Facial Emotion Recognition to Examine Human Face Using Hybridization Method

A. Sravanthi, B. Sindhuja, and D. Lakshmi Rohitha

Abstract Emotion recognition is a method used to inspect the ones internal feelings on a human face by using a technique Facial recognition technology can be used for authentification, recognition, and verification across various industries, including KYC, payment verification, and access control. Moreover, its aptitude is first to inspect facial expressions for emotions like happiness, sadness, surprise, anger, etc., Facial expression recognition is progressively receiving attention now a days. A person will express feelings through their emotions. The expressions are the exterior signals communicate the internal feelings of a person. Face appearances are divided into 7 feeling states (neutral, happy, sad, disgust, surprise, fear, and anger). The present paper is about hybrid method for face expression or emotion recognition. LBP and PCA are two methods individually used to recognize face. LBP method is used for local feature extraction. LBP method is incredibly sensitive to noise and can't distinguish between a powerful and a weak pattern. PCA used for global feature extraction. An Hybridization method can be used for face expression recognition to improve the authentication process.

Keywords Facial expression recognition · Local binary pattern · Principle component analysis

A. Sravanthi (✉) · B. Sindhuja
CSE Department, GRIET, Hyderabad, India
e-mail: sravanthi.dkk@gmail.com

B. Sindhuja
e-mail: bs50041@gmail.com

D. Lakshmi Rohitha
CSE Department, ACE, Hyderabad, India
e-mail: laksshmiroheta@gmail.com

1   Introduction

There is no doubt that the emotions and feelings play a very vital role not just in the life of people but also in the computing domain as well. There can be hundreds of definitions for emotion but this paper defines emotion as "emotion is a reaction to stimuli that lasts for seconds or minutes" [1] The reason we are talking about emotions here is because the emotional state of a person can lead to influence the task given, decision making abilities. So if the computer is able to determine the minute emotion changes in the human then the computer can enhance itself and give a better productivity.

Facial emotion recognition is one of the active topic in image processing domain [2]. The facial expression recognition scheme is functional in diverse dimensions of life like security and surveillance [3]. Facial expression recognition Understand your audience enable real-time target marketing. Make knowledgeable selling decisions and optimize campaigns. Emotion recognition is valuable in many industry including marketplace, Online learning, Internet marketing and even in video Gaming. Emotion recognition is mostly used by many companies to know clients feeling about their products. The possibilities brought by this new-technology go further than research and Internet marketing. These newer technologies can also forecast the criminal actions by inspecting the images of their faces that are captured by the control-camcorder. The facial emotion recognition arrangement has been used in communication field to construct the machine more associated with people. It has very large number of application possibilities that are user-friendly or adaptable bonding man and machine, humanistic design of goods, and emotional robot etc. Recognizing facial features is done in two ways- global feature and local feature [4]. The global feature extraction process, focuses on entire image but it is less accurate, but local characteristic contemplates only the local area inside the image concentrates on nose, eyes and mouth regions which helps to identify a person uniquely, and it is more accurate. In the identification of global features of a face, Eigen vector, Principal Component Analysis [5], methods are used. For identification of local features Local Binary pattern (LBP) is used [6] but in reality there are many methods to extract features from face images. LBP is caption that describes texture of a rectangular block. LBP is one amongst the feature extraction methodology. Local Binary Pattern (LBP) method illuminates invariant narrative of look picture [7]. Anyhow, the current LBP method at rest undergoes much from non-monotonic enlightenment dissimilarity, arbitrary noise, and alters in cause, era, and expression. Even though, the comprehensive features are popular in face recognition but their performance declines in varying atmosphere. Now on the other hand Principle Component Analysis (PCA) is more often than not used as a tool in data analysis and prognostic or predictive models. PCA is the simplest of True Eigenvector-based multivariate analyses. PCA is an arithmetic course of action so as to use an orthogonal renovation to convert a set of values of possibly correlated 'M' variables into a set of values of 'K' uncorrelated variables called principle component. This paper presents a hybridization of face emotional recognition for providing better performance and improving efficiency. Therefore it

is necessary to combine PCA and LBP smartly together for improving the authentication process [8]. Face expression recognition is done in three steps (1) Detecting face—detecting the face coordinates in any input image. The output is the bounding box of the detected faces. (2) Face Recognition—Comparison of multiple faces in order to identify which face belongs to the person. This is done by comparing face embedding vectors (3) Emotion Detection—Categorizing the emotion of the face into 7 has happy, angry, sad, neutral, surprise, disgust or fear.

2 Working of Local Binary Pattern Method

Local binary Pattern method is mostly accepted for face recognition [9]. In LBP Consider 3×3 matrix of pixels with nine elements {PIc, PI0, PI1 … PI7}, where PIc is the strength cost of the fundamental pixel and PIk ($0 \leq k \leq 7$) represent the intensity values of adjoining eight pixels. Each 3×3 figure chunk can be represented by {0, 1} values using, the equation

$$di = 1PI_k - PI_c > 0$$
$$0PI_k - PI_c < 0$$
(1)

Example:

LBP is an efficient and simple texture operator used for recognition.From the above figure it is well-known that an picture is separated into 3×3 matrix. P8 is the MSB (Most significant bit) and P1 (Least significant bit) (Fig. 1).

In the LBP method, the face image is divided into blocks. For each block we have to calculate LBP value. Likewise for the Total image we have to calculate LBP values mentioned in the procedure.
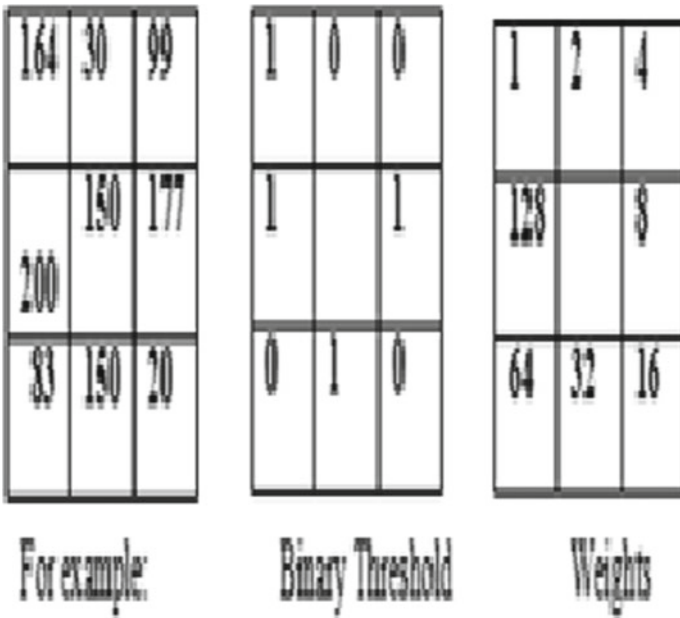
P1	P2	P3
P8	pc	P4
P7	P6	P5

MSB   LSB

1	0	1	0	1	0	0	1

1*27	0*26	1*25	0*24	1*23	0*22	0*21	1*20

**Fig. 1** Local binary pattern method calculated using binary threshold and evaluation of weights

In LBP after calculating Binary Threshold we have to multiply the binary values with 2i where i = 0, 1 … 7.

In this paper JAFFE dataset is used for face expression recognition.An image is recognized by LBP using Haar-cascade method and performance is shown in Table 1. It is one of the deep learning object detection based approach for feature extraction. Some sample images presented in Figs. 2 and 3 are tested using LBP.

Table 1 Performance of LBP of face recognition

Method	Dataset	Accuracy (%)
LBP	JAFEE(64 × 64)	75

Fig. 2 Happy
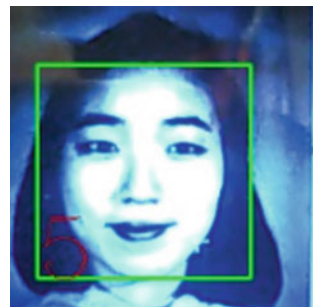
Fig. 3 Neutral

In testing phase the histogram is created for the test image and compares the histogram with training histograms and match give accuracy score. The accuracy varies between lighting conditions and quality of web cam. Haar cascade classifier is used. It is a deep and machine learning based approach used to detect objects. It helps in face detection and feature extraction.

3 Working of Principal Component Analysis

Principal Component Analysis, or PCA for short form, is a technique intended for tumbling the dimensionality of data. A picture might be spoken to as a vector of pixels where the estimation of every entry in the vector is the grayscale force estimation of the comparing pixel in picture.

For example, a 10×10 picture might be opened up and treated as a vector of length 100. The picture is said to be in N -dimensional space, where N is the quantity of pixels of picture (the length of the vector). This vector portrayal of the picture is considered to be the first space of the picture. This high dimensionality vector of pixels in unique space can be decreased by anticipating it into the lower dimensional space called subspace. A few subspace projection procedures are PCA (Eigen space), FDA (fisher spaces), and so forth.

The following are the steps

1. Taking the whole dataset
2. Computing the mean vector
3. Calculating the Covariance Matrix.
4. Calculating eigenvectors and corresponding Eigen values
5. Arranging the Eigen vectors in some predetermining order in increasing order
6. selecting k eigenvectors with the biggest eigen values
7. Converting the samples onto the new subspace.

Fig. 4 Some of the sample images of JAFFE database

4 Proposed Method

LBP and PCA are two methods individually used in identification of face. PCA is used for universal feature extraction and LBP is used for local feature extraction. This method is incredibly sensitive to noise and can't distinguish between a powerful and a weak pattern. In PCA, standardization of data before implementation is must. Also, there is loss of information if number of principal components is not chosen wisely. The histograms which is produced in LBP are longer, as a result pace of recognition becomes less when a larger database is considered. The binary data i.e., 0 or 1 which is produced is sometimes noise sensitive and at some instants of time, local structure is missed out when centre pixel is ignored. Though LBP is a powerful technique for face recognition even though high memory and computational resources are used in LBP [10] (Fig. 4).

In this proposed method, to overcome all this disadvantages, An Hybridization method can be used for face expression recognition [11] can be used to improve the authentication process which is presented in Fig. 5.

5 Working of PCA and LBP Algorithm

Firstly the training images undergo face detection. In the next step, face parts are detected further. Next step involves extraction of features from specified regions. In
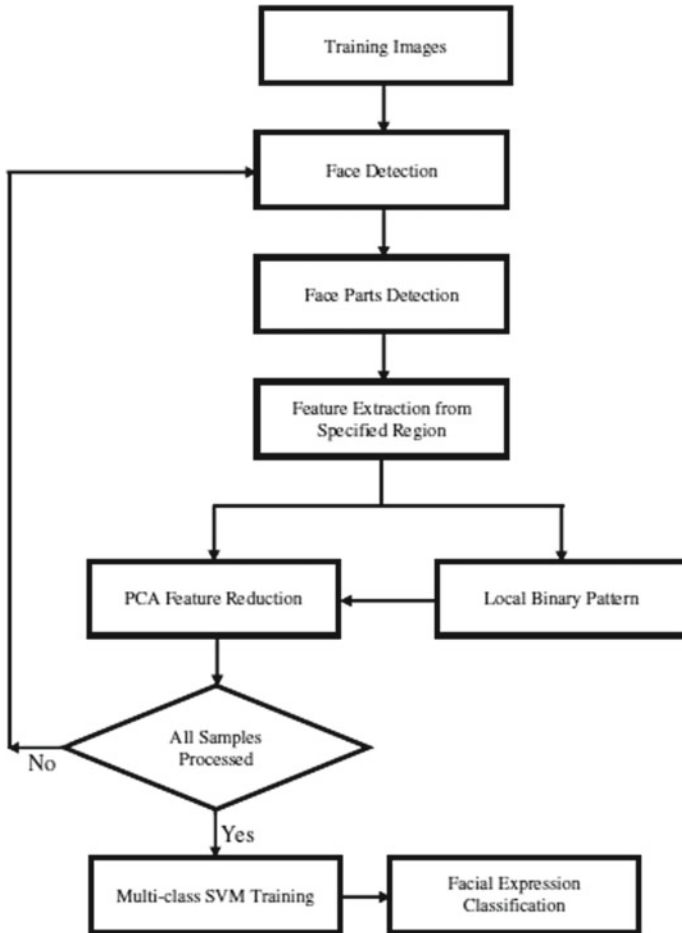
Fig. 5 Block diagram for proposed methodology to classify the facial expressions

the next step, hybrid model (PCA + LBP) is used. After this, if all the samples are processed, it undergoes multi class SVM training and finally expression is classified. Suppose if all the samples are not processed again the same process repeats from face detection as shown in Fig. 4.

To improve the authentication process of face recognition we have to combine PCA with LBP.

As shown in the Table 1 accuracy of 75% is obtained when only LBP is used. The accuracy obtained when this hybrid model is used is 90 percent.

As a result, the drawbacks of PCA and LBP when used individually is overcome and greater accuracy is achieved with hybrid model and results are presented in Table 2.

Table 2 Expected
Performance of LBP and
PCA for face recognition

Method	Dataset	Accuracy (%)
LBP	JAFEE(64 × 64)	75
PCA + LBP	JAFEE(64 × 64)	90

6   Conclusion

In this Paper JAFFE (Japanese Female Facial Expression) dataset is used. Which contains 10 Japanese female models of 7 facial expressions in total 213 images. Each image has been posed in 6 emotion +1 neutral.

In this paper, It is proposed that a hybrid method PCA and LBP is used to dig out the features of the complete expression image and the local texture features separately. PCA is used for dimension reduction. Which also reduces computational cost. Then, SVM used for feature expression classification and recognition. The process adopted in this paper will improve the accuracy in authentication process. This method is powerful to facial emotional recognition. Still the same kind expression, citizens possibly will have diverse shape. Our method, is used on static images. But in future this method can be used to recognize faces and emotions in videos with improved higher recognition rate.

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