

Integration of Artificial Intelligence in Ayurvedic Diagnostic Methods: A Comprehensive Systematic Review

Dinesh Rathod^{1*}, Rajiv Mundane², Sanjay Pawade³

1. P. G. Scholar,
2. Professor and Principal,
3. Assistant Professor and Guide,

Department of Rognidan Evum Vikruti Vigyan,

D.M.M. Ayurved Mahavidyalaya, Yavatmal, Maharashtra, India

*Corresponding Author: vddineshrathod@gmail.com

Abstract

Ayurveda, the ancient Indian system of medicine, relies on a highly personalized, holistic approach to healthcare, fundamentally rooted in the equilibrium of the *Tridoshas* (*Vata*, *Pitta*, and *Kapha*). Traditionally, *Ayurvedic* diagnostics depend on the subjective expertise of practitioners through multi-modal clinical examinations, most notably the *Ashtavidha Pariksha* (eight-fold examination) and *Prakriti* (innate constitution) analysis. However, the subjective nature of these methods introduces inter-observer variability and limits their integration into modern, evidence-based healthcare systems. The advent of Artificial Intelligence (AI), encompassing machine learning (ML), deep learning (DL), computer vision, and natural language processing (NLP), has initiated a paradigm

shift toward objective, data-driven, and scalable diagnostic methodologies. This comprehensive review examines the intersection of AI and *Ayurvedic* diagnostics, exploring current technological integrations across *Nadi Pariksha* (pulse), *Jihva Pariksha* (tongue), *Drik Pariksha* (eye), *Mutra Pariksha* (urine), and other classical assessment protocols. Recent literature indicates that AI-driven algorithms achieve high diagnostic accuracies—often exceeding 85% to 95%—in *Dosha* classification, *Prakriti* phenotyping, and disease prediction. The synthesis of wearable sensors, Internet of Things (IoT) devices, and sophisticated ML models facilitates the quantification of previously intangible *Ayurvedic* concepts. Furthermore, this report delineates the emergence of *Ayurgenomics*, AI-assisted Clinical Decision Support Systems (CDSS), and automated detoxification

monitoring (*Panchakarma*). While the convergence of these epistemological systems presents unprecedented opportunities for integrative healthcare, significant challenges pertaining to data standardization, algorithmic interpretability, and rigorous clinical validation remain. By establishing a robust, evidence-based framework, AI possesses the potential to democratize Ayurvedic medicine, ensuring global accessibility while preserving its fundamental holistic essence.

Keywords: Artificial Intelligence, *Ashtavidha Pariksha*, *Ayurveda*, *Ayurgenomics*, Deep Learning, Machine Learning, *Nadi Pariksha*, *Prakriti* Analysis.

Introduction

The foundational epistemology of Ayurveda postulates that human physiology, pathology, and psychology are governed by three dynamic bio-energies, or *Doshas*: *Vata* (kinetic energy), *Pitta* (thermal and metabolic energy), and *Kapha* (cohesive and structural energy).³ True health (*Swasthya*) is defined as the dynamic equilibrium of these *Doshas*, alongside balanced *Dhatus* (tissues), *Agni* (digestive and metabolic fire), and *Malas* (excretory products), coupled with profound sensory, mental, and spiritual well-being.⁵ Conversely, pathogenesis occurs when these bio-energies become vitiated due to environmental, dietary, or psychological stressors, leading to the accumulation of toxic byproducts known as *Ama*.

For millennia, the diagnosis of disease (*Vyadhi Vinischaya*) and the determination of an individual's innate constitution (*Prakriti*) have been executed through rigorous clinical examinations. The most prominent and comprehensive of these

frameworks is the *Ashtavidha Pariksha*, an eight-fold examination detailed by classical authorities such as *Acharya Yogaratnakara*.⁷ This protocol encompasses *Nadi* (pulse), *Mutra* (urine), *Mala* (stool), *Jihva* (tongue), *Shabda* (speech/voice), *Sparsha* (touch/palpation), *Drik* (eyes), and *Akriti* (general appearance).⁷ The physician synthesizes data from these eight vectors to construct a holistic profile of the patient's internal metabolic environment.

Despite its profound clinical utility and historical success, traditional Ayurvedic diagnosis faces substantial challenges in the contemporary, evidence-based healthcare landscape. The heavy reliance on the physician's subjective sensory perception, extensive clinical experience, and inferential logic inevitably introduces inter-observer variability.¹⁰ The subtle nuances of pulse rhythms, the visual grading of tongue coatings, or the olfactory assessment of excretions are inherently difficult to quantify, standardize, and transmit across modern global healthcare systems.¹⁰ This subjective barrier has historically hindered the widespread integration of Ayurvedic practices into mainstream clinical workflows and large-scale public health initiatives.

Artificial Intelligence (AI) has emerged as a revolutionary technological catalyst capable of bridging this significant epistemological gap. By emulating human cognitive and perceptual processes—specifically through computer vision, complex pattern recognition, natural language processing (NLP), and predictive analytics—AI provides the necessary computational infrastructure to digitize, quantify, and standardize Ayurvedic diagnostics.¹² The integration of AI

facilitates a monumental transition for traditional medicine: moving from episodic, subjective, doctor-centric evaluations to continuous, objective, real-time, and patient-centric diagnostic monitoring.¹⁰ By transforming qualitative ancient heuristics into measurable, data-driven algorithms, AI enables the empirical validation of Ayurveda. This comprehensive review exhaustively details how specific branches of artificial intelligence are currently being engineered to augment each facet of Ayurvedic diagnosis, thereby transforming an ancient healing art into an evidence-based, computationally rigorous science.

Methodology

To ensure a comprehensive and rigorous synthesis of the current landscape regarding AI in Ayurvedic diagnostics, a systematic literature search strategy was employed, drawing upon methodological frameworks established in recent high-impact reviews.¹ The objective was to map applications of machine learning, deep learning, computer vision, and natural language processing across all modalities of traditional Ayurvedic examination.

The literature search encompassed major electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, Cochrane Library, Google Scholar, and specialized AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy) research portals. The temporal scope of the search was concentrated primarily on the rapid technological advancements published between January 2020 and July 2025, capturing the exponential growth in AI integration.¹ A combination of Boolean operators and controlled vocabulary (MeSH terms) was utilized. Search strings included

variations of "Artificial Intelligence," "Machine Learning," "Deep Learning," and "Natural Language Processing" combined with traditional Ayurvedic terms such as "*Ayurveda*," "*Prakriti*," "*Dosha*," "*Nadi Pariksha*," "*Ashtavidha Pariksha*," "*Jihva*," and "*Taila Bindu*."

Inclusion criteria were strictly defined to encompass peer-reviewed original research articles, comprehensive reviews, validated case studies, and technological conference proceedings that explicitly detailed the application of a computational or algorithmic model to an Ayurvedic diagnostic methodology.¹ Articles focusing solely on conventional modern diagnostics without an Ayurvedic conceptual framework, as well as unvalidated opinion pieces or non-peer-reviewed grey literature, were excluded to maintain scientific rigor.² Data extraction focused on the type of AI methodology deployed, the specific Ayurvedic diagnostic modality targeted, the sample size of the computational validation, the accuracy metrics of the models, and the clinical implications of the findings. The synthesized data were then categorized thematically according to the classical examination frameworks.

AI-Driven Prakriti Analysis: Quantifying the Human Constitution

Prakriti represents an individual's unique psychosomatic constitution, established at the exact moment of conception through the combination of parental bio-energies, and it remains relatively immutable throughout the individual's lifespan.¹ It dictates an individual's physical characteristics, physiological responses to environmental stimuli, basal metabolic rates, immunological resilience, and psychological predispositions.¹⁴ There are

seven primary types of Prakriti based on the dominance of single or combined *Doshas* (*Vata*, *Pitta*, *Kapha*, *Vata-Pitta*, *Pitta-Kapha*, *Vata-Kapha*, and *Sama* or balanced). Accurate Prakriti assessment is the absolute bedrock of Ayurvedic personalized medicine, serving as the foundational compass for all subsequent dietary, lifestyle, and therapeutic interventions.¹²

Machine Learning and Multi-Modal Data Fusion

Traditionally, Prakriti is assessed through extensive clinical interrogation (*Prashna Pariksha*) and observational heuristics, requiring the physician to synthesize dozens of physical and psychological traits.¹ This process is highly time-consuming and prone to subjective interpretation. Since 2020, substantial research has concentrated on replacing manual, paper-based questionnaires with automated, AI-driven Clinical Decision Support Systems (CDSS).¹ Modern AI architectures utilize multi-modal data fusion, combining phenotypic, biometric, and behavioral datasets to achieve Prakriti classification accuracies ranging from 90% to 95%.¹

To operationalize this highly complex classification, data is systematically captured and processed across several distinct technological vectors. First, Natural Language Processing (NLP) is deployed through automated digital chatbots and sophisticated questionnaires. These systems conduct structured interrogations (*Prashna Pariksha*), extracting nuanced behavioral and psychological data from patient responses.¹⁰ NLP algorithms parse natural text for symptom clustering, identifying underlying psychological traits (such as

anxiety indicative of *Vata*, or irritability indicative of *Pitta*) with high precision.¹¹

Second, Computer Vision is utilized to digitize *Akriti Pariksha* (the examination of physical appearance). Deep learning algorithms analyze high-resolution facial and full-body images to quantify physical attributes such as skin texture, structural pallor, facial geometry, eye shape, and lip morphology.¹³ For instance, a *Vata*-dominant constitution often correlates with dry, rough skin, a slender frame, and angular facial features, while a *Kapha*-dominant constitution aligns with smooth, oily skin, a broad frame, and rounded features. Convolutional Neural Networks (CNNs) process these visual pixel arrays to extract feature vectors, outputting a probabilistic *Dosha* distribution that maps precisely to classical texts.¹⁰

Third, Biometric and Wearable Data Integration plays a crucial role. Real-time continuous monitoring via Internet of Things (IoT) devices feeds physiological data—such as heart rate variability, sleep architecture, galvanic skin response, and basal body temperature—directly into supervised machine learning models.¹⁷ This allows for a dynamic assessment of how a patient's baseline Prakriti responds to real-world stressors, facilitating a deeper understanding of current imbalances (*Vikriti*).

Ayurgenomics and the Microbiome Link

Perhaps one of the most profound scientific advancements facilitated by AI is the rapid rise of *Ayurgenomics*, an interdisciplinary field that seeks robust biological and genetic correlates for traditional Ayurvedic phenotypes.¹ Advanced predictive models are increasingly utilizing deep neural networks to map vast datasets of genomic

markers (Single Nucleotide Polymorphisms or SNPs) to specific Prakriti types. This computational heavy lifting proves that Prakriti is not a mere philosophical construct but a genetically encoded reality.

Furthermore, recent exploratory studies have highlighted the gut microbiome's critical role in this diagnostic paradigm. Deep learning models can successfully predict an individual's Prakriti based solely on their gut microbiome composition. Computational analysis has revealed that certain microbial genera exhibit statistically significant variations across Vata, Pitta, and

Kapha individuals.¹ By utilizing random forest classifiers and deep learning to analyze 16S rRNA sequencing data, AI acts as a translation engine. It proves that ancient holistic categorizations are robust biological clusters, allowing practitioners to leverage modern systemic biology to validate ancient wisdom.¹⁰

Table 1, cited below, delineates the specific computational algorithms currently deployed in the assessment of Prakriti, highlighting the convergence of traditional modalities with modern technological interventions.

Table 1: Computational Algorithms Deployed in Prakriti Assessment

Diagnostic Vector	AI/ML Modality	Analyzed Features	Clinical Utility
Prashna (Interrogation)	NLP, Chatbots, Decision Trees	Psychological traits, behavioral patterns, digestive habits	Automated questionnaire scoring, subjective symptom clustering ¹⁰
Akriti (Appearance)	Computer Vision, CNNs	Skin texture, facial geometry, eye clarity, hair type	Objective physical phenotyping, non-invasive Dosha mapping ¹³
Ayurgenomics	Deep Learning, Neural Networks	DNA polymorphisms, gut microbiome profiles	Correlating genetic markers with Dosha dominance ¹
<i>Source: Original synthesis based on reviewed literature.</i>			

Digital Transformation of the Ashtavidha Pariksha

The Ashtavidha Pariksha remains the most comprehensive and clinically utilized

diagnostic framework in practical Ayurveda. The comprehensive digitalization of these eight distinct parameters relies on the deployment of

varied sensing technologies, signal-processing algorithms, and sophisticated machine learning classifiers.

1. Nadi Pariksha (Pulse Diagnosis)

Nadi Pariksha is unequivocally the preeminent diagnostic tool in traditional Ayurveda, historically requiring decades of specialized clinical training and heightened tactile sensitivity to master.¹⁸ The physician palpates the radial artery at the wrist using three fingers—the index, middle, and ring fingers—to assess the subtle rhythms and amplitudes of the Vata, Pitta, and Kapha pulses, respectively.³ AI and sensor technology have revolutionized this practice, initiating a massive shift from a qualitative, highly subjective art to a quantitative, sensor-based, reproducible science.³

Technological Architecture and Signal Acquisition Modern automated Nadi Pariksha systems employ highly sensitive arrays of sensors to capture the pulse waveforms from the radial artery.³ The two primary modalities are piezoelectric pressure sensors, which measure the mechanical force of the expanding artery, and photoplethysmography (PPG) sensors, which use infrared light to measure volumetric changes in blood flow. These sensors capture hemodynamics at the three specific spatial locations correlating to the traditional *doshic* points.¹⁸ Because human pulse signals are highly susceptible to motion artifacts, respiratory interference, and baseline wander, the raw analog signals undergo rigorous digital pre-processing. Recent comparative studies indicate that moving average filters and Butterworth low-pass filters exhibit the highest efficiency for isolating the pure Nadi signal from environmental noise.¹⁸

Feature Extraction and Machine Learning Classification Once the analog pulse signal is digitized and filtered, sophisticated algorithms extract both time-domain and frequency-domain features. These modern hemodynamic metrics—such as pulse wave velocity, arterial stiffness indices, and pulse rate variability—are mathematically mapped to the traditional qualitative concepts of *Gati* (movement or gait, often compared to the movement of animals like a swan or frog), *Vega* (rate), *Tala* (rhythm), *Bala* (force), and *Kathinya* (consistency of the vessel wall).¹⁸

Following feature extraction, machine learning classifiers are deployed to categorize the pulse. Algorithms such as Support Vector Machines (SVM), K-Nearest Neighbors (KNN), Decision Trees (DT), and Artificial Neural Networks (ANN) process these high-dimensional feature vectors. Experimental validations of these models, analyzing vast datasets from hundreds of human volunteers across varying age groups and health statuses, have demonstrated remarkable efficacy. Specifically, the implementation of DT and KNN classifiers has achieved classification accuracies of up to 92% in distinguishing healthy subjects from non-healthy subjects, and consistently achieves over 85% accuracy in the precise sub-typing of specific Dosha imbalances.¹⁰

Clinical Implementation and Cloud Integration Advanced commercial devices such as the *Nadi Tarangini* and *Tridosho Scanner* exemplify the successful clinical integration of these technologies.¹³ The *Nadi Tarangini*, an AI-powered, sensor-based pulse diagnostic device, utilizes these cutting-edge algorithms to rapidly analyze

22 distinct Ayurvedic parameters.³ Beyond basic *Tridosha* balance, the system evaluates stress indices, overall systemic well-being, and most importantly, the status of *Jatharagni* (digestive fire), which is the cornerstone of preventive health in Ayurveda.³ By seamlessly uploading the captured pulse signals to dedicated IoT cloud platforms, these modern systems enable continuous, longitudinal health monitoring. This paradigm allows practitioners to track subtle physiological shifts over time, predict disease trajectories before clinical manifestation, and precisely customize treatments based on real-time, empirical data rather than isolated clinic visits.²⁰

2. Jihva Pariksha (Tongue Diagnosis)

In Ayurvedic physiology, the tongue serves as an exposed, highly vascularized topological map of the internal organs and the gastrointestinal tract. Jihva Pariksha evaluates specific variables—namely the tongue's color, physical shape, structural indentations, localized moisture, and the distribution of coating (*Kleda*)—to diagnose impairments in the digestive fire (*Agni*) and the accumulation of systemic metabolic toxins (*Ama*).²¹

Computer Vision and Deep Learning Integration AI models completely replace the subjective visual assessment of the tongue with precise, mathematical digital image processing. Using standard smartphone cameras or specialized enclosed imaging hardware that controls for ambient lighting, high-resolution images of the tongue are captured. These images are initially subjected to advanced pre-processing techniques, including watershed segmentation to isolate the tongue body from the background (lips, teeth, face),

followed by color space transformations (e.g., converting RGB color spaces to CIELAB or HSV) to isolate hue and saturation without the interference of localized shadows.²¹

Subsequently, deep learning models, particularly Convolutional Neural Networks (CNNs) and Random Forest ensemble algorithms, analyze these segmented images to extract highly specific quantitative features. Color histograms are generated to identify subtle discolorations directly linked to *Dosha* imbalances; for example, an excessively yellowish or greenish coating indicates *Pitta* vitiation, a thick whitish coating implies *Kapha* dominance, and a dark, cracking appearance points to *Vata* aggravation.¹⁰ Texture analysis matrices are applied to determine the exact thickness, density, and spatial distribution of the tongue coating, which correlates directly to the severity of *Ama* accumulation.¹ Furthermore, geometric shape descriptors map physical indentations along the margins of the tongue (often indicating malabsorption) or central fissures (indicating *Vata* accumulation in the colon).¹⁰ Current empirical data derived from these studies suggests that AI-assisted Jihva Pariksha models consistently achieve over 85% accuracy in generalized disease categorization and greater than 75% accuracy in complex, multi-doshic typing, offering a reliable, non-invasive diagnostic adjunct.¹⁰

3. Drik Pariksha (Eye Examination)

Drik Pariksha entails the meticulous evaluation of ocular characteristics to deduce systemic metabolic and neurologic imbalances. Classical Ayurvedic treatises provide highly detailed semiotics regarding

how specific ocular manifestations correlate with the Doshas. Aggravation of Vata yields eyes that are excessively dry, sunken, uncharacteristically mobile, and reddish-brown; Pitta vitiation leads to distinct yellowing of the sclera, acute redness, burning sensations, and photophobia; while Kapha predominance results in excessively watery eyes, heavy eyelids, and a thick, whitish secretion.²³

Ophthalmic AI and Ayurvedic Semiotic Correlation In contemporary allopathic settings, artificial intelligence has already demonstrated exceptional proficiency in ophthalmology, specifically in analyzing retinal fundus images and anterior segment photographs to autonomously diagnose conditions such as diabetic retinopathy and Dry Eye Disease (DED).²⁴ In an integrative Ayurvedic clinical context, these exact computer vision modalities and imaging devices are being thoughtfully repurposed.

A recent comprehensive narrative review exploring the intersection of AI and DED highlights how machine learning algorithms rapidly process diverse ocular symptoms, meibomian gland dysfunction parameters, and tear film instability metrics.²⁴ From a classical Ayurvedic perspective, DED is recognized as a quintessential manifestation of systemic Vata imbalance, characterized primarily by *Rukshata* (dryness) and a localized loss of lubricating Kapha.²³ Advanced AI facial scanning and high-definition anterior ocular imaging algorithms can now track microscopic changes in scleral color, perilimbal vascularity, and corneal moisture indices. This offers practitioners real-time, objective feedback on systemic vitality (Ojas) and specific Dosha vitiations.¹⁶ By mathematically bridging AI-driven

ophthalmic imaging with classical Ayurvedic ocular semiotics, practitioners gain a powerful, non-invasive tool for early systemic disease detection long before overt physical symptoms manifest throughout the broader physiology.¹⁶

Figure 1 provides a conceptual map of this integration. (Note: Figure 1 is cited here in accordance with author instructions).

Figure 1: Conceptual mapping of conventional ophthalmic imaging algorithms to classical Drik Pariksha (Eye Examination) parameters for the automated detection of Dosha imbalances.

Source: Original conceptual framework based on synthesized literature.

4. Mutra Pariksha (Urine Examination) and Taila Bindu Analysis

Mutra Pariksha involves assessing the qualitative, functional, and physical characteristics of urine to gauge the body's hydration, metabolic waste clearance, and renal function. Within this domain exists a highly specialized, historically significant prognostic and diagnostic test known as *Taila Bindu Pariksha* (the oil drop test). In this procedure, a single drop of sesame oil is gently deposited onto the surface of an early morning urine sample collected in a standardized vessel. The resulting spread pattern, geometric direction, and speed of dispersion offer profound prognostic insights.²⁶

Algorithmic Interpretation of Fluid Dynamics Historically, the interpretation relies on visual pattern recognition: if the oil drop assumes a rapid, snake-like shape, it indicates a Vata disorder; an umbrella or ring shape signifies a Pitta disorder; and a dense, pearl-like shape indicates a Kapha disorder.²⁸ Sieve-like spreading suggests

deep-seated genetic or hereditary predispositions (*Kuladosha*).²⁸ Furthermore, the direction of the spread indicates the prognosis (*Sadhya* or *Asadhya*) of the disease.²⁶

While traditional interpretation relies heavily on the observer's visual acuity and experience, the rigorous standardization of this test is currently underway. Artificial intelligence, specifically deep learning computer vision, is uniquely suited to analyze these complex, non-linear fluid dynamics. By recording the oil drop's dispersion via overhead high-resolution video, computer vision algorithms can trace the topological boundary of the spread pixel by pixel, calculate precise surface area expansion rates, and mathematically define the resulting geometric shapes.²⁷ The physical properties governing this test—surface tension, fluid viscosity, and the specific gravity of the urine—are altered by the patient's pathological state. Though AI applications in Taila Bindu Pariksha are still in the nascent conceptual and early experimental phases, the theoretical framework for utilizing CNNs to autonomously classify these specific dispersion patterns represents a fascinating frontier in highly objective Ayurvedic urinalysis.⁵

5. Mala Pariksha (Stool Examination)

Mala Pariksha is critical for assessing the efficiency of the digestive fire (*Agni*), the integrity of the gastrointestinal tract, and the presence of undigested, toxic metabolic waste (*Ama*). The classical examination focuses on the consistency, color, buoyancy (whether it sinks or floats in water), and odor of the feces.⁷

Mobile Application Integration and Image Processing Recent research has

proposed and developed smartphone-based digital health applications that leverage ML specifically for Purisha (stool) Pariksha. Recognizing the inherent reluctance of patients to handle stool samples, these applications utilize computer vision. By capturing standard images of the stool in the toilet bowl, Python-based ML algorithms analyze visual features (color, texture, form) against a comprehensive digital repository of classically defined physiological and pathological stool conditions.³⁰ This image-based CNN processing enables the user or practitioner to instantly, and hygienically, differentiate between *Saama* (stool containing toxins, which typically sinks and is foul-smelling) and *Niraama* (toxin-free stool, which floats and is well-formed) states. This allows for an objective, daily assessment of Agnibala (digestive strength) directly from the patient's home, drastically improving longitudinal data collection.³⁰

6. Shabda Pariksha (Voice and Acoustic Examination)

Shabda Pariksha involves the careful auscultation of all bodily sounds, predominantly including the patient's voice, respiratory wheezes, joint crepitus, and gastrointestinal borborygmi. Ayurveda asserts that an individual's vocal timbre, pitch, and cadence are deeply influenced by their constitutional Dosha and current state of health.³¹

Acoustic Signal Processing and Vocal Biomarkers AI effectively automates Shabda Pariksha through the application of sophisticated audio signal processing and NLP. By analyzing audio waveforms and generating spectrograms derived from brief samples of patient speech or coughing patterns, AI models execute highly precise

frequency analysis and acoustic profiling.³¹ From a clinical perspective, a rough, hoarse, or broken voice is strongly indicative of Vata; a sharp, intense, commanding tone relates to Pitta; and a deep, resonant, slow voice aligns with Kapha.³² Machine learning algorithms extract specific acoustic biomarkers such as fundamental frequency (pitch), jitter (frequency instability), shimmer (amplitude instability), and formants.³¹ These algorithms compare the extracted acoustic features against known pathological acoustic states—such as *Shwasa* (dyspnea/asthma) and *Kasa* (coughing disorders)—to yield rapid, non-invasive diagnostic correlations that augment the physician's auditory examination.³¹

7 & 8. Sparsha (Touch/Palpation) and Akriti (Appearance) Pariksha

While Nadi Pariksha is the most universally recognized form of Sparsha (touch), the classical examination extends to assessing localized body temperature, skin texture, moisture, and tissue firmness across the entire body. AI augments Sparsha Pariksha through the deployment of wearable biometric sensors and IoT devices. These

devices continuously monitor tactile surrogates such as micro-temperature gradients, galvanic skin response (which indicates sympathetic nervous system arousal and localized sweating), and dermal hydration levels, providing a continuous stream of data regarding dermal Vata (dryness) or Pitta (heat).¹⁰

Akriti Pariksha evaluates the general body build, skeletal structure, posture, and gait of the patient.⁸ Deep learning-based pose estimation models and advanced computer vision algorithms are utilized to analyze human biomechanics in real-time clinical settings. These systems detect subtle postural asymmetries, joint inflammation and immobility (as characteristically seen in *Sandhigata Vata* or osteoarthritis), and overall body mass indices. This automatically and seamlessly integrates these complex morphological and kinetic datasets into the patient's comprehensive Ayurvedic digital profile.³²

Table 2, cited below, systematically maps the integration of AI technologies across all eight modalities of the Ashtavidha Pariksha.

Table 2: AI Integration Across the Eight Modalities of Ashtavidha Pariksha

Classical Examination	Sensory Modality	AI Technological Intervention	Diagnostic Output
<i>Nadi</i> (Pulse)	Palpation	PPG, Piezoelectric sensors, Time/Frequency domain ML	Dosha imbalance, cardiovascular stress, <i>Jatharagni</i> status ³
<i>Jihva</i> (Tongue)	Visual	CNNs, Color Space Transformation, Segmentation	Ama accumulation, digestive tract pathology ¹⁰

Drik (Eye)	Visual	Ophthalmic Image Processing, Retinal scanning	Systemic <i>Vata/Pitta</i> assessment, <i>Ojas</i> tracking ¹⁶
Mutra (Urine)	Visual/Fluidics	Digital video tracking, Pattern Recognition (Conceptual)	Disease prognosis via <i>Taila Bindu</i> geometric spreading ¹³
Mala (Stool)	Visual	Mobile App Image Classification (Python/CNN)	Agni strength, <i>Ama</i> vs. <i>Niraama</i> differentiation ³⁰
Shabda (Voice/Sound)	Auditory	Audio Spectrograms, Acoustic Biomarker extraction	Respiratory pathology (Shwasa/Kasa), vocal Dosha profiling ³¹
Sparsa (Touch)	Tactile	Wearable IoT sensors, Galvanic Skin Response	Tissue temperature, hydration, dermal <i>Vata/Pitta</i> assessment ¹⁰
Akriti (Appearance)	Visual	Pose Estimation, Facial recognition algorithms	Somatotype identification, postural/structural imbalances ⁸
<i>Source: Original synthesis mapping classical literature to modern computational methodologies.</i>			

Advanced AI Applications: CDSS and Therapeutic Emesis Monitoring

Moving beyond the basic digitization and mapping of diagnostic parameters, the profound convergence of AI and Ayurveda is currently yielding highly sophisticated clinical tools. These tools are capable of dynamic, multi-variable treatment planning and real-time procedural monitoring, elevating the standard of care.

Clinical Decision Support Systems (CDSS) and Deep Text Mining

The foundation of Ayurvedic knowledge is incredibly vast, encoded in ancient Sanskrit treatises collectively known as the *Brihatrayi* (the great triad), which includes the *Charak Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*.⁵ The sheer volume, poetic structure, and linguistic complexity of this textual data make exhaustive cross-referencing nearly impossible for a human

practitioner during a standard clinical encounter. Artificial Intelligence addresses this massive data retrieval challenge through Natural Language Processing (NLP) and Large Language Models (LLMs).

These NLP algorithms systematically mine classical texts, parsing millions of Sanskrit verses and their translations to construct structured, queryable ontological networks that map herbs, symptoms, disease pathogenesis, and contraindications.¹⁶ By simultaneously analyzing historical treatment paradigms alongside the patient's modern clinical data inputs, machine learning-driven CDSS engines achieve two major clinical feats. First, they predict disease risk; for instance, supervised AI algorithms have successfully analyzed a constellation of Ayurvedic diagnostic inputs (such as Prakriti, BMI, and Agni status) to predict the onset of gestational diabetes with remarkable accuracy, subsequently generating tailored Ayurvedic management protocols.¹ Second, they personalize herbal formulations; CDSS models compute the optimal individualized dosage of complex polyherbal formulations based on the patient's real-time Prakriti, gut microbiome health, and circadian rhythms. This computational precision maximizes therapeutic efficacy while preemptively identifying and avoiding potential herb-drug interactions, particularly when integrating Ayurvedic treatments with allopathic medications.¹

Automating Panchakarma: AI in Vamana Karma (Therapeutic Emesis)

Panchakarma constitutes the primary, intensive detoxification and purificatory therapies in Ayurveda, designed to violently but safely expel deep-seated

Doshas and Ama from the tissues. *Vamana Karma* (therapeutic emesis) is a specific Panchakarma procedure indicated for the expulsion of severely vitiated *Kapha Dosha* from the respiratory and upper gastrointestinal tracts.³³ Traditionally, the safety and efficacy of *Vamana* are judged entirely by the attending physician's continuous, highly subjective visual assessment of the vomitus (monitoring the number of bouts, the nature of the expelled content, and the patient's physiological signs of distress or relief).³³ This reliance on prolonged human observation introduces significant inter-observer variability, fatigue, and the inherent risk of human error in a potentially stressful clinical scenario.

Pioneering, paradigm-shifting research has recently introduced sophisticated deep learning frameworks designed to completely objectify the assessment of therapeutic emesis. By utilizing state-of-the-art object detection algorithms such as YOLOv9 (You Only Look Once) paired sequentially with ResNet classification architectures, AI systems process live, real-time video feeds of the entire *Vamana* procedure.³³ The AI framework operates autonomously to detect discrete vomiting events, rigorously classify the expelled biological content (specifically identifying the presence of *Kapha*/mucus, *Pitta*/bile, or concerning indicators like blood), accurately count the total number of emetic bouts, and continuously monitor the patient's facial expressions and body gestures for signs of cardiovascular or respiratory distress.³³ This technological marvel represents the very first digital framework designed for the objective, computerized evaluation of classical Ayurvedic purification therapies. The models are validated using standard

machine learning accuracy metrics and Fleiss kappa scores to ensure maximum agreement with expert human clinical assessments.³³

Discussion: Challenges, Limitations, and Ethical Considerations

While the integration of artificial intelligence into Ayurvedic diagnostics presents a breathtaking horizon for integrative medicine, it is not without significant methodological, epistemological, and ethical hurdles. Addressing these systemic challenges is paramount for the safe, effective, and ethically sound adoption of digital therapeutics in traditional medical systems.

1. Epistemological and Methodological Mismatches

At its core, Ayurveda is inherently holistic and systems-based, viewing the human patient as a deeply integrated psychosomatic entity governed by complex, non-linear environmental, spiritual, and internal factors.¹⁰ Conversely, contemporary machine learning algorithms frequently operate on highly reductionist principles, requiring discrete, independent, and quantifiable variables to optimize their mathematical predictive models. Attempting to force profoundly holistic and fluid concepts—such as *Ojas* (vital essence), *Prana* (vital force), or the dynamic flux of *Agni*—into rigid, binary computational data arrays risks severely oversimplifying the philosophical nuances and clinical depth of the science.¹⁰

Furthermore, a critical review of the current literature reveals that research in this domain is predominantly constrained to small-scale, pilot studies. Many of the machine learning models discussed are

trained on relatively small, demographically homogeneous datasets originating from single academic institutions. This severely limits the generalizability of the algorithms across diverse global populations with varying genetic and environmental backgrounds.¹ The glaring lack of large-scale, multi-center Randomized Controlled Trials (RCTs) that rigorously verify AI diagnostic outputs against long-term, real-world patient outcomes remains a critical gap in the current scientific literature.¹

2. Data Standardization and Ontological Deficits

The predictive efficacy and accuracy of any AI model are intrinsically and unalterably linked to the quality, cleanliness, and volume of its training data. In the realm of *Ayurveda*, there is currently a pronounced lack of standardized, machine-readable datasets and widely shared open-source digital repositories.¹⁰ The historically subjective nature of traditional diagnostic recording means that legacy patient records are often highly fragmented, non-uniform, and expressed in localized or idiosyncratic terminology rather than universal medical ontologies. Monumental efforts by global bodies, such as the World Health Organization (WHO) and the Indian Ministry of Ayush, to formally integrate traditional medicine morbidity codes into the ICD-11 (International Classification of Diseases, 11th Revision) framework are vital, indispensable steps toward international data comparability and standardization.³⁶ However, extensive, laborious data curation is still urgently required to train robust, unbiased AI models capable of global deployment.

3. Algorithmic Transparency and

Explainable AI (XAI)

In clinical medicine, reliance on "black box" algorithms—where the deep learning model provides a confident diagnosis without clarifying its internal inferential logic or the specific weights of the features analyzed—is clinically unacceptable and poses medical liability risks. For AI-driven Ayurvedic diagnostics to gain widespread trust among traditional practitioners, allopathic physicians, and stringent regulatory bodies, the deployed models must incorporate Explainable AI (XAI) frameworks.¹ The diagnostic rationale generated by the machine must be transparent, interpretable, and directly traceable back to established classical Ayurvedic principles. This transparency ensures that the AI acts as a powerful cognitive adjunct to support, rather than blindly replace, human clinical judgment.¹⁶

4. Ethical, Privacy, and Regulatory Standards

Finally, the deployment of advanced AI in health diagnostics necessitates rigorous adherence to modern data privacy laws and comprehensive ethical frameworks. Systems that continuously capture deep phenotypic data, genomic markers (*Ayurgenomics*), and persistent biometric surveillance pose significant, unprecedented risks concerning patient data sovereignty and cyber-security.²⁴ Furthermore, ethical frameworks must proactively address the danger of algorithmic bias, ensuring that models trained predominantly on specific ethnic demographic data from the Indian subcontinent do not erroneously misdiagnose individuals from differing global genetic backgrounds.¹⁰ Clear, stringent regulatory pathways,

fundamentally akin to FDA (Food and Drug Administration) or CDSCO (Central Drugs Standard Control Organisation) approvals for traditional medical devices, must be urgently established to govern Software as a Medical Device (SaMD) operating within the traditional medicine sector.¹⁰

Conclusion

The profound convergence of Artificial Intelligence with ancient Ayurvedic diagnostic methodologies represents a true watershed moment in the history of global traditional medicine. By systematically integrating machine learning, deep learning neural networks, and advanced IoT sensor arrays with the classical *Ashtavidha Pariksha*, *Ayurveda* is successfully transitioning from an experience-based, subjective healing art to a highly rigorous, evidence-based, and data-driven computational science. The deployment of AI technologies has demonstrated exceptional, validated potential in objectifying traditionally subjective clinical assessments—ranging from the acoustic biomarker profiling of *Shabda Pariksha* to the complex hemodynamic signal processing of *Nadi Pariksha*, and the sophisticated topological image analysis required for *Jihva* and *Drik Pariksha*.

Furthermore, ongoing innovations in *Ayurgenomics* and AI-driven Clinical Decision Support Systems are enabling hyper-personalized therapeutic interventions that respect and honor the constitutional uniqueness (*Prakriti*) of the individual patient at a molecular level. However, realizing the full, transformative potential of this technological renaissance requires carefully navigating complex epistemological, methodological, and ethical challenges. The global scientific

community must prioritize funding for large-scale, multi-center clinical validations, ensure robust international data standardization through ICD-11 integration, and develop transparent, interpretable AI models that deeply respect the holistic integrity of *Ayurvedic* philosophy. By forging a rigorous, transparent, and ethically sound computational framework, the synthesis of Artificial Intelligence and *Ayurveda* possesses the unparalleled potential to democratize preventive and personalized healthcare, offering highly effective, integrative medical solutions tailored to the unique biological and psychological blueprints of patients worldwide.

Author Declarations and Ethical Compliance

In strict adherence to the publication guidelines and instructions for authors established by leading scholarly journals in the field of Ayurvedic research, the following compliance declarations are affirmed. The author instructions and formatting requirements have been thoroughly read, verified, and systematically implemented throughout the conceptualization and drafting of this manuscript [User Query]. This manuscript has been comprehensively seen, reviewed, and approved by all contributing personnel involved in the research synthesis [User Query].

The research and subsequent synthesis presented herein are fully compliant with rigorous ethical standards governing medical and computational research [User Query]. The literature reviewed in this manuscript, particularly studies involving human biometric data, digital imaging, and clinical assessments, relies on primary

research wherein the original investigators obtained appropriate patient and research study participant consent [User Query]. The synthesis provided in this report does not involve the direct collection of new primary human data but rather an analytical review of previously published, ethically cleared studies.¹ Furthermore, there are no conflicts of interest—financial, intellectual, or otherwise—in the preparation, conceptualization, or presentation of this research [User Query].

Regarding manuscript formatting, all structured data are presented in tables that are sequentially numbered, explicitly cited in the continuous text in numerical order, and clearly labelled as original or with details of their primary source [User Query]. Similarly, all figures and conceptual diagrams (represented through descriptive text and placeholders in this format) are cited in the text, equipped with comprehensive legends and headings, and labelled with their source details [User Query].

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