ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)
Vol. 2, Issue 2, Ver. 2 (April - June 2014)
International Journal of Advanced Research in Computer Science & Technology (IJARCST 2014)

Review on Local Binary Pattern For Face Recognition

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Abstract

Recognizing facial expressions of human beings by a computer is an interesting and challenging problem. Face is the most important feature of a human being. Everyone have a different face features and usually used as a identification. Recognizing different faces for humans is not a difficult task but it is difficult to identify different faces and their expressions by a system. Face expression recognition can be used in a number of applications like authentication, security issues, surveillance. This paper presents a survey on the Local Binary Patterns (LBPs) for face recognition and its various variants. LBP is becoming a popular technique for face representation. It is a non-parametric method. Face recognition is an active research area now a days.

Keywords

Face Recognition, LBP, ILBP, MLBP, CS-LBP

I. Introduction

Face recognition is an active research area, and they can be used in wide range applications such as surveillance and security. Face is a complex multidimensional structure and needs a good computing technique for recognition. Face recognition system can be used in two modes: Verification and Identification. Facial feature extraction consists of localizing the most characteristics features of the face image like eyes, nose and mouth regions. There are two types of method to extract features from the facial images and they are:

Geometric feature considers the deviation in shape, location, space between two eyes and length of the nose. The appearance feature presents the appearance variations of the face image, such as wrinkles and furrows. The appearance feature needs to be extracted on either the whole face image or specific regions in a facial image. The face is one of the most important features of the human beings and usually used as identification. Recognizing the different human faces is not a difficult task for humans, but it is quite hard to the system to recognize the human faces. LBP generate the binary code that describes local texture pattern by normalizing intensity values in neighborhood. The eyes and nose region is extracted from the LBP face image and then LBP histograms are drawn for each pixel of the image.PCA is a way of identifying patterns in data and expressing the data to highlight their similarities and differences. [2]

Image Acquisition

This is the first step where we aquire image using any digital device Images used for facial expression recognition are static images or image sequences. 2-D monochrome (grey-scale) facial image sequences are the most popular type of pictures used for automatic expression recognition

Pre-processing

Image pre-processing often takes the form of signal conditioning (such as noise removal, and normalisation against the variation of pixel position or brightness), together with segmentation, location, or tracking of the face or its parts.

Feature Extraction

Feature extraction converts pixel data into a higher-level representation of shape, motion, colour, texture, and spatial configuration of the face or its components.

Classification

Expression categorization is performed by a classifier, which often consists of models of pattern distribution, coupled to a decision procedure. A wide range of classifiers, covering parametric as well as non-parametric techniques, has been applied to the automatic expression recognition problem [14].

Post-processing

Post-processing aims to improve recognition accuracy, by exploiting domain knowledge to correct classification errors or by coupling together several levels of a classification hierarchy. [2]

II. LBP

Since the LBP was, by definition, invariant to monotonic changes in gray scale, it was supplemented by an independent measure of local contrast. Fig. 1 shows how the contrast measure (C) was derived. The average of the gray levels below the center pixel is subtracted from that of the gray levels above (or equal to) the center pixel.[1] Two-dimensional distributions of the LBP and local contrast measures were used as features.

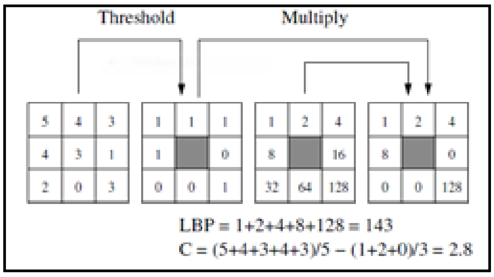

Fig.1: Working of LBP operator

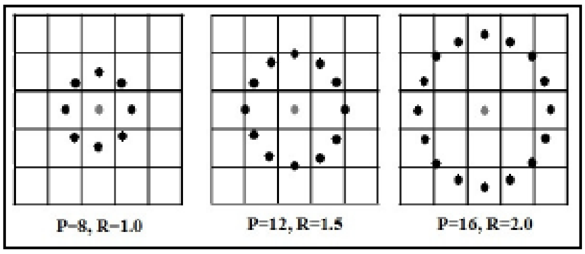

Fig.2 : Circularly symmetric neighbor sets for different (R,P) values of LBP.

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With the LBP operator, good discrimination rates were reported with textures selected from the photographic album. The current form of the LBP operator, described in Fig 2, is quite different from this basic version: the original definition is extended to arbitrary circular neighborhoods, and a number of extensions have been developed. The basic idea is however the same: a binary code that describes the local texture pattern is built by threshold a neighborhood by the gray value of its center. The operator is related to many well-known texture analysis methods.[17]

Designers of LBP face three fundamental problems:

The first issue is how to describe different local patterns of textures and then how to extract these local patterns. Since not all of local patterns are with the same importance to texture analysis.

The second issue is how to select the essential subset of these local patterns to represent textures.

The third issue is how to use these selected local patterns to form an effective texture descriptor.[18]

Solutions to these issues are:

For the first issue, a "local pattern" in LBP operators is defined in the neighborhood of a pixel and describes the relationships between the pixel and its neighborhood pixels. According to the definition of the LBP operator, local patterns are represented with binary codes, which are constructed by threshold the gray values of the neighborhood relative to the corresponding value of the central pixel, as can be seen in Fig. 1. In the fig.3, ones are represented by white circles and zeros by black circles. this figure illustrates the LBP codes of some possible local patterns, including spots, flat areas, edges, edge ends, and curves.

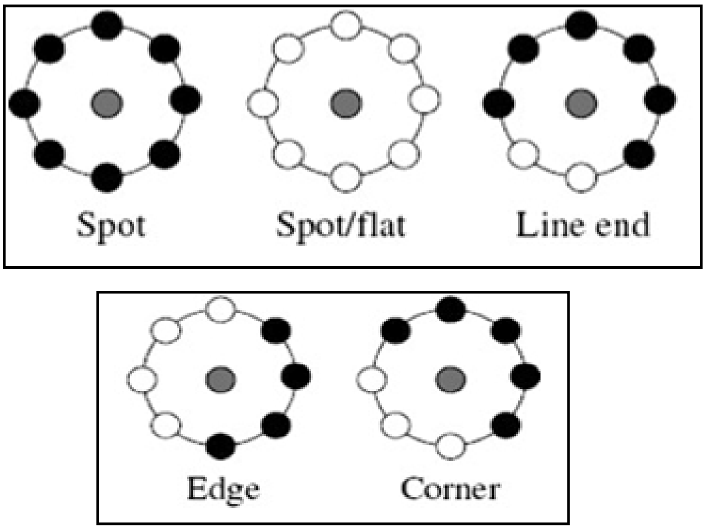

Fig.3 : Different texture primitives detected by the LBP

For the second issue for LBP designers is that not all local patterns are meaningful for modeling the characteristics of textures or are able to improve the reliability of the analysis. It is necessary to select which local patterns are considered as the major parts of all patterns, i.e., which local patterns represent fundamental properties of the local texture. In this work, two classes of local patterns are defined based on the analysis of the structure and occurrence probability of non-uniform patterns. The local patterns in the first class represent the primary structural components of a texture, and these patterns are further classified into two subclasses. The first subclass non-uniform patterns are similar to some uniform patterns; we assign them to the corresponding uniform patterns. The second subclass non-uniform patterns are not similar to any uniform pattern. Uniform patterns are those in which there should me no more than two bitwise transitions from 0 to 1 or 1 to 0.

The last issue for designers can be addressed by assigning a unique label to each local pattern by definition. [2]

The following flow chart shows how LBP works for face recognition.

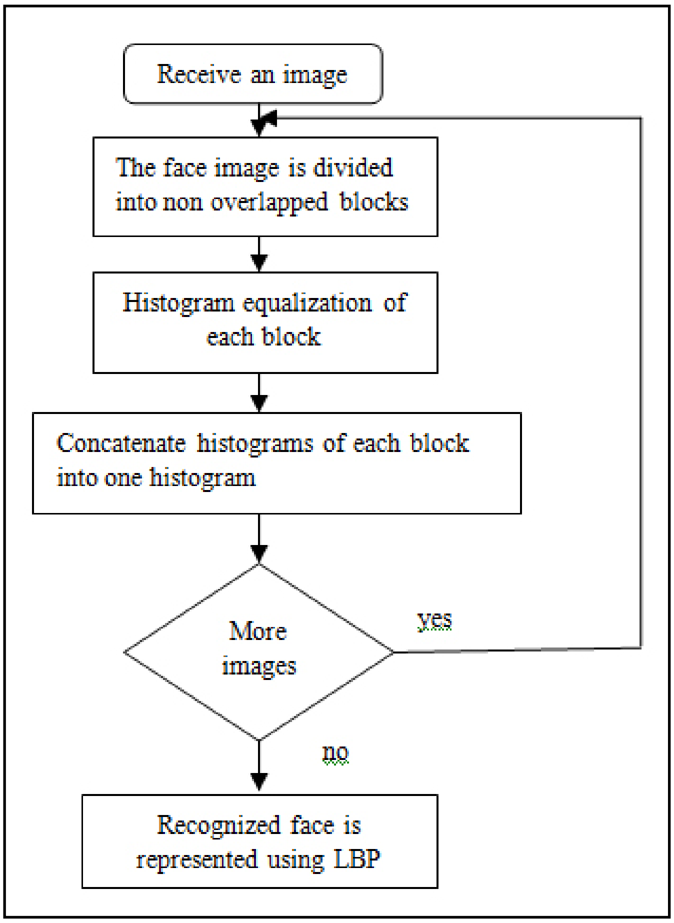

Fig. 4 : Flowchart of LBP for face recognition

$$LBP_{P,R}(g_c) = \sum_{P=0}^{P-1} s(g_p - g_c)2^P \qquad (1)$$

Where gc is the central pixel at (x_c, y_c) coordinates and $f(_{gp}|p = 0,\ldots..P-1)$ are the values of the neighbors.

The comparison function s (x) is defined as[19]:

$$s(x) = 1 \text{ if } x \geq 0$$
$$= 0 \text{ if } x < 0 \qquad (2)$$

$$T = t(g_c, g_0, \ldots, g_{p-1})$$

Where,

g_c corresponds to the gray value of the center pixel of a local neighborhood.

$G_p(p = 0, \ldots, P - 1)$ correspond to the gray values of P equally spaced pixels.

T is texture.

t is threshold

The coordinates of the neighbor g_p are given by

$(x_c+R\cos(2\pi p/P)), (y_c-R\sin(2\pi p/P)),$

Where (x_c, y_c) are the coordinates of the center pixel. [4]

Table 1: List of LBP variations

Variations	Properties	Advantages
Mean LBP	Consider effects of center pixels	Enhances discriminative capability
Hamming LBP	Incorporate non-uniform patterns into the uniform patterns	Enhances discriminative capability
Local ternary patterns	Bring in new thresholds	Improves the robustness
Elongated LBP	Not invariant to rotation	Capable to choose different neighborhood
Volume LBP	Describe dynamic texture	Extending to 3D

(i). Rotation invariant LBP

It is used in order to minimize the effects of rotation. The main idea is to apply a circular shift to find the minimum value that the pattern chain may represents.

$LBP^{MIN}_{P,R}(g_c) = \min\{ROR(LBP_{P,R}(g_c), i \mid i = 0 \ldots p-1\}$ (3)

where ROR(x; i) performs a circular bit-wise right shift operation. [19]

(ii). Improved LBP

Jin et al. [14] pointed out that LBP could miss the local structure information under some circumstances. For instance, LBP(8, 1) operator can only get 256 (2^8) of all 511 patterns (2^9-1, as all zeros and all ones are the same) for a 3x3 neighborhood, as the central pixel is not considered. In order to obtain the complete information, they proposed an Improved LBP (ILBP) which compares all the pixels (including central pixel) with the mean of all the pixels in the kernel. Later ILBP was extended to the neighborhoods of any sizes instead of the original 3x3.[7]

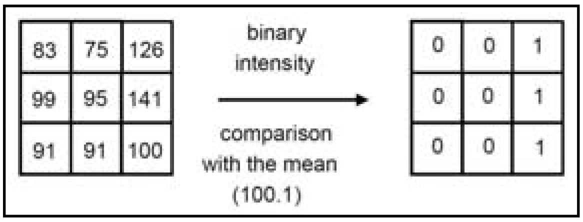

Fig.5 : An example of ILBP operator[20]

(iii). Multivariate local binary pattern

The Multivariate Local Binary Pattern operator, MLBP was developed by Arco Lucifer [13] which describes local pixel relations in three bands. In addition to the spatial interactions of pixels within one band, interactions between bands are considered. Thus, the neighborhood set for a pixel consist the local neighbours in all three bands.[11][12]

$$MLBP = \sum_{i=0}^{7} \begin{matrix} sign(g_i^{b1} - g_c^{b1}) + sign(g_i^{b2} - g_c^{b1}) + sign(g_i^{b3} - g_c^{b1}) \\ sign(g_i^{b1} - g_c^{b2}) + sign(g_i^{b2} - g_c^{b2}) + sign(g_i^{b3} - g_c^{b2}) \\ sign(g_i^{b1} - g_c^{b3}) + sign(g_i^{b2} - g_c^{b3}) + sign(g_i^{b3} - g_c^{b3}) \end{matrix} \quad (4)$$

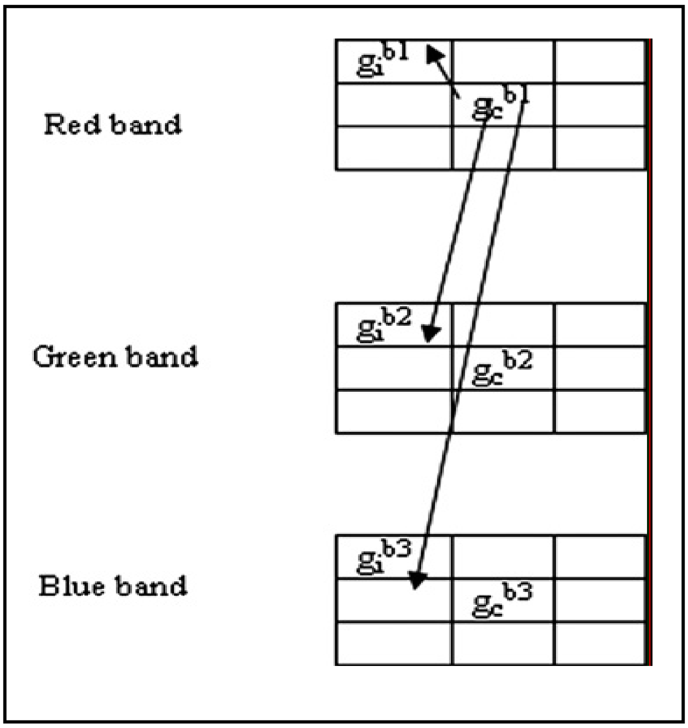

Fig.6 : MLBP operator

(iv). Center Symmetric Local binary pattern(CS-LBP)

It was developed by Marko Heikkila [15] for the recognition of object in PASCAL database. The original LBP was very long its feature is not robust on flat images. In this method, instead of comparing the gray level value of each pixel with the center pixel, the center symmetric pairs of pixels are compared. CS-LBP is closely related to gradient operator. It considers the grey level differences between pairs of opposite pixels in a neighborhood. So CS-LBP take advantage of both LBP and gradient based features. [11,12].

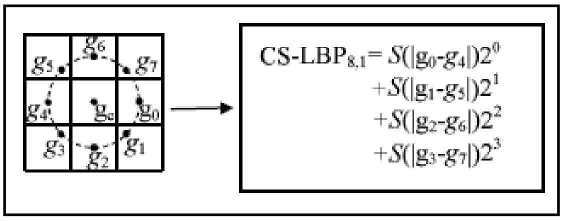

Fig.7 : CS-LBP operator

III. Conclusion

In this paper, a survey on local binary pattern for face recognition has been studied in detail. Also different variants of LBP has been presented. Face recognition is becoming a popular topic in various applications like security, surveillance etc. In LBP the whole image is divided into equal sized blocks. Then local binary pattern is computed for each pixel in all blocks by comparing the center pixel with neighboring pixels. This will give us a binary pattern for each image. A number of variants of LBP exists like Rotation in-variant LBP, improved LBP, Advanced LBP, Modified LBP, Extended LBP, Mulit-scale LBP, Multi-block LBP, Hamming LBP etc.

IV. Acknowledgement

The author is grateful to Mr. Rakesh Singh Raajput ,Assistant Professor, Department of Computer Engineering ,Punjabi University , Patiala for his support and guidance.

ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

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