Expression Recognition Using Local Binary Pattern

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Abstract. This paper presents facial expression recognition method based on local binary pattern (LBP). LBP is used as texture and shape descriptor of digital images. Here, image is divided into several small regions from which features are extracted. These features consist of binary patterns that describe the surroundings of pixels in the regions. The obtained features from the regions are concatenated into a single feature histogram, which forms a whole image. For experimental purpose, we have considered our own created face database. Half illumination face images are compared with full illumination face images in the experiment. The classification of face images has been conducted using 2 class Linear discriminant analysis which generates maximum recognition rate 70%.

Keywords: Local binary pattern, linear discriminant analysis, feature extraction, classification.

1. Introduction

Face is one of the most powerful channels of nonverbal communication. A facial recognition means identifying or verifying a person from a digital image or a video frame from a video source. It is mainly used for security purpose.

Feature extraction is very important in face recognition. Feature extraction is a special form of dimensionality reduction. Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately [1]. Face recognition has been widely applied in security system, credit-card verification, and criminal identifications, teleconference and so on. So it is difficult to recognize a person only by their fingerprint. Now a days facial feature extraction becomes an important issue in automatic recognition of faces. In order to perceive and recognize human faces, we must extract the prominent characteristics on the faces. Usually those features like eyes, nose and mouth together with their geometry distribution and the shape of face is applied. Face recognition system is

divided into two features, one is local feature and another one is global feature. Global features focus on the whole entire image. And here accuracy is less. Whereas local features focus on the local features of the face such as eye, nose, eyebrow, lips etc. Local feature extraction refers to describing only a local region/part of the image by using some transformation rule or specific measurements. It helps to identify and verifying a person using the unique details in the face with more accuracy [2]. LBP is commonly use local feature extraction technique. Local Binary Pattern (LBP) is widely used for texture analysis technique. LBP operator is one of the best performing texture descriptor. Different application of LBP are-

1. The LBP operator has been widely used in different applications such as texture classification, image retrieval etc [3].
2. Due to its monotonic gray level changes and computational efficiency, make it suitable for demanding image analysis tasks [3].
3. Through LBP dimension of face can reduce.

X. Feng and et al. [4] have proposed LBP on facial expression on static images. They did their work in two fields. First, the local binary patterns used on facial images and then the linear programming (LP) technique used for classification of seven facial expressions like anger, disgust, fear, happiness, sadness, surprise, and neutral. The database used here is JAFFE. Average recognition accuracy of 93.8%.

Ms.A.V. Malkapurkar, and Prof. S. Murarka [5] proposed a new face recognition method based on local binary pattern (LBP) with histogram. To describe the texture and shape of a digital image LBP is a very powerful method. Hence it is suitable for feature extraction in face recognition systems. They did their work on ORL Database, JAFFE database. The recognition rate is 96.97%.

T. Ahonen, M. Pietik¨ainen [6] has implemented soft histograms for the Local Binary Pattern (LBP) operator that has been widely applied in different image analysis tasks. Author discusses about how LBP implemented on image pixel. This makes the operator more robust to noise and make its output continuous with respect to input. They use the test image by Randen and Husøy [7]. .And classification error rate is 45.8%.

LBP using the FERET database has been investigated by T. Ahonen, M. Pietik¨ainen [8] in 2006. This paper presents an efficient facial image by LBP texture features. LBP feature distributions are extracted from face image which is divided into several regions and then concatenated feature vector used as a face descriptor. They also discuss about different application LBP. The recognition rate is 95 %.

2. Overview of LBP

Local Binary Pattern is used as a texture operator. LBP is done by thresholding the neighborhood of each pixel and get the output as a binary number. Most important property of LBP is its robustness to monotonic gray-scale changes caused, like illumination variations. LBP is also used in analyze images due to its computational simplicity [9].

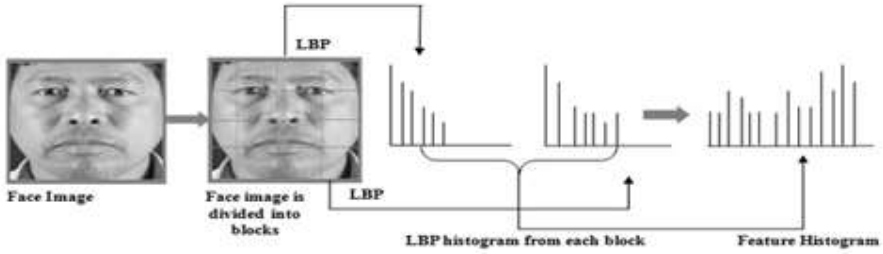

Fig1:- Face description using Local Binary Pattern

Concept of LBP:-

- Divide the examine window into cell (10*10 pixel in a cell).
- For each pixel in a cell, compare the pixel to each of its neighbors.
- Follow all pixels along a circle, i.e. clockwise or counter clockwise.
- If neighbor pixel value is greater than centre pixel then write 1, otherwise 0.
- Compute the histogram, over the cell of frequency of each no. Occurring (i.e. each combination of which pixel is smaller and which are greater than the centre).
- Optionally normalize the histogram.
- Concatenate normalized histogram of all cell that gives the feature vector of window.

2.1. Mathematics

The LBP operator labels the image pixel a local pattern_which is computed by comparing its gray value with those of its neighbours [9].

$$LBP(x_c, y_c) = \sum_{n=0}^{7} s(i_n - i_c)2^n \quad (1)$$

Where i_c corresponding to the value of the center pixel (x_c, y_c), in to the value of the eight surrounding pixels, and function s(x) is defined as:

$$S(x) = \begin{Bmatrix} 1 if x \geq 0 \\ 0 if x < 0 \end{Bmatrix} \quad (2)$$

Following fig. 2(a, b) and 3(a, b) shows how LBP is calculated:-

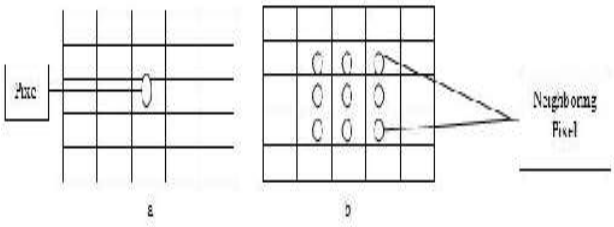

Fig. 2: (a) 5×5 matrix with a pixel, (b) 5×5 matrix with central pixel and its neighbouring pixel.

Example:

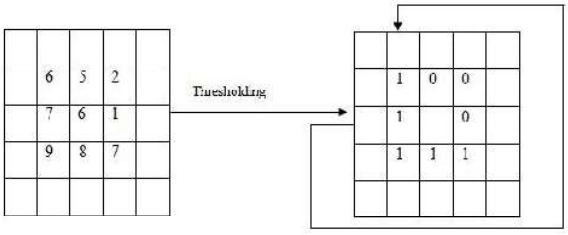

Fig. 3: (a) 5×5 matrix with pixel value, (b) 5×5 matrix with pixel value.

Binary pattern- 10001111

LBP- $1x2^7+0x2^6+0x2^{5+}0x2^4+1x2^3+1x2^2+1x2^1+1x2^0=143$

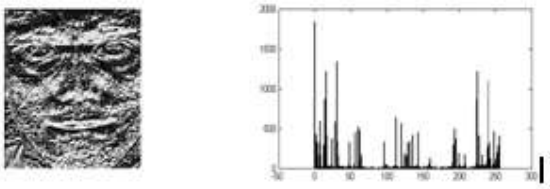

Fig 4: (a) LBP Image, (b) Histogram of the corresponding LBP Image

2.2. LBP on different expressions

Human expressions are classified into six basic emotions which are:

1. Anger,
2. Happy,
3. Sad,
4. Surprised,
5. Fear,
6. Disgust,

Facial expressions are recognized by movements of one or more muscles of the skin that convey the emotional state of the individual to observers [5]. LBP is introducing on different expressions to find the local features and histogram of the face.

Fig.5: (a) Cropped Original Image with Different Expressions and (b) LBP image of Corresponding Original Images.

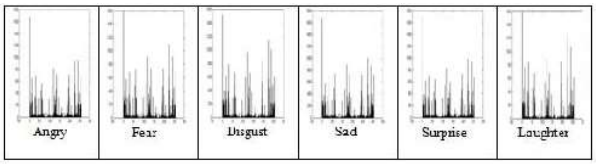

Fig. 6: Histogram of Different Expressions of the LBP Images Shown in Fig. 5(a, b).

2.3. Linear discriminant analysis (LDA)

LDA is a popular feature extraction technique for face recognition. Basically, LDA approaches typically include two phases: training and classification. LDA is a widely used method for feature extraction and dimensionality reduction in pattern recognition. LDA tries to find the “best” project direction in which training samples belonging to different classes are best separated. In the training phase, the fisher space is established from the training samples using LDA and the training face images are mapped to the fisher-space for

classification. In the classification phase, an input face is projected to the same fisher-space and classified by an appropriate classifier.

3. Face image acquisition

Face database comprises visual face images of different tribes and non-tribes. The design of the database is still under development in the Biometrics Laboratory of Tripura University of India. Each person contains 95 face images including the neutral, left light on, right light on, six basic expressions and the close eye. All the state includes individuals both tribes and non tribes. Total numbers of persons are 524.So total image is 49,780 including male, female from different age group.

4. Experimental results

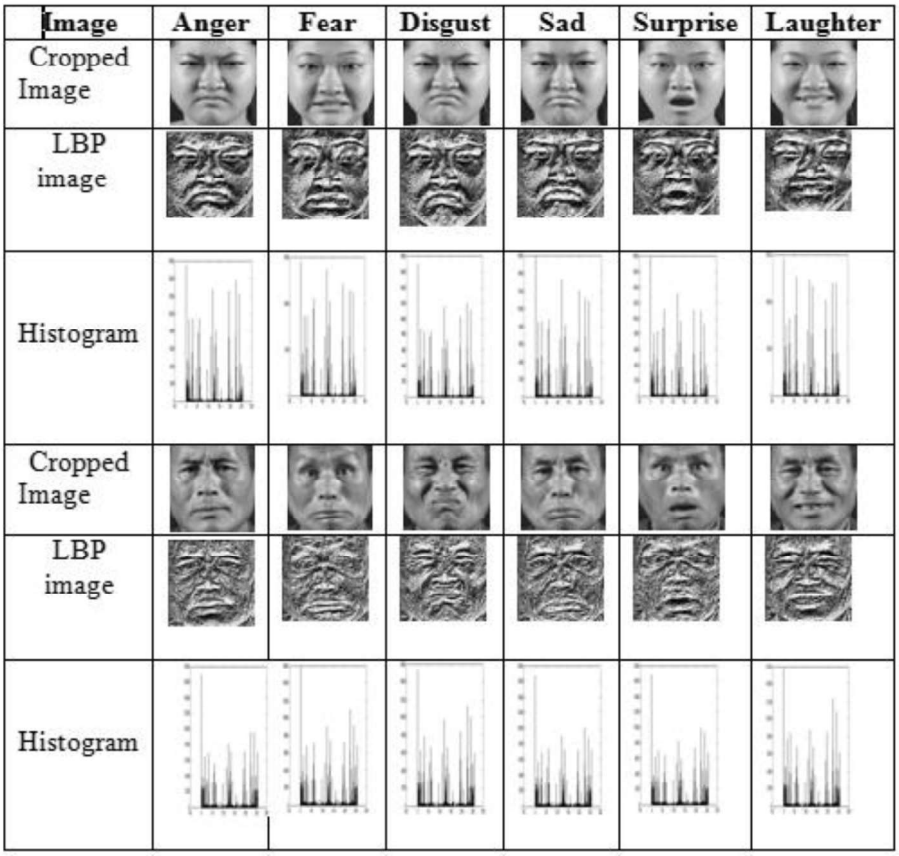

Fig7: Six Expressions with their LBP image and histogram

From 49,780 face images, Linear Discriminant Analysis (LDA) two class classifier considers 10 persons as 2 classes taking 5 images from each class. In the experimental for training

purpose value of LBP of two expressions of 10 persons with full illumination are taken and yield a result of each expression. And then for testing half illumination of that persons are taken individually and compared with that training value.

Following Table 1 shows the recognition rate of the experiment.

Table 1

Number of person for training	Expressions	Recognition rate	
10	Anger and disgust	Anger-70%	Disgust-50%
10	Laughter and surprise	Laughter-50%	Surprise-50%
10	Sad and surprise	Sad-70%	Surprise-50%
10	Fear and disgust	Disgust-60%	Fear-60%

5. Conclusion and future work

This report provides a brief description of the LBP and its use on the images of North-East Indian Face Database. It also gives a detailed description of the image capturing equipments (i.e. lights, cameras etc.) setup and their different angles and distances from the subject. The database images have been captured with four illumination types, eight expressions (including neutral), and faces with glasses, in a controlled environment. Total 49,780 individuals' faces have been captured from three different states (Mizoram, Tripura, and Assam, Manipur, Nagaland). After converting image into LBP image 2 class LDA is used for result. This report mainly focuses on feature extraction. Here, texture of images is extracted from NEI database. We can conclude that our approach has achieved efficient classification performance for face recognition purpose.

In future, the aim is to do extraction of facial expressions using LBP and multiclass LDA and implementing on NEI database.

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