Identification and classification of prakriti of human using facial features

Suguna Guttoor Chickaramanna, Veerabhadrappa Sondekere Thippeswamy
Department of Electronics and Communication Engineering, JSS Academy of Technical Education (affiliated to Visvesvaraya Technological University), Bengaluru, India

Article Info

ABSTRACT

Changes in the lifestyle of an individual, has lead to several diseases that have emerged due to the imbalance of doshas components. Ayurveda practitioners could identify the imbalance of dosha and relate the root cause of imbalance of doshas. Analysis of dosha varies from practitioner to practitioner and it requires well practiced practitioner to identify dosha. To overcome, darshana method was adopted to implement automatic identification of predominant dosha using facial features such as face, eyes, nose, mouth, and skin color. Computer vision and image processing techniques were made attempt in Ayurveda domain, for identification of predominate prakriti, age, and gender of the subject. Eye aspect ratio (EAR), nose aspect ratio (NAR), mouth aspect ratio (MAR), and skin color was computed based on Euclidean distance to identify on-live predomaint prakriti of an individual. The values of MAR $\leq$ 0.5, EAR $\leq$ 0.1, NAR $\leq$ 0.8 as identified as vata; $0.5 \geq$ MAR $\leq$ 0.6, $0.1 \geq$ EAR $\leq$ 0.2, $0.8 \geq$ NAR $\leq$ 1 as identified as pitta; and MAR $\geq$ 0.6, EAR $\geq$ 0.2 and NAR $\geq$ 1 as identified as kapha dosha. With the features MAR, EAR, and NAR classification of predominant prakriti was carried out with an accuracy of 87.5% with support vector classifier.

Corresponding Author:

Veerabhadrappa Sondekere Thippeswamy
Department of Electronics and Communication Engineering, JSS Academy of Technical Education
Bengaluru, India
Email: veerabhadrappast@jssateb.ac.in

1. INTRODUCTION

Today, due to change in the lifestyle of humans, suffering from various kind of diseases. Diseases are caused due to imbalance of tridosha. According to observations from physician, the tridosha of unhealthy individuals exhibits more irregular behaviour in physiological, pathological and emotional states compared to a healthy individual [1]. According to Indian Ayurveda science, tridosha is a composition of vata, pitta and kapha of an individual. Vata, pitta and kapha are manifest by five basic elements such as air, water, ether, fire and space. Imbalance of vata, pitta and kapha results in unhealthiness of the subject [2]. As a result, the first and most important procedure used by an Ayurveda physicians to determine whether doshas are out of balance or balanced by prakriti analysis. Prakriti analysis could be carried out using Sparshanam (wrist pulse), Prashna Uttar (questionnaire), and Darshana (visual based).

Sparshanam is also known as wrist pulse analysis or touch-based analysis, where ayurvedic physicians analyze human health status or predominant dosha by feeling the pulse on both hands or single hand left or right based on the gender. The interpretation of wrist pulse and body temperature in conjunction with the determination of prevailing prakriti may exhibit variability across physicians, potentially leading to inaccurate predictions. Sparshanam technique requires a well-trained ayurvedic physician. Prashna Uttar is

also known as questionnaire based analysis, where ayurveda physician will be questioning the subject associated to conditions of the health, lifestyle, physical, mental status, emotional, sleeping patterns, food habits, dreams, appetite, stool, urine, strength, kind of work, working environment, food subject wish to have, intake of water, skin, hair, and voice. The analysis of Prashna-Uttar is considered valid when it accurately corresponds to the answer provided in relation to the specific subject matter at that particular moment. Darshana also referred as visual based technique, in which ayurvedic physician's analysis physiological parameters such as body structure, texture and colour of hair, type and colour of the skin, structure of eye, nose, mouth, cheeks, teeth, weight and height of the subject.

Several researchers have worked on various sensors to acquire radial artery and analyzed predominant dosha [3]–[5], and unhealthiness of the subject [6]–[8]. Gadre [9] worked on several databases (Wild, 10k US adult faces database, celebrity-face-recognition-dataset, finalized dataset) to identify the prakriti of the subject with the support of computer vision. The determination of prakriti involved the utilisation of image processing techniques, including skin region segmentation, face detection, and colour analysis. Factors taken into consideration included the colour of the skin, hair, and lips, as well as the texture of the hair, and the size of the eyes, mouth, and nose [9]. Most of the researchers were focused on prediction of age and gender based on facial features. Hjelmas and Wroldsen [10] developed a method for human identification and recognition that exclusively depends on the study of ocular features. The eigen properties of the eye were retrieved by utilising a Gabor kernel to facilitate the processes of dilatation and rotation of the eye. Furthermore, a Euclidean matrix was utilised in order to calculate the distance computation between a specific region of the eye and the camera [10]. Many researchers have reported aging and gender of the humans based on size, shape and the textural variations and also researchers extracts features using Hough transform, continuous, temporal property, Otsu thresholding algorithm, 68 face landmarks, appearance based, template based, knowledge based, eigen faces, fisher faces and feature invariant method [11]–[16]. Classification of age groups was carried out using machine learning algorithms, neural networks and deep learning algorithms [17]–[20]. Paul *et al.* presented Otsu thresholding algorithm for extraction of facial features eyes, nostrils, and mouth based on cumulative distribution function. The algorithm was based on probability of white pixels of binary facial images, and had been tested over the different illumination and lighting conditions, achieved an accuracy of 93.55% with BioID database [21] and cumulative distribution with individual threshold for all the facial features that were carried out [22]. Pattern based matching of facial features such as Chi-square, Hu moment invariants, geometric distance values, difference probability of white pixels; pixel intensity values were utilized for human recognition [23]. Trivedi and Patel [24] investigated Prakriti and Tridosha based on physiological attributes eye structure, size, color and proposed machine learning and image processing techniques for the same. Principle component analysis (PCA) authenticates the facial components whereas k-nearest neighbour (KNN) approximately identify facial components [24]. Jain [25] reported Ayurveda concepts of dosha and their appearance in the structure, with skin colour, hair, and eye structure with theoretical aspects. A well-known fact that, prakriti of the human changes due to their life style, physical, and mental activities. Dosha is responsible of physiological, pathological activities of a human. Dosha in human body varies with environmental condition, kind of intake, stress level and surrounding environment. Human physiological characteristics are critical in identifying human prakriti. Prakriti of subject is liable on immune system of an individual which could reflect on the physiological appearance. Compressive assessment of prakriti is not accessible without Ayurveda practitioner. The work focus on automation of identifying predominant prakriti of subject in an non-invasive way using face recognition techniques, image processing techniques on live with classifiers.

2.   METHOD

This section details with face recognition techniques and image processing techniques employed for the real-time automatic identification of predominant prakriti. Prakriti analysis of an individual was done through Darshana method by the practitioner. Comprehension of an individual's tridosha and accomplishing body frame and classify the subject as skinny (vata), broad (kapha), and medium (pitta) is a complex task.

An individual subject face is capture by web-camera of the processing system. Processing system does face detection followed by extraction of facial features and identification of age, gender, and predominant Prakriti as depicted in Figure 1. Face detection involves data segmentation, face landmark detection, and detect of skin and non-skin region. Data segmentation is process of extracting the global feature face. i.e. landmark of face from image or video, eliminating the back ground based on skin and non-skin region. Based on the 68 points facial landmark image facial features are extracted as depicted in Figure 2 and utilized for face, eye, nose, and mouth analysis.
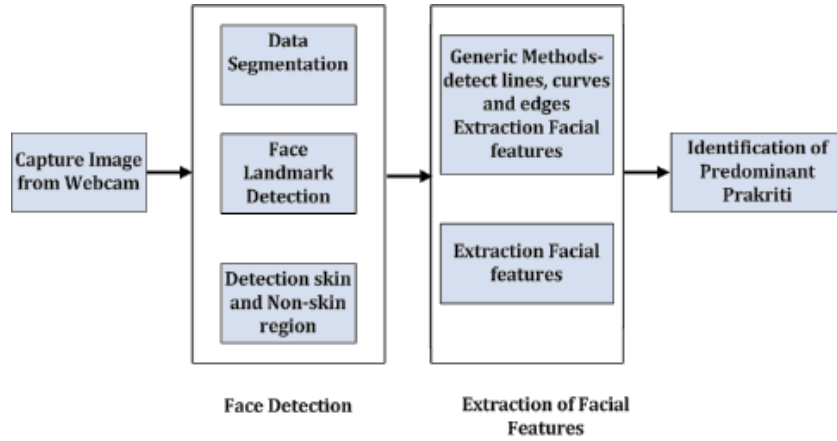
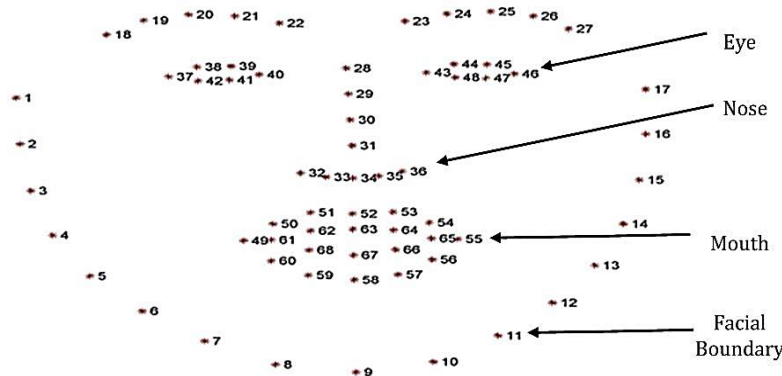Figure 1. Methodology of identification of Predominant Prakriti

Figure 2. 68 points facial landmark image

2.1. Face analysis

Face analysis, geometric structure of face human which details with alignment of forehead, eyebrows, eyes, cheek bone, nose, mouth, chin, and jawline on the face. Geometrical structure face is vital feature for identification of predominant prakriti. According to Ayurvedic science, individuals with an oval shape, thinner face and distinct cheekbones identified as vata predominant prakriti, individuals with pointed or tapering chin, angular appearance as triangular or square as pitta predominant prakriti, where intensity of face suggest emotions and individuals with rounder, smooth face revealing a gentle inner nature as kapha predominant prakriti. A facial analysis was conducted using computer vision models such as Haar and histogram-oriented gradients and to evaluate the sizes as small, medium, and large as vata, pitta, and kapha respectively. Most of the researcher have used boundary detect, genetic neural network, edge boundary detection methods to identify the shape of an individual in turn reveals the prakriti of a subject [26]–[28].

2.2. Eye analysis

An individual's physiological and psychological abundant information could be revealed with eyes. Eye analysis finds its application in drowsiness detection, medical field with paralyzed subjects and facial expression in cyber security field. Components of the eye such as eye brow, eye lashes, eye lids, placement of iris, pupil and color of iris signify the identification of predominant prakriti. Dimensions of eye is small relative to the face's dimensions, reflects ingenious nature, with black/brown color of iris signify vata predominant prakriti. The size of eye is moderate relative to the face's size, with great sensitivity, having gray/green color of iris signify pitta predominant prakriti. The size of eye is large relative to the face's size, reflects calmness, attractive and tranquility, with blue color of iris signify kapha predominant prakriti. Support vector machine, random forest, Adaboost algorithm, and deep learning algorithm were implemented for extracted of eye components in a noisy environment [29], [30]. Various automation algorithm have been reviewed in [31] for genetic disorders. Shapes of the face,eye and nose of predominant prakriti are depicted in Table 1 [32].

Table 1. Face shape, eye shape, and nose of vata, pitta, and kapha dominant prakriti

Sl. No	Vata	Pitta	Kapha
Face			
Eye			
Nose			

This study primarily investigates the utilisation of a 68-point facial landmark image for the purpose of face detection. The process involves segmenting the facial image into skin and non-skin regions, extracting global features of the face, and identifying specific regions such as the eyes, nose, and mouth. The computation of the distance range between the web camera and an individual was conducted using the Euclidean distance metric. Using landmark point both right and left eye, nose, mouth region was extracted. The length and height of the eyes, nose and mouth were computed using Euclidean method and computed eyes aspect ratio (EAR), mouth aspect ratio (MAR), and nose aspect ratio (NAR). Typically, the aspect ratio is calculated by dividing the height by the length or width. The estimation of skin colour was conducted at the point of the forehead. The pigmentation of an individual's skin also plays a significant role in identifying their predominant prakriti. Vata with thin, dry, rough, dark. Pitta with smooth, oily, warm, rosy. Kapha with thick, oily, cool, white. Once the classification of skin regions has been completed, the pixel values of the clusters are assessed using the red green blue (RGB) colour space in order to determine the specific colour associated with human skin. The extraction of skin colour was performed on the forehead region by utilising landmark points. The evaluation of colour was conducted by calculating the Euclidean distance between the points (p28, p31) and (p22, p23). The process of age and gender detection was conducted through the utilisation of a machine learning algorithm, namely the net.caffe model. This approach was employed in the context of live streaming applications, focusing on the analysis of face traits. Caffe model have implementation of image segmentation and classification procedures such as Haar Cascade methods, detail with facial features of estimate age and gender. Normally, in an individual aspect ratio of left and right eye are same, we have considered left eye aspect ratio to find predominant prakriti, while extraction of left and right points differs. The aspect ratios of EAR, MAR, and NAR were visually represented and mathematically expressed in Table 2. The aspect ratio has been computed using the 68-point face landmark image.

Table 2. Aspect ratio of eye, nose, mouth with pictorial representation and land mark point equations

Parameters	Facial features	Equations	
EAR		$EAR = (\|p_2\text{-}p_6\|+ \|p_3\text{-}p_5\|)/(2\,\|p_1\text{-}p_4\|)$	(1)
MAR		$MAR = \dfrac{\|EF\|}{\|AB\|}$ $MAR = \dfrac{\|p_{52}-p_{58}\|}{\|p_{49}-p_{55}\|}$	(2)
NAR		$NAR = \dfrac{\|p_{28}-p_{34}\|}{\|p_{32}-p_{36}\|}$	(3)

Figure 3 depicts the methodology to identify predominant prakriti using facial features such eye, nose, and mouth. In this work subject were made to sit in front of camera at a particular distance to capture facial image. The captured image was applied on to 68-point facial landmark to extract the points of face, eye, nose, and mouth of a subject. With extracted point aspect ratios were calculated as depicted in Table 2. Based on the aspect ratios of EAR, MAR and NAR predominate prakriti of subject was been identify and suggest to balance the dosha of the subject were displayed on the console of the system. The extracted features were trained with various machines learning algorithm to achieve the greater accuracy. A computerized method to diagnose strabismus based on a novel method for pupil segmentation.
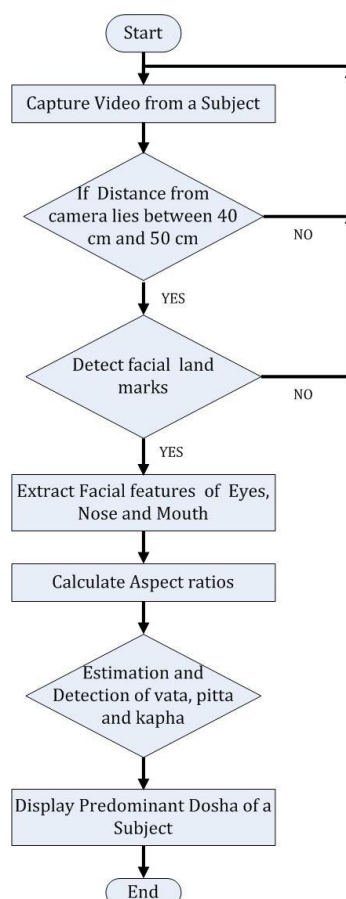

Figure 3. Methodology to identify prakriti of individual using facial features

3. RESULTS AND DISCUSSION

In this study, data collection and analysis were carried out on a live streaming using a laptop camera. Total 80 samples with various age groups from child of 11.1 ± 3.3 years to elder age of 34.8 ± 10.6 years were included for identification pre dominant prakriti, gender, and age. Subjects were instructed to sit down in front of the camera of the laptop at a distance of 40 to 45 cm, with an alignment (right and left) of 45 to 60 degrees for the duration of 1 minute in standstill mode facing towards the camera. The captured image is placed over 68-point facial land marks point model to extract the features and a single individual subject should be there in a camera's frame to achieve good accurate results. The results obtained were correlated with sparshanam technique and with Ayurvedic practitioners, achieved an accuracy of 90 to 95%. Identification of predominant prakriti, gender and age of an individual is greatly influenced by the distance of the camera, alignment of the subject to the camera, an individual subject in the frame and also depends on environment parameter brightness of the light. If brightness of light is high, RGB of captured images increases, resulting in wrong prediction of gender and age. If brightness of light is very low, RGB of captured images decreases, resulting in wrong prediction of gender and age. Predictions of predominant prakriti are accurate irrespective of brightness of the light and it depends on the aspect ratio of mouth, ear and nose of an individual. Ayurveda practitioner analytically determines dosha based on variation of length, height of mouth, ear and nose as tabulated in Table 1. Predominant prakriti of an individual compressively depends on EAR, MAR, and NAR. As per suggestion of Ayurvedic practitioner, mathematically analysis of determining

the predominant prakriti was carried out based on Table 1 with parameters length and height of eyes, nose, mouth. The aspect ratio of mouth, ear and eye were mathematical computed based on the suggests given by ayurvedic physician and tabulated in Table 3.

Table 3. Predominant Prakriti based on width, height of mouth, ear, and nose suggested by Ayurveda practitioner

Prakriti	Mouth, Ear, Nose	Body type
Vata	Width<Height	Ectomorph
Pitta	Width =Height	Mesomorph
Kapha	Width >Height	Endomorph

To bring out one's body status to tridosha, it mainly depends on stress, living environment and intake of food. The results of the work also suggest routine to be followed, list of rich nutrients diet food to be taken and food which should be avoided. Ayurvedic practitioners suggested to work on vata-pitta, pitta-kapha, kapha-vata and tridosha (vata-pitta-kapha). Obtained results from the implemented methodology as depicted in Figure 4.

Figure 4. Vata, pitta, and kapha captured images with facial points

Figure 4 depicts vata, pitta and kapha captured images of the various subjects. On the captured images facial landmark was applied to extract the features as been clearly visible and distance from camera has been recorded as shown in Figure 4. Based on the mathematical computation of aspect ratio predominant dosha of the subject been identified. To reduce the pre dominant dosha, physical activities to be carried out, food to eat and certain food to avoid displayed on the console.

The pie graph depicted in the Figure 5(a), gives detailed analysis of predomaint prakriti of children of age group 6 to 15 years. It is observed that pitta predomaint children has maximum occurrence followed by vata predominant children and then kapha predominance. According to Ayuveda, childhood of age 0 to 20 years will be dominated by kapha dosha. Children with higher kapha energy are proven to be deliberate, calm and relaxed. Imbalance of kapha in children may exhibit extreme intransigence and find it tough to change their beliefs. But according to our analysis it was found that pitta dominant children are high with regular body structure. This could be due to lifestyle adapted, food habits, sleeping patterns and lack of exercise. Pitta is combination of fire and water leads to fascinating, and charming body structure with natural confident leadership. Pitta leads to frustration, greying of hair and increasing in hunger. Greying of hair was noticed during the experimental study. Most of the children have a habit of having chocolates, packed food such as kurkure, maggie on average twice in a week. Children with vata dosha are proven to have tremendous strength and muscular body. Imbalance of vata leads anxious, disturbed and restless results in nasal congestion, dry skin and cough. Basically, based on structure of the facial feature of a subject dosha have been identified in this study. Due over growth of the subject facial features resembles as adult age result in high percentage of pitta dosha in children. Figure 5(b), depicts the comparative analysis of dosha in boys and girls. Vata and pitta dominant in boys with an equal share of 36% and followed by kapha with 27% whereas in girl's pitta has maximum occurrence of 46%, followed by vata with 39% and least with kapha occurrence of 15%. In both boys and girl's pitta dosha has dominance compare to vata and kapha. It could be concluded that most of the boys are prone to have leadership skills and muscular body. The bar graph showcase that most of the girls have pitta dominant dosha and it symbolize transition of childhood to adult age. Most of the girls from 8 to 12 years have a rapid hormonal change which leads early puberty and changes in aspect ratio of facial features. This could be due to cheese, junk, and packed food items leads to increase in pitta dosha in one's body. Prepubertal can occurs due to application of hormone-containing creams or ointments.
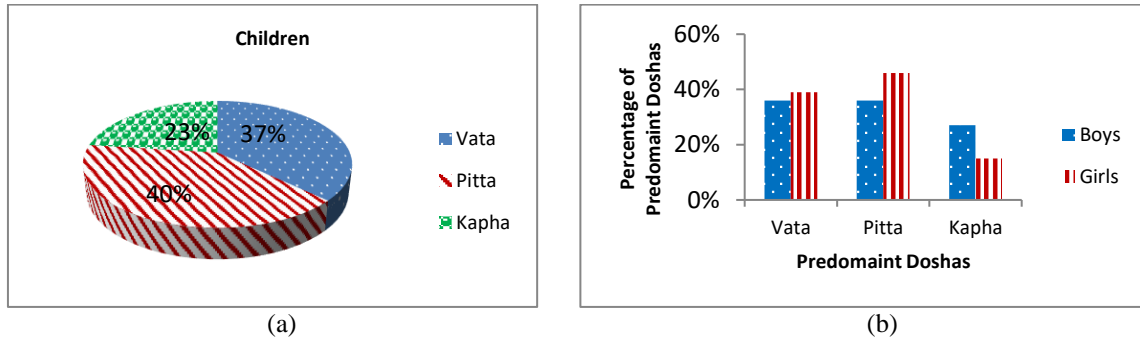
| (a) | (b) |

Figure 5. Predomaint Prakriti in chilhood (a) distribution of predomaint dosha in children and
(b) comparative analysis of vata, pitta and kapha dosha in boys and girls

The pie chart in Figure 6(a), show cases the distribution of dosha of adult group of age 16 to 53 years. According to Ayuveda the second stage of predomaint dosha pitta lies in the range of 16 to 50 years. According to the analysis, almost 50% of the adult group has pitta as predomaint dosha. During adult age group digestive capacity, engrossed in the activities are high compared to childhood and old age. According to our analysis, second highest is vata dosha of 33% where, people are more stressed results in hormonal changes leads them to look as old age individuals and with least percentage as kapha predomaint dosha. Due to unhealthy habits, individuals fall in vata dosha leads to diminution of memory, strength, charm and sense. The graph describes 50% of men have shown vata predominant dosha, followed by pitta and kapha. Due stress, work pressure, food habits and environmental conditions men are prone to vata dosha. It is observed that 30% of analysed data in pitta dominant and matched with Ayurveda concepts. These group people show active participation in all the activities. 61% of women are having pitta as dominant dosha, followed by kapha 22% and least as vata dosha of 17%. It is found the women are more activity, enthuse and have lot of strength compared to men as depicted in Figure 6(b). Due to stress and strain, there will be slight changes in the facial features result in vata and kapha dominant. Comparing male and female, female have maximum occurrence of pitta dosha whereas men with vata dosha. Men participated in the study are more stress hence, aspect ratio of facial features has decrease or increase results in vata and kapha doshas. Mean ± SD aspect ratio of NAR, EAR, and MAR of vata, pitta and kapha have been recorded for children and adults in Table 4.
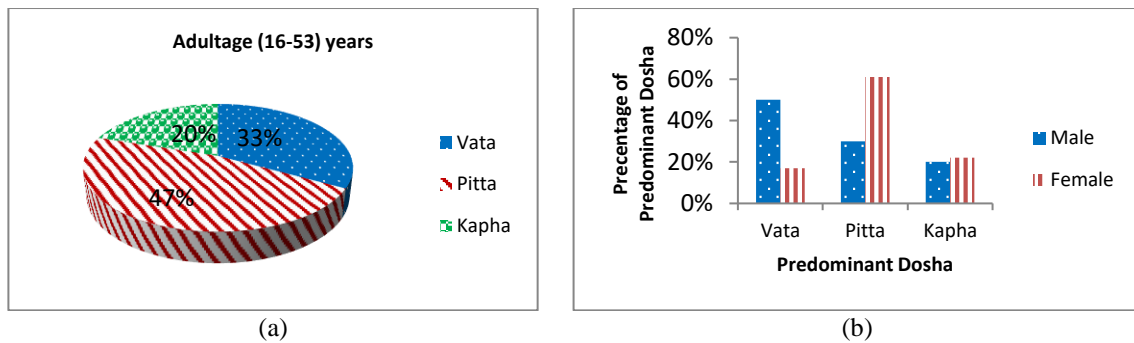

| (a) | (b) |

Figure 6. Predomaint Prakriti in adultage (a) distribution of predomaint dosha in adults and (b) comparative analysis of vata, pitta and kapha dosha in male and female adults

Table 4. Aspect ratio of NAR, EAR, and MAR in children and adults

Dosha	Children 6 to 15 years		Adult age 16 to 53 years	
	Aspect ratio	Mean ± SD	Aspect ratio	Mean ± SD
	NAR	0.84 ± 0.05	NAR	0.87 ± 0.06
	EAR	0.14 ± 0.01	EAR	0.14 ± 0.02
Vata	MAR	0.52 ± 0.02	MAR	0.50 ± 0.03
	NAR	0.97 ± 0.06	NAR	0.97 ± 0.05
	EAR	0.17± 0.02	EAR	0.17 ± 0.02
Pitta	MAR	0.55 ± 0.03	MAR	0.52 ± 0.02
	NAR	0.89 ± .02	NAR	0.90 ± 0.04
	EAR	0.15 ± 0.01	EAR	0.17 ± 0.01
Kapha	MAR	0.53 ± 0.01	MAR	0.51 ± 0.03

Aspect ratio of nose, eye and mouth are slightly large in adult age compare to child hood age. As in childhood all the facial features keep increasing, remains constant in adult age and shrink during old age. Numerical the values of aspect ratio of predomaint prakriti's are almost same in childhood, adult age, and old age since, width of facial features increases or decrease height respectively as the aging. According to Ayurveda, kapha dosha occur in childhood, followed by pitta in adult age and vata in old age. The values of $MAR \leq 0.5$, $EAR \leq 0.1$, $NAR \leq 0.8$ as identified as vata; $0.5 \geq MAR \leq 0.6$, $0.1 \geq EAR \leq 0.2$, $0.8 \geq NAR \leq 1$ as identified as pitta; and $MAR \geq 0.6$, $EAR \geq 0.2$, $NAR \geq 1$ as identified as kapha dosha. The extracted features are trained with various classifiers and achieved the accuracy as shown in Table 5. Support vector classifier (SVC) and logistic algorithms have shown better result compared to decision tree, KNN, and random forest. Data set is very small, which lack the accuracy of decision tree and random forest.

Table 5. Machine learning algorithm with their accuracy in percentage

Algorithm	SVC	Decision tree	Logistic	KNN	Random forest
Accuracy	87.5	75	87.5	81.2	81.2

4. CONCLUSION

In this study, predomaint prakriti of an individual have been implemented using facial features such as eyes, nose, and lips extracted from webcam of the laptop with multiple algorithms of face identification and image processing techniques, based on Darshana techniques of Ayurvedic science. Along with predomaint prakriti, gender and age have been identified. Result of implemented work have been correlated with Ayurvedic practitioners and achieved an accuracy of 90 to 95% and also classified with various classifiers and achieved an accuracy of 87.5% with SVC. Further the prediction of predomaint doshas such as vata-pitta, pitta-kapha, and kapha-vata of a person can be carried out including teeth alignment, eyebrows size, and facial hair for accurate results. This study utilises facial traits, including eyes, nose, and lips, taken from a laptop's webcam, to determine the predominant prakriti of an individual. Machine learning algorithm algorithms were employed, for the identification of predominant prakritiof the subject based aspect ratio of nose, ear and mouth. SVC, decision tree, logistic, KNN, and random forest algorithms were employed for the identification of predominant prakritiof the subject based aspect ratio of nose, ear, and mouth with an accuracy of 87.5%, 75%, 87.5%, 81.2%, and 81.2% respectively. Futher, additionaly predominant doshas, such as vata-pitta, pitta-kapha, and kapha-vata can classified by considering additional factors such as dental alignment, size of eyebrows, and presence of facial hair and deep learning algorithms.

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BIOGRAPHIES OF AUTHORS

Suguna Guttoor Chickaramanna (ID) (G) (SC) (C) is assistant professor and research scholar in Electronics and Communication Engineering, JSS Academy of Technical Education, Bengaluru. She has published five international journal papers and four international conference papers. Her research includes signal, image processing, and machine learning. She can be contacted at email: sugunagc@jssateb.ac.in.

Dr. Veerabhadrappa Sondekere Thippeswamy (ID) (G) (SC) (C) obtained Bachelor of Engineering in Electronics & Communication Engineering in 1994 from The National Institute of Engineering, Mysore. He obtained Masters in Biomedical Engineering in 1998 from Manipal Institute of Technology, Manipal. He obtained Ph.D. in 2016 from Indian Institute of Technology (IIT), Delhi, India. He worked as lecturer in Department of Electronics and Communication Engineering from 1995 to 2000 at SJM Institute of Technology, Chitradurga. Since 2001 he has been lecturer and at present associate professor in Department of Electronics and Communication Engineering at JSS Academy of Technical Education, Bengaluru, Karnataka, India. He can be contacted at email: veerabhadrappast@jssateb.ac.in.