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LBPH Based Improved Face Recognition At Low Resolution

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***Abstract*—Automatic individual face recognition is the most challenging query from the past decade in computer vision. However, the law enforcement agencies are inadequate to identify and recognize any person through the video monitoring cameras further efficiently; the blur conditions, illumination, resolution, and lighting are still the major problems in face recognition. Our proposed system operates better at the minimum low resolution of 35px to identify the human face in various angles, side poses and tracking the face during human motion. We have designed the dataset (LR500) for training and classification. This paper employs the Local Binary Patterns Histogram (LBPH) algorithm architecture to address the human face recognition in real time at the low level of resolution.**

Keywords-face recognition; LBPH; low resolution; feature extraction

I. INTRODUCTION

Currently, the Face recognition becomes the more important topic in computer vision and having much importance in many applications such as for security, surveillance, banking and so on. But it becomes more challengeable because of accuracy and efficiency. Over the years, many scholars have developed variety kinds of face recognition algorithms, including Sparse Coding (SC) algorithm [1], Local Binary Pattern (LBP) algorithm [2], Histograms of Oriented Gradients (HOG) algorithm [3], Linear Discriminant Analysis (LDA) algorithm [4], and Gabor feature algorithm [5].These all algorithms provide accuracy rate between 50% - 76% [6. Compared with the above algorithms the LBPH algorithm can not only recognize the front face, but also recognize the side face, with 90% accuracy rate [6].

II. WORK FLOW OF FACE RECOGNITION SYSTEM

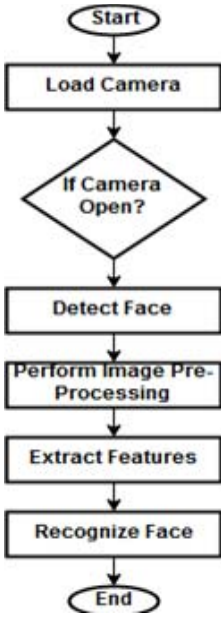

Figure 1. Face recognition system work flow.

Mostly face recognition system includes four main parts: information acquisition module, feature extraction module, classification module and training classifier database module

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[7]. The image information collected by the learning acquisition module which will be used as a test sample for analysis. In the feature extraction module, which can represent human identity information is extracted and examined. In the classification module, the classifier trained by the database is used to classify test samples to determine the identification information of individuals.

A. Face Detection

We have used OpenCV which presents a Haar cascade classifier [8], [12], which is used for face detection. The Haar cascade classifier uses the AdaBoost algorithm to detect multiple facial features. First, it reads the image to be detected and converts it into the gray image, then loads Haar cascade classifier to decide whether it contains a human face. If so, it proceeds to examine the face features and draw a rectangular frame on the detected face. Otherwise, it continues to test the next picture.

B. Feature Extraction

The LBP operator is applied to describe the contrast information of a pixel to its neighborhood pixels. The original LBP operator is defined in the window of 3*3. Using the median pixel value as the threshold of the window, it compares with the gray value of the adjacent 8 pixels. If the neighborhood pixel value is larger or equal compare to the median pixel value, the value of pixel position is marked as 1, otherwise marked as (0) [9]. The function is defined as shown in equation 1. It can be illustrated in Figure 2.

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases} \quad (1)$$

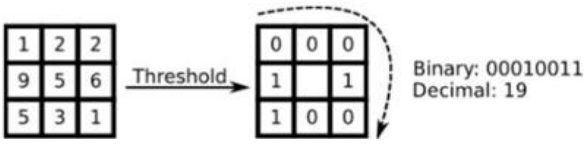

Figure 2. Original LBP Operator.

In this way, 8 points in the 3*3 neighborhood are compared to generate 8-bit binary numbers. Changing it to decimal numbers, the LBP values of the middle pixel points of the window are obtained, which is used to display the texture features of the region. The current LBPH algorithm uses an improved circular LBP operator. It can be represented by Figure 3 and equation 2.

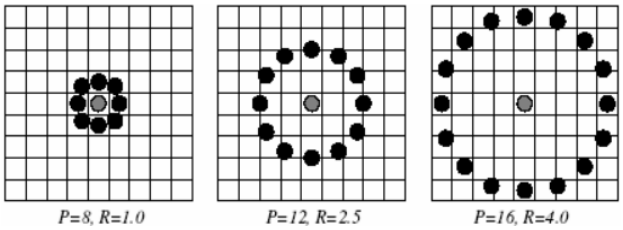

Figure 3. Circular LBP Operator.

$$LBP_P^P = \sum_{P=0}^{P-1} S(g_P - g_C)2^P \quad (2)$$

The gray value GP of P neighborhoods of the pixel C, the radius of which is R. GC is the gray value pixel value C (x_c,y_c). This algorithm makes the LBP operator no longer limited to fixed radius and neighborhood and can meet the needs of more different size and texture features. For each pixel of an image, it computes its LBP eigenvalues. Then these eigenvalues can form the LBP feature spectrum. The LBPH algorithm uses the histogram of the LBP characteristic spectrum as the feature vector for classification. It divides a picture into several sub regions, then extracts LBP feature from each pixel of the sub-region, establishing a statistical histogram of the LBP characteristic spectrum in each sub region, so that each sub region can using a statistical histogram to describe the whole picture through a number of statistical histogram components. The advantage is to reduce the error that the image is not fully aligned with a certain range.

C. Dataset LR500

We have designed our own database named LR500, which stores 500 images of each person. It is created on the basis of face detection. Make different facial expressions and postures to a scene and detect faces. The saved pictures are stored in the same folder to form the generated face database. During image acquisition step, the dataset images have been converted into gray scale images for features extraction; and then normalized those images for good recognition results. Normalization technique has been applied on all images to remove noise and set the alignment position of images.

Figure 4. Test Images of Face Database LR500.

III. FACE RECOGNITON ALGORITHM

To perform the face recognition system here the Local Binary Pattern Algorithm has been applied. The LBP operator is used in local features through Local Binary Pattern acts which shorten the local special arrangement of a face image [10]. The LBP operator is the number of binary ratios of pixels intensities within the pixel of center and it's around eight pixels. It can be shown in below equation.

$$LBP(x_c, y_c) = \sum_{n=0}^{7} S(i_n - i_c)2^n \quad (3)$$

Where i_c indicates the value of the center pixel and (x_c, y_c), shows eight surrounding pixels information. Therefore, it is very helpful in determining the face features. From the original matrix Features of the image are extracted then these values are compared with the center pixel values, the later binary code is generated.

The Algorithm works as below:

1. First, we need to start with temp=0
2. Where I, is the training for each image
3. H=0,then Initialize the pattern histogram

4. Calculate the model label of LBP
5. Keep adding the corresponding bin by 1.
6. Get the greatest LBP feature during each face image and then merging into the unique vector.
7. It's time to compare the features.
8. Finally, if it resembles with the stored database the image is recognized.

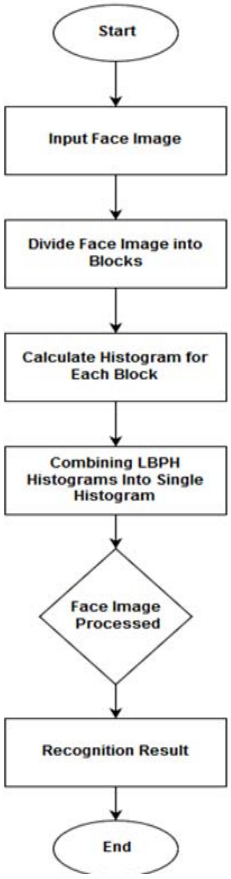

Figure 5. LBPH algorithm flowchart

A. Feature Vectors

In order to receive the feature vectors, the pattern for each pixel is obtained [11]. To represent all faces efficiently, the image has to be subdivided into K2 regions, i-e 82= 64 regions. A histogram with each potential label is composed. Each bin in a histogram gives the information about a pattern. While the feature vectors can be obtained from the histograms. So we can say that each regional histogram hold of P (P − 1) + 3 bins: P (P −1).

To achieve the area with a distance with the help of the LBP system from the edges of the image, if it's not then it means some area on the border of the image is not used.

For the image (NxM), the feature vector is designed with the help of calculating the LBP code for all pixels (X_c, Y_c) with xc ϵ {R + 1,. .., N − R} and yc {R + 1, . . . , M − R}.

If an image is divided into k × k regions, then the histogram for region (k_x, k_y), with k_x ϵ {1, . . . , k} and k_y ϵ {1, . . . , k}, Mathematically, :

$$H_i(K_x,K_y) = \sum x,y\, I\{LBP_{P,R(x,y)} = L\,(i)\}, i = 1, \ldots\ldots P(P-1)+3 \quad (4)$$

$$x \in \begin{cases} \left\{R+1, \ldots\ldots\ldots\ldots, \frac{N}{K}\right\} K_x = 1 & \\ \left\{(K_x-1)\left(\frac{N}{K}\right)\right\}+1, \ldots\ldots N-R & K_x = K \\ \left\{(K_x-1)\left(\frac{N}{K}\right)\right\}+1, \ldots\ldots K_x\left(\frac{N}{K}\right) & \text{else} \end{cases} \quad (5)$$

$$\in \begin{cases} \left\{R+1, \ldots\ldots\ldots\ldots, \frac{M}{K}\right\} K_y = 1 & \\ \left\{(K_y-1)\left(\frac{M}{K}\right)\right\}+1, \ldots\ldots M-R & K_y = K \\ \left\{(K_y-1)\left(\frac{M}{K}\right)\right\}+1, \ldots\ldots K_y\left(\frac{M}{K}\right) & \text{else} \end{cases} \quad (6)$$

in which L is the label of binary i and

$$I(A) = \begin{cases} 1, A\ is\ True \\ 0, A\ is\ False \end{cases} \quad (7)$$

The three distinct levels of locality of the face can be determined from feature vector: the labels include information at the little environmental level and design architecture of histograms provides information about the face.

IV. Results and Discussion

In this experiment, each image in the face database has the distinct ID number. First, prepare the face database, and then extract the LBP texture features of each test image. Finally, classify and recognize the face information. For this test we have collected 2500 face images, those face images are taken with a TTQ HD 1080px camera.

We compare the input face images with database face images and work as if the given appearance images, after extracting features compared with the dataset so finally we can figure-out the face image is favorably recognized otherwise the face image would not be recognized. It can be shown in Figure 6.

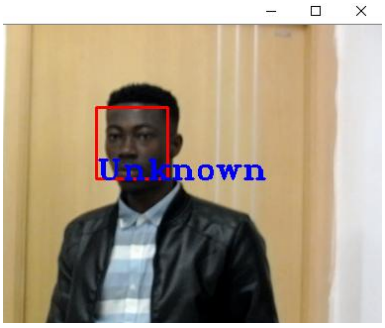

Figure 6. unknown person.

Based on the algorithm, this information of face image of known and an unknown identity is compared with the face image of known individuals from the available database. In the research, we have performed major three tasks, capture, train, and recognize the face images by using the camera.

A. Face Detection

In face detection step, the system detects the face in an input image via camera and captures the gray scale image.

B. *Training Face Images*

After image acquisition and pre-processing task, we have to perform dataset training. For training phase, the training recognizer is applied to store the histogram values of face images.

Figure 7. Face detection.

TABLE I. TRAINING IMAGES STATISTICS

Total Images	Recognized Images	Unrecognized Images	Training Time
2500	2470	30	35 sec

Figure 8. Dataset training.

C. *Recognize Face Image*

The final task is to recognize face images. The Haar cascaded classifier and training recognizer will be used for face recognition. The classifier will compare the stored face images with input face images. If the face features of input images matched with the database images, the recognition result will be displayed on the camera screen.

@35px @45px

Figure 9. Recognizing face images.

TABLE II. RECOGNITION ACCURACY RATE COMPARISON

Algorithm	45px	35px
LBPH	94%	90%

V. CONCLUSION AND FUTURE IMPROVEMENTS

We used Local Binary Patterns at low resolution for the face recognition. It essentially contains three major parts, i-e the representation of the face, feature extraction, and finally classification. While in Face representation describes the input of face behaves and moreover, it limits the algorithms for the detection and recognition. Further, for feature extraction, this LBPH histogram found a novel result and finally we classify input detected face compare with the proposed DATASET (LR500). Then we can analyze our system either recognized a known person or unknown person.

In future, this proposed approach will be more beneficial for security agencies to identify criminals, whose have criminal record in database. It will help to recognize any unknown or known person in surveillance area at low resolutions due to long distance of camera and observed subject.

VI. ACKNOWLEDGEMENT:

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