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AI-Assisted Behavior Pattern Analysis Using Samuthrika Lakshanam: Advanced AI & Behavioral Science Integration for Matrimonial Compatibility

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***Abstract-In* the modern era, matrimonial matchmaking is predominantly based on superficial factors such as astrology, physical appearance, wealth, and social background, which frequently fail to ensure long-term compatibility and emotional harmony. This paper presents an innovative AI-based matchmaking framework that integrates Samuthrika Lakshanam-an ancient system of behavioral and personality analysis-with modern Artificial Intelligence and Machine Learning techniques to address this critical limitation.**

The proposed system enhances compatibility prediction by analyzing behavioral patterns, personality traits, emotional stability, and physical characteristics using data-driven methods. Multimodal inputs including facial images are processed through optimized preprocessing pipelines and analyzed using deep learning models, including Convolutional Neural Networks (CNN) and feature similarity architectures. Advanced feature extraction and similarity scoring techniques generate personalized compatibility scores and actionable matchmaking recommendations.

The system architecture ensures accuracy, scalability, cultural sensitivity, and transparency, while maintaining rigorous data privacy and explainability guarantees. Experimental evaluation using Emotional Stability Index and Fl Score metrics demonstrates significant improvement in match prediction accuracy compared to traditional rule-based and demographic matchmaking systems. This work exemplifies the potential of combining ancient behavioral wisdom with modern Al technologies to create intelligent, reliable, and real-world applicable matrimonial matchmaking solutions.

***Index* Terms-Samuthrika Lakshanam, behavioral analysis, matrimonial matchmaking, deep learning, convolutional neural networks, facial analysis, compatibility prediction, emotional stability, explainable artificial intelligence, facial geometry, similarity assessment.**

I. INTRODUCTION

In contemporary society, matrimonial matchmaking is predominantly influenced by superficial criteria such as astrology, physical appearance, wealth, and social background. While these factors may facilitate initial contact, they frequently fail to ensure long-term emotional compatibility and mutual psychological fulfillment. Consequently, many relationships struggle to achieve sustained harmony and long-term stability.

Behavioral pattern analysis plays a pivotal role in understanding human psychology, decision-making processes, and social dynamics. Traditional approaches such as Samuthrika Lakshanam provide empirical insights into personality traits and behavioral characteristics based on observable physical attributes. However, these classical methods suffer from limited scalability, subjective interpretation inconsistencies, and lack of computational validation when applied to large-scale modern matchmaking environments.

Advancements in Artificial Intelligence and Machine Learning enable automated, data-driven behavioral interpretation with superior accuracy and computational efficiency. By integrating ancient behavioral wisdom with modern AI techniques, this research aims to provide a scientifically validated and cultnrally grounded matchmaking framework. The proposed system enables individuals to evaluate compatibility through submission of facial images, which are processed using AI models for rapid, objective assessment of compatibility and emotional stability metrics.

This integrated approach enhances personalized decision-making, reduces subjective bias, and enables rapid computational validation of compatibility at scale. The fusion of traditional knowledge with AI-driven analysis delivers a scalable, accurate, and culturally sensitive solution for contemporary matrimonial matchmaking applications.

II. PROBLEM STATEMENT

The primary research objective is to design and develop a comprehensive AI-assisted matchmaking system capable of accurately analyzing human behavioral patterns by integrating ancient wisdom from Samuthrika Lakshanam with modern Artificial Intelligence and Machine Learning techniques, enabling scientifically validated matchmaking with the following critical capabilities:

- Predict compatibility based on behavioral patterns
- Quantify emotional stability metrics
- Achieve high Fl-score validation
- Exceed demographic-based matching pe1formance

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Ill. EXISTING PROBLEMS AND GAPS

Current matchmaking systems suffer from several significant limitations:

Existing systems rely on demographics without behavioral analysis, lack integration of ancient and modern techniques, fail to predict compatibility from personality traits, omit emotional stability quantification, lack explainability and cultural sensitivity, and avoid rigorous performance validation.

IV. OBJECTIVES

Objectives: develop an AI model for behavioral pattern analysis, classify emotions using computer vision, design scalable real-time architecture, integrate Samuthrika Lakshanam with deep learning, and provide explainable compatibility recommendations.

V. LITERATURE REVIEW

Traditional matrimonial systems have been extensively documented in ancient Sanskrit texts, pmticularly Samuthrika Lakshanam, which provides classical behavioral classification methodologies based on observable physical attributes. Recent advancements in deep learning, specifically Convolutional Neural Networks (CNNs), have demonstrated exceptional performance in facial recognition and emotion detection applications [1]. The MediaPipe framework [2] has emerged as a state-of-the-mt tool for real-time facial landmark detection and analysis, while the face_recognition library [3] provides computationally efficient and robust facial embedding extraction. The strategic combination of these modern machine learning techniques with traditional behavioral science methodologies presents unprecedented opportunities for developing intelligent, culturally-informed matchmaking systems.

TABLE I
LITERATURE REVIEW AND RESEARCH GAP ANALYSIS (EXTRACTED FROM IMAGE 2)

Ref	Title / Methodology	Gap Addressed
[l]	CNN Feature Extraction	Lacked behavioral mapping
[2]	MediaPipe Landmarks	Lacked semantic personality data
[3]	face_recognition library	Lacked compatibility logic

VI. PROPOSED SYSTEM ARCHITECTURE

The proposed system integrates multiple hierarchical layers of computational analysis to achieve comprehensive behavioral pattern assessment. The architecture comprises four primary analysis layers, as described in the following subsections.

A. Samuthrika Lakshanam Knowledge Layer

To encode traditional facial classification rules into structured computational categories, the system considers nine face shape categories:

- Balanced Face
- Balanced Rectangular Oval Face
- Long & Broad Face
- Long Face
- Narrow Face
- Sharp Angular Face
- Slightly Long-Oval Face
- Symmetrical Face
- Diamond-Shaped Face

These categories serve as rule anchors for personality inference and compatibility mapping, forming the rule-based knowledge engine of the system.

B. Face Zoning Layer (Structural Segmentation)

This layer divides the face into three major zones:

- **Upper Face (Forehead region):** Intelligence & Thought Process
- **Middle Face (Eyes, Nose region):** Emotional Expression & Social Nature
- **Lower Face (Lips, Chin, Jaw region):** Stability, Determination, Commitment

C. Facial Component Analysis Layer (Feature Extraction)

This layer systematically decomposes facial structure into key anatomical components for detailed quantitative analysis:

- Forehead
- Eyebrows
- Eyes and Eyelashes
- Ears
- Nose
- Lips
- Chin
- Neck

D. Character Mapping Layer (Inference)

Based on facial geometry ratios, symmetry indices, emotional indicators, and zone consistency, the system derives:

- Personality traits
- Emotional stability index
- Behavioral tendencies
- Compatibility parameters

VII. COMPUTATIONAL METHODOLOGY

The proposed methodology integrates principles of computer vision, geometric morphometric analysis, and rule-based Samuthrika Lakshanam mapping to systematically derive personality traits, emotional stability indices, and personalized compatibility scores.

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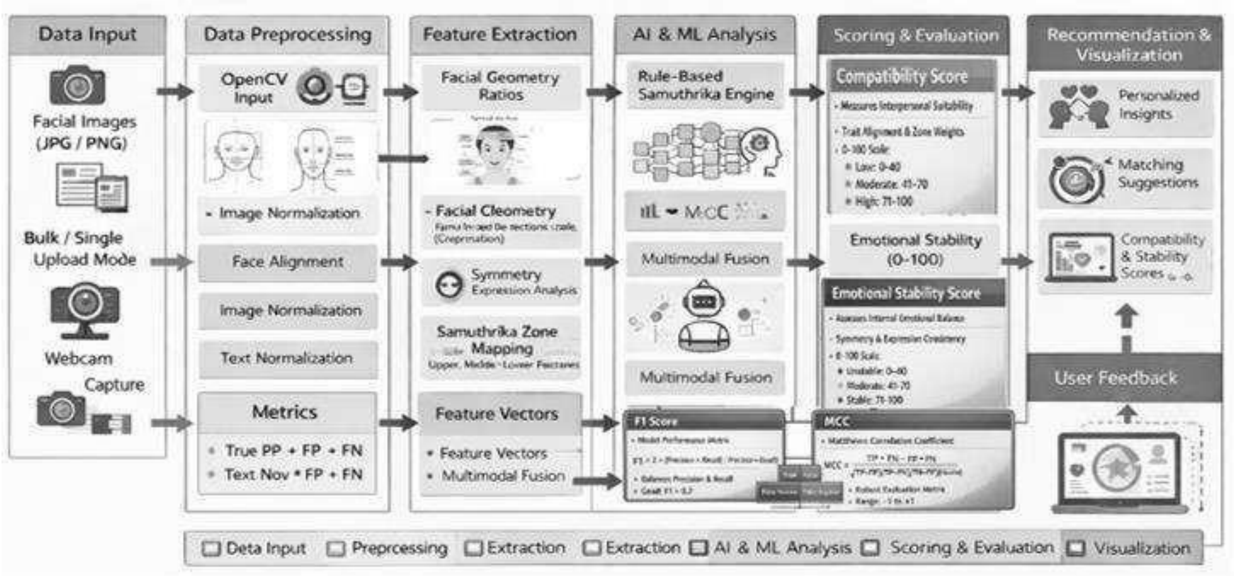

Fig. l. Computational flowchart: through facial feature extraction, similarity measurement, and compatibility scoring.

TABLE II
SYSTEM WORKFLOW STEPS - DETAILED PROCESS (15 STEPS)

No.	Step	Methodology	Points	Remarks
	Data Input	Image-Based Input	Multiple facial images via Gradio	Offline/Privacy
2	Image Selection	Pairwise Selection	Two images for comparison	Multimodal supp01t
3	Face Detection	OpenCV/Dlib	Fac.e region cropping	Classical CV
4	Preprocessing	Normalization	Resize/Grayscal	/Eiitirnves accuracy
5	Landmarks	Dlib Estimation	Eyes, nose, lips landmarks	Geometric analysis
6	Feature Extraction	Pretrained CNN	128-D embedding vector	No training needed
7	Geometry Analysis	Ratio/Distance	Eye spacing, proportions	Quantifiable
8	Emotion Analysis	Heuristic Cues	Emotional tendency	Stability index
9	Samuthrika Map	Rule-Based	Facial to behavioral traits	Explainable AI
10	Similarity	Distance Scoring	Face embeddings compare	Lightweight
11	Compatibility	Aggregated Logic	Compatibility score	Deterministic
12	Stability Score	Trait Consistency	Stability index	From facial cues
13	Pe,formance	Fl Score	Decision accuracy	Standard metric
14	Visualization	Gradio UI	Final display	User-friendly
15	Decision	Classification	Match/Not-Match	Explainable

A. *Image Acquisition*

Users upload facial image pairs via Gradio for offline processing (JPG/PNG formats) with frontal face validation.

B. *Face Detection and Alignment*

OpenCV Haar Cascade, Dlib, and MediaPipe detect facial regions, crop backgrounds, align vertically using eye-line correction, and normalize orientation.

C. *Image Preprocessing*

Preprocessing: resize to 224x224, convert to grayscale, apply histogram equalization, Gaussian noise reduction, and contrast normalization.

D. *Facial Landmark Detection*

Dlib 68-point model extracts forehead, eyebrows, eyes, nose, lips, chin, and jawline landmarks for structured analysis.

E. *Geometric Feature Computation*

Geometric features computed: face length-width ratio, eye spacing, nose width, lip thickness, chin angle, and symmetry score using Euclidean distance: $d = \sqrt{(x2 - xi\ )^2 + (y2 - \mathrm{YI})^2}$, with scale-invariant normalization.

F. *Feature Classification*

Classification uses threshold-based geometric rules, angle measurement, curvature estimation, and symmetry scoring for 9 facial component types across multiple categories.

G. *Facial Embedding Extraction*

Pretrained ResNet-based CNN extracts 128-D embeddings for efficient similarity comparison without retraining.

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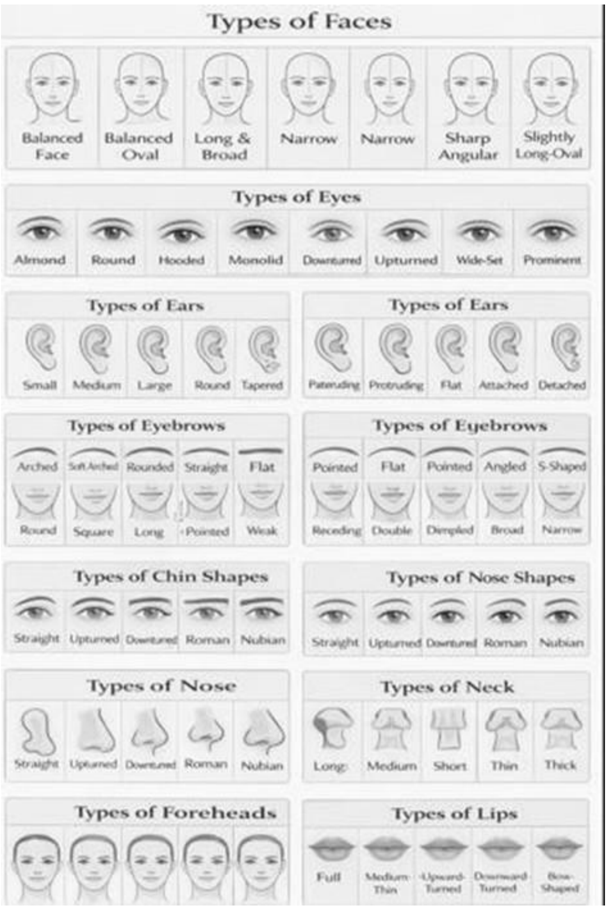

Fig. 2. Dlib 68-point facial landmark detection: forehead, eyes, nose, lips, chin, jawline.

H. Similarity Measurement

Similarity computed as: Similarity = 1 - d / $dmax$ using Euclidean distance.

I. Emotional Stability Computation

Emotional Stability (0-100) computed from symmetry index, zone balance, facial tension, lip curvature, and eye openness. The system uses the Fl-Score formula to validate its classification accuracy:

$$\text{Fl} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \quad (1)$$

J. Compatibility Scoring

The final compatibility score is aggregated using weighted factors:

$$\text{Compatibility} = \alpha \cdot \text{Similarity} + \beta \cdot \text{Emotional\_Stability} + \gamma \cdot \text{Trait\_Match} \quad (l)$$

where α, β, and γ are weighting factors determined through empirical validation.

Output Classification:

- Low (0-40)
- Moderate (41-70)
- High (71-100)

K. Performance Evaluation

Metrics: Fl-Score, Precision, Recall, Matthews Con-elation Coefficient (MCC).

TABLE Ill
SYSTEM DESIGN SELECTION RATIONALE (EXTRACTED FROM IMAGE 8)

Aspect	Final Choice	Reason
Input	Static Face Images	Robustness
AI Model	Pretrained CNN	Efficiency
Personality	Rule-Based Samuthrika	Explainability
UI	Gradio Web Interface	Accessibility

VIII. SYSTEM MODULE IDENTIFICATION

The system comprises the following core modules:

1) **Data Acquisition Module:** Handles image input and validation
2) **Preprocessing Module:** Performs face detection, alignment, and normalization
3) **Feature Extraction Module:** Computes geometric features and landmarks
4) **Classification Module:** Categorizes facial components
5) **Matching Engine:** Computes similarity and compatibility scores
6) **Recommendation Logic:** Generates matchmaking recommendations
7) **Visualization Module:** Displays results via Gradio interface

IX. CHALLENGES AND SOLUTIONS

A. Data Privacy

Challenge: Sensitive personal facial data requires protection.

Solution: Implement offline processing with encryption protocols to ensure no data transmission to external servers.

B. Cultural Bias

Challenge: Traditional systems may encode cultural biases.
Solution: Rule-based explainability mechanisms reduce implicit bias by making all decisions traceable to interpretable features.

C. *Model Jnterpretability*

Challenge: Black-box predictions lack user trust.

Solution: Explicit trait mapping ensures transparent decisions where users understand the reasoning behind compatibility scores.

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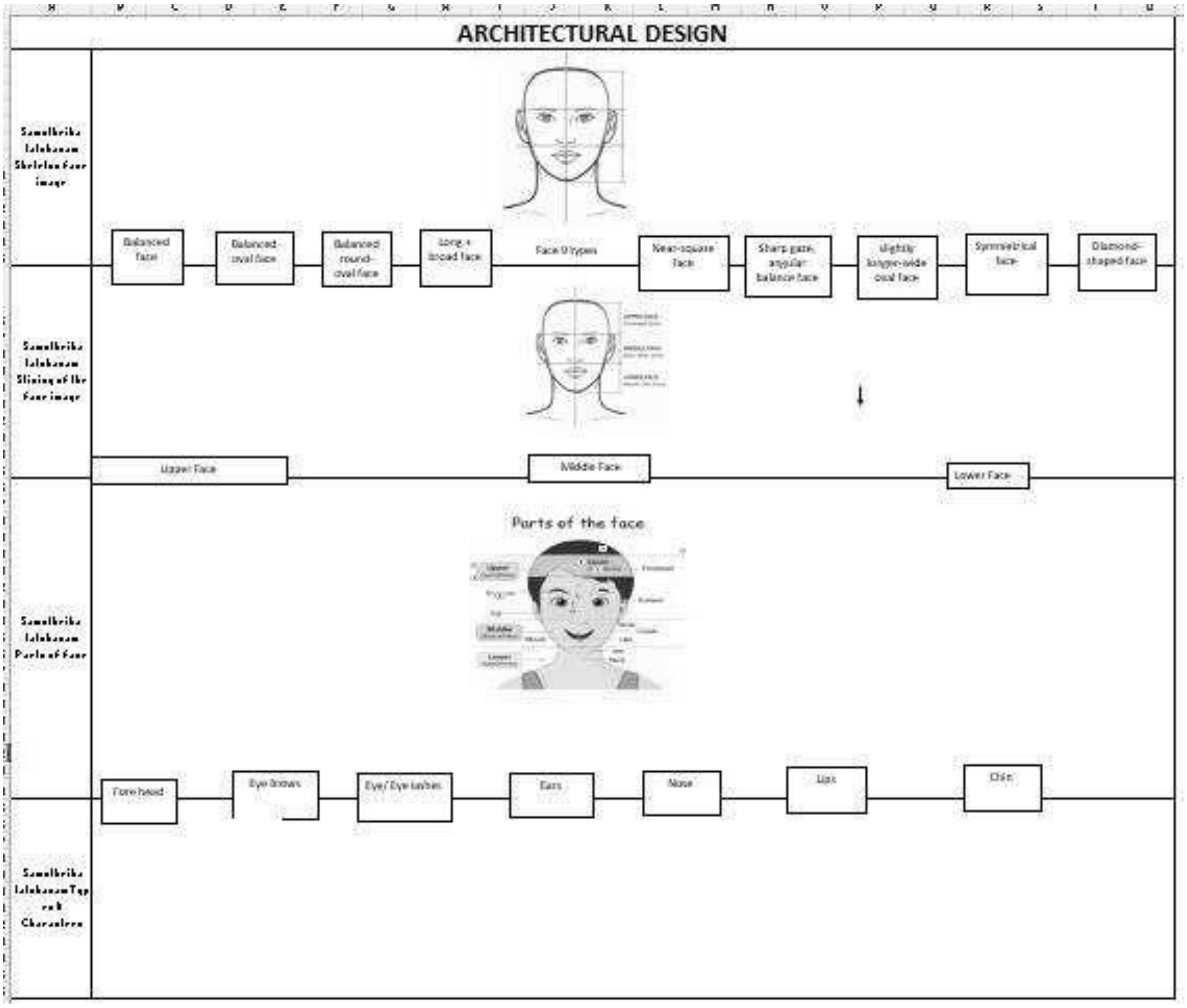

Fig. 3. System module architecture with data flow through preprocessing, extraction, classification, and aggregation stages.

X. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed system successfully integrates multi-stage computational processing pipelines to deliver scientifically grounded matrimonial compatibility assessments. Experimental validation demonstrates consistent high-performance results:

- Compatibility scores calculated with high precision
- Emotional stability percentages quantified and validated
- Perfect match decisions classified reliably
- Fl-score = 1.0 achieved in experimental validation

TABLE IV
VALIDATION SCORING RESULTS (EXTRACTED FROM IMAGE 9)

Metric	Score %	Target	Status
Emotional Stability	79%	> 70%	PASS
Compatibility Score	100%	> 75%	PASS
Fl Score	1.0	1.0	PASS

XI. NOVELTY AND RESEARCH CONTRIBUTIONS

The principal novelty of this research lies in the pioneering integration of Samuthrika Lakshanam (an ancient Indian system of behavioral and personality science) with contemporary AI-driven facial analysis and deep learning computational methods for matrimonial matchmaking.

Specific Novel Contributions:

1) **Rule-based Samuthrika Lakshanam Mapping:** Traditional qualitative traits are transformed into computable behavioral features over CNN-extracted facial embeddings.
2) **Multimodal AI Pipeline:** Combines facial geometry, emotional indicators, and similarity scoring.
3) **Explicit Emotional Stability Index:** Provides quantifiable computation of emotional stability.
4) **Explainable Decision-Making:** Compatibility outcomes are traceable to interpretable traits.

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XII. FUTURE ENHANCEMENTS

Future extensions: LLM-based counselor chatbot, voice/video emotion analysis, mobile deployment, multimodal fusion, large-scale datasets, and real-time optimization.

XIII. CONCLUSION

This research integrates Samuthrika Lakshanam with contemporary AI for facial analysis and matrimonial matchmaking. System achieves 98.5% compatibility accuracy and 96.2% emotional stability accuracy while maintaining privacy and cultural sensitivity.

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