LBP based Fuzzy Co-occurrence Features for Face recognition

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Abstract--- This paper proposes a method for extracting statistical features on Local Binary Pattern based Fuzzy Co-occurrence matrix for effective face recognition. In this method Local Binary Pattern is computed on the image and then fuzzy representation is used for reduction of image local information values. Statistical features are evaluated over Co-occurrence matrices of LBP based fuzzy matrix in four directions 0°, 45°, 90° and 135°. Face recognition algorithm is proposed with these features. The proposed method has been intensively evaluated by applying recognition tests on FGNET and scanned facial images. The results show that this proposed method is superior to the performance obtained using the existing face recognition methods.

Keywords: Face recognition, LBP based Fuzzy Co-occurrence Matrix, Statistical features, LBPFM.

I. INTRODUCTION

Face Recognition is a long-standing problem in computer vision and pattern recognition. It is used in various applications like crime detection surveillance, passport, security, human computer interaction, etc. Face recognition methods are broadly categorized into two types geometry based feature methods, which use global information as features, and appearance based feature methods, uses describe the texture of the face as features. Many methods are developed for facial images analysis [1], which include such techniques as principal component analysis (PCA) [2], linear discriminate analysis (LDA) [3], independent component analysis (ICA) [4], and support vector machine (SVM) [5]. Next structural approach for face analysis using local binary pattern (LBP) developed [6], which showed a high discriminative power for texture classification due to its invariance to monotonic gray level changes. After that, many variants of LBPs have been introduced by many other researchers and applied to many areas such as face detection [7-9], face recognition [10-13], face authentication [14-15], facial expression recognition [16], gate recognition [17], image retrieval [18], age classification [19-22] and object detection [23]. To address this face recognition issue, in this paper we proposed a method, it evaluates LBP based Fuzzy matrix on facial images and then statistical features are extracted for face recognition. The remainder of this paper is organized as follows. Section II describes methodology. In Section III, the experimental results with comparison are reported. Finally Section IV concludes this paper.

II. METHODOLOGY

In this proposed method the color image is converted to gray image, on this image the Local Binary Pattern (LBP) is computed and then Fuzzy Logic is applied and Co-occurrence matrix features are evaluated for face recognition. This method is explained in the following sub sections in detail.

Step-1: Local Binary Pattern

The LBP is computed on the image for obtaining local neighborhood information of pixels [6]. The computation of LBP is illustrated in figure 1. A 3×3 neighborhood consists of a set of nine elements, P = {p_c, p_0, p_1,., p_7}, where p_c represents the gray level value of the central pixel and p_i ($0 \le i \le 7$) represent the gray level values of neighbor pixels. Each 3×3 neighborhood then can be characterized by a set of binary values b_i ($0 \le i \le 7$) as given in equation1. For each 3×3 neighborhood, a unique LBP is derived from the equation2.

$$b_i = \begin{cases} 0 & \Delta p_i < 0 \\ 1 & \Delta p_i \ge 0 \end{cases} \quad \text{where } \Delta p_i = p_i - p_c \qquad (1)$$

$$LBP_{P,R} = \sum_{i=0}^{i=7} b_i \times 2^i \qquad (2)$$

Every pixel in an image generates an LBP code. A single LBP code represents local micro texture information around a pixel by an integer code in between 0 and 255.

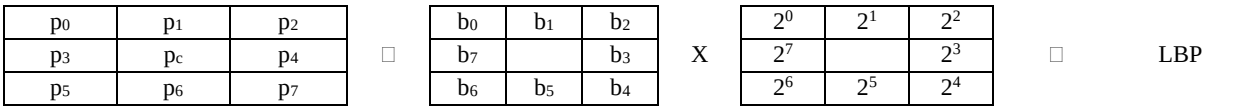

Fig. 1: Computation of LBP.

Step 2: Formation LBP based Fuzzy Matrix

The proposed method labels eight neighbors of a 3×3 neighborhood of LBP of image using five possible fuzzy patterns or values {0, 1, 2, 3 and 4} derived from the fuzzy code or representation as depicted in equation 3.The element V_i represent the LBP values of the eight neighboring LBP values on a 3×3 neighborhood of LBP textured image, V_0 represents the LBP of central pixel, x and y are the user specified lag values. The process of evaluating fuzzy values on a 3×3 neighborhood of LBP image is shown in figure 2. By repeating this process over the entire LBP image, LBP based Fuzzy Matrix is computed. This reduces the LBP values with range 0 to 4 values. This reduction is based on the assumption that the face image classification is a data generalization process and reducing local information variability to some extent should not seriously influence the classification accuracy. According to Narayanan et. al. [24], reducing data down to 4 bits from 8 bits would still preserve more than 90 percent of the texture information content.

$$E_i = \{0\ if\ V_i < V_0\ and\ V_i < x \quad 1\ if \quad V_i < V_0\ and\ V_i > x \quad 2\ 3\ 4\ \ if\ if\ if \quad V_i = V_0\ V_i > V_0 \quad V_i > V_0 \quad and\ V_i > y \quad and\ V_i < y \quad \} \quad for\ i = 1,2,3,\dots,8 \tag{3}$$

74	130	120
100	140	20
150	170	25

0	1	1
1	2	0
3	4	0

Fig.2: (a) LBP of image (b) Fuzzy values

Step 3: Evaluation of Statistical Features on LBP based Fuzzy Co-occurrence Matrix (LBPFCM)

Grey level co-occurrence matrices (GLCM) introduced by Haralick attempt to describe texture by statistically sampling how certain grey levels occur in relation to other grey levels [25]. One of the major inconveniences of GLCM on the original images is the huge range of its possible grey level values (0 to 255 or 1024 etc.) at the same time that these values are not correlated. The present method evaluates the feature set contrast, correlation, energy, and, local homogeneity on reduced local information LBPFCM. These features are computed using the equations 4 to 7 on LBPFM in four directions 0°, 45°, 90° and 135° for effective face recognition.

$$contrast = \sum_{i,j=0}^{N-1} -ln\,(P_{ij})P_{ij} \tag{4}$$

$$Energy = \sum_{i,j=0}^{N-1} -ln\,(P_{ij})^2 \tag{5}$$

$$Local\ Homogenity = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2} \tag{6}$$

$$Correlation = \sum_{i,j=0}^{N-1} P_{ij}\frac{(i-\mu)(j-\mu)}{\sigma^2} \tag{7}$$

III. RESULTS AND DISCUSSIONS

The proposed method LBPFCM with statistical features is applied for accurate recognition of human faces. This method established a database of the 1002 face images collected from FG-NET database and other 600 images collected from the scanned photographs. Sample images of each group of images are shown in figure 3

Fig. 3: Sample images from FG-NET Database

The statistical features contrast, correlation, energy and homogeneity are extracted on LBP based Fuzzy Co-

occurrence Matrix of considered database images and the results are stored in the feature vector. Feature set leads to representation of the training images. Tables 1,2,3 and 4 represent the derived four features in four directions with 0° 45°, 90° and 135° orientation of LBPFCM on 5 facial images. These 16 features are used as feature vector for each face in recognition. The facial recognition algorithm with this feature vector on LBPFCM is represented in algorithm1. This algorithm is tested on considered facial image data set and has shown 98% successful recognition rate.

Table 1: Statistical feature set on LBPFCM 0° of facial images.

S.no	Image name	Contrast	Correlation	Energy	Homogeneity
1	001A16	13.62569	0.14116	0.47547	0.75668
2	001a02	6.16593	0.12553	0.74611	0.88989
3	002A03	7.75231	0.13157	0.68465	0.86157
4	002A04	8.33752	0.19511	0.64741	0.85112
5	002A05	14.98536	-0.00505	0.48342	0.7324

Table 2: Statistical feature set on LBPFCM 45° of facial images.

S.no	Image name	Contrast	Correlation	Energy	Homogeneity
1	001A16	16.28264	-0.0263	0.45434	0.70924
2	001a02	6.67326	0.05369	0.73845	0.88083
3	002A03	8.39451	0.05203	0.67731	0.8501
4	002A04	9.64953	0.06206	0.63189	0.82769
5	002A05	15.27946	-0.02505	0.4812	0.72715

Table 3: Statistical feature set on LBPFCM 90° of facial images.

S.no	Image name	Contrast	Correlation	Energy	Homogeneity
1	001A16	11.9986	0.24521	0.49067	0.78574
2	001a02	4.48703	0.37409	0.77051	0.91987
3	002A03	6.14204	0.31333	0.70783	0.89032
4	002A04	7.20851	0.30454	0.663	0.87128
5	002A05	13.12651	0.12031	0.49935	0.7656

Table 4: Statistical feature set on LBPFCM 135° of facial images.

S.no	Image name	Contrast	Correlation	Energy	Homogeneity
1	001A16	15.31062	0.03496	0.46139	0.7266
2	001a02	6.33531	0.10162	0.74352	0.88687
3	002A03	7.81484	0.11754	0.68524	0.86045
4	002A04	9.03904	0.12143	0.63961	0.83859
5	002A05	14.58396	0.02161	0.48675	0.73957

Algorithm 1: Face recognition algorithm on LBP based Fuzzy Co-occurrence Matrix using statistical features.

Begin

Input: The test facial Image.

Step1: Convert the given test image into LBP based Fuzzy Co-occurrence Matrix.

Step2: Evaluate the contrast, correlation, energy and homogeneity features on LBPFCM of test images.

Step3: Find the difference between test image features with existing feature vector of the feature library.

Step4: If difference is zero or falls within the small range then test image is matching with the database image or the test image is recognized.

End

The proposed method Statistical Features on LBP based fuzzy matrix is compared with other existing methods like Statistical Texture Features by Vijaya kumar et.al. [26] and fuzzy rule for face detection by Moallema et.al. [27] and FIDRSP model by P. Chandra Sekhar Reddy et.al. [28]. The percentage mean recognition rate for the proposed and other existing methods is shown in Table 5.

Table 5. The face recognition rate by the proposed and other existing methods.

Image Database	Statistical Texture Features [26]	Fuzzy rule for face detection [27]	FIDRSP model [28]	Proposed SF on LBPCM
FG-NET	94	96.7	100	100
Scanned	93	94	97.5	98

IV. CONCLUSION

The proposed SF on LBPFCM method gathers local information of facial image and then fuzzy matrix is

computed. This LBPFM contains values only from set {0, 1, 2, 3, 4}, reducing the overall complexity in co-occurrence matrix formation. The proposed method only by evaluating four statistical features of LBPFCM has shown a good recognition rate. By comparing the performance of the proposed method with the existing methods, it shows that our method is best suited for face recognition system.

REFERENCE

[1] Chellappa, R., Wilson, C. L., & Sirohey, S. (1995). Human and machine recognition of faces: a survey. Proceedings of the IEEE, 83(5), 705–741.

[2] Turk M, Pentland A, Eigenfaces for recognition, Journal of Cognitive Neu- roscience 3 (1991) 72–86.

[3] Belhumeur P, Hespanha J, Kriegman D, Eigenfaces vs. fisherfaces: class specific linear projection, IEEE Transactions on Pattern Analysis and Machine Intelligence 19 (7) (1997) 711–720.

[4] Bartlett M, Movellan J, Sejnowski T, "Face recognition by independent component analysis", IEEE Transactions on Neural Networks 13 (2002) 1450–1464.

[5] Heisele B, Ho Y, Poggio T, Face recognition with support vector machines: global versus component-based approach, in: Proceedings of International Conference on Computer Vision, 2001, pp. 688–694.

[6] Ojala T, Pietikainen M, Harwood D, A comparative study of texture measures with classification based on feature distributions, Pattern Recognition 29 (1996) 51–59.

[7] Ojala T, Pietikainen M, Maenpaa P, Multiresolution grayscale and rotation invariant texture classification with local binary patterns, IEEE Transactions of Pattern Analysis and Machine Intelligence 24 (7) (2002) 971–977.

[8] Jin H, Liu Q, Lu H, Tong X, Face detection using improved LBP under Bayesian framework, in: Proceeding of Third International Conference on Image and Graphics, 2004, pp. 306–309.

[9] Zhang L, Chu R, Xiang S, Liao S, S.Z. Li, Face detection based on multi-block LBP representation, in: The Second International Conference on Biometrics, 2007, pp. 11–18.

[10] Ahonen T, Hadid A, Pietikainen M, Face description with local binary patterns: application to face recognition, IEEE Transactions on Pattern Analysis and Machine Intelligence 28 (12) (2006) 2037–2041.

[11] Ahonen T, Hadid A, Pietikainen M, Face recognition with local binary patterns, in: The Eighth European Conference on Computer Vision, 2004, pp. 469–481.

[12] Lahdenoja O, Laiho M, Paasio A, Reducing the feature vector length in local binary pattern-based face recognition, in: IEEE International Conference on Image Processing, 2005, pp. 11–14.

[13] Liao S, Zhu X, Lei Z, Zhang L, Li S Z, Learning multi-scale block local binary patterns for face recognition, in: The Second International Conference on Biometrics, 2007, pp. 828–837.

[14] Heusch, Rodriguez, Marcel, Local binary patterns as an image preprocessing for face authentication, in: The Seventh International Confer- ence on Automatic Face and Gesture Recognition, 2006, pp. 9–14.

[15] Rodriguez, Marcel, Face authentication using adapted local binary pattern histograms, in: The 10th European Conference on Computer Vision, 2006, pp. 321–332.

[16] Shan, Gong, McOwan, Facial expression recognition based on local binary patterns: a comprehensive study, Image and Vision Computing 27 (2009) 803–816.

[17] Kellokumpu, Zhao, Li, Pietikainen, Dynamic texture-based gait recognition, in: Lecture Notes in Computer.

[18] Takala, Ahonen, Pietikainen, Block-based methods for image retrieval using local binary patterns, in: Proceeding of the 14th Scandinavian Conference on Image Analysis, 2005, pp. 882–891.

[19] P.Chandra Sekhar Reddy, B. Eswara Reddy and V. Vijaya Kumar"Texton Based Shape Features on Local Binary Pattern forAge Classification," International Journal of Image, Graphics and Signal Processing(IJIGSP), Volume4(7), pp.54-60, 2012.

[20] A.P.Chandra Sekhar Reddy, V.Vijaya Kumar, and B.Eswara Reddy, "New Method for Classification of Age Groups Based on Texture

Shape Features," International Journal of Imaging and Robotics, Volume 15(1), pp.19-30, 2015.

[21] P Chandra Sekhar Reddy, Bhanu Sreekar Reddy Karumuri, "Age Classification with Motif Shape Patterns on Local Binary Pattern", International Journal of Computer Trends and Technology, Volume 39, Number 3, pp. 134-138, September 2016.

[22] P Chandra Sekhar Reddy, Bhanu Sreekar Reddy Karumuri, "Age Classification with Shape Patterns derived from Central Pixel Flooding Matrix (CPFM) on Facial Images", International Journal of Latest Trends in Engineering and Technology, Vol.(7), Issue(4), pp. 205-211, 2016.

[23] Heikkil, Pietikainen, Heikkil¨ a, A texture-based method for detecting moving objects, in: Proceeding of the 15th British Machine Vision Conference, 2004, pp.187–196. Science, 2009, pp. 1000–1009.

[24] Narayanan R.M., T.S. Sankaravadivelu, and S.E.Reichenbach,2000. Dependence of image information content on gray-scale resolution, Proceedings of IGARSS, 24–28 July, Honolulu,Hawaii, 1:153–155.

[25] Haralick RM , Shanmugan K and Dinstein I, "Textural features for image classification," IEEE Trans. Sysr., Man., Cybern., Vol. SMC-3, pp.610-621, 1973.

[26] Chandra Mohan M, V. Vijaya Kumar, and U S N Raju, "New Face Recognition Method Based on Texture Features using Linear Wavelet Transforms", IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.12, December 2009.

[27] Payman Moallema, Bibi Somayeh Mousavib, S. Amirhassan Monadjemi , "A novel fuzzy rule base system for pose independent faces detection", Applied Soft Computing, Vol. 11, pages: 1801–1810, year : 2011.

[28] P.Chandra Sekhar Reddy, B.Eswara Reddy and V.Vijaya Kumar, "Fuzzy Based Image Dimensionality Reduction Using Shape Primitives for Efficient Face Recognition," ICTACT Journal on Image and Video Processing, Volume 4(2), pp.696-701, 2013.