# Face Recognition based Only on Eyes' Information and Local Binary Pattern

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**Abstract.** In this paper the implementation of the Local Binary Pattern algorithm for face recognition is presented using the partial information of the face, the main contribution of this work is that segmenting the parts of face (forehead, eyes, mouth) can make the recognition a person using only their eyes and getting a percentage of up to 69%, which considering the limited information provided a good success rate is obtained. In the test phase AR facedatabase it was used and using the method of Viola Jones face is located and segmented to obtain templates for each person and each part of his face and Euclidean distance was used for classification task. Because in a real application do not always have all the face of the person to identify the proposed system shows that you can get good results with partial information about it, in addition the results show that in the ranking 6 always provided the right person, which is also useful in real applications.

**Keywords:** Face recognition, partial information, local binary pattern, eyes information

## 1 Introduction

Nowadays insecurity is observed in restricted areas such as banks, shopping centers, airports, etc. Therefore it is necessary have a strict control of the persons that enter to this kind of places, and thus know if the people belong to it or not. This requires recognizing people without invading your privacy; this is done by a biometric analysis.

Biometrics is a responsible discipline of automatic recognition of persons through their physical features (face, retina, iris, voice, fingerprint, etc.) or behavioral traits (gait, writing, etc.). For this, the system uses a facial recognition, but if it is a system implemented in an uncontrolled environment take place to problems of occlusion of the face like lighting conditions at the time of image capture, plus, the face to recognize may contain facial hair, makeup and accessories such as sunglasses, caps, hats or scarves. The recognition of facial images allows determining the identity of a person, when you compare a picture of this face with reference images stored in a database that contains the regions of interest taken in a controlled environment.

This work proposes a solution to the problem of face recognition using information from the eyes, through the algorithms: Viola-Jones, segmentation of the face for the extraction of features (LBP), system training through the overlap of images LBP and finally using Euclidean distance for the comparison with the database in order to carry out the identification of the person.

## 2 Methodology

The block diagram of proposed system is based on a series of processes as shown in Fig. 1, where each block is described below.

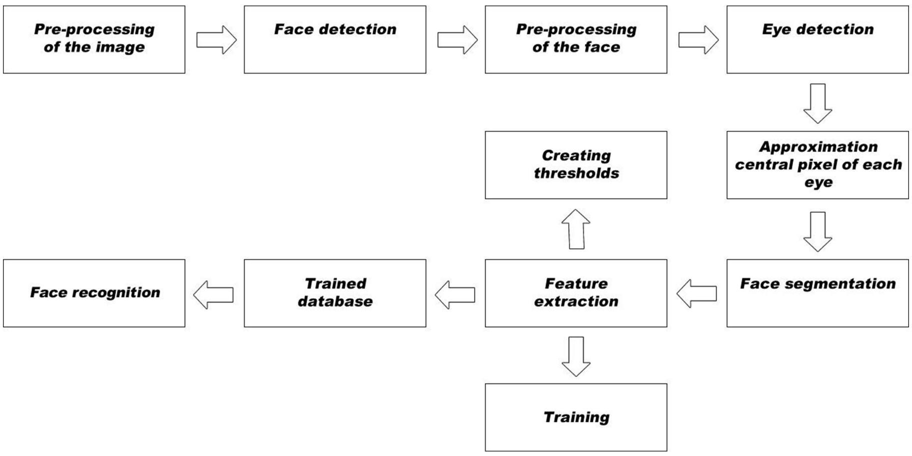


**Fig. 1.** Block diagram of the system

### 2.1 Face Detection

To implement the face detection was used the Viola-Jones algorithm which uses a classifier in cascade through simple descriptors called "Haar", which can be calculated efficiently using a representation of the intermediate image call it integral image [6]. If a face is not found in the original image, it is carried out a pre-processing of the image, in order to have a higher rate of detection of face. Fig. 2 shows the stage of pre-processing and possible processing of the input image to face detection. In the first instance is the original image (a), (b) is the result of the pre-processing of the input image using the adaptive histogram equalization to contrast limited (CLAHE) [4] and in subsection (c) the results of the possible processing if and only if, in the stage of pre-processing it will not detect any face in the input image.


**Fig. 2.** Image Processing.
(a) Original Image. (b) Pre-processing image. (C) Further processing in the event of failing to detect a face in the first iteration.

### 2.2 Eyes Detection

The eyes are detected through the toolbox Face Parts Detection [5], which through an algorithm in cascade finds the eyes and also in a variable stores the coordinates where start the eyes and the pixels that have long and wide for each one of them.

The eyes detection of this toolbox is very effective, however, when the faces have eyeglasses, problems of lighting, contrast and even if the face is slightly inclined, it can submit detection problems that affect the facial segmentation algorithm, which seeks a eye detection as more closely aligned as possible. To improve eyes detection, a processing was done of the face in the same way as was done in the face detection described above.

### 2.3 Approximation of the Center Pixel of the Eyes

The facial segmentation algorithm is based on the distance that exists between the center of the eyes, therefore, was proposed a method to obtain the approximation of the center pixel of each eye. Once detected the eyes in the face as shown in Fig. 3, Face Parts Detection returns 4 values for each eye detected, the starting coordinates ($C_i$) and the dimensions of the area of detection (DAD).

$C_i$ and DAD are denoted by:

$$Ci = (X_1, Y_1), \tag{1}$$

$$DAD = (width, height), \tag{2}$$

with the previous data is make the approximation of the coordinates of the center pixel ($Pc = (X_{pc}, Y_{pc})$) of each eye using the following equations:

$$X_{pc} = X_1 + (width/2), \tag{3}$$

$$Y_{pc} = Y_1 + (height/2). \tag{4}$$

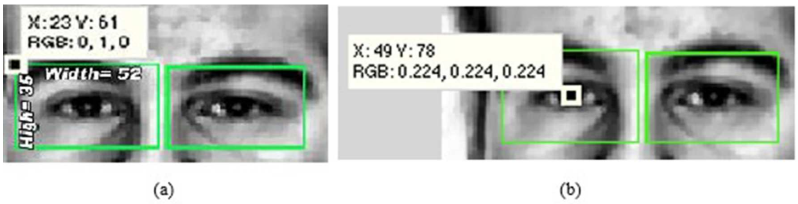


**Fig. 3.** Results of approximation of the center pixel. (a)data generated by Face Parts Detection. (B) center Pixel obtained.

In case that not finding the eyes in the previous stage, the system gives the user the choice to get manually the location of the center of each eye, subsequently it take the coordinates of the pixels and based on them segment the face in their parties more significant.

### 2.4 Face Segmentation

The implementation of the segmentation algorithm is based on the proportions of the face that are calculated from the distance of the center between the eyes, which are given by the points $(X_1, Y_1)$ and $(X_2, Y_2)$, respectively. Coordinates $X_1, Y_1, X_2$, and $Y_2$ are shown graphically in Figure 4.

The distance between the eyes, DO, is given by:

$$DO = X_2 - X_1. \tag{5}$$


**Fig. 4.** Eyes coordinates.

The segmentation algorithm that was used gets 8 regions of interest (mouth, forehead, eyes, nose, left eye, right eye, left half and right half of the face), which are obtained with different proportions, in addition that they are all related to the distance from the center of the eyes (equation 5). The segmentation results obtained are similar to those proposed by Zisheng et al. [1], where the face is segmented into 4 regions. Taking as reference the previous procedure Table 1 shows the proportions for each region of interest; in this work only took the regions of the eyes.

**Table 1.** Proportions of the face

| Region | Coordinate in x | Coordinate in y | High | Width |
|---|---|---|---|---|
| Eyes | $X_1 - 0.5 * DO$ | $Y_1 - (0.5 * DO)$ | $0.8 * ED$ | $2 * DO$ |
| Left Eye | $X_1 - (0.5 * DO$ | $Y_1 - (0.5 * DO)$ | $0.8 * DO$ | $DO$ |
| Right Eye | $X_1 + (0 - 5 * DO)$ | $Y_1 - (0.5 * DO)$ | $0.8 * DO$ | $DO$ |

### 2.5 Feature Extraction

The LBP algorithm introduced by Ojala et al. [3] is one of the most efficient methods for describing texture. The original LBP method, that is, the hLBPH, uses masks of 3 x 3 pixels, called the "texture spectrum", to represent a neighborhood around a central pixel, as shown in Figure 5(a), where the values of the neighboring pixels are compared with the central pixel, taking that pixel value as the threshold. Pixels are labeled as 0 if values are smaller than the threshold; otherwise, they are labeled as 1, as shown in Figure 5(b). Next, the pixel labels are multiplied by $2^p$, where $0 \leq p \leq 7$ is the position of each pixel in the neighborhood, as shown in Figure 5(c). Finally, the resulting values are added to obtain the label of the central pixel in that neighborhood, yielding Figure 5(d). This method produces 128 possible values for the central pixel label. This process is repeated for the entire image, producing a LBP labeling matrix (with the same size as the input images), which is used to estimate the vector for the face image features.

### 2.6 Training System

The training was done with only three faces already processed with the LBP algorithm; in order not to lose characteristics between each overlay face. The three images will be known as the original image (IO), image to join (UI) and the resulting image (IR). To generate the template we have to reduce to half the values of the arrays of each face in order to obtain an average that will be the resulting image (IR), that is to say:

$$IO = IO * \frac{1}{2}, \tag{6}$$

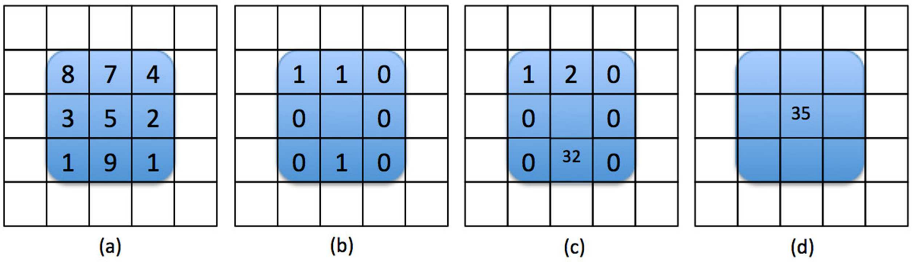


**Fig. 5.** LBP neighborhood example.

$$IU = IU * \frac{1}{2}, \tag{7}$$

$$IR = IO + IA. \tag{8}$$

For the next image is performed the same procedure, only that now we multiply to go by $\frac{1}{2}$ as well as the next image to join ($IU_n$), in order to obtain the image template (IP) of that face.

$$IP = (IR * \frac{1}{2}) + (IU * \frac{1}{2}). \tag{9}$$

Giving as a result the image template (IP) shown in Fig. 6.

**Fig. 6.** Final Template.

## 3 Results

To obtain the results is calculated the euclidean distance to determine which person is the winner. Two different tests were performed, the first of these is the facial verification which consists of two stages, the first consists in the face detection, to perform the segmentation and getting features of the regions of interest with LBP, in the second stage we take a sample of 5 persons, of which it was obtained the segmentation and characteristics of each one to carry out a comparison between these regions and the templates produced with their corresponding thresholds, where, if any region of the face is in the range of the threshold will accept that image and give by the fact that the individual has similarity with the person to recognize.

Table 2 shows the results obtained when performing the verification using the left eye and right eye as well as both eyes, in the temporary results tells us what percentage of the images entered in the thresholds, that is, at least some of the regions of interest used are accepted in the verification. In the column of final results will have to perform a confirmation, which is that, at least two of the regions of interest come in the thresholds.

**Table 2.** Verification Result.

| | Temporary Results | Final Results | False positives |
|---|---|---|---|
| Person 1 | 80% | 45% | 36% |
| Person 2 | 73.68% | 52.63% | 18.18% |
| Person 3 | 73.68% | 47.36% | 0% |
| Person 4 | 84.21% | 68.42% | 0% |
| Person 5 | 65% | 50% | 0% |
| Average | 75.31% | 52.58% | 10.96% |

The other test was the facial recognition classified in a ranking 1, 3 and 6, this test was conducted with a total of 20 people, and each person has around 20 images to 25 images. The ranking is the probability that the person linked to the image under analysis is within a group of N people which have the lower values in the Euclidean distance, not importing the image to be associated with the wrong person, it is important that the correct person is within this group N [2].

For the tests as well as in verification, we used the regions of the eyes as a whole and separately, in Fig. 7, shows the graph of the percentage of the number of images that were within the respective ranking for the left eye. Fig. 8shows the graph of the percentage of the number of images that were within the respective ranking for the right eye.

Fig. 9 shows the graph of the percentage of the number of images that were within the respective ranking for both eyes, in which it was obtained the highest percentage in ranking 6 since it reached the 94%.

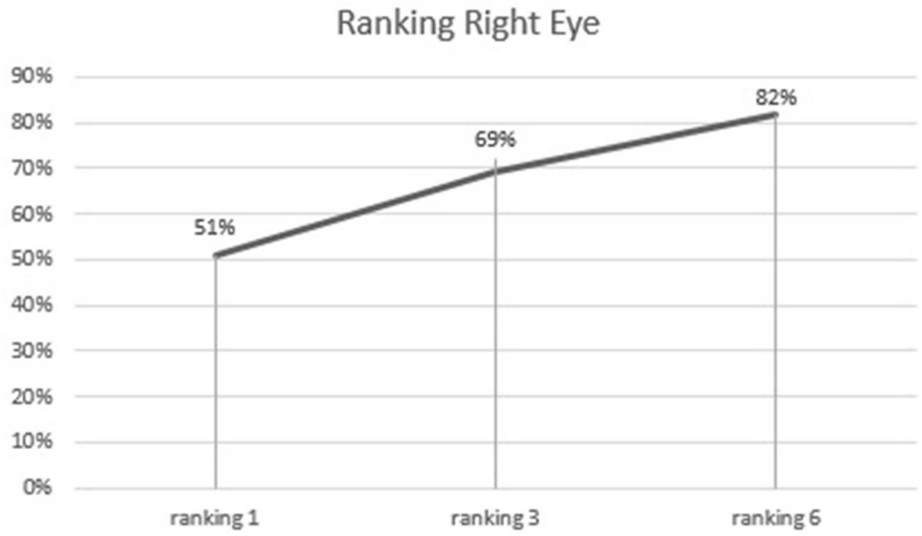


**Fig. 7.** Ranking Right Eye.

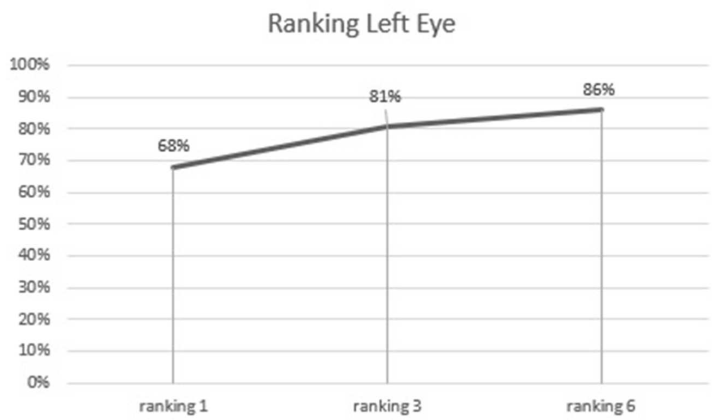


**Fig. 8.** Ranking Left Eye.

## 4 Conclusions

This investigation culminated successfully, the goals are met to carry out the recognition of face without being invasive, using only one eye either left, right or both of the person to recognize versus the database of templates, coupled with the effectiveness of the proposed algorithms for processing, detect, segment,

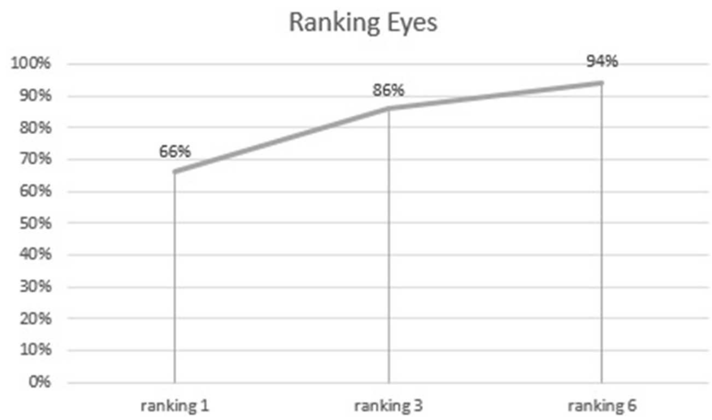


**Fig. 9.** Ranking Eyes.

extract features, among others, achieving good results in the different tests of ranking: 1 with 66%, 3 with 86% and highlighting ranking 6 where it was obtained up to 94% of recognition of the person of interest using both eyes, that is, the face to recognize it is part of the group of 6 people with faces that share similar characteristics, being more easy to detect who is the person of interest. For the tests as well as in the verification, we used the regions of the eyes as a whole and separately, in the Fig 6,7,8 show the graphs of the percentage of the number of images that were within the respective ranking for the left eye, right eye, and both eyes, respectively.

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