Electronic Letters on Science & Engineering 16(2) (2020)
Available online at dergipark.org.tr/else

# Face Recognition using Local Binary Patterns

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**Abstract:** Face recognition is one of the most successful applications of image analysis, which has recently drawn significant attention. Face recognition is one of the topics that are difficult to construct a computational model. Unlike other detections, these face recognition models are high-level tasks, and a variety of methods have been proposed to obtain these models. On the other hand, face recognition is needed as a suitable data source for various applications that supplying the recognition of individuals. In this article, face recognition will be examined and consider a method based on Local Binary Patterns and provided algorithms for Local Binary Patterns. The results found with this method show the effectiveness of the method.

*Keywords:* Face recognition, Image processing, Local Binary Patterns (LBP), Image analysis.

# Yerel İkili Örüntüleri Kullanarak Yüz Tanıma

**Özet:** Yüz tanıma, görüntü analizinin en başarılı uygulamalarından biridir ve son zamanlarda büyük ilgi görmektedir. Yüz tanıma, bir hesaplama modeli oluşturmanın zor olduğu konulardan biridir. Diğer tarama yöntemlerinin aksine, yüz tanıma modelleri üst düzey hesaplamalar içerir ve bu modeller için çeşitli yöntemler önerilmiştir. Öte yandan, bireylerin tanınmasını sağlayan çeşitli uygulamalar için uygun bir veri kaynağı olarak yüz tanımaya ihtiyaç duyulmaktadır. Bu çalışmada, yüz tanımlama konusu incelenecek, Yerel İkili Örüntülere dayalı bir yöntem ele alınacak ve bunun için algoritmalar sunulacaktır. Bu yöntemle elde edilen sonuçlar yöntemin verimliliğini göstermektedir.

*Anahtar Kelimeler:* Yüz tanıma, Görüntü işleme, Yerel ikili örüntüler, Görüntü analizi.

Reference to this paper should be made as follows (bu makaleye aşağıdaki şekilde atıfta bulunulmalı): O. Orhan, B. Milani, M. Milani, 'Face Recognition using Local Binary Patterns', Elec Lett Sci Eng , vol. 16(2) , (2020), 202-207

## 1. Introduction

Face recognition [1, 4] is about identifying people belonging to that face, unlike recognizing the presence of a face in an image [3] or video [4], which is a simple step of face detection. Therefore, face recognition can be considered as a way to identify a person, which we use extensively in security and surveillance systems. Because face recognition requires face detection, we can consider face recognition as a two-phase process. The faces can be detected in a picture or video stream using methods that can localize faces in the first phase and receive each of the faces identified in the previous step and assign a name to each face in the second phase. So, face recognition is the process of taking a face in an image and actually identifying who the face belongs to. Face recognition is thus a form of personal identification.

ISSN 1305-8614 

Until the 1970s, the issue of face recognition was a topic that was mostly discussed in fiction books and as a science-fiction topic. But after an article by Goldstein, et al. published in 1971 under the title Identification of human faces [5], the subject of face recognition was considered as a scientific subject and one of the branches of computer vision. In the first face recognition measures, 21 facial features were considered as face recognition features. These features included some general features such as hair color and lip thickness in the images.

Early facial recognition systems also relied heavily on facial features extracted from images, such as the relative position and size of the eyes, nose, cheekbones, and jaw [6]. In general, these systems were often highly subjective and error-prone, as these facial quantifications were manually extracted by computer scientists and face recognition software operators.

Then, more than a decade later, in 1987, Kirby and Sirovich [7] published their major work, A Small-Scale Procedure for Describing Human Faces. This is also known as the Eigenfaces algorithm. Kirby and Sirovich have been shown that a standard method of linear algebra for dimensionality called Principal Component Analysis (PCA) could be used to identify faces.

A lot of research has been done on face recognition following the work of Kirby and Sirovich. Nowadays, it can be seen that other linear algebra techniques such as linear diagnostic analysis are used to identify faces [8]. These are commonly known as Fisherfaces. Feature-based approaches such as local binary patterns that are going to start by exploring the 2006 work of Ahonen et al. on Local Binary Patterns (LBPs) for face recognition [9] have also been introduced and are still widely used in real-world applications [9, 10]. It can be seen that deep learning starts to use in face recognition [11, 12], but typically for facial alignment, it is a pre-processing step that takes place before face recognition.

Newer face recognition systems rely on feature extraction [13, 14] and machine learning [15, 16] to train classifiers to identify faces in images. These systems are not only subjective but also automated.

In this study, the CALTECH Faces dataset will be examined, LBPs will be reviewed for the face recognition algorithm, LBPs will be implemented for face recognition, and faces in the CALTECH faces dataset will be classified using our implementation.

## 2. Local Binary Patterns for Face Recognition

While the Eigenfaces algorithm relies on PCA to create small-scale representations of facial images, the local binary pattern (LBPs) method, as its name implies, relies on feature extraction. This method was first introduced by [17]. They suggested dividing a face image into a 7x7 grid of cells of the same size in their article. Figure 1 shows a face as a 7x7 grid divided into cells of the same size using LBP.

**Figure 1. Division of the face image into a 7x7 grid of cells of the same size.**

After dividing the image into 49 cells of the same size, these cells can be used as input tools for the Local Binary Pattern method. Finally, the information will be in the form of histograms required for LBP. In this method, some cells are used in a way that helps further representation. Cells in the corners define facial information less than cells in the center of the network (which contain the structures of the eyes, nose, and lips). Finally, LBP weight histograms from 49 cells to form our final feature vector are combined.

To identify the face, the KNN (K Nearest Neighbors) classification method can be performed using the $\chi 2$ (chi-square) distance between the image in question and the data set of the tagged faces. Since we are using a histogram comparison in this method, the $\chi 2$ distance is a better choice than the Euclidean distance.

While both Eigenfaces and LBP are relatively simple face recognition algorithms for face recognition, the feature-based LBP method is more flexible against noise and usually has better results.

## 3. The CALTECH Faces Dataset

Specific data sets are needed to determine the effectiveness of face recognition methods. CALTECH Faces is a popular dataset for face recognition algorithms. In total, this dataset contains 450 images obtained from 27 unique individuals. Each person is recorded under different lighting conditions, background scenes, and face modes. Figure 2 shows an example of the data set in question.

**Figure 2. An example of the CALTECH Faces data set**

In this article, the efficiency of using LBP is examined for face recognition to identify each person in the CALTECH Faces data set. In the following sections, the issue of face recognition will be addressed. First, face recognition algorithms can be obtained using a simple, intuitive, and understandable dataset.

## 4. Local Binary Patterns for Face Recognition Algorithm

In this section, we will present the LBP method for the face recognition algorithm in general. This algorithm, which in general is a very simple algorithm, can be considered as an efficient method for face recognition. In the method discussed, according to a face in a data set, the first step of the algorithm is to divide the face into 7x7 cells of the same size. It can be seen that to Figure 3 to understand the method better. Once a face is identified in the image, the first step is to divide the ROI (Region of Interest) of the face into 7x7 cells. Then, for each of these cells, the Local Binary Pattern histogram is computed. By definition, a histogram gives all spatial information about how patterns fit together. However, by calculating the histogram for each cell, we can actually encode a level of spatial information such as eyes, nose, mouth, etc. that we cannot obtain with other methods.

This spatial encoding also allows us to measure the histograms from each cell differently and to give more distinction power to distinct features.

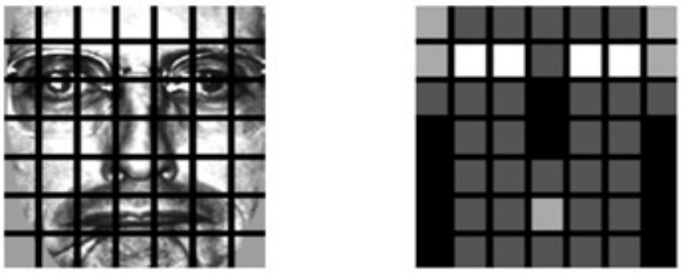

**Figure 3. The original face image (left) followed by the weighting scheme for the** 7x7 **cells (right).**

It can be seen that the main image of the face, which is divided into 7x7 cells (left) in Figure 3. Also, on the right, it can be seen that the weighing scheme for each cell. The LBP histogram weighs 4 times more than white blood cells (such as the eye). This simply means that we take LBP histograms from the white cell regions and multiply them by 4.

Light gray cells (mouth and ear) help twice as much to obtain histogram. Dark gray cells (inner and forehead species) play only 1-fold role. Eventually, black cells such as the nose and outer cheeks are completely ignored and weigh 0x. These weight values were found experimentally by [17] by implementing parameter override algorithms on top of training, validation and data sharing testing. Finally, the 7x7 LBP histograms are combined to form the final feature vector. Face recognition is performed using $\chi 2$ distance and nearest neighbor classification.

## 5. Face Recognition Algorithm

In this section, an algorithm based on the LBP method is examined. According to the algorithm, a face image is first presented to the system. Using LBPs, extraction, weighting, and joining of the image can be performed as training data. In the next step, the k-NN method (with k = 1) is performed with a distance of $\chi 2$ to find the closest figure in the training data. Finally, the name

of the person associated with the face with the smallest distance $\chi 2$ is selected as the final classification.

The algorithm in question is shown in List 1.

**List 1. Algorithm of Face Recognition**

1. Give the picture
2. Weight extraction, and similar integration of training data in LBP
3. Perform k-NN (with k = 1) with interval $\chi 2$
4. Find the closest faces in the training data
5. Extract a person's name

As shown in List 1, Local Binary Patterns is quite simple for the face recognition algorithm and it simply builds on our concepts covered within this study. To extract local binary patterns is not difficult, and to extend the extraction method to compute the histogram for cells 7x7= 49 is a simple way. In addition, it can be shown that computing $\chi 2$ distance from the construction of image search engines can be seen easy when comparing feature vectors.

At the end of this section, it is important to point out that LBPs for the face recognition algorithm can be updated as new faces are introduced into the dataset. Other popular algorithms, such as Eigenfaces, require the detection of all faces during training. This means that if a new face is added to the dataset, the entire Eigenfaces classification must be re-trained, which is purely computational. Instead, LBPs for face recognition algorithms can simply import new face samples without having to retrain, which is an obvious advantage when working with face-escape datasets that change frequently.

## 6. Conclusion

In this article, face recognition and face detection are examined. The other important concept which is examined is the difference between face detection and face recognition. Unlike face detection, which is used exclusively to identify and separate a face from an image, face recognition determines who the discovered face belongs to. It is emphasized that only the faces of people who are already in the training data set can be identified.

In addition, different methods of face recognition are expressed, and in this article, and Local Binary Patterns method is investigated detail. The algorithm of this method clearly shows that the method under study is very simple and efficient.

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