Automatic Face Recognition via Local Directional Patterns

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Abstract

Automatic facial recognition has many potential applications in different areas of human computer interaction. However, they are not yet fully realized due to the lack of an effective facial feature descriptor. In this paper, we present a new appearance based feature descriptor, the local directional pattern (LDP), to represent facial geometry and analyze its performance in recognition. An LDP feature is obtained by computing the edge response values in 8 directions at each pixel and encoding them into an 8 bit binary number using the relative strength of these edge responses. The LDP descriptor, a distribution of LDP codes within an image or image patch, is used to describe each image. Two well-known machine learning methods, template matching and support vector machine, are used for classification using the ORL female facial expression databases. Better classification accuracy shows the superiority of LDP descriptor against other appearance-based feature descriptors. Entropy + LDP + SVM is as an improved algorithm for facial recognition than previous presented methods that improves recognition rate by features extraction of images. Test results showed that Entropy + LDP + SVM, method presented in this paper, is fast and efficient. Innovation proposed in this paper is the use of entropy operator before applying LDP feature extraction method. The test results showed that the application of this method on ORL database images causes 3 percent increases in comparison with not using entropy operator.

Key words: Facial recognition, Local Directional Pattern, Support vector machine, Entropy, Texture Image, Features extraction.

1-Introduction

From 1964 until now, the field of image processing research, has had a high growth. In addition to the space research programs, image processing techniques are used in numerous cases, including face recognition and facial expression recognition. Face recognition system is a Biometric system which confirms or recognizes identity of a person by using auto Smart methods based on physiological characteristics. In two recent subject, face recognition has been vast research fields of machine vision and pattern recognition. One of the wide applications of face recognition is in the field of authentication and security such as in controlling places with high population, such as airports, railway stations, metro, etc. This method is more efficient than other methods of surveillance. In this way, various photos of individuals' face is taken and device must have the ability to recognize these people at different times, different gestures, and different light incident direction [1].

2. Overview of Face Recognition System

The facial recognition process normally has four interrelated phases or steps:

(1) Face detection

(2) Normalization

(3) Feature extraction

(4) Face recognition

The first step in the facial recognition process is the capturing of a face image. This would normally be done using a still or video camera.

2-1-Face detection

Detecting a face in an image has to decide which pixels in the image is part of the face and which are not. Traditionally, methods that focus on facial landmarks (such as eyes, nose, etc.) that detect face-like colors in circular regions, or that use standard feature templates, were used to detect faces.

2-2-Normalization

Once the face has been detected (separated from its background), the face needs to be normalized. This means that the image must be standardized in terms of size, pose, illumination, etc. relative to the images in the gallery or reference database. To normalization a probe image, the key facial landmarks must be located accurately. Using these landmarks, the normalization algorithm can reorient the image for slight variations. Recognition can only succeed if the probe image and the gallery images are the same in terms of pose orientation, rotation, scale, size, etc.

2-3-Feature Extraction

Once the face image has been normalized, the feature extraction and recognition of the face can take place. In feature extraction, a mathematical representation called a biometric template or biometric reference is generated, which is stored in the database and will form the basis of any recognition task.

2-4-Face Recognition

In last phase the biometric template of the suspect face is compared with the biometric template of each face present in the database. We recognize the face when we get a match between these two biometric templates.

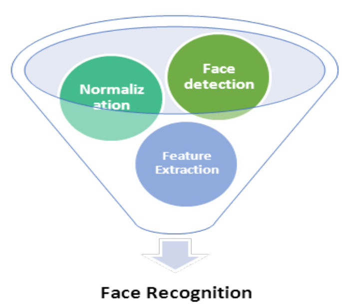

Fig .1. The steps of a face recognition system [2].

The goal of designing above sections is to train classifier by using the face images in the infinitive, predefined database, firstly. Then, recognition system must be able to determine trained face on the test image (uncertain image) automatically.

3-LDP algorithms

An LBP operator encodes the micro-level information of edges, spots, and other local features in an image using Information of intensity changes around pixels. Some researchers apply the LBP operator on gradient image to encode the texture. These variations simply replace the intensity value with the gradient magnitude value of that pixel. Then the LBP code is calculated trivially. Lack of robustness of those methods can be alleviated by encoding the edge response in a different direction from a pixel. Being motivated by this, we propose LDP that computes the edge response values in different directions and uses these to encode the image texture. Since the edge responses are less sensitive to illumination and noise than intensity values, the resultant LDP feature describes the local primitives, including different types of curves, corners, and junctions, in a more stable manner and also retains more information.

4-Proposed method

Proposed algorithm of this article is based on local directional pattern that affect texture images using the entropy which increased recognition percent that the process step by step procedure is presented for following.

1) Locating and identifying the input image to ensure correct positioning face using common face recognition
2) Convert images to gray levels if colorful and balancing the histogram in order to increase the uniformity of brightness in different areas of the face and normalize facial image
3) Areas Division and feature extraction based on LDP algorithms
4) Block collection to generate a histogram of the image face
5) Increasing the rate of face recognition with effect entropy on input texture image
6) Use a suitable category for recognition of facial expressions
7) Acceptance related algorithms for recognition and adaption

Testing and evaluating the performance of the proposed method on ORL database is done. This database contains a collection of face images taken by the group of Robotics and Machine Vision Engineering Department, University of Cambridge, which is used for facial recognition project.
The database was created 10 different images of 40 classes. For each class that contains images of a person, taken several pictures of these images of brightness, the word face (opened and closed eyes, laughing and non-laughing), details of the face (glasses, no glasses) have been taken. Images format are pgm and the size of each image is 92 * 112 pixels and images are gray level mode.

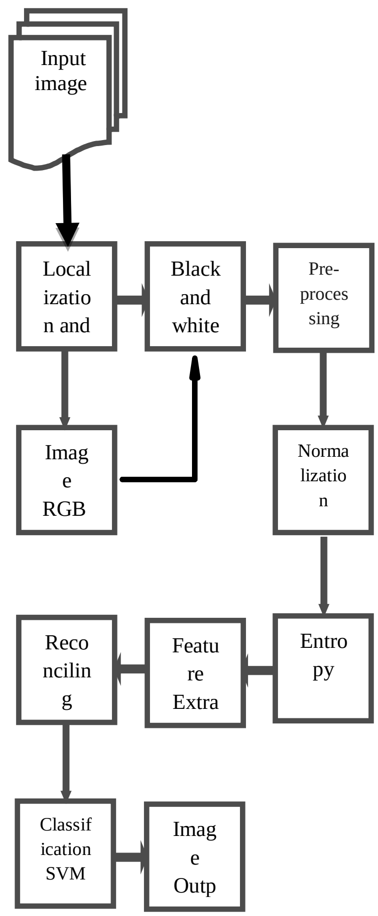

Fig .2. Block diagram of the proposed face recognition system in this paper

Fig. 3. Sample images from the database ORL face [4]

In this paper, the proposed method was evaluated for different training and tests, for each one of the 10 images. For first time, train and test data composed 40 % and 60 % of 10 images of the defined person, respectively. The second time training and testing data both are 50% and finally, training and testing data of 60% and 40%, respectively while the desired results were achieved. In the second part of the algorithm, adding entropy to simplify the statistical distribution of data before entering the directional pattern through which Shannon entropy is used to improve recognition. Shannon entropy law is derived from the general rule. Shannon showed that the entropy as a measure of the level of uncertainty and is a function of the probability distribution. The Shannon $X=\{x_1,x_2,...,x_n\}$ entropy is defined as follows:

Image entropy given as a data to LDP, that is, the entropy and image as a data is given to LDP, so that the texture of the input image recognized and image processing operations performs onto image.

In the next part of the algorithms, to enter classification for pre-processing the images we have to use the histeq in the MATLAB environment at this stage to smooth the histogram. Then, if the images are in color; they are converted to gray levels.

The proposed LDP method assigns an 8 bit binary code to each pixel of an input image. This pattern is then calculated by comparing the relative edge response values of a pixel in different directions. The Kirsch, Prewitt, and Sobel edge detectors are some of the different representative edge detectors which can be used in this regard. The Kirsch edge detector detects different directional edge responses more accurately than the others, because it considers all 8 neighbors. Given a central pixel in the image, the eight-directional edge response values {mi}, i=0, 1,7are computed by Kirsch masks, Mi., in eight different orientations centered on the pixel’s position. These masks are shown in the Fig. 4. In this figure. Kirsch edge masks in all eight directions [5]

$$LDP_k = \sum_{i=0}^{7} b_i\left(m_i - m_k\right)\times 2^i \quad , \quad b_i(a) = \begin{cases} 1, & a \geq 0 \\ 0, & a < 0 \end{cases}$$

$$\begin{bmatrix} -3 & -3 & 3 \\ -3 & 0 & 5 \\ -3 & -3 & 5 \end{bmatrix} \begin{bmatrix} -3 & 5 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & -3 \end{bmatrix} \begin{bmatrix} 5 & 5 & 5 \\ -3 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix} \begin{bmatrix} 5 & 5 & -3 \\ 5 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix} \tag{1}$$

East M_0 North east M_1 North M_2 North west M_3

$$\begin{bmatrix} 5 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & -3 & -3 \end{bmatrix} \begin{bmatrix} -3 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & 5 & -3 \end{bmatrix} \begin{bmatrix} -3 & -3 & -3 \\ -3 & 0 & -3 \\ 5 & 5 & 5 \end{bmatrix} \begin{bmatrix} -3 & -3 & -3 \\ -3 & 0 & 5 \\ -3 & 5 & 5 \end{bmatrix}$$

West M_4 South west M_5 South M_6 South east M_7

$$H = -\sum_{i=1}^{n} p_i Logp_i \tag{2}$$

$$H(i) = \sum_{r=1}^{M} \sum_{c=1}^{N} f\left(LDP_k(r,c), i\right), \; f(a,i) = \begin{cases} 1, & a = i, \\ 0, & a \neq i, \end{cases} \tag{3}$$

The response values are not equally important in all directions. The presence of a corner or an edge shows high Response values in some particular directions. Therefore, we need to know the most prominent k directions to generate the LDP. Here, the top-k directional bit responses, bi, are set to 1. The remaining 8 k bits of the 8 bit LDP pattern are set to 0. Finally, the LDP code is derived by fig .5.

Which LDP histograms are extracted and concatenated into LDP descriptor. At the end of this stage, the local directional pattern for each image as a vector displayed, and then directional pattern of all images are saved in a matrix to use at the next stage.

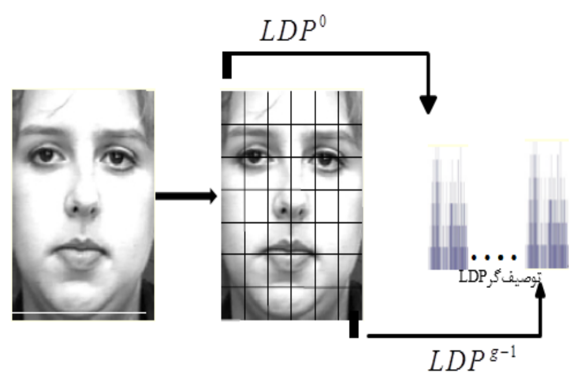

Fig.4. Image is divided into small regions

5-The results of simulations and experiments

In this paper, the SVM classifier is used to classify the feature vectors extracted from the image using the proposed method. As mentioned earlier, in this experiment, the different percentages are used to train and test images database. Recognition accuracy for different ratios of train and test images by using SVM method is tested. This method considers percentage of the images as train image and the rest of images as test image. Tags tests prepared by us compared with trained by SVM and then the comparison results is defined as the process of recognition accuracy. By comparing different algorithm, efficiency and accuracy recognition rate algorithms turns out to be different. ORL database is used to check the results of the proposed method. Entropy + LDP + SVM algorithm recognition accuracy and LDP are shown in Table 1.

Table .1 .Comparison of the recognition accuracy of the proposed method for different ratio of ORL database

Test/train ratio (%)	LDP+SVM	Entropy+LDP+SVM
40-60	97.5	98.125
50-50	91.5	94.5
60-40	90.833	91.25

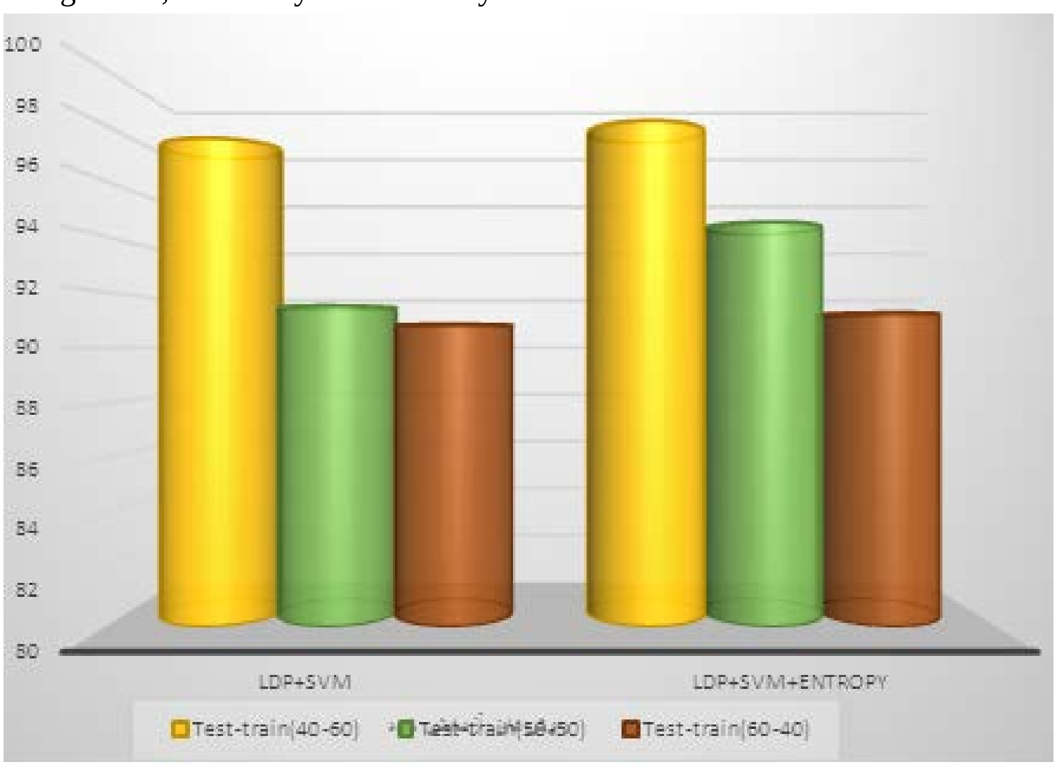

Fig.5. Comparison of the accuracy of recognition database ORL.

Acknowledgment

Depending on the results of this article, it can be seen that face recognition accuracy of Entropy + LDP + SVM method has been improved to ORL LDP + SVM for the ORL database. As the results of the tests implies, proposed method for face recognition (Entropy + LDP + SVM) the accuracy and recognition rate is higher than classic LDP. Also, it could be argued that the rate of recognition of facial expressions by using the proposed method is more than classic mode. Because the use of entropy algorithm is applied after the LDP, it reduces the size of the edge which reduces testing time. In general, it can be concluded that the proposed algorithm in terms of accuracy and paper have a relatively high rate of efficiency.

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