Face Recognition Based on Histogram Equalization and LBP Algorithm

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ABSTRACT

In the recent time bioinformatics take wide field in image processing. Face recognition which is basically the task of recognizing a person based on its facial image. It has become very popular in the last two decades, mainly because of the new methods developed and the high quality of the current visual instruments. There are different types of face recognition algorithms, and each method has a different approach to extract the image features and perform the matching with the input image.

In this paper the Local Binary Patterns (LBP) was used, which is a particular case of the Texture Spectrum model, and powerful feature for texture classification. The face recognition system consists of recognizing the faces acquisition from a given data base via two phases. The most useful and unique features of the face image are extracted in the feature extraction phase. In the classification the face image is compared with the images from the database.

The proposed algorithm for face recognition in this paper adopt the LBP features encode local texture information with default values. Apply histogram equalization and Resize the image into 80x60, divide it to five blocks, then Save every LBP feature as a vector table.

Matlab R2019a was used to build the face recognition system. The Results which obtained are accurate and they are 98.8% overall (500 face image).

Keywords: local binary pattern (LBP), feature extraction, classification, pattern recognition, histogram, feature vector.

1. Introduction

[1]Human beings perform face recognition automatically every day and practically with no effort.[1] The face of a human being conveys a lot of information about identity and emotional state of the person.

Face recognition with a single sample per person (SSPP) is common in real-world face recognition applications.[2]

It is a very tough challenge due to variation in size, shape, color, and texture of human faces and also there is no unique method to recognize the face among the humans.[3]

Face recognition has been used in many commercial and law enforcement applications such as some of the airport's systems, and ATM and electronic payment started to test facial recognition in real events. This availability of efficient face recognition algorithms leads to the fact that it can be used in real-time security issues where there is nowhere to hide. Facial expression as a powerful nonverbal channel, plays an important role for human beings to convey emotions and transmit messages.[4][5]

The face recognition systems consist of two procedures:

1.1 Verification or Authentication of a Facial Image

Facial identification is one of the biometrical approaches implemented for identifying any facial image with the use of the basic properties of that face, in this mode the input facial image compares with the facial image related to the user which is requiring the authentication. It is basically a (1 to 1) comparison.[6]

1.2 Identification or facial recognition

This mode compares the input facial image with all facial images from a dataset with the aim to find the user that matches that face It is basically a (1 to N) comparison.[1]

2. Local Binary Pattern

Local Binary Patterns (LBP) is a non-parametric descriptor whose aim is to efficiently summarize the

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local structures of images. LBP summarizes local structures of images efficiently by comparing each pixel with its neighboring pixels and considers the result as a binary number.[13]

. The most important properties of LBP are its tolerance regarding monotonic illumination changes and its computational simplicity.[7]

The original LBP operator labels the pixels of an image with decimal numbers, called Local Binary Patterns or LBP codes, which encode the local structure around each pixel. It proceeds thus, as illustrated in Fig.1: Each pixel is compared with its eight neighbors in a 3x3 neighborhood by subtracting the center pixel value; The resulting strictly negative values are encoded with 0 and the others with 1; A binary number is obtained by concatenating all these binary codes in a clockwise direction starting from the top-left one and its corresponding decimal value is used for labeling. The derived binary numbers are referred to as Local Binary Patterns or LBP codes.[8]

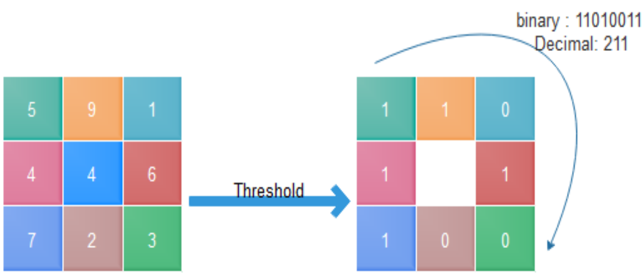

Figure 1. Example of the basic LBP operator

3. Related Work

Face recognition has attracted much attention in computer vision and numerous face recognition have been proposed over the past three decades. Face recognition defers from face detection, in the first algorithm, the goal is to find the location and size of the faces in an image to be used in other algorithms (may be face recognition). While the face recognition algorithm is used to find the characteristics which best describe the image by extract the facial images, cropped, resized and usually converted to grayscale.[8] In recent years, some methods have been proposed for face recognition problem. like: virtual sample generating methods, generic learning methods and image partitioning-based methods.[2] So, there are many types of face recognition algorithms, and each type has a different method to extract the image information and perform the matching with the input image. Such as Scale-invariant feature transform which key points of objects are first extracted from a set of reference images and stored in a database. An object is recognized in a new image by individually comparing each feature from the new image to this database and finding candidate matching features based on Euclidean distance of their feature vectors. [14] Another type of face recognition is Speeded up robust features, in this algorithm to detect interest points, it uses an integer approximation of the determinant of Hessian blob detector, which can be computed with 3 integer operations using a precomputed integral image. Its feature descriptor is based on the sum of the Haar wavelet response around the point of interest. These can also be computed with the aid of the integral image.[15]

4. Proposed Algorithm

In this paper a new algorithm was proposed which is consist of two stages as shown in figure (2):

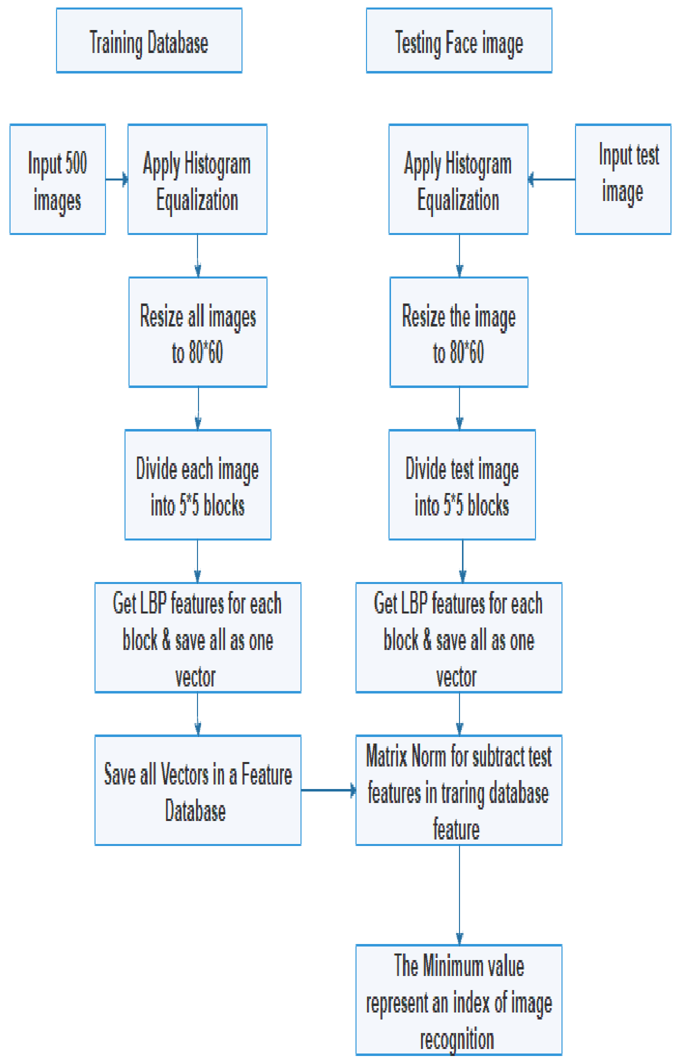

Figure 2. Flowchart of the proposed algorithm

4.1 Stage1-Training

Initially the algorithm will be trained. so, a dataset was used with the facial images of the people we want to recognize their faces, as well as we need a number or

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the name of the input image and give an output. Images of the same person must have the same ID. With the training set already constructed. Then apply histogram equalization to all images in the trained data base as shown in figure (3):

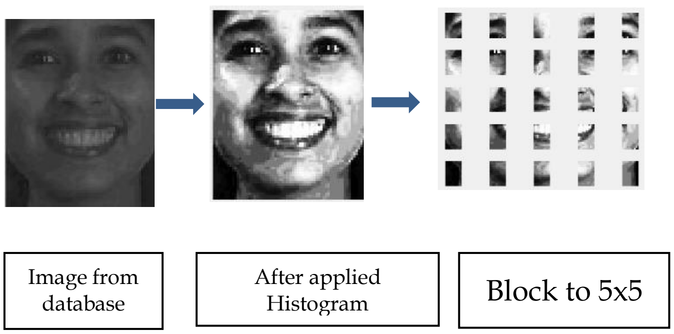
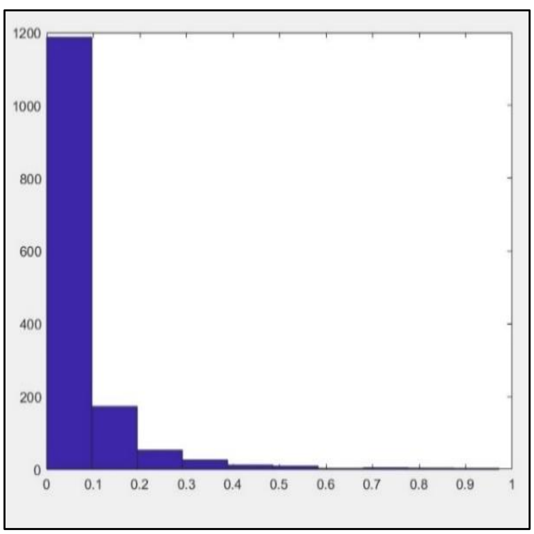
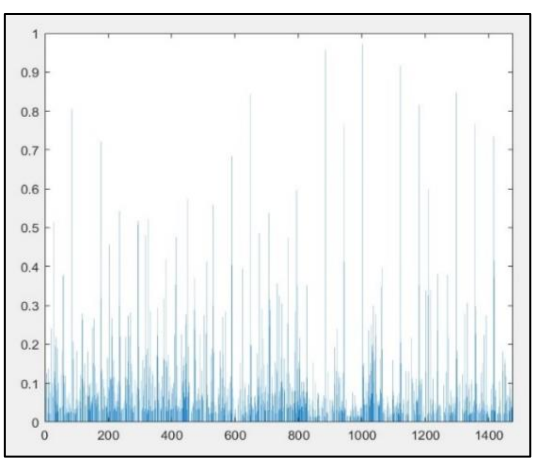


Figure 3. Training Stage

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. Block each image to 5x5. After extract LBP features for each block which was equal 59 features, so for whole image: 59*5 = 1475 features will save as a LBP database.



(a)



(b)

Figure 4. (a) All LBP feature for one image

Figure 4. (b) Histogram LBP feature for one image

Since the LBP was, by definition, invariant to monotonic changes in gray scale, it was supplemented by an orthogonal measure of local contrast. Figure 4 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. Two-dimensional distributions of the LBP and local contrast measures were used as features. The operator was called LBP/C.

Example

6	5	2
7	6	1
9	8	7

Thresholded

1	0	0
1		0
1	1	1

Weights

1	2	4
128		8
64	32	16

Figure 5. Calculating the original LBP code and a contrast measure.

Pattern = 1 0 0 0 1 1 1 1 …..(1)

LBP = 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 …..(2)

= 1 + 0 + 0 + 0 + 16 + 32 + 64 + 128

= 241

C = (6 + 7 + 8 + 9 + 7)/5 − (5 + 2 + 1)/3 …..(3)

= 4.7

Derivation: Let define texture T as the joint distribution of the gray levels of $P+1 (P > 0)$ image pixels:

$$T = t(g_c, g_0 \ldots, g_{P-1}) \quad \ldots..(4)$$

where g_c corresponds to the gray value of the center pixel of a local neighborhood, g_P (**P=0**…, **P-1**) correspond to the gray values of ***P*** equally spaced pixels on a circle of radius ***R*** **(R > 0)** that form a circularly symmetric set of neighbors. Figure 6 illustrates three circularly symmetric neighbor sets for different values and three circularly symmetric neighbor sets for different values of ***P*** and ***R***

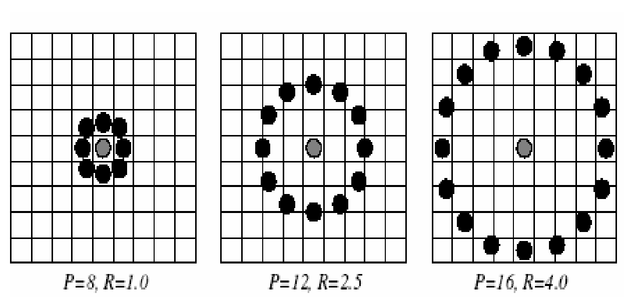


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Figure 6. Circularly symmetric neighbor sets.

Without losing information, g_c can be subtracted from g_p:

$$T= t(\Omega g_c , g_0 - g_c , \ldots , g_{p-1} - g_c) \qquad \ldots\ldots(5)$$

Assuming that the differences are independent of g_c , the distribution can be factorized:

$$T \approx t(g_c)\ t(g_c , g_0 - g_c , \ldots , g_{p-1} - g_c) \qquad \ldots..(6)$$

Since t (gc) describes the overall luminance of an image, which is unrelated to local image texture, it can be ignored:

$$T \approx t(g_0 - g_c , \ldots , g_{p-1} - g_c) \qquad \ldots.(7)$$

Although invariant against gray scale shifts, the differences are affected by scaling. To achieve invariance with respect to any monotonic transformation of the gray scale, only the signs of the differences are considered:

$$T \approx t(s\ (g_0 - g_c), \ldots , s(g_{p-1} - g_c)) \qquad \ldots..(8)$$

Where:

$$I(x)=\begin{cases}1, & x\geq 0\\ 0, & x<0\end{cases} \qquad \ldots.(9)$$

The equations used for LBP are:

$$H_i=\sum_{x,y} I\{f_l(x,y)=i\},\ i=0,\ldots,n\text{-}1 \qquad \ldots.(10)$$

$$N_i=\frac{H_i}{\sum_{j=0}^{n-1} H_j} \qquad \ldots.(11)$$

Where:

H: is the number of histograms from convert to binary image (*I*) which are represent as a feature.

I: is a counter of label N.

N: size of set of neighbor pixel depend of radian from point center.

f_l: label input gray image.

$f(x, y)$: binary image.

Recognition have been done with finding the *norm* between difference test image with all LBP feature database, As shown in the equations 12 & 13:

$$dist = ||H_{train} - H_{test}|| \qquad \ldots\ldots(12)$$

$$index = \min(\text{dist.}) \qquad \ldots\ldots(13)$$

4.2 Stage2-Performing the face recognition

In this step, the algorithm was already trained. Each histogram created was used to represent each image from the training dataset. So, given an input image, the steps will perform again on this new image and creates a histogram.

The obtained accuracy results out of this proposed algorithm is about 98.8% overall (500 face images, figure (7) contains many sample images:

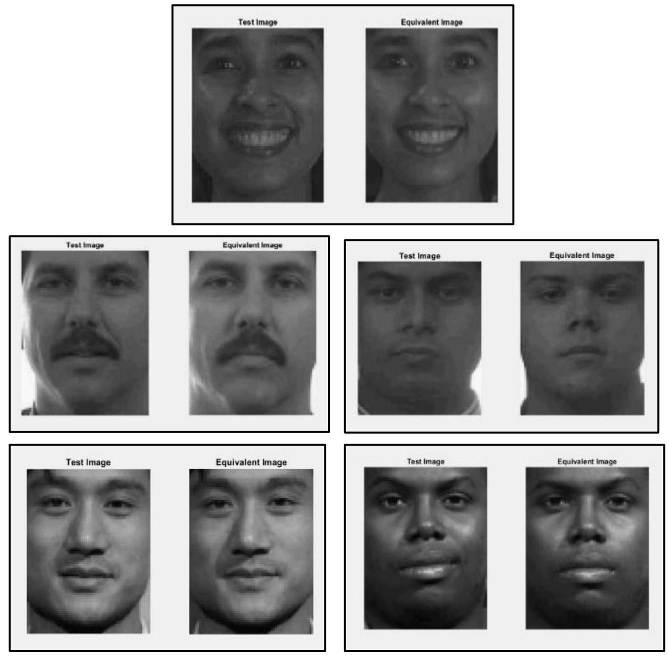

Figure 7. Final results of sample images

5. Results

The final results obtained by using different LBP operator in different number of neighbor and blocks to assess the best performance of the proposed algorithm, then calculate the distance matrices and the accuracy for each of the different settings and used the permutation tool to calculate the probabilities of the measures outperforming each other.

After normalizing the illumination factor, much improved results which obtained at LBP operator. The final results were shown in Table (1) and (2):

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The best result obtained when the image divide into five blocks with seven neighbors, the accuracy is 98.8% that is refer to the validity of the result even though there is different view of the image i.e. the original image with glasses or smile face …etc. The high accuracy obtained from this proposed algorithm make it better than many algorithms of face recognition as shown in table (3):

Table 1. Five blocks for each image

No. Neighbor	Features of LBP × No of Block	Image size	Accuracy	No. Mistake
6	33 × 4 = 132	80 × 60	97.4 %	13
7	45 × 4 = 180	80 × 60	98.2 %	9
8	59 × 4 = 236	80 × 60	98 %	10
9	75 × 4 = 300	80 × 60	98.2 %	9
10	93 × 4 = 372	80 × 60	97.8 %	11

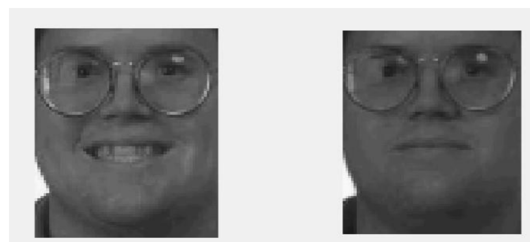
Table 2. Four blocks for each image

No.	Algorithm	Accuracy
1	Facial Recognition System Using Local Binary Patterns (LBP).[9]	89.3%
2	Face Recognition with Local Binary Patterns.[10]	93 %
3	Extended local binary patterns for face recognition.[11]	74.6%
4	Face recognition with local binary patterns.[12]	95%

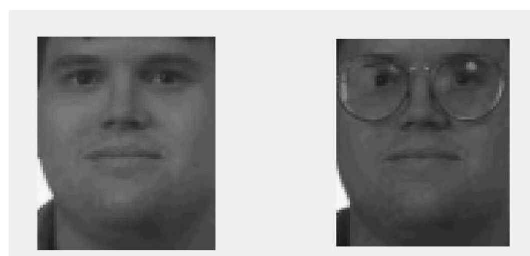
Figure (8) shows different view of faces withe the same accuracy.

Table 3. Comparison between proposed algorithm and other algorithms

No. Neighbor	Features of LBP × No of Block	Image size	Accuracy	No. Mistake
6	33 × 5 = 165	80 × 60	98.6 %	7
7	45 × 5 = 225	80 × 60	98.8 %	6
8	59 × 5 = 295	80 × 60	98.4 %	8
9	75 × 5 = 375	80 × 60	98.6 %	7
10	93 × 5 = 465	80 × 60	98.4 %	8



Test image Equivalend face



Test image Equivalend face

Test image Equivalend face

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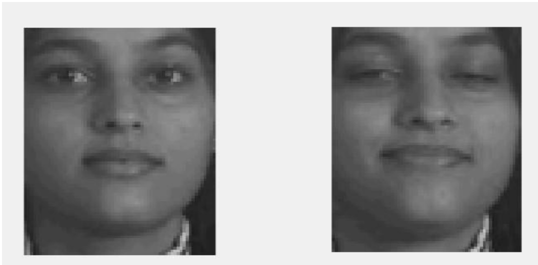

Test image Equivalend face

Test image Equivalend face

Figure 8. Different samples

6. Conclusion

Despite of the fact that at this moment already numerous of commercial face recognition systems are in use, this way of identification continues to be an interesting topic due to the fact that the current systems perform well under relatively simple and controlled environments.

As well as LBPH is one of the easiest face recognition algorithms. It can represent local features in the images and It is possible to get great results (mainly in a controlled environment). Over the decade the LBP algorithm has evolved faster as compared to the other face recognition algorithm which makes it perfect and efficient one.

7. Recommendations

These results can be further recuperated by using weighted LBP in which weights are assigned to each region of the face. The more important the characteristics of the region, the highest weight are assigned to that region, hence making it more proficient to distinguish between images.

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