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ANALYSIS OF FACIAL EXPRESSIONS WITH RESPECT TO NAVARASAS IN BHARATHANATYM STYLES USING IMAGE PROCESSING

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Abstract- Facial expression analysis with respect to Bharathanatyam a classical dance style of south India is studied in this paper by using image processing techniques and several properties associated with the face are taken into consideration. The emotional changes result in the changes in the facial expression. Accordingly the curvatures developed on the face and the dimensions of the objects on the face such as eyebrows, lips and the area of the mouth also change. Naturally there exist changes in the intensity of the pixels corresponding to these objects. The natural eyes can distinguish these sharp changes in both the cases and understand the facial expressions. The experimental results predicted a definite change in every trail. These results can also be used as a tool to design intelligent system which recognizes different emotions of people in different environment. The results are found to be of immense scientific and psychological interest.

Keywords- pixels, facial expressions, intelligent systems, environment, kurtosis, entropy, skewness

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Introduction

The automatic recognition of facial expressions has been an active research topic since the early nineties. There have been several advances in the past few years in terms of face detection and tracking, feature extraction mechanisms and the techniques used for expression classification. The Studies pertaining to Facial Expressions and Physiognomy date back to the period of Aristotelian era. It was quoted in Wikipedia that the assessment of a person's character or personality from their outer appearance, especially the face is termed as Physiognomy. For many years, while the interest in Physiognomy has been changing with trends, the study of facial expressions has consistently been an active topic. The pioneering

work conducted in 17th century on the studies of facial expressions formed the basis for today's research in image processing technique. A detailed note on the various facial expressions and movement of head muscles was given already in 1649 by John Bulwer in his book "Pathomyotomia". Another very interesting work on facial expressions (and Physiognomy) was given by Le Brun, the French academician and painter by profession. Later, in 1667, Le Brun himself gave a lecture at the Royal Academy of Painting which was later reproduced as a book in 1734. It is interesting to know that the ancient actors and artists referred to his book to achieve perfection in imitation of genuine facial expressions. The work by J. Montagu on the origin and influence of Le Brun's lectures [1] can be referred and used by any reader for through understanding of expressions on the face.

A through survey of the literature pertaining to the topic of research reveals that no work is available in this direction. Therefore, the present study is undertaken in order to provide the qualitative and quantitative aspects of the problem.

The organization of the paper is as follows: Section II presents the related work, section III with the methodology, the section IV with the data set description, section V with the experiments and results and section VI deals with the conclusion.

Related work

Moving on to the 19th century, one of the important works on facial expression analysis that has a direct relationship to the modern day science of automatic facial expression recognition was the work done by Charles Darwin. Darwin's work on 1872, established the general principles of expression and the means of expressions in both humans and animals [2]. He also grouped various kinds of expressions into similar categories. The categorization is as follows: shame, shyness, modesty, anxiety, grief, low spirits, dejection, despair joy, tender feelings, high spirits, love, devotion, reflection, meditation, ill-temper, anger disdain, contempt, sulkiness, determination, hatred, disgust, astonishment, fear, guilt, pride, surprise, horror, self-attention.

Furthermore, Darwin also catalogued the facial deformations that occur for each of the above mentioned class of expressions. For example: "the expansion of the muscles round the eyes when in fear", "the firm opening of the mouth when in surprise", "the depression of the corners results in the mouth when in low spirits", etc [2]. Another very important milestone in the study of facial expressions and human emotions was found in the work done by psychologist Paul Ekman and his colleagues in the year 1970. Their work is of significant importance and has a large influence on the development of modern day automatic facial expression recognizers. Here, a considerable part of section 3 and section 4 is devoted to give an introduction to their work and the impact it has on the present day systems. Traditionally, facial expressions have been studied by clinical and social psychologists, scientists, actors and artists, medical practitioners. Automatic facial expression analysis, A survey of affect recognition methods are analyzed through [3-7] respectively. However the research in the field of facial expression captured the

Interest of the computer scientists due to the tremendous developments in the areas of computer vision, robotics, computer graphics and animators.

Methodology

Human life is a rich fabric which gains color and feel amidst the series of happenings that shape it. These actions that characterize every day as well as the extraordinary happenings make life further interesting while evoking feelings in human beings. These feelings are called the emotions or rasas, which indeed offer life colours and pattern. Thus, Rasas define the unedited realities of life amidst their vibrancies of emotion. The theory of Indian art is housed within the rasas as expounded by Bharata Muni in Natyasastra and Nandikeswaran in Abhinayadarpana. Rasa is a dominant mental state evoked in the audience by the performer. Rasa is created by bhavas. Bhava is the permanent mood and rasa is an expression of it. For example, when bhaya (fear) is the bhava, the rasa created is bhayanaka. Indian masters have identified nine rasas or Navarasas and we see that man lives his life through these nine basic expressions. A thorough study of the Navarasas helps us understand basic human emotions and human psyche. The Navarasa, in the Indian scriptures refer to the nine expressions that humans often show. These are shringara, hasya, karuna, roudra, veera, bhayanaka, bheebhatsya, wonder or adbhutha and shantha. In addition to the above nine Rasas, two more added later. They are Vatsalya and Bhakti. In art related works, rasa is best described as the interplay of moods expressed by various characters. The theory of rasa embodies the aesthetic underpinning of all Indian classical dance and theatre art, such as Bharatanatyam, Kathakali, Kuchipudi, Odissi, Manipuri, kathak, Kudiyattam, and others. A rasa indicates an essential mental state and is the prominent emotional theme of a work of art or the primary feeling that is evoked in the person that views, reads or hears such a work.

Although the concept of rasa is fundamental to many forms of Indian art including musical theatre, dance, music, literature and cinema, the interpretation of each, treatment, usage and actual performance of a particular rasa differs greatly between different styles and schools of classical dance forms, and the major regional differences even within one style. Bharata Muni is responsible for enunciating the eight Rasas in the Natyashastra an ancient work of dramatic theory. According to Natyashastra, each rasa has a presiding deity and a specific colour. There are four pairs of rasas. For example, Hasya arises out of Sringara. The Aura of a frightened person is found to be black, and the aura of an angry person is found to be red. Bharata Muni has established the following. The Nine moods or the rasas are associated with colours. The nine colours of Navarasa speak the emotions that they depict. Vlz: Shringara : represents love or attractiveness. Its Presiding deity: Vishnu. Colour: light green. Hasya represents Laughter or Comedy. Its Presiding deity: Pramata. Colour: white. Raudra :It represents Fury or anger. Its presiding deity: Rudra. Colour: red. Karuna: It represents Tragedy or compassion. Its presiding deity: Yama. Colour: grey. Bībhatsa :It represents Disgust or Aversion. Its presiding deity: Shiva. Colour: blue Bhayanaka: It represents Horror or Terror. Its presiding deity: Kala. Colour: black. Veera: It represents Heroic mood or courage. Its presiding deity: Indra. Colour: yellowish. Adbhuta: Wonder, or surprise & Amazement. Its presiding deity: Brahma. Colour: yellow. Shanta: It represents peace or tranquillity. Its presiding deity: Vishnu and the colour is white. We had already studied the facial expressions of Japanese females through a paper "Parametric analysis of facial expressions based on the statistical approach [8]. Comparison of Japanese female facial expressions and the Indian female facial expressions was also reflected in [9]. There was no work reflected in the direction of analysis of facial expressions with respected to Navarasas though the expressions were recognised. Our investigation revealed certain important results which we have discussed in the later sections. To verify these aspects in different facial expressions, we used the following parameters

Entropy- It is a measure of the amount of information that can be derived from the image i.e.,

$$E = \sqrt{\sum_{i=0}^{255} P(i)\log_2 P(j)}$$

It can be noted that the image having uniform histogram will have entropy value = 8.

Skewness- It is a measure of the degree of asymmetry or the departure from symmetry of the histogram. Its value lies between -1 and +1 and is represented by $\gamma_1 = \sqrt{\frac{\mu_3}{\sigma_3}}$ where μ_3 = third one dimensional moment and σ is the standard deviation.

Kurtosis- Degree of peakiness of a histogram is measured in terms of kurtosis and is represented by K and is computed as

$$\sigma_T^2 = \sum i(i-\mu_T)^2 Pi$$

where σ_T^2 = is the total variance of levels

$$K = (\frac{\mu_4}{\sigma_4}) - 3$$

If K {= 0, the curve is normal; -ve the curve is more flat tapped; +ve the curve is more peaked}

The Present Analysis

It consists of comparing the changes in certain parameters corresponding to the same components such as eyes, nose and mouth of different facial expressions in navarasa moods in bharathanatyam art of south India. In the following sections we discuss about the results of the experiments.

Data Set Description

[Fig-1], is used for testing the variations in navarasa facial expressions the nine types of emotional changes with respect to entropy, skewness and kurtosis. It contains 207 grayscale images of 9 facial expressions (Hasya, shringara, roudra, bebhatsa, bhayanaka, shanta, veera, adbuta and karuna) posed by 22 indian female students from Nrithya ganga kala Kendra run by Roopashree madusudhan in nagarabhavi, Bangalore, Karnataka. The size of each image is 256X256. Tests are performed for investigatingthe changes with respect to above said parameters on different expressions of the same face and then on different faces by using VC++ software. The data base [Fig-1] was created by us using Sony cyber shot camera with 12.1mega pixels resolution as shown below.

Experiments and Results

In this section, the results of the experiments conducted on the data set discussed above are presented and discussed.

[Fig-2] and [Fig-3] represent the changes in skewness and entropy respectively of different facial expressions corresponding to navarasa expressions of all the females with costumes. It is very clear from the above graphs that the entropy and the skewness are inversely proportional to each other

Fig. 1- Database of navarasa expressions the nine types of emotions of Indian females

Ie, the pixel with greater entropy will have lesser skewness. This holds good even with respect to the natural expressions of different males and females taken in different situations. It is found that only 50% of the faces will have similar variations in entropy and skewness for the expressions related to navarsas. It is better than natural expressions where we had only 30% similar variations. But, human brain still understands and recognizes these variations.

[Fig-4] represents the variation of kurtosis against navarasa expressions with makeup. It is found that in most of the faces, the variation in kurtosis is same as the navarasa expression changes. These changes are found to be 85%. But the changes are found to be 95% similar when we tested the facial expressions without makeup as shown in [Fig- 5].

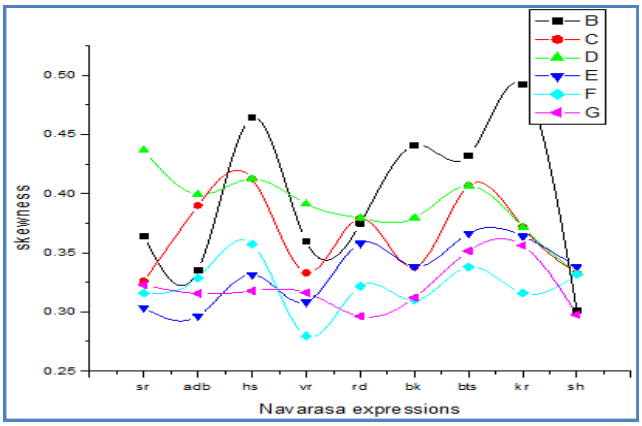

Fig. 2- Skewness Vs Navarasa Expressions.

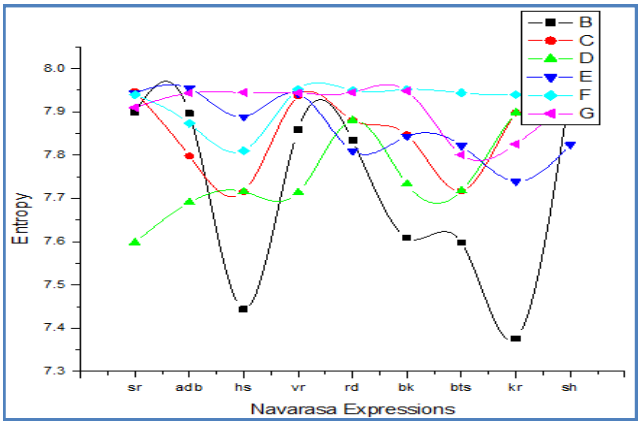

Fig. 3- Entropy Vs Navarasa Expressions

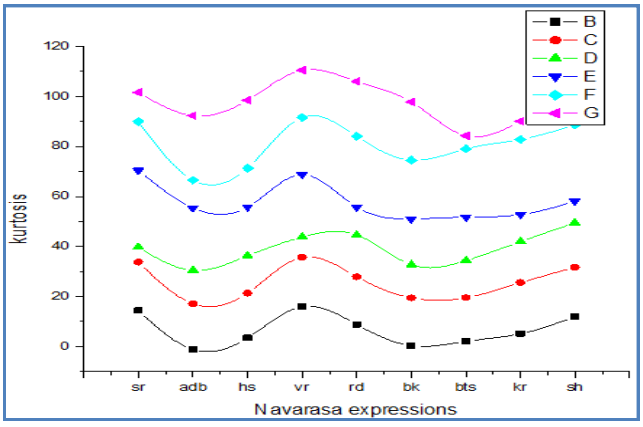

Fig. 4- Kurtosis Vs Navarasa Expressions with makeup

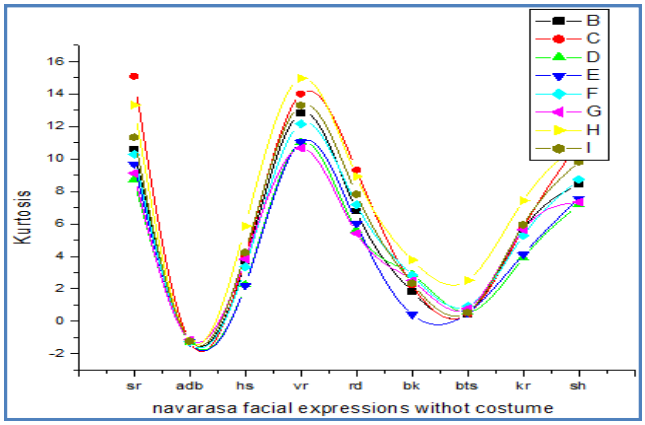

Fig. 5- Kurtosis Vs. Navarasa expressions without makeup

Conclusions

Facial expressions are the basic instinct of human beings to express sudden feelings of spontaneous outburst of nine emotions illustrated in Indian art forms. Out of these nine emotions, researchers have succeeded in detecting only six basic expressions. The present study throws light on the qualitative as well as the quantitative aspects of the problem and some important developments in automatic facial expression recognition and its applications. Initially, the facial expression measurement was provided on the basis of the location of facial expression. It was far from satisfactory due to its static nature and lack of intensity measurements with respect to light. The facial expression analysis has made a remarkable change in the computation of automatic change in the onset and offset of facial expressions. The inadequacy due to static nature has been rectified with the introduction of facial expression recognition through image sequence. The expressive expression mapping with ratio images made it possible to measure the change of one person's expression by computing the expression ratio image, to generate more expressive facial expressions of other persons. The defects with respect to expression measurement were rectified at a certain extent with the introduction of facial intensity measurement. A simple and useful method, then evolved for the expression recognition, based on line based caricatures. The invention of HOSVD was a revolution in facial expression recognition due to its earmarking of expression subspace and person subspace. The results of the present investigation can provide an excellent platform for future research.

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