Local Binary Pattern Base Face Recognition System

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***Abstract*—Facial image analysis is an important and popular research topic in the computer vision and image processing area, which includes face detection, face recognition, facial expression analysis, and several other related applications. A critical step for successful facial image analysis is to derive an effective facial representation from the original face images. In recent years, Local Binary Patterns (LBP) has received increasing attention for facial description. Local binary pattern (LBP) is a nonparametric descriptor, which efficiently summarizes the local structures of images. This paper presents a comprehensive survey of LBP methodology, including several more recent variations. As a typical application of the LBP approach, LBP-based facial image analysis is extensively reviewed, while its successful extensions, which deal with various tasks of facial image analysis, are also highlighted.**

Keywords—Local Binary Patterns (LBP), face detection, face recognition, facial expression analysis, local features.

I. INTRODUCTION

During the past few years, local binary patterns (LBPs)[1] have aroused increasing interest in image processing and computer vision. As a nonparametric method, LBP summarizes local structures of images efficiently by comparing each pixel with its neighbouring pixels. The most important properties of LBP are its computational simplicity and have proved to be highly effective features foe face recognition [2][3]. LBP was originally proposed for texture analysis [4], and has proved a simple yet powerful approach to describe local structures. It has been extensively exploited in many applications, for instance, face image analysis [5], [6], image retrieval [7], [8], environment modeling [9], [10], visual inspection [11], [12], biomedical and aerial image analysis [13], [14].LBP-based facial image analysis has been one of the most popular and successful applications in recent years. Facial image analysis is an active research topic in computer vision, with a wide range of important applications, e.g., human–computer interaction, biometric identification, surveillance and security, and computer animation. LBP has been exploited for facial representation in different tasks, which include face detection [15] face recognition [20], facial expression alysis demographic classification and other related applications The development of LBP methodology can be well illustrated in facial image analysis, and most of its recent variations are proposed in this area.

Some brief surveys on image analysis or face analysis which use LBP, were given, but all these studies discussed limited papers of the literature, and many new related methods have appeared in more recent years.

In this paper, we present a comprehensive survey of the LBP methodology, including its recent variations and LBP-based feature selection, as well as the application to facial image analysis.

To the best of our knowledge, this paper is the first survey that extensively reviews LBP methodology. LBP-based feature-

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selection methods are discussed in this paper.

II. THE PARADIGM OF THE FACE RECOGNITION

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 for researchers. This is due to the fact that the current systems perform well under relatively simple and controlled environments, but perform much worse when variations in different factors are present, such as pose, viewpoint, facial expressions, time (when the pictures are made) and illumination (lightening changes)[16]. The goal in this research area is to minimize the influence of these factors and create robust face recognition system. A model for face recognition is shown in Figure-1.

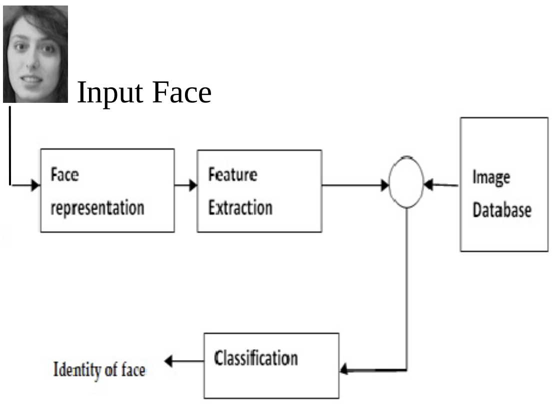

Figure 1: **Principle of an identification process with face recognition**

The process of person identification by using face recognition can be split into three main phases (figure 1). These are face representation, feature extraction and classification [17]. Face representation is the first task, that is, how to model a face. The way to represent a face determines the successive algorithms of detection and identification. For the entry-level recognition (that is, to determine whether or not the given image represents a face), the image is transformed (scaled and rotated) till it has the same 'position' as the images from the database. In the feature extraction phase, the most useful and unique features (properties) of the face image are extracted. With these obtained features, the face image is compared with the images from the database. This is done in the classification phase [16, 18]. The output of the classification part is the identity of a face image from the database with the highest matching score, thus with the smallest differences compared to the input face image. Also a threshold value can be used to determine if the differences are small enough.

III LOCAL BINARY PATTERNS

The LBP operator [19] is one of the best performing texture descriptors and it has been widely used in various applications. It has proven to be highly discriminative and its key advantages, namely its invariance to monotonic gray level changes and computational efficiency, make it suitable for demanding image analysis tasks .The idea of using LBP for face description is motivated by the fact that faces can be seen as a composition of micro-patterns which are well described by such operator .The LBP operator was originally designed for texture description. The operator assigns a label to every pixel of an image by thresholding the 3x3-neighborhood of each pixel with the centre pixel value and considering the result as a binary number. Then the histogram of the labels can be used as a texture descriptor. See Figuare 2 for an illustration of the basic LBP operator. Formally, the LBP operator takes the form

$$\text{LBP}\ (X_c, Y_c) = \sum_{n=0}^{7} 2^n S(i_n - i_c)$$

where in this case n runs over the 8 neighbours of the central pixel c , i_c and in are gray level values at c and n s(u)=1 if u ≥ 0 and 0 otherwise

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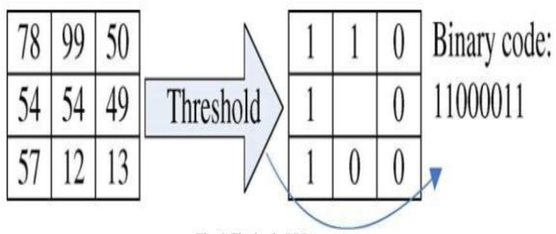

Fig. 3 The basic LBP operator.

Two extensions of the original operator were made in [19]. The first defined LBPs for neighbourhoods of different sizes, thus making it feasible to deal with textures at different scales. The second defined the so-called uniform patterns: A local binary pattern is called uniform if the binary pattern contains at most two bitwise transitions from 0 to 1 or vice versa when the bit pattern is considered circular. For example, the patterns 00000000 (0 transitions), 01110000 (2transitions) and 11001111 (2 transitions) are uniform whereas the patterns 11001001 (4 transitions) and 01010011 (6transitions) are not. In the computation of the LBP histogram, uniform patterns are used so that the histogram has a separate bin for every uniform pattern and all non-uniform patterns are assigned to a single bin. Uniformity is important because it characterizes the patches that contain primitive structural information such as edges and corners. Ojala *et al.*observed that although only 58 of the 256 8-bit patterns are uniform, nearly 90% of all observed image neighbourhoods are uniform and many of the remaining ones contain essentially noise. Thus, when histogramming LBPs the number of bins can be reduced significantly by assigning all non uniform patterns to a single bin, typically without losing too much information. The facial image is divided into local regions and texture descriptors are extracted from each region independently. The descriptors are then concatenated to form a global description of the face. See Figure 3 for an example of a facial image divided into rectangular regions.

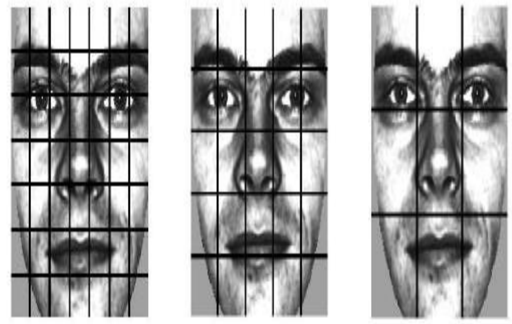

Figure 3: A facial image divided into 7x7, 5x5 and 3x3 Rectangular Region

The basic histogram can be extended into a spatially enhanced histogram which encodes both the appearance and the spatial relations of facial regions. As the m facial regions R0, R1….Rm-1 has been determined, a histogram is computed independently within each of the m regions. The resulting m histograms are combined yielding the spatially enhanced histogram. The spatially enhanced histogram has size m x n where n is the length of a single LBP histogram. In the spatially enhanced histogram, we effectively have a description of the face on three different levels of locality: the LBP labels for the histogram contain information about the patterns on a pixel-level, the labels are summed over a small region to produce information on a regional level and the regional histograms are concatenated to build a global description of the face. It should be noted that when using the histogram-based methods, despite the examples in Fig 3b, the regions R0, R1…..Rm-1, do not need to be rectangular. Both do they need to be of the same size or shape, and they do not necessarily have to cover the whole image. For example, they could be circular regions located at the fiducially points like in the EBGM method. It is also possible to have partially overlapping regions.

V. Face Recognition Algorithm

To implement the face recognition in this research work, we proposed the Local Binary patterns methodology. Local Binary Pattern works on local features that uses LBP operator which summarizes the local special structure of a face image [20].LBP is defined as an orders set of

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binary comparisons of pixels intensities between the centre pixels and its eight surrounding pixels. Local Binary Pattern do this comparison by applying the following formula:

$$\text{LBP}\ (X_c, Y_c) = \sum_{n=0}^{7} 2^n S(i_n - i_c)$$

Where i_c corresponds to the value of the centre pixel (X_c, Y_c) i_n in to the value of eight surrounding pixels. It is used to determine the local features in the face and also works by using basic LBP operator. Feature extracted matrix originally of size 3 x 3, the values are compared by the value of the centre pixel, then binary pattern code is produced and also LBP code is obtained by converting the binary code into decimal one. The Face Recognition Algorithm Input: Training Image set. Output: Feature extracted from face image and compared with centre pixel and recognition with unknown face image.

1. Initialize temp = 0
2. FOR each image I in the training image set
3. Initialize the pattern histogram, H = 0
4. FOR each centre pixel g_c
5. Compute the pattern label of g_c , LBP (1)
6. Increase the corresponding bin by 1.
7. END FOR
8. Find the highest LBP feature for each face image and combined into single vector.
9. Compare with test face image.
10. If it match it most similar face in database then Successfully recognized.

VI Results and Discussion

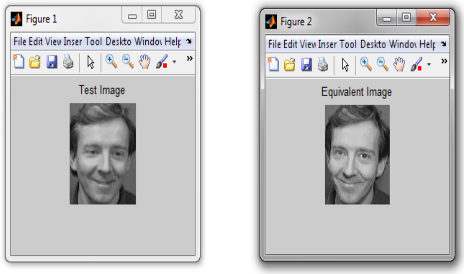
This implementation is used to test the performance of the LBP-method on different kind of face images. Several parameters, like the LBP operator, non-weighted or weighted regions and the dividing of the regions, are varied to see the influence of these parameters on the performance. For this experiment we have collected lots of face images. And also collected face images from the face database [25]. In the proposed algorithm, different types of face images have been recognized. Based on algorithm, the face image of an unknown identity is compared with face images of known individuals from a database. In the figure 7 we can see the input facial images used for input for face recognition are given below:

Figure 7: Different input images

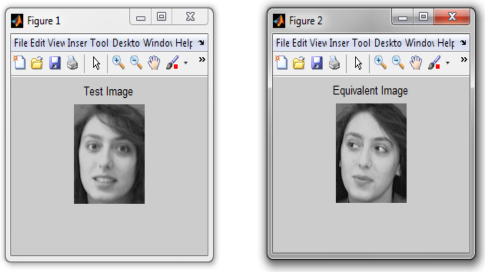
And also in the figure 8 we can see the facial images that are stored in the database which compared with the input facial images. If the input face images are found or the more similarities face images are matched in the database then we say the face image is successfully recognized.

Figure 8: Facial image from the Database

In the experiment we can train the face images in the database. That the facial images are successfully trained shown in the bellow:



Based on the algorithm the input face images are compared with database facial images for identification. The face recognition results are shown in below.



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The following table shows overall face recognition rate:

Number of face image stored in database	Number of input face images compared with database	Recognized Images	Unrecognized Images	Recognition Percent
10	10	10	0	100%

Table 1: Recognition Rate of the Research.

In the table 1 the recognition rate is 100%. We recognize the face images from the database face images by comparing between input face image and database image. From the experimental result, it is seen that the research satisfies all the requirements to recognize the face images.

VII CONCLUSION

In this research has been done to the performance of a face recognition system by making use of feature extraction with Local Binary Patterns [21]. It mainly consists of three parts, namely face representation, feature extraction and classification. Face representation represents how to model a face and determines the successive algorithms of detection and recognition. 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. This method represents the local feature of the face and matches it with the most similar face image in database. The accuracy of the system is 100% by the Local Binary Patterns algorithm.

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