Adaptive hybrid technique for face recognition

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Article Info	ABSTRACT

One of the most important biometric features for personal identification is the face. In current paper, a new method of face verification upon on singular value decomposition (SVD) and standard deviation (SD) would be described. Due to many variations in real-life such as pose, illumination, or facial expression, there would be difficulty of face recognition. It should be mentioned that there are many approaches for face recognition, however, there is no one could be considered as the most suitable for many situations. One of the methods used is Singular value vector for an image detecting, but the drawback of this approach is the low rate of recognition, where one scale singular value vector is used for face acknowledgment. There an algorithm has been developed to expand the rate of the recognition. In this paper, an approach has been proposed to associate two feature sets obtained from SVD and SD method. It has noticed a good recognition rate could be obtained from the experimental results, where approximately more that 97.5% recognition rate has obtained on the ORL data base. The results from current proposed method have matched with some techniques and it has shown that this method is better than the existing approaches. An extensive experiment has demonstrated not only better performance, but it offers a great likely to achieve equivalent performance to other categories of state-of-the-art methods.

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1. Introduction

The face recognition method which been studied here is considered as one of the most authentic biometric approaches. It is a powerful application of Pattern recognition and Image analysis. Verification and identification are the two main tasks of the face recognition. Where the face verification aimed to match exactly a face of images with the template face of images whose character being claimed. While, face identification objective is that there is 1: N problems and this would compare a query face image against all image templates in a face database. Because of the wide range of marketable and edict enforcement applications such as actual scientific identification, entrance of control, border of surveillance and human communications, the machine recognition became crucial tool. Basically, there are three approaches of face recognition, which are holistic methods and this method would be essentially used whole face area as required input to what has been knowing as a recognition system. Second method is Feature-based, this method uses the feature of the face such a nose, eyes and mouth. The third method is Hybrid method which uses both face feature and whole face area to recognize the face [2]. Since of founding many images variation in real-life, such as lighting, brightness, facial appearance, as well as, partial obstruction and imprecise local that express in many different of   face area. face recognition is considered as a difficult problem [3]. Many systems for

face recognition have been projected in the literatures [2]. The principal component analysis (PCA) considered as the most popular approach, which is holistic based method and it is suggested by [4]. The objective of this method it to transform 2D face pictures for 1D vector. Obtained vector would have highly-dimensional space where assessment of covariance matrix will became more difficult due to giant size or inordinate numbers of training samples. Furthermore, there has to compute the eigenvectors of a huge covariance of matrix, and this time consuming process. Linear discriminant of analysis (LDA) is well documented and used as traditional technique. It is used for feature abstraction and dimension dropping and utilized for a while to organize the problems [5]. Algebraic features (AF) are effective feature in objective classification for example, doing to achieve some of face recognition, and that was suggested by Hong [6]. He suggested a utilizing what is known as singular value decomposition (SVD) as basic for recognition method, and this is based on remarkable values of feature vectors. Effective of SVD process has tested in [6] and [7]. Fusion of some selected left and/or right singular vectors of SVD and DCT-RLDA can generate superior results on face images as compared to their individual counterpart [8]. In this paper, an approach has been developed to mix two sets of features that are obtained from SVD and SD method. The exactness of projected recognition approaches is compered to exist techniques. The organization of the paper is as follows, section 2 describe the Singular Value Decompositions. Then the Standard Deviation has introduced in section 3. In Section 4 Dissimilarity measurement is described. Section 5describes the proposed approach. The main results of current experiment are presented in section 6 and conclusions which is drawn are explained in section 7.

2. Singular Value Decomposition (SVD)

Singular Value Decompositions (SVDs) are define as an algebraic practice to factor several rectangular matrixs for the product of three other matrices. If $A \in R^{m \times n}$ is identify as a gray level facial image and $rank(A) = r$, after that there are two orthogonal matrices

$$U = [u_1, \ldots, u_m] \in R^{m \times m}, U^t U = I$$
$$V = [v_1, \ldots, v_n] \in R^{n \times n}, V^t V = I$$

and diagonal matrix

$$\Sigma = diag(\lambda_1, \lambda_2, \ldots, \lambda_r, 0, \ldots, 0) \in R^{m \times n}, \ \lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_r \geq 0$$

such that

$$A = U\Sigma V^t = \sum_{i=1}^{r} \lambda_i u_i v_i^t \qquad (1)$$

where λ_i^2 is the eigenvalue of $A^t A$ in addition to $A A^t$, λ_i is Singular of Value (SV) from facial pic A, u_i, v_i, are pillar of eigenvectors of $A^t A$ and $A A^t$ corresponding to eigenvalue λ_i^2, respectively[9-11].

SVD has important properties and these are verified in [12]. These properties are stability, transposition invariance, rotation invariance, proportion invariance, mirror trans- form invariance. The singular values are invariant to translation, rotation, mirror transforms, and this is proven in literature [6]. It should be mention that it is stable in spite of the occurrence of other variations, such as noise or changing lighting.

3. Standard Deviation (SD)

Standard Deviation (SD) of our data is a measured of in what way to extent out data as in [13]. Mathematically, SDs are square root of the variances. The main character for population standard deviation is known in literature as σ. Corresponding formula for the population standard deviation σ is:

$$\sigma = \sqrt{\sigma^2} \qquad (2)$$

where σ^2 is adjustment, Variances are average of squares of the distances for each value from the mean of these values. Formula for variance is:

$$\sigma^2 = \frac{\sum_{i=1}^{N}(X_i - \mu)^2}{N} \qquad (3)$$

where X_i individual values, μ mean of the data set. N is number of elements in the data set [13,14].

4.   Dissimilarity measurement

In our study we are interested to city of block distance measurement, in our metric, the distances between 2 vectors are summations of common absolute alterations of their essentials. Mathematically, distances between 2 vectors $u = (u_1, u_2, ..., u_N)$ and $v = (v_1, v_2, ..., u_N)$ which are given by [15]:

$$D(u, v) = \sum_{i=1}^{N} |u_i - v_i| \quad (4)$$

5.   The Proposed Approach

Figure (1) shows the block diagram of the proposed approach. It consists of the following steps:
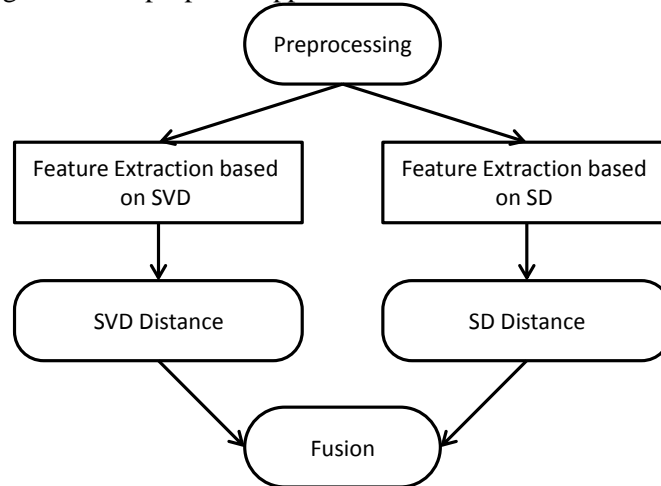

Figure 1. Block diagram of the proposed approach

1-Preprocessing: First, the image from the database is obtained and improved to gray scale. Then the picture is divided into (4x4) 16 blocks with (28x23) pixels (See Figure (2)).
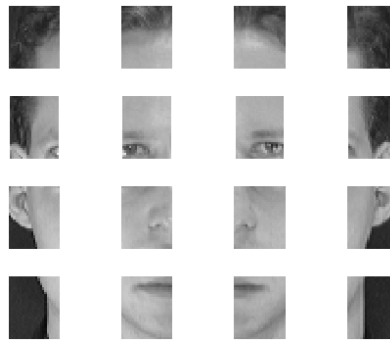

Figure 2. Example the face image is divided

2-Feature Extraction based on SVD: SVD for each block obtained in the preprocessing step is calculated. Then we used the singular values as the feature vectors.

3-Feature Extraction based on SD: SD values for each column of each block obtained in the preprocessing step is calculated and use them as the feature vectors.

4-Computation of Dissimilarity Measure: In SVD-Based Features Extraction, we have a vector V that contain features of consistent to examined face and a matrix F_k (k = 1, 2, …, M), such as M represents numbers of training faces. The judgment between F_k and v is done by computing the distances amongst them to obtain the distance vector $D_{SVD} = (d_1, d_2, ..., d_M)$. D_{SVD} would be characterized the score that be collected with SD. In SD-base Features Extraction, now comparison between F_k and v is done by manipulative the distances between them to obtain the distance vector $D_{SD} = (d_1, d_2, ..., d_M)$ that characterized the score that be combined to SVD.

5- Fusion Method: After computing 2 distances vectors, we collected the two main results vectors D_{SVD} and D_{SD} in order to calculate combined vector D_{Fusion}. Finally, D_{Fusion} are calculated as multiplication of 2 distances vectors. We selected the conforming class according to the smallest value of D_{Fusion}.

$$D_{Fusion} = ((D_1^{SVD}.D_1^{SD}), (D_2^{SVD}.D_2^{SD}), \dots, (D_M^{SVD}.D_M^{SD}))(5)$$

6.   Experiment results

The standard database Olivetti Research Laboratory (ORL) [16] is selected to test recognition accuracy of the new proposed approach. In the ORL database, it has been approved that there are 10 dissimilar images for each of the 40 different themes. Differences in face expression are present (smile and/or non-smile face as well as open and/or close eyes), and face specifics such as wearing glasses and/ or no glasses on. Most of these pictures were taken against black standardized background with the subjects in frontal position and an up-right, all of these images are tolerance for some tilting's and revolutions of up to about 20°. Figure (3) is a picture of a person shown in the database. Database are component from 400 face images. The resolution of all images is 112×92, and 8-bit grey levels.

Figure 3. Images of one person in the ORL database

In our experiments, 5 images from each person were chosen as training group and the rest are the testing images. The entire number of training and testing images in the current study is 200.Table (1) shows the recognition rate of SVD, SD and proposed approach for randomly six training sets. As Table (1) show, the recognition rate of the proposed approach is better than the SVD and SD. The recognition rate of suggested approach is 2.5% higher than SVD and 8% than SD.

Table 1. Recognition rates of SVD, SD and proposed approach

Filenames of training set	SVD	SD	*Proposed Approach*
a1, a2, a3, a, and a5	95%	89.5%	97.5%
a1, a2, a3, a9, and a10	93.5%	90%	98%
a1, a2, a, a7, and a9	96.5%	92%	97.5%
a2, a, a5, a6, and a10	97%	92.5%	98.5%
a1, a3, a, a5, and a8	97%	91.5%	97.5%
a2, a5, a6, a7, and a8	95%	93%	96.5%

The presentation of the anticipated method is analyzed against particular of the available methods. Table (2) shows the recognition accuracy of some well-known face recognition methods on ORL database wherein first 5 images are taken of each person in the training group and remaining all kept in the test cluster.

Table 2. Performance comparison of various face recognition approaches

Method	Recognition rate
PCA (Eigenface) [17]	87.8%
LDA [18]	91%
SVD and DCT [19]	91.5%
SVD and DCT-RLDA[8]	95%
SVD	95%

SD	89.5%
Proposed Approach	**97.5%**

7. Conclusion

In this paper, SVD and SD based face recognition approaches have been proposed. The image was divided into 16 blocks and features were extracted from each block by using singular values and SD values for each column in each block. The recognition rate obtained by the proposed approaches was superior to that obtained by the individual SVD and SD method. The recognition accuracy of the recommended approach has also been thriving compared to existing methods and it is observed that on these databases of recognition accuracy for the offered method is better than accuracy of these familiar face recognition methods.

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