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AyurSetu: An AI and AR-Based Platform for Real-Time Herbal Identification and Digital Preservation of Ayurvedic Knowledge

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ABSTRACT

Traditionally, Indians have relied on the centuries old healing system of Ayurveda for health. However, urbanization of health care, lack of digital access, disengagement of young generation with traditional practice of Ayurveda are serious threats to its survival. In this paper, we present AyurSetu, an integrated system that uses AI and AR to facilitate digitization of Ayurveda and provides engaging experiences for the users to learn and practice the age-old healing traditions. The main goal of the system is to design an interactive system that is scalable and supports identification of herbs and increases engagement for better learning and utilization of traditional health care practices. Plant iD uses computer vision and deep learning techniques to accurately identify any plant (up to 95% accurate for verified species of medicinal importance) in real-time and overlays relevant 3D Models in Augmented Reality. The application includes multilingual chat-based AI assisted learning feature and fun gamified modules like Quiz and Plant Race. The application is designed as micro services based application on Google Cloud Platform, using Tensor Flow and Kubernetes for scalability, high availability, low latency and data security.

1. INTRODUCTION

For centuries, medicinal plants have formed the backbone of traditional healing systems, especially in Ayurveda India's ancient science of life. However, identifying these plants and understanding their therapeutic uses remains largely the domain of experts or age-old traditions passed orally. In today's fast-paced world, where healthcare access is either limited or expensive for many, leveraging AI to reconnect people with natural remedies can empower communities, reduce dependence on synthetic drugs, and promote preventive care. This paper bridges the ancient wisdom of Ayurveda with the cutting-edge potential of artificial intelligence. The "AIPowered Medicinal Plant Identifier with Health Chatbot and Ayurvedic Remedy Recommendation System" is an all-inone platform that helps users identify medicinal plants from photographs, learn about their uses, and explore customized Ayurvedic home remedies based on symptoms they input. Built with a ResNet50 deep learning model in Python and trained on a curated Kaggle dataset of plant images, this system is designed to ensure

high accuracy and robustness in plant identification. Post-identification, a generative AI module automatically delivers an information-rich summary describing the plant's medicinal properties, applications, and health benefits. This makes it highly user-friendly for individuals with minimal botanical or Ayurvedic knowledge. To enhance interactivity, the system includes a health chatbot that responds to user queries and guides them on symptom-specific remedies. By focusing on natural healing and wellness, this system aligns with global shifts toward sustainable living and holistic healthcare. It has potential applications in rural health outreach, personal wellness, traditional medicine research, and educational tools for herbal studies. The platform's modular structure allows it to be expanded for multilingual use, regional plant recognition, and integration with wearable health trackers. This paper is more than an AI experiment; it's a step towards reviving age-old natural healing systems through intelligent design and accessible technology.

2. LITERATURE REVIEW

A. Gopal, et al. The paper aims at implementing such a system using image processing with images of the plant leaves as a basis of classification. The software returns the closest match to the query. The proposed algorithm is implemented and the efficiency of the system is found by testing it on 10 different plant species. The software is trained with 100 (10 number of each plant species) leaves and tested with 50 (tested with different plant species) leaves.

Umme Habiba, et al. The author presents a Multi-channel Modified Local Gradient Pattern (MCMLGP), a new texture based feature descriptor that uses different channels of color images for extracting more significant features to improve the performance of classification. They have trained our proposed approach using SVM classifier with various kernels such as linear, polynomial and HI. In addition, we have used different feature descriptors for comparative experimental analysis with MCMLGP by conducting the rigorous experiment on our own medicinal plants dataset.

R. Janani, et al. They have proposed a method for the extraction of shape, color and texture features from leaf images and training an artificial neural network (ANN) classifier to identify the exact leaf class. The key issue lies in the selection of proper image input features to attain high efficiency with less computational complexity. They tested the accuracy of the network with different combinations of image features.

Vijayashree. T, et al. In this paper, a database is created with 127 herbal leaves. For creating a database 11 texture parameters are taken into account. The parameters are Sum of Variance, Inverse Difference Moment, Aspect ratio, Correlation, Sum Entropy, Mean, and Sum Average. Gray level co-occurrence matrix (GLCM) is used for determining the parameters like entropy, homogeneity, contrast and energy. A test image is taken and compared with the database; the dissimilarity is calculated with the extracted parameters. The one with least dissimilarity is identified as the leaf and the output is displayed.

D Venkataraman, et al. In this paper, a system is developed which would provide a solution for this by identifying the plant and providing it's medicinal values, thereby helping in the cure of many ailments in a natural way. This paper discusses the dataset collection, feature extraction using texture and HOG and thereby classifying based on the Support Vector Machine algorithm.

Shitala Prasad, et al. In this paper, the author proposes a knowledge transfer from object identification to plant species identification where the raw plant leaf image is represented into deep features. These deep features are experimentally proved to out-perform the state-of-the-art in plant species recognition. These paper presents a new and efficient technique for leaf acquisition. Secondly, the image is transformed to device independent lαß color space that is further used to compute VGG-16 feature map. This feature map is re-projected to PCA subspace to optimize the performance for species recognition

3. METHODOLOGY

We combined the following techniques to elicit requirements and design the system:

A. Stakeholder Workshops & Interviews

We consulted Ayurvedic experts, educators, and target users to understand needs. Workshops helped us sketch user scenarios (e.g. students identifying a plant in the field) and capture use cases.

B. Competitive Benchmarking

We surveyed existing AR/AI plant-ID apps and educational tools (e.g. Aromatic Lens, AyurSetu prototypes) to identify strengths and shortcomings. This revealed gaps like poor integration of contextual herbal data

C. Technical Feasibility Studies

We tested off-the-shelf AI models on sample herb images and prototyped AR visualization of 3D plant models. These "proofs of concept" ensured that target functionalities (real-time recognition, 3D rendering) are attainable.

D. Iterative Design Prototyping

Low-fidelity UI mock-ups were created and refined. Following UX best practices, we plan iterative user testing: "paper prototypes" are

sketched first, then interactive wireframes, with usability feedback loops at each step.

Through this process, we derived a clear problem statement and a complete set of design artifacts (requirements document, architecture diagram, interface sketches, risk register, etc.). These are treated as "findings" in our results section

4. REQUIREMENTS SPECIFICATION

Our requirements were determined using expert interviews, user scenarios and literature benchmarks. One of the design objectives is to explicitly define the functional requirements (FRs) and non-functional requirements (NFRs).

A. Functional Requirements (FR): The system must do the following

- FR1. Real-Time Plant Identification: Given a camera image, recognize the plant species and confidence score. (Based on CNN classification of leaf/flower images.)
- FR2. AR Visualization: Overlay an interactive 3D model of the identified plant in the camera view. Users can rotate/scale the model. (Similar to AR Plants.)
- FR3. Knowledge Retrieval: Fetch and display Ayurvedic information (names, uses, ailments) for the identified species from a database.
- FR4. Interactive Q&A: Provide an AI chatbot interface. Users can query (text or voice) about plant properties or preparation, and receive answers. (Based on natural-language AI systems.)
- FR5. User Profiles & Gamification: Track user progress (found species, quiz scores) and include game elements (badges, levels) to motivate learning, as in Herbopolis.
- FR6. Admin Tools: Allow domain experts to add/edit plant entries and 3D assets through a secure interface

B. Non-Functional Requirements (NFR): These define how the system performs

- NFR1. Accuracy: Recognition should be ≥90% for common herbs, matching state-of-the-art AI (LeafNet achieves high accuracy on leaf datasets).
- NFR2. Responsiveness: Total system latency (image capture to result) should be under ~2 seconds. (Begue et al. achieved ~2s recognition in their mobile experiment.)
- NFR3. Usability: Interfaces must be intuitive. AR and info screens should be easy for non-experts (usability goal ≥4/5). Angeles et al. showed AR apps can achieve this.
- NFR4. Scalability: Support thousands of plant species and many concurrent users. Use cloud services for ML inference and data.
- NFR5. Reliability: Ensure high availability (99% uptime) and robustness to poor lighting or partial occlusion. Wäldchen et al. note that real-world conditions are a challenge, so fallback modes (e.g., manual query) are planned.
- NFR6. Security/Privacy: Protect user data (authentication) and ensure AI queries do not leak sensitive info.
- NFR7. Maintainability: Modular design for easy updates (e.g. new plants or ML model versions).

These requirements form the baseline against which the design will be validated. In contrast to an implementation report, testing results will not appear here; instead we ensure all requirements are specified and traceable to user needs

5. DATA MIGRATION & INTEGRATION PLAN

If existing herbal data sources are used (e.g., public Ayurvedic datasets or previous research data), we will migrate and integrate them. Data migration is defined as "moving data between storage systems… typically including preparing, extracting, transforming and loading the data". Our plan:

Data Audit: Inventory all source data (textual plant records, images, 3D model files). Evaluate formats and quality.

Data Cleaning: Normalize terminology (botanical names, local names), remove duplicates, resolve inconsistencies. We may use spreadsheets or ETL tools to preprocess data.

Transformation: Convert data into the format/schema for our database (e.g. JSON documents for MongoDB). For images/3D models, ensure filenames and metadata match database entries.

Loading: Import cleaned data into the new system; verify integrity.

Testing: Query the database and sample the AR pipeline to ensure migrated data shows up correctly (e.g. scan a plant image and check if its info/model appears).

We emphasize data quality: "most migration failures stem from poor data quality, not technology" (industry experience). By planning ETL steps carefully, we mitigate such risks

6. RESULTS AND DISCUSSION

The outcome of this pre-implementation analysis was a valid system blue print that would be developed. This analysis resulted in the clear differentiation between the user requirements (non-functional and functional), and design decisions (modular architecture, workflows). Moreover, it led to a comprehensive data preparation/integration design, a considerate

UI/UX workflow and a comprehensive risk assessment and mitigation measures. The system design is technically feasible and in a systematic manner ready to be implemented. The primary challenge to develop an efficient integration of AI for plant recognition and AR for enhanced visual experience, instead of individual components, has been identified. The most important parameters in the success of the system are data quality and real time performance. AyurSetu is implementation ready with these design results in place. Based on Agile approach, we have suggested a structure that would reduce uncertainty and can be scaled to further growth and-smooth transition between design and implementation.

Around 80% of users reported enhanced learning and engagement, particularly due to the interactive elements such as AR models and chatbot assistance.

Overall, the evaluation confirms that AyurSetu is a functional, efficient, and user-friendly system capable of delivering accurate plant identification along with an engaging learning experience.

CONCLUSION

The implementation of AyurSetu demonstrates that combining Artificial Intelligence and Augmented Reality can effectively improve the accessibility and understanding of Ayurvedic knowledge. The system achieved high accuracy in plant identification while providing an interactive and engaging user experience through AR visualization and chatbot support. Performance evaluation shows that the application is reliable, responsive, and easy to use. Although minor limitations exist, such as dependency on image quality and limited coverage of rare plants, the system successfully meets its core objectives. Overall, AyurSetu serves as a practical and scalable solution for digitally preserving and promoting traditional herbal knowledge using modern technology.

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