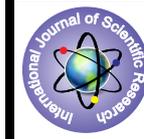


Using LBP histogram for Face Recognition



Engineering

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ABSTRACT

In this paper, a new face recognition method based on local binary pattern (LBP) histogram is presented. It describes 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. A face image is first divided into small regions from which LBP histograms are extracted and then concatenated into a single feature vector. This feature vector gives an efficient representation of the face and can be used to measure similarities between images.

I. Introduction

The local binary pattern (LBP) [1] was originally designed for texture description. It is invariant to monotonic grey-scale transformations which is very important for texture analysis. With LBP it is possible to describe the texture and shape of a digital image. This is done by dividing an image into several small regions from which the features are extracted (figure 1). 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 representation of the image. Images can then be compared by measuring the similarity (distance) between their histograms. According to several studies [2, 3, 4] face recognition using the LBP method provides very good results, both in terms of processing speed and discrimination performance. The texture and shape of images is described, the method seems to be quite robust against face images with different facial expressions, different lightening conditions, image rotation and aging of persons. This paper is organized as follows: Section III presents the definition and description of LBP descriptor and the extended ones. Section IV presents the LBP for face recognition and feature extraction. The last section concludes this paper and points out the future work.

II. Literature Survey

The local binary pattern (LBP) was originally designed for texture description [1] which achieved promising result [5]. In the last few years, the LBP method has been widely used for face recognition problems [6]. Performances are obtained by various methods like PCA, DCT, Hybrid, LBP with SVDA and PCA, etc on different databases like ORL Database ref [11], JAFFE database [12], yale database [13].

III. Principles of Local Binary Patterns

Local Binary Pattern (LBP) operator is designed to describe the texture and shape of a digital (gray scale) image. One LBP is a binary code for an image-pixel which tells something about the local neighborhood of that pixel.

The original LBP operator was introduced by Ojala et al. [7]. This operator works with the eight neighbors of a pixel, using the value of this center pixel as a threshold. If a neighbor pixel has a higher gray value than the center pixel (or the same gray value) than a one is assigned to that pixel, else it gets a zero. The LBP code for the center pixel is then produced by concatenating the eight ones or zeros to a binary code as shown in figure 1.

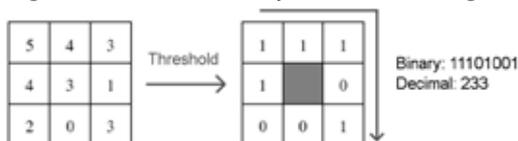


Figure1: The original LBP operator.

Also the LBP operator was extended to use neighborhoods of different sizes. In this case a circle is made with radius R from the center pixel. P sampling points on the edge of this circle are

taken and compared with the value of the center pixel. To get the values of all sampling points in the neighborhood for any radius and any number of pixels. For neighborhoods the notation (P, R) is used. Figure 2 illustrates three neighbor-sets for different values of P and R. Also it is referred as the multiscale LBP or extended LBP as shown in figure 2.

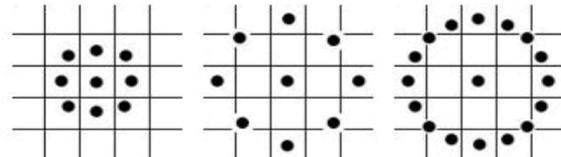


Figure 2: Multiscale LBP pattern patterns (a) P=8, R=1 (b) P=8, R=2 (c) P=16, R=2.

If the coordinates of the center pixel are (xc, yc) then the coordinates of his P neighbors (xp, yp) on the edge of the circle with radius R can be calculated with the sinus and cosines:

$$xp = xc + R \cos(2\pi p/P), \tag{3.1a}$$

$$yp = yc + R \sin(2\pi p/P). \tag{3.1b}$$

To achieve invariance with respect to any monotonic transformation of the gray scale, only the signs of the differences are considered. This means that in the case a point on the circle has a higher gray value than the center pixel (or the same value), a one is assigned to that point, else it gets a zero:

$$s(x) = \begin{cases} 1 & ; x \geq 0 \\ 0 & ; x < 0. \end{cases} \tag{3.2}$$

The Local Binary Pattern gives the local image texture around (xc, yc).

IV Local Binary Patterns for face recognition

The use of the LBP in face recognition was introduced in [8] and it has been applied in many face recognition applications afterwards [9],[14]. The original LBP operator labels the pixels of an image by thresholding the 3x3- neighborhood of each pixel with the centre value and considering the result as a binary number called the LBP code. Later the operator was extended to be applied in a circular neighborhood of different radius size and was refined to represent the most important microstructures with the uniform LBP [10].

The main idea is that for every pixel of an image the LBP-code is calculated. The occurrence of each possible pattern in the image is kept up. The histogram of these patterns forms a feature vector, and it is the representation for the texture of the image. These histograms can then be used to measure the similarity between the images, by calculating the distance between the histograms.

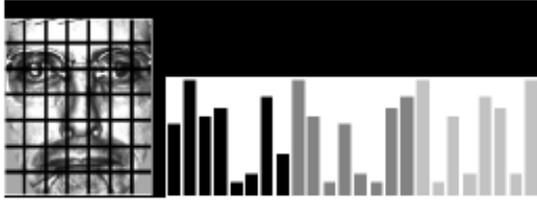


Figure3: Face image divided into 49 regions with every region histogram

Feature vectors

Once the Local Binary Pattern for every pixel is calculated, the feature vector of the image can be constructed. For an efficient representation of the face, first the image is divided into k^2 regions. In figure 3 a face image is divided into $7^2 = 49$ regions. For every region a histogram with all possible labels is constructed. This means that every bin in a histogram represents a pattern and contains the number of its appearance in the region. The feature vector is then constructed by concatenating the regional histograms to one big histogram.

$$I(A) = \begin{cases} 1, & A \text{ is true} \\ 0, & A \text{ is false.} \end{cases} \quad (4.1)$$

ALGORITHM FOR FACE RECOGNITION

To compare two face images of same subject following algorithm is used. This algorithm provides three outputs i.e., good match, probable match and no match.

- 1) select image1 and image2 from face database
- 2) LBP for image1 and image2 stored in h1 & h2 respectively
- 3) the difference of the LBP histogram stored in a difference histogram $n1=h1-h2$
- 4) initialize $i1=0$
- 5) initialize a matrix of zeros mp & $r1$ with size as that of $h1$ (or $h2$)
- 6) if $-135 < \text{element } n1[i1] < 135$ (ie difference < 135) go to step 7 else go to step 8
- 7) $ri[i1]=1$, positive match $mp[i1]=n1[i1]$, total match $tp=h1[i1]$
- 8) $i1++$
- 9) if $i1 > \text{numel}(n1)$ go to step 10, else go to step 6)
- 10) $\text{match} = \text{number of 1's in } r1$, $\text{match3} = \text{sum of all elements in } mp$, $\text{total3} = \text{sum of all elements in } tp$
- 11) $\text{ratio} = \text{match}/\text{numel}(r1)$, $\text{ratio3} = \text{match3}/\text{total3}$
- 12) if $\text{ratio}=1$ or if $\text{ratio3} < 0.25$ go to step 13, else go to step 14
- 13) good match, go to step 17
- 14) if $\text{ratio} > 0.8$ or if $\text{ratio3} < 0.12$ go to step 15, else go to step 16
- 15) probable match, go to step 17

- 16) no match
- 17) end

V COMPARISONS of experimental results by various methods

- Performances obtained for ORL Database ref [11]

Table 1

PCA (principle component analysis):	71.38 %
DCT (Discrete cosine transform)	67 %
Hybrid method(PCA + DCT)	72.77 %

- Algorithms Recognition on JAFFE database [12]

Table 2

LBP+SVDA (Support Vector Discriminant Analysis)	69.3%
LBP+PCA(principle component analysis)	63.7%
LBP+LDA (linear discriminant analysis)	64.3%
PCA (principle component analysis) [13]	56.3%
LDA(linear discriminant analysis) [13]	58.2%
2DPCA (2D-principle component analysis) [13]	63.1%
2DLDA(2D- linear discriminant analysis)[13]	60.5%

- Ultimate LBP histogram vector's on Yale Database ref [14] gives 96.97%

Conclusion and future work

- Here a face recognition algorithm for color as well as monochrome images is presented, which uses LBP histogram matching technique. The method uses the comparison of histogram of the images and can easily recognize the faces.
- The processing time of the LBP histogram method is superior as compared to other methods. In this work, it was found that the distance of the face from the camera plays a significant role in face recognition techniques that were implemented.
- Efficiency of the code is 97.5%
- One of the problems faced during the testing is the quality of the images. It is necessary to crop bad quality image to see the efficiency of the design code.
- By the minimum distance between the histograms, it will find the most matching image of the original one.
- The maximum efficiency of this code would be put to test only for recognition of face in still images apart from motion pictures as of now

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