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ROBUST SINGULAR VALUE DECOMPOSITION ALGORITHM FOR UNIQUE FACES

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ABSTRACT

It has been read and also seen by physical encounters that there found to be seven near resembling humans by appearance .Many a times one becomes confused with respect to identification of such near resembling faces when one encounters them. The recognition of familiar faces plays a fundamental role in our social interactions. Humans are able to identify reliably a large number of faces and psychologists are interested in understanding the perceptual and cognitive mechanisms at the base of the face recognition process. As it is needed that an automated face recognition system should be faces specific, it should effectively use features that discriminate a face from others by preferably amplifying distinctive characteristics of face. Face recognition has drawn wide attention from researchers in areas of machine learning, computer vision, pattern recognition, neural networks, access control, information security, law enforcement and surveillance, smart cards etc. The paper shows that the most resembling faces can be recognized by having a unique value per face under different variations. Certain image transformations, such as intensity negation, strange viewpoint changes, and changes in lighting direction can severely disrupt human face recognition. It has been said again and again by research scholars that SVD algorithm is not good enough to classify faces under large variations but this paper proves that the SVD algorithm is most robust algorithm and can be proved effective in identifying faces under large variations as applicable to unique faces. This paper works on these aspects and tries to recognize the unique faces by applying optimized SVD algorithm.

Indexing terms

SV, SVD, OUSVD, PCA

I. INTRODUCTION

Face recognition remains as an unsolved problem and a demanded technology, a simple search with the phrase "face recognition" in the IEEE Digital Library throws 5671base papers. Face recognition is a relevant subject in pattern recognition, neural networks, computer graphics, image processing and psychology. From the year 1960 Researchers started to show interest in face recognition and diversity of approaches from the year 1980's with L. Sirovich and M. Kirby given Eigen face approach in 1986 .The first one that developed a fully automated face recognition system was Kenade in 1973. Researchers concluded that humans have a specialized facial recognition mechanism which only focuses on particular areas or features in order for recognition. This conclusion the researchers applied for dimensionality reduction techniques such as PCA. There was an effort to try to measure the importance of certain intuitive features such as mouth, eyes, cheeks and geometric measures (between-eye distance, width-length ratio). The introduction of abstract mathematical tools like eigenfaces created another approach to face recognition and ultimately given up a decomposition algorithm for calculating singular values by which in this paper a unique face has been defined and classified.

II UNIQUE FACE RECOGNITION

Recognition is a pattern recognition problem and hence similarity of the faces is considered. The faces for which the singular values are unique are said to be the unique faces. Retrieval of faces is a challenging aspect since faces are affected by illumination conditions, occlusions and so on.

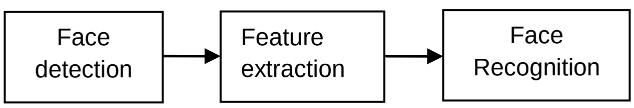

Figure 1: A generic face recognition system.

The input of a face recognition system is always an image. The output is an identification or verification of the subject or subjects that appear in the image. The approach define a face recognition system as a three step process as

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shown in Figure 1. The Face Detection and Feature Extraction phases could run simultaneously. Face detection identifies a certain image region as a face. The feature extraction step involves obtaining relevant facial features from the data. These features could be certain face regions, variations, angles or measures, which can be human relevant. In this paper singular values (SV) are obtained as face features which are said to be unique and singular value which has highest value is said to be the first SV and it will be having large information with it. These SV'S are arranged in decreasing order of magnitude. Finally, the system does recognize the face. In an identification task, the system would report an identity from a database. This phase involves a comparison method, a classification algorithm and an accuracy measure.

III.OPTIMIZED AND UNIFORM SVD APPROACH

Every *Image Matrix A can* always have the SVD as $A = U\sum V^T$

Where U is an m x m orthogonal matrix; V an n x n orthogonal matrix, and ∑ is an m x n matrix containing the singular values of A. $\sigma_1 \geq \sigma_2 \geq \cdots \geq \sigma_n \geq o$ along its main diagonal.

These SVD features are used for facial feature decomposition to represent an image in dimensionality reduction (DR) factor. An SVD operation breaks down the matrix *A* into three separate matrices.

$$A = U\sum V^T$$

$$A = [u_1 \ldots . u_n] \begin{bmatrix} \sigma_1 & & \\ & \cdots & \\ & & \sigma_n \end{bmatrix} \begin{bmatrix} v_1^T \\ \vdots \\ v_n^T \end{bmatrix}$$

$$A = [u_1 \ldots u_n] \begin{bmatrix} \sigma_1 v_1^T \\ \vdots \\ \sigma_n v_n^T \end{bmatrix}$$

$$A = \sigma_1 u_1 v_1^T + \ldots + \sigma_n u_n v_n^T$$

because $\sigma_{r+1} \cdots \sigma_n =$ are equal to zeros

In order to get unique singular values following algorithmic steps are followed:

1) Apply SVD on each of the face image for each class in the data base, such that Ψi = UiSiVi ^{t}. where, $U = [u_1, u_2, \ldots, u_m]$, $V = [v_1, v_2, \ldots, v_n]$, and $S = [0\ X_i\ 0]$, X_i=diag (s_i), s_i are the computed Singular vector for each face image.

2) The obtained Singular Vector is applied with the fractional value of α and a optimized SVD values are obtained as, $Bi=Ui\ Si^{\alpha}Vi^{t}$

3) Each training face image $F_i^{(k)}$ is then projected using the these obtained face feature image.

4) For the obtained representing image apply a DR method PCA, where the eigen features are computed and for the maximum eigen values eigen vectors are located and normalized for this projected image.

5) A test face image Tr ~ є $R^{m \times n}$ is transformed into a face feature matrix Yr є $R^{r \times c}$ by Yr = UrSrVr ^{t}.

6) For the developed query feature an image representation is developed and passed to the PCA.

7) For the computed face feature the distance between a test face image T and a training face images $X_i^{(j)}$ is calculated by $R_{ji} = \delta(Y, X_i^{(j)}) = \left\| Y - X_i^{(j)} \right\|_F$, a Frobenius norm.

8) Retrieve the top 8 subjects of the database according to the rank of Rji

IV IMPLEMENTATION

This forms the first state for the face recognition module. To this module a face image is passed as an input for the system. The input image samples are considered of non-uniform illumination effects, variable facial expressions, and face image with glasses. Figure 4.2 shows the taken facial image as test sample for face recognition. The input image is randomly picked up from the self generated & yale

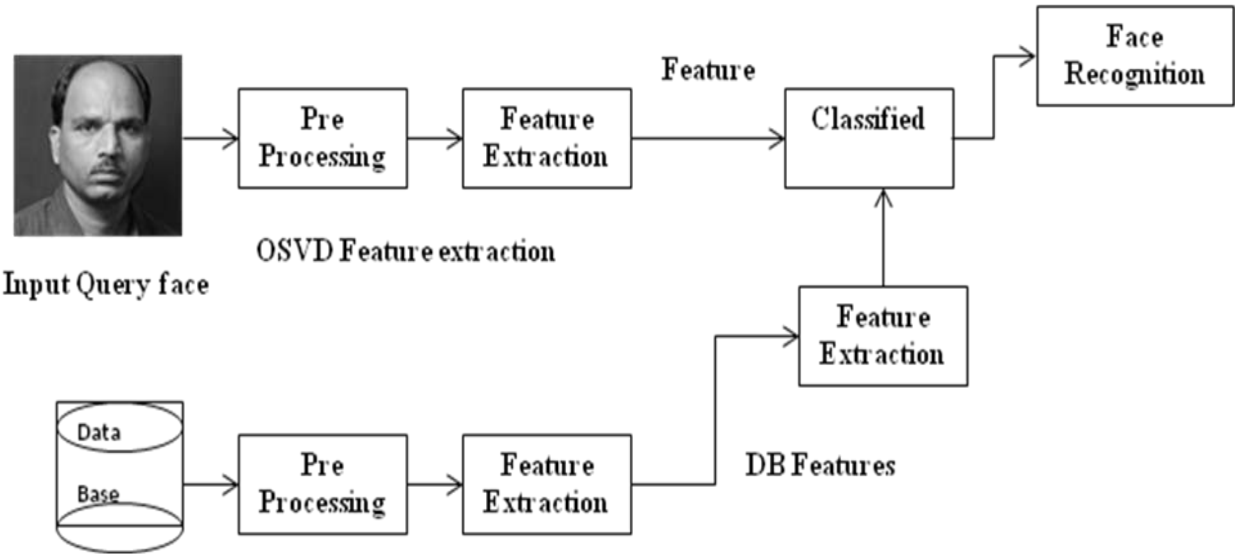

Fig 2: Block diagram implemented for face Recognition

data base used for training and evaluated for the recognition accuracy.

Fig.1: sample Input images considered

V PRE-PROCESSING

In this phase of operation the face image passed is transformed to operational compatible format, where the face image is resized to uniform dimension, the data type of the image sample is transformed to double precision and passed for feature extraction.

A. FEATURE EXTRACTION

This unit runs the OUFSVD algorithm for the computation of face features for recognition. The unit calculates the U, V, S matrix using SVD operation for given face image. On computation to SVD features for the calculation of OUSVD features this unit takes the fractional factor **α** for the computation of **B=U $S^{\alpha}V^{T}$.** The obtained facial expressions are the SV used as facial feature for face recognition. These features are passed to the classifier unit for the classification of given face query with the knowledge created for the available database.

B. DATA BASE

For the implementation of face recognition a self built face database is used. Face database contains 53 gray level face images of 7 persons. Images of different facial expression or configurations: center-light, wearing glasses, happy, left-light, wearing no glasses, normal, right-light, sad, sleepy, surprised and wink. In this implementation all images are sized to a size of 128x128.

C. TRAINING

For the implementation of the proposed face recognition architecture the database samples are trained for the knowledge creation for classification. During training phase when a new facial image is added to the system the features are calculated and aligned for the dataset formation. These data sets consist of the image index and its corresponding features extracted. This feature table is created for the entire database image and passed for recognition.

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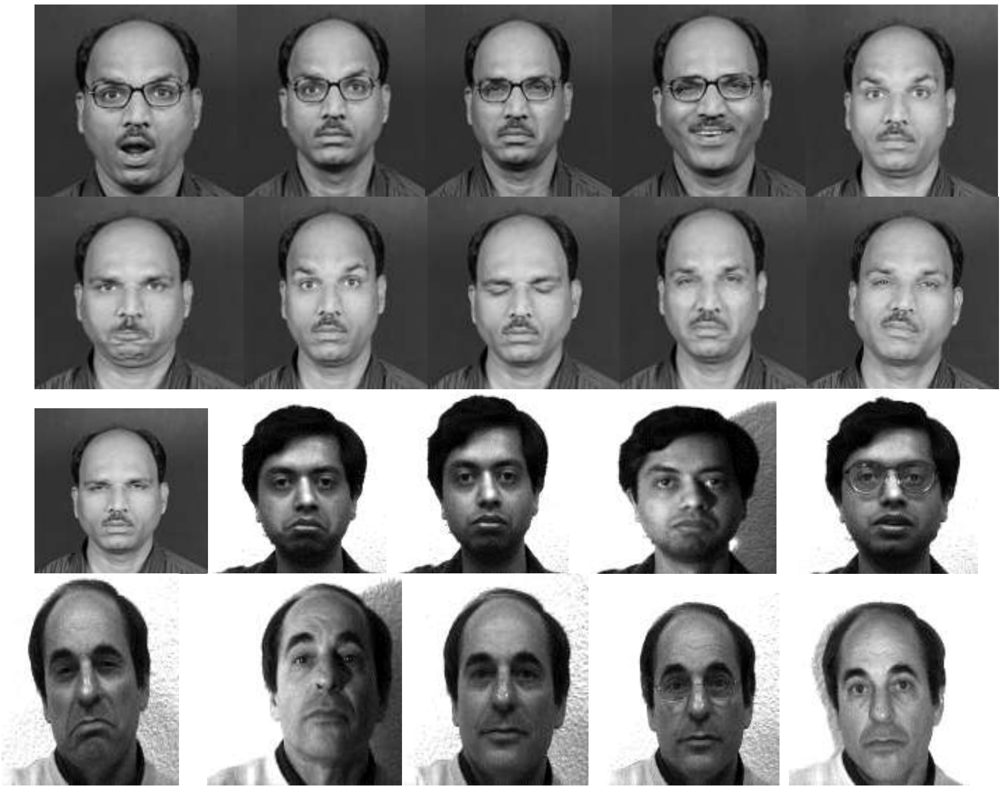

Figure 3: shows typical database images considered for face recognition.

D. CLASSIFICATION

To demonstrate the capability and the accuracy of the recognition stage, a selected database of 24 faces of 6 classes is considered. The faces presented are the inputs into the training stage where a representative set of facial features were determined. After training, new images are processed and entered into the recognition stage for identification. Comparing the weights of the test face with the known weights of the database performs identification. Mathematically, a score is found by calculating the norm of the differences between the test and known set of weights, such that a minimum difference between any pair would symbolize the closest match. For the realization of classification unit the Euclidian distance based recognition system is developed. The system reads the query features and compares with the knowledge available for face recognition.

Fig 4: the training images considered for face recognition.

VI RESULT ANALYSIS

The developed system is evaluated for various effects of illumination, expression and wearing glass effects. For the robustness of the developed system the Database is trained and evaluated for various classes of face information with the variation effects of fractional parameter α. The effect of recognition on the value of α and number of training sample per class is evaluated.

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CASE 1:

Image with No variation

Original query image

Fig. 5: Original image considered for the testing with no variation

OUSVD based outputs with α = 1

Recognized image

Fig 6: obtained OUSVD results for the given query image

OUSVD based result with α = 0.5

Fig 7: OUSVD based recognition for the same input image at α = 0.5

CASE 2:
Image having facial variation

Fig 8: An original query image taken for the testing

OUSVD based output with α = 0.5

Fig 9: obtained result after the OUSVD approach for the same query sample with α = 0.5

OUSVD based output with α = 0.7

Fig 10: obtained result after the OUSVD approach for the same query sample with α = 0.7

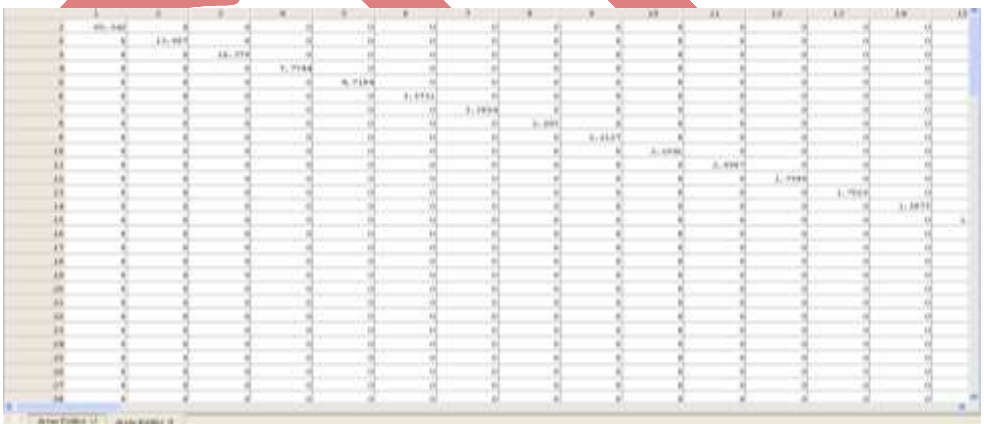

Fig 11: Generated Singular matrix at the variation of different α values

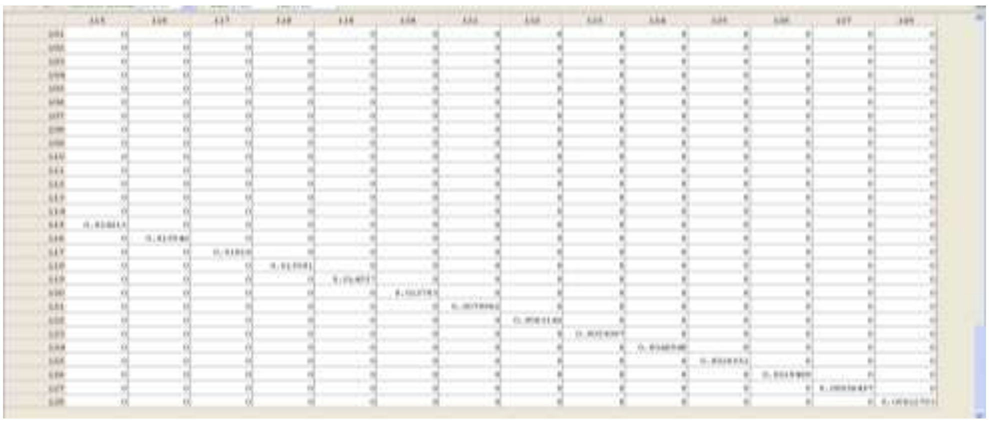

Fig 12: Generated Singular matrix at the variation of different α values

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VII CONCLUSION

Face Recognition plays an important role in biometrics based personal identification. A biometrics Recognition system is designed to verify or recognize the identity of a living person on the basis of his/her natural characters, such as face, fingerprint, iris etc. Compared with other biometric verification techniques, face recognition are more dominantly been used because of its higher exposer to the facial features? Though these techniques were used for various applications a differentiation in facial expression or illumination effects in the facial data may result in poorer identification. In this paper work a method for face recognition is suggested based on optimized and uniform singular value decomposition method. The method is observed to give better result compared to the existing SVD based face recognition. It is observed that the fractional factor applied onto the SVD features result in high accuracy in estimation under lower value assumption and deviates when increased. The facial variation effect is observed to be minimized in case of OUSVD approach as compared to SVD based face recognition. The developed face recognition system is simulated on Yale database with images having high facial expression variation, illumination variation, and images with glasses for face recognition. The OUSVD based approach is evaluated on variable fractional factor on SVD feature for different input samples for its robustness to face recognition. From all the observation made it could be concluded that OUSVD based face recognition can result in higher accuracy in estimation as compared to the previous techniques for face recognition.

VIII FUTURE SCOPE

The suggestive approach developed in this is carried out on facial images captured from a image capturing device and passed as a static image information, the work could also be incorporated for recognizing images in video sequences localized images. As most researches are happening towards the recognition of facial images in both static information and continuous information, this method could be very suitable in such a scenarios as in continuous observation there are lot of external effects in lighting and expressions are observed. This work is also developed without considering system level distortion such as noise effects, the work could be extended with incorporation of suitable image filtering technique for the recognition of face image in real-time application.

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