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Facial Recognition System Based on Score-level Fusion of LBP and Gabor Feature Extraction Techniques

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Abstract

Face recognition is gaining recognition over the last few decades. Nowadays, this technology is highly used in smartphones to unlock the phone by sensing the face of an individual. In our paper, we aim to maximize recognition rates by performing the score-level fusion of two feature extraction techniques: Local Binary Pattern (LBP) and Gabor features. These two techniques on fusion provide better recognition rates as compared to the recognition rates when they are considered individually.

Keywords: *Biometrics, face recognition, Gabor filter, local binary pattern (LBP), principal component analysis (PCA)*

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INTRODUCTION

Biometrics is the physical property that is used for identification of individuals. Some important types of biometric technology include the face, fingerprint, iris, and retina recognition. The security devices incorporating biometric security features play an important role in identifying a person by applying various access control methods through their special biological characteristics [1].

Face Recognition

Facial recognition is biometric software which translates features of the face of a person mathematically and stores it as a print [2]. The facial recognition process is basically initialized by taking an input image, detection followed by feature extraction. After the features are extracted, feature selection is performed and optimal features are first selected and then compared with images previously stored in the database and then based on its matching level, the graph is designed. Several algorithms can be used for feature extraction like DWT (Discrete Wavelet Transform), LBP (Local Binary Pattern), DCT (Discrete Cosine Transform), etc. [3].

RELATED WORK

TSV Priya et. al. proposed texture operator technique which uses LBP (Local Binary Pattern) [4]. This technique will extract the features from a given image first and then measures similar features between different faces. Dipesh Vaya and Teena Hadpawat proposed a PCA feature selection technique for face recognition and match the actual results with various distance classifiers like Eucledian distance, Manhattan Distance and Mahalanobis distance [5]. Faizan Ahmad et. al., proposed many techniques for face recognition with improved accuracy by using several databases [6]. It basically uses five different datasets on the basis of pose, emotions, race, light and subject. K. Srilaxmi et. al discussed an approach in facial recognition, performing the Gabor filter convolution with the image by marking the fiducial points [7]. Bhagyalaxmi Tejinkar and Dr. S.R. Patil proposed a new approach that uses SVM classifier and encodes whole data of face without leaving any part [8]. Ms. B. Saranya Bargavi, Ms. C. Santhi proposed a 2D Hidden Markov Model (2D-HMM) that uses the fusion of localized and globalized features

of the face that results into the feature vector which is used to describe the whole face [9]. Venu Kumar, K.B. Raja, K.S. Babu, and Venugopal K.R., Chandrakala proposed the facial recognition technique involving discrete wavelet transform (DWT) and enhanced terminology of texture operator technique (Local Binary Pattern) [10]. It uses local pattern and LBP has applied to that pattern. Vinodpuri Rampuri Gosavi, Ganesh S. Sable, Anil K. Deshmane showed the comparative analysis of various terminologies which automatically categorizes different facial expressions [11].

PROPOSED APPROACH

The paradigm of the approach proposed can be illustrated (Figure 1).

Feature Extraction

There are several techniques for extracting features from an image. In our work, we have used two techniques which are discussed below:

Local Binary Pattern

LBP, also known as Local Binary Pattern, is a simple and effective technique in which image size (in pixels) is labeled by adjusting the neighborhood of each pixel to a value (threshold) and compares them and stores the result in the form of binary value (either 0 or 1). In the initial LBP technique, labeling of pixels was performed by measuring the neighbor of the pixel with a middle number, which stores the result in binary form (Figure 2). If the image pixel value is more than middle (or threshold) value, the result stored will be 1, otherwise 0. This technique gained recognition due to its simplicity of computation, and discriminative power [12]. An illustration of the original LBP technique can be shown by the following image:

Gabor Filter

Gabor filter is very useful in extracting features in facial recognition. This is a sinusoidal signal having no. of bandpass filters that are used to extract features during image processing. A Gabor filter is essentially a sinusoidal signal with a given frequency and orientation. These filters are used in as a feature extractor in face recognition. Other applications where these can be applied are in the detection of an object, representation of an image, etc. [13, 14].

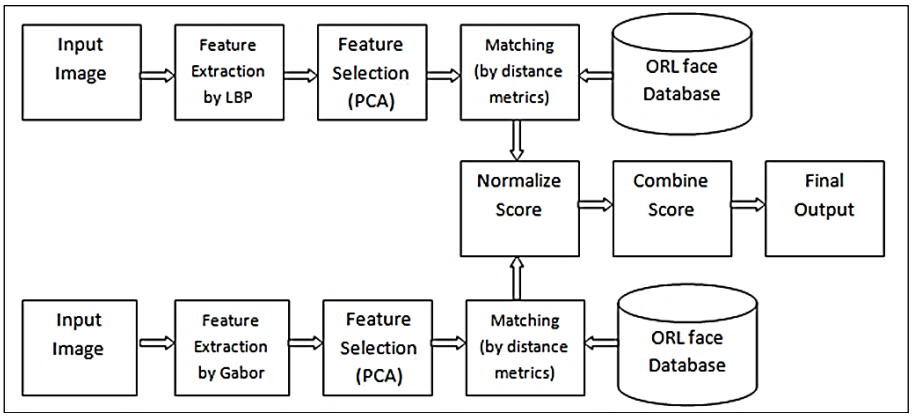

Fig. 1: *An illustration of the approach proposed.*

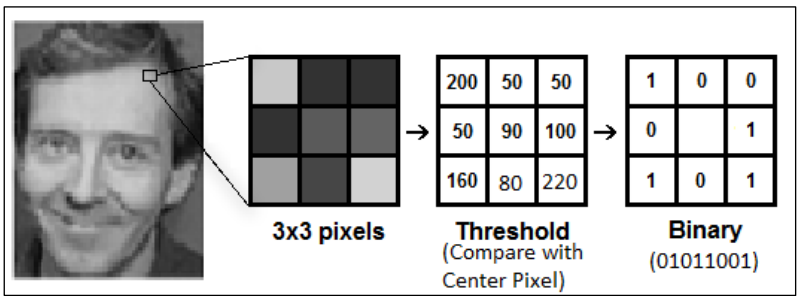

Fig. 2: *Illustration of LBP Operator.*

Feature Selection

After the feature extraction is done, the next step is to select the optimal features using an efficient feature selection technique. We have used PCA for selecting features.

Principal Component Analysis (PCA)

Principal Component Analysis, which is often called as Karhunen - Loeve method is a commonly used method for feature selection and reduction in the size of an image [15]. This technique mainly emphasizes on the reduction of the dataset used and selects the most optimal features out of them. The method called as the Eigenface method is basically used to reduce the size of the dataset. The reduced dataset is then used for facial recognition. The components of the reduced dataset are called as the principal components. The technique is basically used to calculate the optimal feature vector of the image under test. This method is advantageous as it reduces the size and hence, the complexity [16].

Fusion and Matching

In this step, features of the image under test are matched against the features of the training dataset by using various distance classifiers and similarity score is computed (for both LBP and Gabor individually). In our work, we have used 5 distance classifiers: Euclidean, Cityblock, Minkowski, Cosine and Correlation. Higher is the similarity measure, t lesser is the distance and we can identify which is the best similar image in the database. The individual scores of both are then normalized and fused by using the weighted sum formula given as,

*Final Score = a*score of LBP + b*score of Gabor filter*

Here a and b are normalized constants.

This technique of fusion at score level is commonly termed as score-level fusion.

EXPERIMENTAL ANALYSIS AND RESULTS

In our work, we have used the ORL Database. ORL (Olivetti Research Laboratory) (now AT&T) dataset comprises of 200 images of 20 people, each having 10 images. We matched our results with the ORL database. The sample images of ORL dataset can be shown as (Figure 3).

Fig. 3: *Sample image of ORL database.*

Table 1: *Recognition rates of LBP, Gabor and fused (LBP + Gabor) approaches.*

Distance Metric	Accuracy % (LBP)	Accuracy % (Gabor)	Accuracy % (LBP + Gabor)
Euclidean	95	96.66667	99.16667
Cityblock	95.83333	88.33333	97.5
Minkowski	95	96.66667	99.16667
Cosine	95.83333	99.16667	100
Correlation	95.83333	99.16667	100

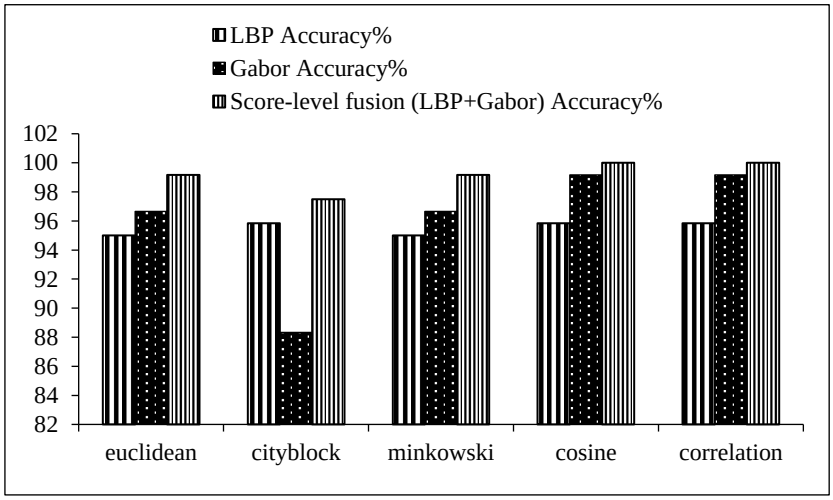

Fig. 4: *Recognition Rate Graph of Proposed Technique*

In this paper, our main focus is to maximize the recognition rates. Our research progresses in 2 steps:

In the first step, we calculated the individual scores for LBP and Gabor using various distance classifiers and based on the results we plotted a graph of the recognition rates of both individually.

In the second step, we have fused together these two techniques (LBP + Gabor) and calculated the fusion score as shown (Table 1).

Hence, we have concluded from the graph that the hybrid approach of the two techniques (LBP + Gabor) gives better results in terms of recognition rate (accuracy) as compared to the individual results of both at score-level.

Based on these results, the graph of recognition rates (accuracy) is obtained (Figure 4).

CONCLUSION

In our paper, we have studied the whole paradigm of facial recognition and made efforts to maximize the recognition rates as much as possible using score-level fusion. So, we have concluded that score-level fusion of two techniques (Local Binary Pattern and Gabor) provided us with better results against various distance classifiers as compared to the recognition rates of both individually.

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