

Efficient Facial Recognition System using Lbp Technique

P. Ajay Kumar Reddy, G.N Kodanda Ramaiah, M.N Giri Prasad

Abstract: Facial Recognition system is a popular technique used in identifying the human features. It has numerous applications like surveillance, Smart cards, Law enforcement, security etc. because of these applications, the study of facial recognition system has become research interest for many of the researchers. The Local Binary Pattern (LBP) Method has been extensively employed for the facial recognition system. In this paper, we have evaluated the LBP method for facial expression recognition by using the JAFFE database. The facial recognition rate is used as the performance metric. The emotions which are taken into consideration for evaluation are Happy, Anger, Fear, sadness and a neutral image.

Keywords: Facial Recognition system, LBP, JAFFE, Emotion Recognition.

I. INTRODUCTION

Facial recognition is one of the biometric techniques which is widely used in the present days. There are two types of face recognition methods.[10]

- i. Face Verification (1:1)
- ii. Face Identification (1: N)

Face verification is also used as authentication where one to one matching is performed. It compares a test image with the facial image which is present in the existing database. Identification is the process where one to many matchings is performed. The face recognition system is classified into three models.

Holistic Model: -

In the holistic model, the total face region is taken into consideration for face detection.

Feature-Based Model: -

Here facial features like lips, eyes, nose etc, are used as input parameters for face detection.

Hybrid model: -

It is a blend of both holistic and feature based methods where both local and global features are considered for the recognition process. Generally, face recognition process[8,9] is divided into three stages and shown in figure1. Face detection is used to detect the face in any given image.

Feature extraction is used to extract the features like lips, eyes and nose from the given face image. Classification is used to match the query image to the image present in the database.

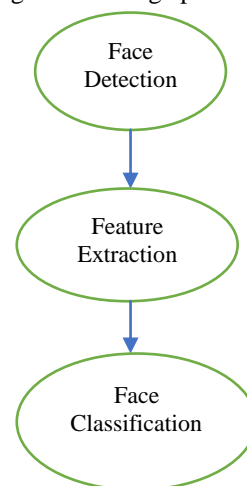


Figure 1: Face recognition process.

Though the significance of face recognition is increased over the period, there are various limitations of facial recognition[11] such as

- 1) Facial emotions
- 2) Illumination
- 3) Pose variations
- 4) Ageing
- 5) Occlusions

In this paper one of the limitations, facial emotions were chosen for recognition.

II. LOCAL BINARY PATTERN (LBP) METHODOLOGY

The LBP was proposed by Ojala[1] et al. (1996) to determine the shape and texture of any facial image. Various features are extracted from a face image by dividing it into several smaller regions. These features contain various binary patterns, which describes the neighbourhoods of pixels in those regions. The obtained features are concatenated into a single feature histogram. These histograms represent the facial image. Various faces can be compared by using the similarity between their histograms. [4,5].The LBP operator works on the neighbourhood of the centre pixel using its value as a threshold. if the neighbourhood pixel has a larger value than the centre pixel, then it is assigned as '1' else it is assigned as '0'. By concatenating all the eight values a binary code is obtained for the central pixel [8]. The LBP Code is shown in figure 2.

Revised Manuscript Received on 22 May 2019.

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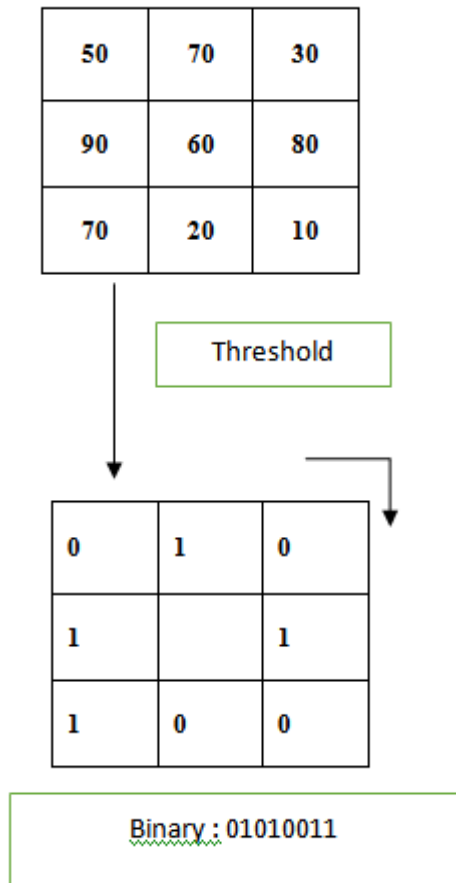


Figure 2: LBP Code

The LBP code is extended to use various neighbourhoods of different radius. Hence radius 'R' from centre pixel is used to take 'P' sampling points around the pixel. The notation of (P, R) is used to illustrate various neighbourhood values. Figure 3 shows various radius and sampling points considered around the centre pixel.

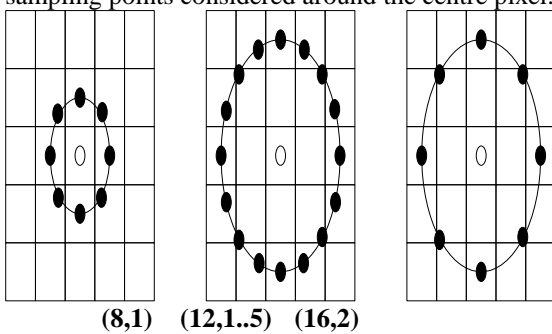


Figure 3: Various radius and sampling points considered around the centre pixel.

The LBP Code contains information about the patterns on pixel level over a smaller region. These smaller region histograms are concatenated to build a global description of the facial image. LBP is a set of binary comparisons of pixel intensities between the neighbouring pixels to the centre pixel. It is represented by the below formula [3,7]

$$LBP(X_c, Y_c) = \sum_{n=0}^7 2^n S(i_n - i_c)$$

Where (X_c, Y_c) represents centre pixel coordinates, i_c is centre pixel value and i_n is neighborhood pixel value. The LBP feature extracted matrix of the size 3X3, values of the neighborhood pixel in comparison to the centre pixel is

used to produce the LBP code in binary code, which will be converted into a decimal number. [6] Figure 4 shows the flowchart of the Face Recognition System.

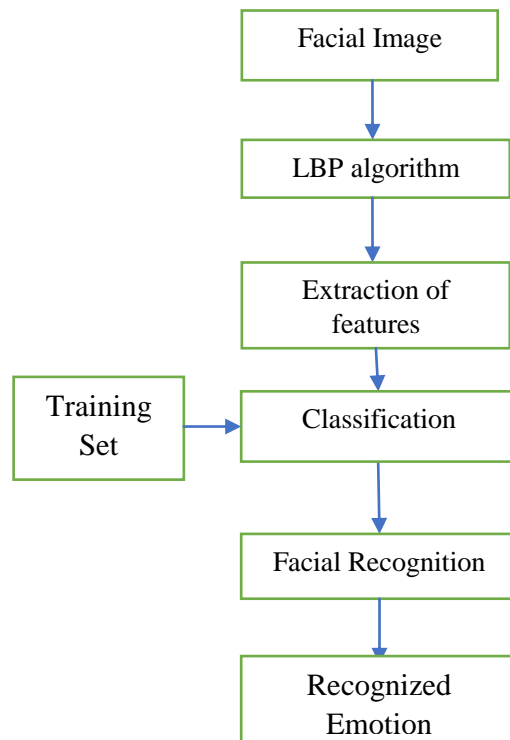


Figure 5: Flowchart of Face Recognition System

III. RESULTS AND DISCUSSION

The LBP algorithm is evaluated by using the JAFFE database [2]. This database consists of 213 images of 7 facial expressions like (6 basic facial expressions + 1 neutral) posed by 10 Japanese female models. The sample images are shown in figure 5. For the evaluation process, 4 facial expressions like Happy, Anger, Fear, sadness and neutral expressions are taken. The evaluation is done both for both speaker dependent and speaker independent.

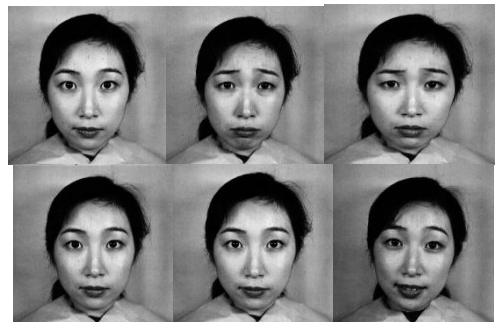


Figure 5: JAFFE Sample Dataset

By using LBP technique, the facial expression recognition is done, where the input image is taken from JAFFE database and undergoes various pre-processing like face detection, feature extraction, face cropping and finally recognized expression are obtained. Figure 6 shows Face detection and cropping of an image.

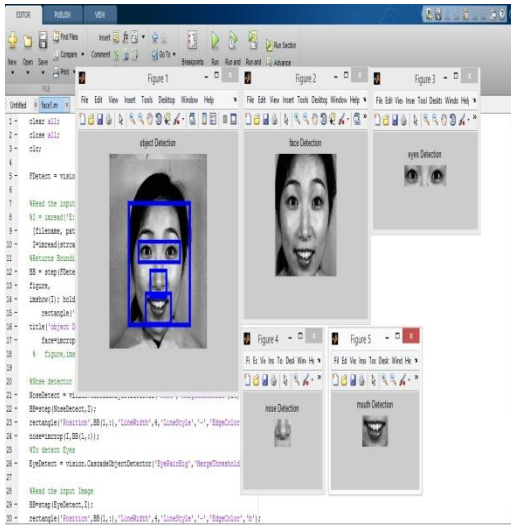


Figure 6: Face detection and cropping of the image.

After cropping, LBP is applied for each cropped image. The Experimental results are evaluated based on Speaker Dependent and Independent.

1) Speaker Dependent.

In the speaker dependent method the query image of the person is compared with the different images of the same person present in the database. These evaluations are done with various radius values and sampling points when compared with the centre pixel of the image.

Table 1 shows the Recognition rate of facial emotions at radius R=1, sampling points P=8. Here the emotions like Anger and fear has given the highest recognition rate 73.33 and 71.87 respectively The average recognition rate of this method is 67.12%.

Table 1: Recognition rate of facial emotions at radius R=1, sampling points P=8

Radius 1,8					
	Anger	Fear	Happy	Neutral	Sad
Anger	73.33	3.33	0	6.66	16.66
Fear	3.12	71.87	0	6.25	18.75
Happy	12.5	15.62	59.37	3.12	9.37
Neutral	3.33	16.66	10	63.33	6.66
Sad	3.22	16.12	6.45	6.45	67.74

Table 2 shows the Recognition rate of facial emotions at radius R=1.5, sampling points P=12. When the radius has been increased from 1 to 1.5 the number of sampling points is increased 8 to 12. The Performance is high for high-value R and P. Here the highest recognition rate is achieved for anger and neutral images. The average recognition rate is 76.67. the recognition rate of LBP (1.5,12) has been increased by 14.23 %.

Table 2: Recognition rate of facial emotions at radius R=1.5, sampling points P=12

Radius 1.5, 12					
	Anger	Fear	Happy	Neutral	Sad
Anger	80	3.33	0	13.33	3.33
Fear	3.12	75	3.12	3.12	15.62
Happy	3.22	6.45	74.19	6.45	9.67
Neutral	0	6.66	1	80	3.33

Sad	0	9.67	9.67	6.45	74.19
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Table 3 shows the Recognition rate of facial emotions at radius R=2, sampling points P=16. At the radius of 2 and sampling points of 16, the recognition rate of emotions like anger and neutral was the highest. The average recognition rate is 79.29. LBP (2,16) method has 3.24 percent improvement than LBP (1.5,12).

Table 3: Recognition rate of facial emotions at radius R=2, sampling points P=16

Radius 2, 16					
	Anger	Fear	Happy	Neutral	Sad
Anger	83.33	6.66	0	3.33	6.66
Fear	0	78.12	6.25	3.12	12.5
Happy	3.22	6.45	77.4	6.45	6.45
Neutral	0	3.33	3.33	86.66	6.66
Sad	0	12.9	6.45	9.677	70.96

The Comparison of various emotion recognition rates at a different radius and sampling points of the proposed method for speaker dependent is tabulated in table 4 and shown in figure 7.

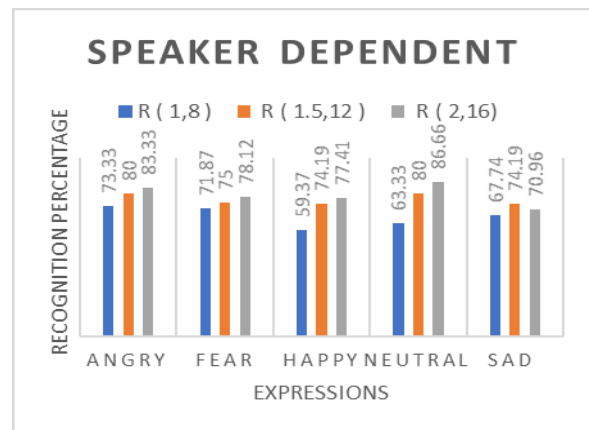


Figure 7: comparison of various emotion recognition rates at a different radius and sampling points.

Table 4: Speaker Dependent Facial Emotional Recognition Rate

Expression	Various Radius and Sampling Points		
	R (1,8)	R (1.5,12)	R (2,16)
Angry	73.3	80	83.3
Fear	71.9	75	78.1
Happy	59.4	74.2	77.4
Neutral	63.3	80	86.7
Sad	67.7	74.2	71
Recognition Rate	67.128	76.676	79.296

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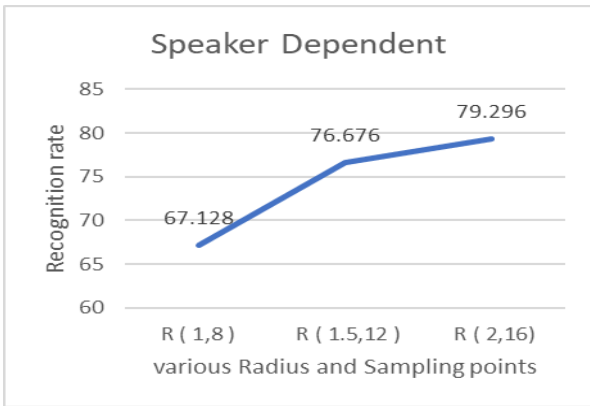


Figure 8: Facial Recognition rate for various radius and sample points in the speaker dependent method.

The average recognition rate of LBP for the various radius is shown in figure 8. From figure 8, the greater radius and high sampling points have a good recognition rate.

2) Speaker Independent

In the speaker independent system, the query image is compared with the images of different persons in the database. The evaluations of facial expression system with various radius values are evaluated.

Table 5 shows the Recognition rate of facial emotions at radius R=1, sampling points P=8. Here the emotion Anger has the highest recognition rate. The average recognition rate of LBP(1,8) is 55.22 percent.

Table 6 shows the Recognition rate of facial emotions at radius R=1.5, sampling points P=12. In this method, the emotion anger has the highest recognition rate. The average facial recognition rate is 57.18 percent. LBP(1.5,12) recognition rate has been increased by 3.54 percent to LBP (1,8).

Table 5: Recognition rate of facial emotions at radius R=1, sampling points P=8

Radius 1,8					
	Anger	Fear	Happy	Neutral	Sad
Anger	66.66	10	10	3.33	10
Fear	9.37	56.25	12.5	9.37	12.5
Happy	9.67	22.58	58.06	3.22	6.45
Neutral	16.66	6.66	13.33	50	13.33
Sad	16.12	16.12	12.9	9.67	45.16

Table 6: Recognition rate of facial emotions at radius R=1.5, sampling points P=12

Radius 1.5, 12					
	Anger	Fear	Happy	Neutral	Sad
Anger	66.66	3.33	6.66	10	13.33
Fear	9.37	56.25	12.5	9.37	12.5
Happy	9.67	22.58	58.06	3.22	6.45
Neutral	10	10	13.33	53.33	13.33
Sad	6.45	16.12	16.12	9.67	51.6

Table 7: Recognition rate of facial emotions at radius R=2, sampling points P=16

Radius 2, 16					
	Anger	Fear	Happy	Neutral	Sad
Anger	73.33	10	0	13.33	3.33
Fear	12.5	56.25	9.375	6.25	15.62
Happy	9.67	12.9	61.2	9.67	6.45

Neutral	10	20	3.33	63.33	3.33
Sad	6.45	19.35	6.45	12.9	54.83

Table 7 shows the Recognition rate of facial emotions at radius R=2, sampling points P=16. Here LBP(2,16) also the emotion Anger has the highest recognition rate. The total recognition rate is 61.78 percent. The recognition rate has been increased by 8 percent when compared to LBP(1.5,12) method.

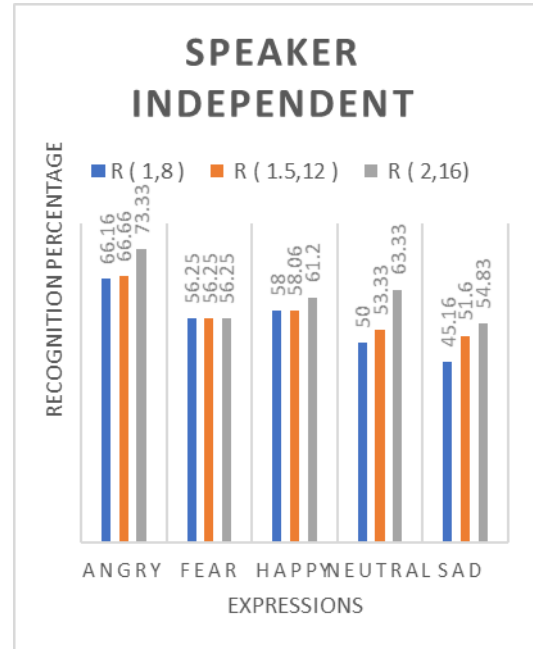


Figure 9: speaker independent emotional recognition rates of various emotions at different and sampling points.

The Comparison of various emotion recognition rates at a different radius and sampling points of the proposed method for speaker dependent is tabulated in table 8 and shown in figure 9.

Table 8: Speaker Independent Recognition Rate

Expression	Various Radius and Sampling Points		
	R (1,8)	R (1.5,12)	R (2,16)
Angry	66.16	66.66	73.33
Fear	56.25	56.25	56.25
Happy	58	58.06	61.2
Neutral	50	53.33	63.33
Sad	45.16	51.6	54.83
Recognition Rate	55.114	57.18	61.788

From table 8, observe that as the radius of the centre pixel is increased the recognition rates of facial expression system has been increased. The average recognition rate of speaker independent is 58.26 percent.

The average recognition rate of LBP for the various radius is shown in figure 10. From figure 10, the greater radius and high sampling points have a good recognition rate.

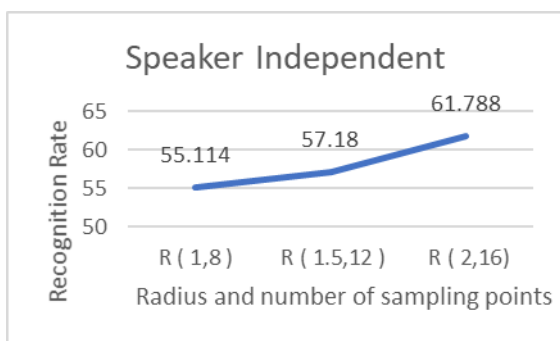


Figure 10: Facial Recognition rate for various radius and sample points in the speaker independent method.

IV. CONCLUSION

The LBP method divides the face into regions and extracts the features of the faces. For each region, histograms are calculated and all these histograms are concatenated to form LBP Descriptor. In this research work various radius 1, 1.5 and 2 and sampling point 8, 12 and 16 are taken for evaluation. the greater radius and high sampling points have a good recognition rate. The Anger emotion has high recognition in all LBP's method. The recognition rates for speaker dependent method are 74.36 percent and for speaker independent method it is 58.02 percent.

ACKNOWLEDGEMENT

This work is carried out in the research and development cell of Kuppam Engineering College. I thank my guide and co-guide for helping me with their suggestions and guidance in carrying out this work.

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