

Fusing Tradition with Technology: Generative AI in Personalized Ayush Herb Consultations and Knowledge base Creation

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Abstract— The rapid advancement made in the Generative AI has brought a transformative wave in Traditional Medicine (TM) systems. Medicinal herbs often address physical symptoms and mental and emotional well-being. This paper highlights the design of personalized Ayush herb consultations using generative AI algorithms. In order to design efficient Q&A systems, training models play a vital role, which is proportionally related to the domain-specific datasets. Here, an attempt is made to harness the power of each component, i.e. from collecting the data to the multi-modal knowledge base, classification, recommendation and Large Language Model construction in relevance to bridging the gap between traditionalism and scientific methods for Ayush. This paper sheds lights on incorporating generative AI into the Ayush industry, creates opportunities to bridge traditional healing methods with advanced technological innovations, and thus promotes wider acceptance and usage of the Ayush system globally.

Index Terms— Ayush; Multi-modal data; Generative AI systems; Ayush herbs and Large Language Model.

I. INTRODUCTION

In the present scenario of healthcare systems, the experiential wisdom of Traditional, Complementary, and Integrative Medicine (TCIM) systems remains a treasured system that facilitates a holistic and preventive healthcare systems. The integration of TCIM into conventional healthcare systems has excellent capabilities to promote well-being, affordability, and equity, which align with the principles of global health. The TCIM systems contain different varieties of traditional healing practices such as Ayurveda, Unani, Siddha, Naturopathy, Homeopathy, Chinese, Tibetan, Thai and so on. It is observed that 80% of people from both low- and high-income countries seek TCIM for their health-related issues. At the 76th World Health Assembly in May 2023 [1], a new global strategy for TCIM 2025-2034 was developed, recognizing the TCIM's potentialities in fostering various health conditions, including the COVID-19 pandemic. TCIM field explores the preservation and acknowledging of traditional knowledge. Henceforth, it's a time to rely on the holistic healthcare model where the individuals take care of their health and also respecting the traditional healing systems. An emerging interest in the TCIM field, India has an ancient heritage of AYUSH, a traditional medicinal system practiced from 5000 years ago to recent years.

The significance of digital technology and innovation in achieving Sustainable Development Goals (SDGs) is progressing in this era.

India is a wealthy nation that serves as a home for several medicinal plants such as Neem, Turmeric, Cumin, etc. The parts of the plants, such as roots, bark, seeds, fruits, and leaves, are widely used to produce herbal medicines [2]. It is considered valuable complementary medicine for chronic diseases, mental health and overall wellness. It aims to balance the structural and functional aspects of the body. According to Ayurveda's medicinal system, any disruptions caused by internal and external factors lead to imbalance, resolved through procedures and dietary adjustments. The therapeutic principles of Ayurveda focus on the Prakriti, Vikriti and Tridoshas assessment. Every individual is believed to have their own Prakriti constitution [3]. Spreading awareness of Ayurvedic principles across the globe can be facilitated by combining the understanding of contemporary analytical techniques with a more comprehensive viewpoint. The advent of Artificial Intelligence (AI) needs to be integrated into the larger digital health ecosystem, guided by a robust strategy, and should be more people-centred, efficient, sustainable, and inclusive in nature. The global interest and the adoption of generative AI helps to create a new content that promotes the Indian traditional medicine on international platforms, increasing its adoption and acceptance worldwide [4]. Henceforth, the purpose of the study is to integrate the generative AI techniques in Ayush herb, an Indian Traditional Medicine system for preserving the ancient knowledge, making it accessible to a global audience, and ensuring that it continues to play a significant role in contemporary healthcare through the lens of Generative Large Language Models.

II. CURRENT STATE IF AI TECHNIQUES IN AYUSH

A. Data augmentation and fusion models

TABLE I. COMPARATIVE ANALYSIS

Proposed method	Issues handled	Limitations
Res2Net and Efficient Channel Attention (ECA) mechanism [5]	Enhanced the grouping of convoluted operators.	The method is suitable for small-scale datasets.
Raw data collected from the Mekong Delta Area [6]	Fine-tuning of hyperparameters	Hyperparameters tuning between intra-class variations are limited.
Convolutional Neural Network (CNN) with two architecture comparisons between VGG16 and DenseNet121 [7]	Covered the Data sparsity issue	Many convoluted layers are used for performance assessment.
Convolutional Neural Networks MobileNet architecture [8]	Disease severity detection on leaf spots.	The maturity prediction of those leaves under different climate conditions is limited.
VGG16 model [9]	Geometric features of leaf are improvised.	Developed knowledge system is not applicable in real-time.
The authors has analyzed the relationship between Nadi Pariksha and pulse signal from a peripheral pulse analyzer [10].	Physical attributes, including composition of body, type (built), facial traits, kind of hair, and so on are captured.	This study in developing stage. Hair type is mainly used for prediction purpose. Complex patterns are not studied.
The pitta imbalance evaluation using machine learning algorithm with real time pitta datasets and machine learning algorithms are studied [11].	They explored the Vata-Pitta analysis on common people.	Limited on the dataset collection tasks. Data fetching process becomes overload.

B. Data classification and Recommendation models

TABLE II. COMPARATIVE ANALYSIS

Proposed method	Issues handled	Limitations
Nadi Pariksha is a non-invasive pulse diagnosis method for assessing health of person in Ayurveda [12].	Data sets were created with the help of hundred volunteers. The fundamental parameters are analyzed with the predefined threshold values.	Fundamental parameters analysis is limited. Data outlier is not addressed in this study.
The author has addressed the issues of medicinal plants classification using deep learning and image processing techniques [13].	Compared to the CNN architectures, the ensemble model (EEXR) has gained better accuracy rate with the lowered false positive rates.	The study is limited to the significant medicinal plants. Hyperparameters of ensemble models are not tuned properly in the case of image translation process.

The immune system of the individual determines the treatment protocols that varies from man to man [14]	The different herbal formulations mentioned in the Charak Samhita, Sushruta Samhita, and other classic texts of Ayurveda are derived.	The climatic –based medicinal plants have to be addressed in extensively.
The authors have designed a digital database system from the analysis of classical siddha poems by formulating into web portal of siddha content [15].	The combinations of medicals are analyzed to design a treatment protocols and trials.	It is limited by formulating from siddha poems. Data duplications and security aspects of those sensitive data are not discussed.
AyushNets, a self-supervised mobile application that eliminates manual classification and predicts the label of medicinal plants based on leaf images [16].	The well-known medicinal plants are studied using the designed system.	System has restricted the model’s training in terms of tuning hyperparameters.

The comparative analysis is given in Table I and II, states that the datasets limitations [5-7], automatic plant recognition [8-10], Prakriti and Tridoshas assessment [11-14] and Traditional poems [15] are explored by the researchers using the Computer Vision, Machine learning and Deep learning models, Internet of Things (IoT) [16] and Database system. It is observed that there is a lack of knowledge prevails in the field of Traditional Indian Medicines (TIM) in relevance to the usage of Generative Artificial Intelligence technologies. Limited training dataset is the foremost issue that deprives the efficiency of constructing the deep learning models.

III. BARRIERS TO THE ADOPTION OF GENERATIVE AI TECHNIQUES

In the Ayurveda domain, utilizing generative AI and multi-modal data analysis poses unique challenges due to the complex integration of diverse data types and contextual insights. Ayurveda’s focus on individualized treatments, considering factors like constitution (Prakriti), current state (Vikriti), and lifestyle, complicates the development of universal AI models. Emerging technologies like 3D-RGB imaging are being explored to enhance diagnostics, including tongue and skin analysis, and to aid in herb identification by capturing detailed leaf morphology. However, challenges such as distinguishing dry (or) aged herbs persist. Efforts to incorporate user personalization and variability into collaborative recommender systems aim to address these complexities, reflecting Ayurveda’s inherently individualized approach to healthcare.

From the current state of AI adoption in Ayush, the challenges need to be addressed are:

- Multi-modal analysis and application for Generative AI in Ayurveda domain is still an open challenge.
- Usage of 3D- RGB image in data analysis for Ayurveda domain is still in the developing stage
- Challenges in Leaf Recognition due to dry herb species (or) aged leaves is very challenging tasks due its format
- User personalization and variability in designing collaborative recommender system for traditional medicine and its applications.

IV. PROSPECTS OF MULTI-MODAL GENERATIVE AI FRAMEWORK FOR AYUSH HERBS

This section portrays the prospects of designing Question and Answering System for Ayush herbs using the concepts of Generative Artificial Intelligence (Gen-AI) and Prompt Engineering (PE). The review states that the creation of structured multi-modal data has a greater contribution in modernizing the Ayush healthcare and the preservation of traditional knowledge.

In order to design an efficient Q&A system, the need of training dataset is much significant. However, the knowledge exists in the text (or) unstructured form that restricts the functioning of research and integration with modern machines. The figure 1 presents the proposed multi-modal framework for Ayush herbs. It illustrates the approaches overview, and how each component serves as input/ output of the proposed framework. The proposed phases of designing Q&A are discussed as follows:

A. Collection of data

The collection of data is the first step of the proposed methodology. It portrays the collection of Ayush herbs data via focused web crawling approach.

The texts and images of Ayush herbs are collected from the Government and Health organization databases, textbooks, blogs, Ayush related portals and open benchmark datasets. The selection of the URLs is an important entity of a focused crawler.

The primary goal of this approach is to locate the relevant web pages and acquire the Ayush herbs texts and plant images. The herbs images are collected from the Kaggle repository.

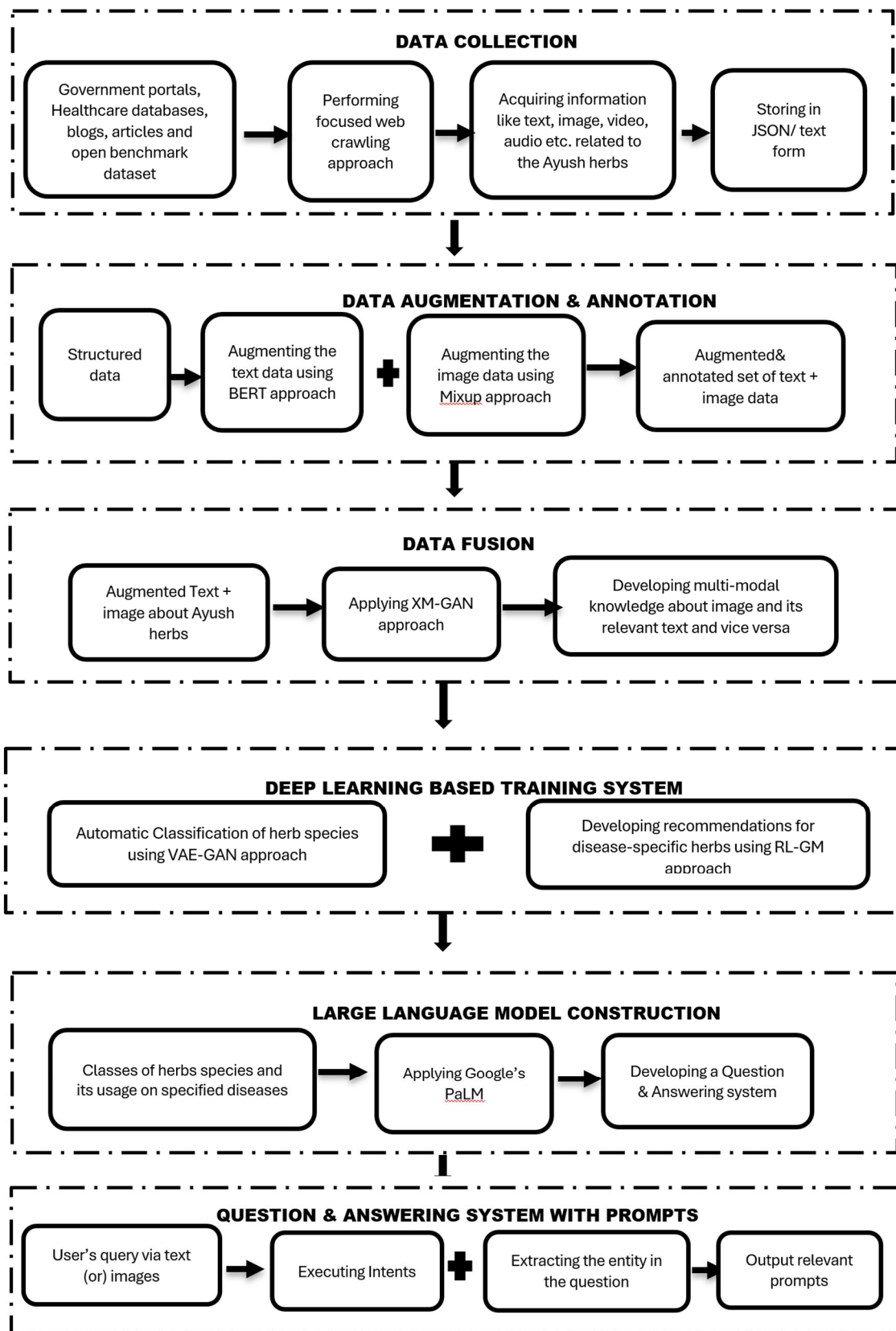


Figure 1. Multi-modal framework for Ayush herbs

B. Data augmentation and annotation

The second step of the proposed methodology is the data augmentation that augments the acquired Ayush herbs texts and plant images. The objectives of this step are to create a new multi-modal dataset that improves the diversity and data volume for an efficient Generative AI's training models without deteriorating the consistency across different modalities and also annotating the augmented data. For text augmentation, the Bidirectional Encoder Representations from Transformers (BERT) model is employed to improve contextual understanding by pretraining and fine-tuning classical Ayush texts. For images, a Mixup technique is used to create new herb images, increasing generalization and regularization for visually similar herbs.

C. Data fusion

Data fusion is the third phase of the proposed methodology that intends to integrate the generated text and the images for constructing efficient multi-modal knowledge base. Cross-modal Generative Adversarial Networks (GAN) is designed to connect text and image modelling to realize bidirectional generation between image and text. By doing so, the corresponding images can be generated with the text description and the vice-versa. The heterogeneity between modalities seeks for proper alignment of latent spaces. Here, the cross-modal GAN is applied on the text-to- image and image-to-text processing. A) Text-to-image: The generator function generates the realistic images of Tulsi from the provided textual description. B) Image-to-text: The generator function generates the texts from the provided image. From the cross-modal GANs, the text-image alignment of the Tulsi herbs is formed and preserved at the knowledge base.

D. Deep learning-based training system

The training system is constructed by framing classification and recommendation engines. The classification engine leverages Variational Auto-Encoders (VAE) and Generative Adversarial Networks (GAN) to automatically identify herb species by generating high-quality images without mode collapse, improving classification accuracy. The recommendation engine builds user profiles based on health data, treatment preferences, and prior interactions with herbs. Personalized treatment plans are developed through Prakriti and Vikriti assessments, with a Reinforcement Learning and Generative Model (RL-GM) approach that simulates recommendation strategies. This adaptive system evolves with user feedback to optimize diagnostic and decision-making processes.

TABLE III. SAMPLE DATASET AND EXPECTED PROMPTS

Herb Name	Description	Label	Images	Prompts
Ashwagandha	An adaptogen herb that helps the body adapt to stress, supports energy levels, and vitality.	Adaptogenic		What are the health benefits of Ashwagandha? In traditional Ayurveda, what properties does Ashwagandha have, and how is it used for stress relief? List the medicinal uses of the herb Ashwagandha If someone has a cold, which AYUSH herbs could they use for relief, and why?

The table III presents the sample dataset that describes the medicinal properties, images and the prompts formulation for the design of efficient Q/A system.

E. Large Language Model (LLM) construction

Google's Pathways Language Model (PaLM) will be incorporated to design an efficient Question and Answering (Q&A) system for the construction of large-scale systems. PaLM is one of the leading Large Language Models (LLM) that can work with multi-modal data and multi- task language model. Compared to the GPT-4, Llama and other transformer-based architectures, PaLM supports an accurate contextual understanding to generate relevant and coherent responses. By taking multi-modal knowledge base and the deep-learning training models as input, the PaLM works on fine-tuning those input data to form Question & Answering system.

F. Question and Answering system formation

Q& A system will be designed using Multi-Modal Generative AI framework that will be executed by the Prompt Engineering (PE) process. The PE process has the capabilities of processing, analyzing and retrieving the

relevant prompts in text and video formats. The Table II presents the types of prompts to be considered for the Q&A design. Once the PaLM model is formulated with the responses, the prompts are structured from the contexts of basic question, contextual questions, benefits extraction, comparative question and use-case scenario. The efficiency of the PaLM model is achieved by the effective Prompt Engineering process in related to Ayush herbs.

V. INSIGHTS TO BUILD REAL-TIME SYSTEM

The design of a question-and-answering system via the PaLM and Prompt Engineering for Ayush herbs presents a set of challenges. The computational costs, interpretability, and robustness are the technical challenges to these models. However, the complexity of the task is further heightened by the challenges of integrating multi-modality and ensuring the efficacy of the Generative AI algorithms. Key challenges include high computational costs due to the extensive resources needed for training. Overfitting is also a concern, as the model may generate irrelevant responses if it picks up on noisy patterns that necessitating a balanced training dataset. The reasoning and planning capabilities of the models remain limited that could affecting inference tasks. Additionally, PaLM models may produce "hallucinations," where responses are misaligned with facts. Finally, prompt engineering is crucial, as variations in syntax and semantics significantly impact output quality.

VI. CONCLUSION

This paper emphasizes the scope of Ayush herbs and personalized herb consultations of the Ayush industry by unleashing the full potential of generative AI in healthcare management systems. This intersection of tradition and modern science highlights medicinal herb's ongoing importance in preventive and curative health systems. The study encompasses the roadmap to realize the efforts of designing personalized medicinal herb consultations for Ayush by nurturing and leveraging each system component, data source, data augmentation, data fusion, deep learning-oriented training system, LLM construction and Question-Answering design. Investing in tailored Generative AI algorithms, addressing the multi-modal data aspects, and promoting the Ayush herbs will pave the way for successful AI-driven healthcare advancements. By surmounting the multi-modal knowledge base, classification, and recommendation issues, the transformative capabilities of Generative AI can be unlocked in enhancing patient outcomes and modernizing healthcare in India.

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