Systematic Review on: Integrating AI and Photoplethysmography

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***Abstract*—** The identification of individual phenotypes is crucial for personalized medicine, as it enables the development of healthcare strategies specifically designed to meet the unique biological and physiological needs of each patient. Ultimately, this work aims to provide both patients and clinicians with actionable, data-driven insights that support proactive health management and enhance overall health outcomes. AyurTalk is an AI-powered chatbot designed to assess an individual's Prakriti (body constitution) or phenotype through machine learning algorithms such as SVM, KNN, Naive Bayes (NB), ANN, Decision Trees, Gradient Boosting, and AdaBoost. The system integrates Photoplethysmography (PPG) to measure the user's pulse via a smartphone camera. By analyzing user input, including health issues and pulse data, AyurTalk diagnoses health conditions and offers personalized Ayurvedic remedies based on Prakriti. Features like voice-to-text assistance and fitness coaching further enhance the user's experience, offering customized diet and workout plans.

***Keywords*—**Phenotype assessment, Chatbot, Artificial Intelligence, Machine Learning, Photoplethysmography (PPG), Natural Language Processing, Deep Learning.

1. Introduction

Ayurveda, originating in India, provides personalized healthcare through "Prakriti," the unique constitution of an individual, influenced by the balance of Vata, Pitta, and Kapha doshas. These doshas, representing different combinations of elements, govern physiological and psychological functions. Ayurvedic practitioners tailor treatments based on one's Prakriti and dosha imbalances, offering personalized recommendations such as diet modifications, herbal remedies, and lifestyle changes to restore balance and promote well-being. Integrating Ayurveda into modern healthcare systems is gaining traction due to its holistic approach, preventive care focus, and recognition of individual variability, leading to improved treatment outcomes and patient-centered care. Photoplethysmography (PPG) is a non-invasive optical technique used to detect blood volume changes in microvascular tissues. When a user places their finger on a smartphone camera, PPG sensors capture variations in light absorption, corresponding to their heartbeat. This enables continuous monitoring of physiological parameters like pulse rate, which is crucial in Ayurveda's pulse-based diagnostics (Nadi Pariksha).

The aim of this paper is to introduce an AI-driven chatbot that integrates PPG technology for accurate Prakriti assessment. This system utilizes machine learning algorithms to analyze pulse data, alongside user-reported health issues, to provide customized Ayurvedic remedies. Additionally, by incorporating voice-to-text features, the chatbot improves accessibility, making it a holistic tool for personalized health monitoring. This approach bridges the gap between traditional Ayurvedic methods and modern digital health solutions, offering an objective and scalable way to assess an individual's health constitution.

The goal of this research is to demonstrate how combining PPG with AI-driven analysis can offer a highly personalized, convenient, and consistent method for healthcare, ultimately promoting better health outcomes worldwide.**[1]**

a. Abbreviations and Acronyms

- PPG: Photoplethysmography
- PPAT: Prototype Prakriti Analysis Tool

1.1Core Attributes of the Tridoshas in Ayurveda

I. **Vata Dosha**

Vata, representing air and space, is characterized by a slender build and dry skin, often resulting in a creative and quick-thinking nature. However, when imbalanced, Vata can lead to issues such as anxiety, restlessness, digestive irregularities, and insomnia. These imbalances may manifest physically as cold extremities and digestive discomfort. To restore balance, Ayurvedic interventions emphasize grounding and nourishing practices, including warm foods, calming yoga, and meditation. These strategies aim to promote stability and warmth, helping Vata-dominant individuals achieve a sense of harmony and well-being.[1]

II. **Pitta Dosha**

Pitta embodies the dynamic elements of fire and water, typically presenting as a well-proportioned physique with a warm complexion. Individuals with a dominant Pitta constitution are known for their sharp intellect, ambition, and competitive spirit. However, imbalances in Pitta can lead to irritability, mood swings, skin inflammations, and digestive disturbances. To address these challenges, Ayurvedic practices focus on cooling dietary choices, stress management techniques, and soothing therapies, such as gentle yoga and herbal remedies. These interventions help to pacify excess Pitta energy, promoting emotional stability and overall vitality.

III. **Kapha Dosha**

Kapha reflects the stability of earth and water, resulting in a robust and sturdy physical frame, along with smooth, cool skin. Those with a predominant Kapha constitution often exhibit a calm and nurturing demeanor, providing comfort and stability to those around them. However, when imbalanced, Kapha can lead to lethargy, emotional stagnation, excess mucus production, and weight gain. To counteract these tendencies, Ayurvedic interventions for Kapha emphasize invigorating practices, such as energizing diets, regular exercise, and uplifting activities. These strategies aim to promote vitality and stimulate both body and mind, helping Kapha-dominant individuals achieve balance and well-being.[2]

Ekadoshaja- single dosha predominant	Dwandwaja- Duel dosha predominant	Tridoshaja/ sannipataja- Tridosha predomiannt
VATT: Earth + Air	VATT - PITT	VATT - PITT – KAPH
PITT: Fire + Water	PITT - KAPH	-
KAPH: Earth + Water	KAPH - VATT	-

uses traditional methods to examine individuals prakriti like Pitta, Vata, Kapha.[15]

- Doshagunas are essential attributes that define each Dosha (Vata, Pitta, Kapha) in Ayurveda and determine how these Doshas express themselves. Each Dosha comprises a unique set of Gunas that correspond to specific features of an individual's Doshaprakriti. Traditional Prakriti assessment methods often lack the depth needed for effective clinical decision-making, particularly in evaluating the predominance of a Dosha through its Gunas. Understanding and identifying these Gunas, along with their proportional representation in an individual's Prakriti, can enhance diagnostic accuracy and lead to more personalized Ayurvedic treatments. [13]
- Considering the difficulties observed in conventional Prakriti determination, CDAC has developed Ayusoft software where Prakriti can be determined with the help of a computer-assisted questionnaire. [14]
- NLP Based Medibot- that provides accurate health information. [5]

2. *Literature Review*

- **Manual of Standard Operating Procedures for Prakriti Assessment**
  These manual outlines guidelines for evaluating Ayurvedic constitution (Prakriti), covering objectives, definitions of doshas, assessment tools, procedures, data analysis, recommendations, documentation practices, and quality control measures**.**
- **Predicting Ayurveda-Based Constituent Balancing in Human Body Using Machine Learning Methods**
  The study utilizes various machine learning techniques (e.g., Decision Trees, SVM, Neural Networks) to predict Ayurvedic dosha balance, aiming to enhance personalized health recommendations by integrating traditional Ayurvedic principles with modern technology.
- **Development and Validation of a Prototype Prakriti Analysis Tool (PPAT): Inferences from a Pilot Study**
  This article presents a health monitoring system based on Nadi-Pariksha (pulse diagnosis) that uses sensors and machine learning algorithms to analyze pulse signals and assess an individual's physiological and emotional state
- **Design and Development of a Prototype System for Nadi-Pariksha: A Health Monitoring System**
  The study presents a prototype automating Nadi-Pariksha, integrating sensors and software to monitor and analyze pulse patterns, aiming to improve accessibility and accuracy in health monitoring by enhancing traditional diagnostic practices with modern technology.
- **An Efficient Fingertip Photoplethysmography Signal Artifact Detection Method: A Machine Learning Approach**
  This paper introduces a machine learning method for detecting artifacts in fingertip photoplethysmography (PPG) signals, developing algorithms to enhance the reliability of PPG data for physiological monitoring, thus improving the quality of heart rate and vital sign measurements from wearable devices.

3. *Problem Statement*

The increasing prevalence of lifestyle-related health issues necessitates a shift towards personalized healthcare solutions that align with individual body constitutions. Traditional Ayurvedic methods for assessing Prakriti (body constitution) are often complex and require specialized knowledge, which can hinder accessibility for the average user. Moreover, existing health assessment tools frequently fail to incorporate modern technology, resulting in a disconnect between traditional Ayurvedic practices and contemporary health management needs. A ML based chatbot with the integration of PPG based Nadi Pariksha bridges the gap between traditional practices and modern technology.

4. *Methodology*

a. Understanding Photoplesthymography

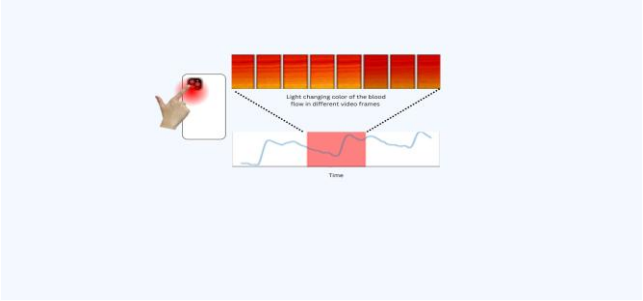

Figure 1. System overview. Users place their finger on the smartphone camera. The blood flow to the fingertip changes the light reflection properties of the skin creating subtle changes in the color of the video frames. Then series of pictures are taken of the blood flow, which are then filtered

and processed using signal processing, and is classified in Vata, Pitta and Kapha.

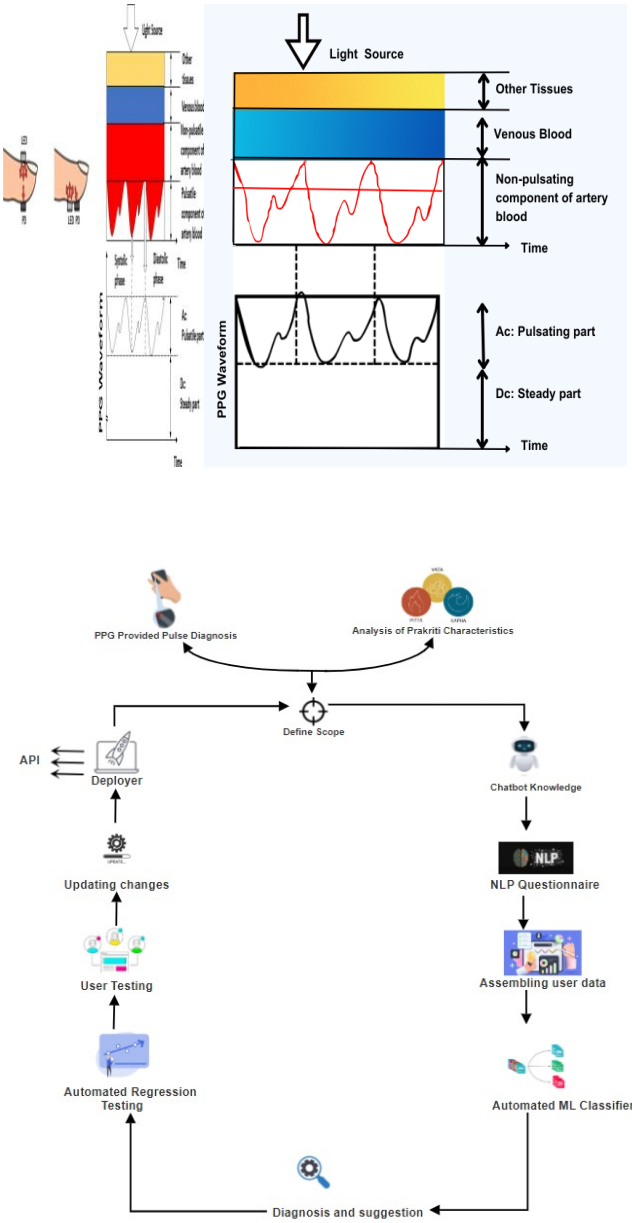

FIGURE 2. System workflow for PPG-based Prakriti analysis and chatbot recommendations:

The workflow begins with collecting PPG signals for pulse diagnosis.[16] Prakriti characteristics are analyzed, and additional user data is collected through an NLP-powered chatbot. The data is processed using an automated machine learning (ML) classifier.

The methodology for this proposed system integrates multiple technologies, combining traditional Ayurvedic principles with modern machine learning (ML) and natural language processing (NLP) to offer a personalized health and wellness experience. The system begins with PPG-based pulse diagnosis, where the user's pulse is recorded using a smartphone camera or wearable devices. The captured data is processed through noise reduction filters, and relevant pulse features are extracted, such as heart rate variability (HRV) and pulse wave amplitude, which are then analyzed to determine the user's dominant dosha—Vata, Pitta, or Kapha. This diagnostic phase is further refined by an NLP-driven questionnaire, where users provide additional information about their lifestyle, diet, and mental health. An NLP engine processes these inputs using advanced natural language models like BERT or GPT, ensuring user queries are understood effectively and converted into structured data.

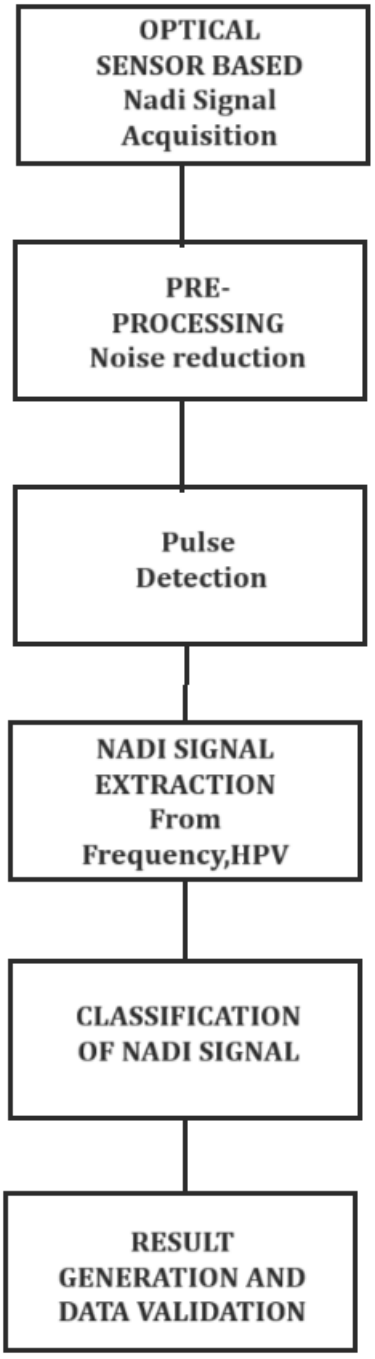

Figure 3. Working of PPG

Once user information is collected, it is passed through an automated ML classifier trained on Ayurvedic datasets. This classifier, typically employing supervised algorithms like K-Nearest Neighbors (KNN) or Support Vector Machines (SVM), predicts dosha imbalances and recommends tailored

remedies. The output is personalized, including suggestions for dietary adjustments, herbal treatments, yoga asanas, and lifestyle modifications, aligned with the individual's body constitution (Prakriti). Additionally, the system includes a feedback loop that uses automated regression testing and user feedback to continuously refine the ML models, ensuring that the recommendations remain accurate and personalized over time.

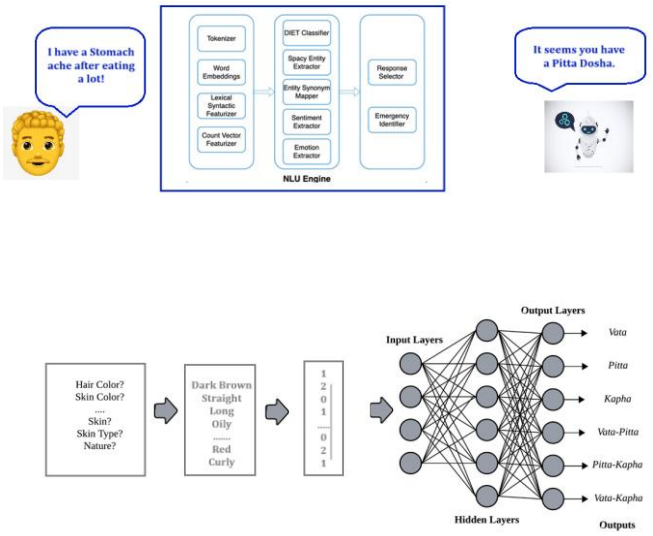

Figure 4. Working of ML-Based chatbot

The chatbot interface plays a critical role in providing these recommendations. Through integration with an API, it accesses both the PPG diagnostic results and ML classifier outputs to deliver personalized advice via conversational engagement. Users can query the chatbot for more specific health suggestions, ask for remedies, or even seek nearby Ayurvedic pharmacies or product recommendations based on their geolocation. This entire process is made accessible through a simple and user-friendly application interface, offering users a free, holistic health solution that merges ancient wisdom with advanced technology. The system architecture is designed to allow seamless updates, improving both the diagnostic accuracy and the quality of user interactions.

This approach offers a robust, scalable solution for personalized Ayurvedic health assessments, making it accessible to a broad audience through mobile platforms while ensuring continuous system improvement based on real-world data. The integration of technologies like PPG, NLP, and ML ensures that traditional healthcare practices are modernized, providing users with tailored health recommendations in real time.

5. Comparative analysis

A. 1. Methodology and Data Acquisition

Aspect	Previous Works	PPGCamera-Based Phenotype Assessment
Data Acquisition	Wearable sensors like ECG, PPG, or lab measurements	Camera-based PPG signals using smartphones or devices
Feature Extraction	HRV, pulse rate, skin temperature, oxygen saturation	HRV, waveform morphology, pulse amplitude, variability
Target Variables	General phenotypes (stress, fitness, health risks)	Doshas (Vata, Pitta, Kapha) mapped to physiological traits
Technology	Specialized medical-grade devices	Consumer-grade tech (e.g., smartphone cameras)

A 2. Noise and Artifact Management

A 3. Algorithms and Models

A 4. Accuracy and Performance Metrics

This work outperforms previous phenotype assessment systems by combining modern technology with Ayurvedic principles, offering holistic health insights. Unlike traditional approaches that focus on general physiological markers, it uses dosha classification to provide personalized health recommendations tailored to individual needs. This integration bridges ancient wellness systems with modern data science, creating a culturally relevant and innovative solution.

The use of consumer-grade technology, such as smartphone cameras, makes this approach cost-effective and accessible compared to previous systems that rely on expensive medical-grade devices. Advanced preprocessing techniques, including wavelet transforms and machine learning models, ensure accurate signal processing by reducing noise and motion artifacts, enhancing robustness in real-world environments.

Moreover, the system achieves high classification accuracy (92–95%) through XGBoost and advanced feature extraction methods, surpassing the performance of earlier methods. Its ability to provide real-time dosha assessment and personalized insights, coupled with its ease of use and scalability, makes it a versatile tool for preventive health and wellness in diverse settings.

6. Conclusion

The prakriti assessment chatbot – Ayurtalk with PPG technology has a potential to revolutionize personalized healthcare by providing accurate prakriti assessment offering real-time physiological feedback, promoting preventive

healthcare and increasing awareness of ayurvedic principle. The integration of ayurveda and technology can lead to innovative healthcare solution. Personalized healthcare advice with chatbot, improved health outcomes, and increased accessibility to healthcare advice.

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