I developed a variety of custom scripts to handle everything from plant interaction behavior and information retrieval to search features, bookmarking systems, navigation controls, educational modules, and tracking user progress. By applying object-oriented programming principles, I was able to create code structures that are both modular and reusable. I also incorporated event-driven programming techniques to efficiently manage user interactions and system responses. The seamless integration between Visual Studio and Unity made it easy to rapidly develop, debug, and test the application's functionality.

• Firebase Database

Firebase Database Firebase Database was chosen as the main cloud data storage for the project. It offers scalable, real-time services that support efficient storage and retrieval of structured info. The database holds medicinal plant details like names, scientific classifications, botanical descriptions, medicinal applications, images, and educational content. Firebase lets dynamic content updates happen without needing to change the application source code. This kind of flexibility opens up possibilities for future growth of the medicinal plant database and supports the system's long-term maintainability.

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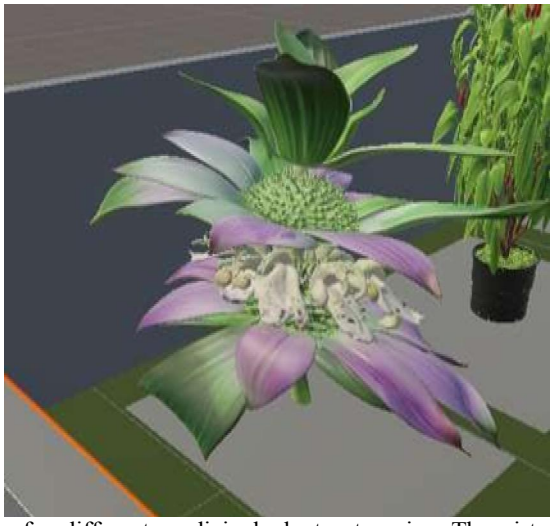
1. AI-Based 3D Plant Generation and Virtual Environment Development The first epic was all about creating digital assets and designing the virtual herbal garden. To kick things off, a broad dataset of medicinal plant images was gathered from botanical repositories, research publications, and public image databases. Careful thought went into image quality, resolution, lighting, and clarity to maximize AI reconstruction accuracy. Meshy AI processed the collected images and generated 3D plant models. Then, these models were optimized using Blender and exported in GLB format. Once optimized, all models were imported into Unity Engine and laid out according to a predefined

garden design. Specific sections of the garden were set aside for different medicinal plant categories. The virtual environment got a boost through terrain creation, vegetation placement, pathway design, tweaking environmental lighting, configuring the skybox, and adding decorative objects. By the end of, a fully navigable virtual herbal garden with realistic medicinal plant models was developed successfully.

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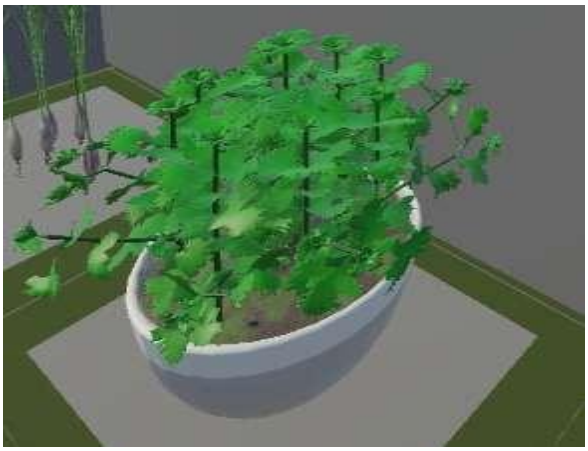
2. Interactive Learning System Development The second epic aimed at adding interactivity to the virtual herbal garden. Each medicinal plant got a collider component and an interaction script. When users select or get close to a plant, the system recognizes the chosen object and pulls up relevant info from Firebase. Interactive info panels were created using Unity's Canvas User Interface system. These panels dynamically show plant names, scientific classifications, medicinal uses, traditional applications, and botanical descriptions. There were also several user experience enhancements, like responsive layouts, better typography, smooth transitions, and improved visual consistency. By the end of , the system had evolved from a simple virtual environment into an interactive educational platform.



3. Educational Intelligence and User Engagement The final epic focused on adding educational features and smart learning mechanisms. A plant search system was developed so users could easily find specific medicinal plants. Search results pop up dynamically based on user queries. A bookmarking system lets users save their favorite plants for later. Plus, a learning progress tracker was made to monitor user exploration activities. To boost educational engagement, case-based learning scenarios were woven into the application. These scenarios present real-world health conditions and challenge users to identify suitable medicinal plants based on what they've learned. This approach promotes active learning, critical thinking, and knowledge retention, making the educational experience quite engaging and interactive.

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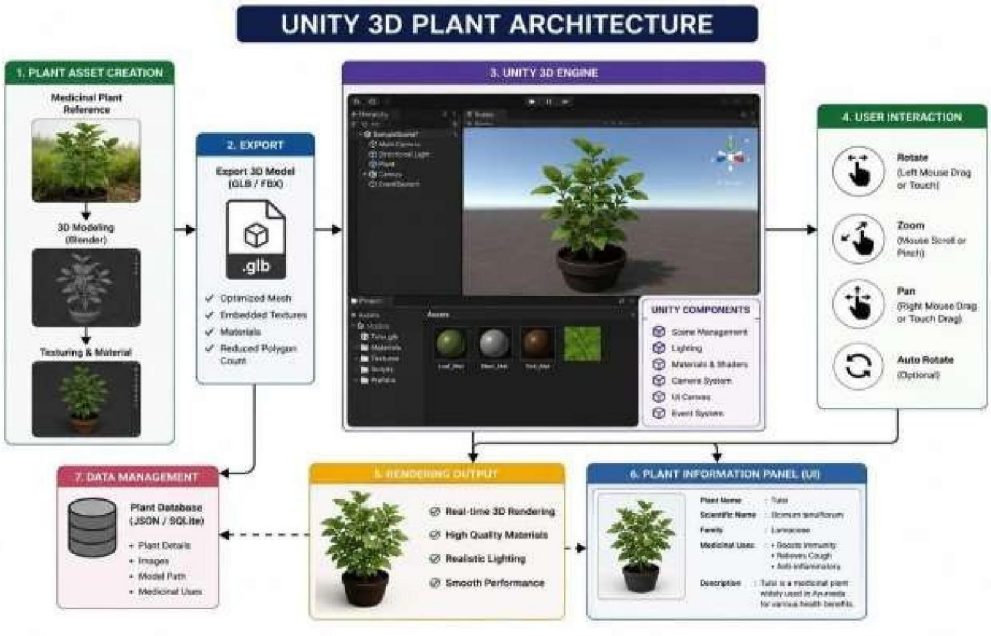
V. SYSTEM ARCHITECTURE



1. Plant Asset Creation

Everything starts with reference images. We dig through botanical databases, research papers, and open image libraries to gather clear photos of medicinal plants. These pictures aren't just for show—they're the blueprint for building real 3D models. In the past, artists had to craft every detail by hand in tools like Blender. Now, with AI-driven reconstruction, the process moves a lot faster.

Once we've got enough images, we rebuild the plant's basic shape in 3D. The goal is to nail the important stuff—how the leaves line up, what the stems and flowers look like, just the overall vibe of the plant. After that, it's time for textures and materials. Laying out good textures brings out the true colors, details in the veins, and all those subtle touches you'd see if you went outside and looked at the plant for real.

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At its core, 3D modeling is just geometry—stitching together vertices, edges, and faces. The real challenge is making the model as true to life as possible, both inside and out, without bogging down your system. It's always a trade-off between adding detail and keeping things quick and smooth.

2. Export of 3D Models

When a plant model's done, we export it in formats that actually work for real-time stuff—GLB and FBX. These handle everything: the mesh, textures, materials, and even animations, if there are any.

Before setting them loose, we clean them up. Polygon reduction keeps the shape looking good while ditching unnecessary detail. We pack textures straight into the model file, so loading's faster and less messy.

This all comes from Level of Detail (LOD) theory and mesh simplification—basically, keeping things as light as possible so the virtual garden doesn't slow down or stutter.

3. Unity 3D Engine Integration

Then comes Unity. We import the plant models into Unity, which handles everything for the Virtual Herbal Garden: graphics, physics, user interfaces, interactions, and all the educational extras.

Inside Unity, plants find their spots within a clean garden layout. The terrain system shapes the landscape, while lighting and shading boost realism. Materials and shaders make sure surfaces look right and the plants "fit in" visually with their world.

Unity's whole setup is pretty flexible. Every plant becomes a "GameObject," and we add features—like rendering, physics, or animation—by sticking on components. It's simple to update or expand things later.

4. User Interaction System

But this garden isn't just about good looks. It's interactive. People can click on any plant, spin it around, zoom in to see the veins on a leaf, or just pan across the scene. There's even an auto-rotate if you just want to watch.

Putting control in the user's hands turns it from a static exhibit into an actual learning tool.

The base idea is Human-Computer Interaction (HCI). Good interaction means the garden's easy to use, simple to figure out, and pulls people in—helping them remember more about what they've seen.

5. Real-Time Rendering and Visualization

Unity ties everything together with real-time rendering. It takes the raw 3D data and turns it into detailed images, right away. Real-time lighting, moving shadows, realistic materials, sharp textures, weather effects, and smooth camera controls—it's all there.

All these tricks don't just make the plants look great. They keep the experience smooth, even for people with different computers or devices.

This is classic Computer Graphics Theory. It's all about using math and smart programming to keep you immersed and interested.

6. Plant Information Panel

Every plant comes with a side panel packed with information. Pick a plant, and you'll see its name, scientific classification, description, medicinal uses, traditional info, and tips on how to grow it.

Putting the text next to the model helps users connect what they're seeing in 3D with everything they might want to know about the plant.

That ties straight into Multimedia Learning Theory: people actually remember more when they get the visuals alongside the facts.

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7. Data Management and Information Retrieval

Behind the scenes, all the plant details live in a database—maybe Firebase, SQLite, or just a simple JSON file. The database tracks everything: plant names, classification, pictures, model links, properties, and all the descriptions.

When someone picks a plant, Unity grabs the right information and shows it instantly. This keeps things snappy and lets us add more plants whenever we want. Using a cloud database like Firebase means the garden can update in real time and keep up as it grows.

All of this leans on solid Database Management Theory—storing, organizing, and retrieving information efficiently, so the garden stays responsive and up to date.

VI. BENEFITS TO SOCIETY

The creation of an interactive, educational, and immersive Virtual Herbal Garden that showcases medicinal plants used in AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha, Homeopathy), the platform allows users to explore realistic 3D models of plants; read rich content - botanical, medicinal, and cultivation; watch multimedia; be part of guided virtual tours; and save-and-share discoveries. Its main beneficiaries are students, practitioners, educators, researchers, and interested laypersons.

VII. CONCLUSION

The Virtual Herbal Garden project effectively showcases how contemporary digital technologies can help in preserving, promoting, and educating people about the extensive heritage of medicinal plants within the AYUSH system. It features an interactive virtual setting with 3D models of plants, accurate botanical information, multimedia components, and intuitive navigation tools, creating an engaging and user-friendly learning experience for students, researchers, and herbal enthusiasts.

This platform allows users to explore various medicinal plants from different AYUSH disciplines, learn about their therapeutic uses, and recognize the significance of traditional healing methods. Feedback from user testing shows that the platform boosts interest, knowledge retention, and awareness of herbal medicine.

In summary, the project successfully connects traditional herbal knowledge with modern digital advancements. It serves as a valuable educational resource and lays the groundwork for future improvements, including augmented reality features, a broader plant database, and customized learning options.

VIII. FUTURE SCOPE

1. Incorporating AR/VR technology for more realistic interactions with plants and virtual tours.
2. Launching an AI-driven feature that identifies plants through camera scanning.
3. Expanding the herbal database to add more local and uncommon medicinal plants.

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4. Offering multi-language support to cater to a wider range of users in various regions.
5. Partnering with AYUSH institutions and botanical research centres to provide verified information.
6. Introducing gamified learning elements like quizzes, points, and achievement badges.

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