Redundancy in Face Image Recognition

Dr. Raghavendra Kulkarni[1], Dr.S.G.Hiremath[2]

[1]Department of ECE, K.M.C.E &T, JNTUH, Hyderabad, Telengana state, India
[2]Department of ECE, EWIT, Bangalore, Karnataka state, India

Abstract— *Many researchers paid attention to formulate different algorithms to faces and its classes for accurate classification but, did not paid attention to the fact that redundancy may exists even though faces with different classes are effectively classified. Researchers working on SVD and its extended algorithm versions which were based on face matrix decomposition for face recognition concluded that they are the best algorithms for classification of occluded faces. The problem with these designed algorithms is that there is every likely hood of having more than one value of amplification factor along with classified faces. It is pointed out by researchers that every face will be having one and only one amplification factor and its classified face. This factor will definitely add to the already existing facial recognition problems and challenges. Here is a paper which shows the redundancy in recognition which will be treated as an added problem and challenge for facial recognition.*

Keywords—Face image matrix, SVD, Matrix Decomposition, Singular Value.

I. INTRODUCTION

Face is an interesting domain subject which engulfs in it the whole mystery of recognition and it put together thousands of researchers for its evaluation methods and its classification. Face is a non constant object in nature and subjected to change with respect to its color, features and shape etc. The world saw decades of research but still it is posing a challenge and is a case of deep study.

A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. Facial recognition research is a subfield in a larger field of pattern recognition research and technology. Statistical techniques use Pattern recognition technology to detect and extract patterns from data in order to match it with database patterns. The data upon which the recognition system works (such as a photo of a face) is set of discernable pixel-level patterns for the system. Nevertheless, it is very important for these systems to be able to identify or detect a face in a field of vision so that it is only the image pattern of the face (and not the background "noise") that is processed and analyzed.

Face recognition in human is brain biology and the mechanism advances with memory and cognitive functioning. During perception of faces major activations occur in extra striate areas bilaterally. The occipital face area, the fusiform face area, the superior temporal sulus and the interior/inferior cortex plays an important role in facial perception. Initial face perception starts in the fusiform area and occipital area. Differentiation of faces starts when this entire area becomes a network. The processing of faces in the brain is known as "sum of parts" perception, but these individual parts must be processed first to pull them all together.The occipital face area contributes to face perception by recognizing the eyes, nose and mouth, thus occipital area recognizes single face features whereas the fusiform face area is responsible for holistic configural information meaning that it puts all individual processed features together for future processing. Depending upon this natural activity two models are defined, one is feature based model and another is configural model. The feature based model gives imperfect generalization across view changes whereas the configural model.

Large set of images, bad illumination and poses are some of the challenges faced by the emerging field of face recognition system. The simplest and more efficient face recognition approach is the Eigenface approach. The preprocessing step involves various symmetrization techniques which handle bad illumination and face alignment problems, after which Eigenface approach is used for face recognition. Eigenvectors of covariance matrix, represents eigenface for a given image space. A new face image can be represented as a linear combination of eigenface. The face recognition task becomes easy as it becomes easier to match any two given images. The report gives a basic knowledge of Eigen values, Eigenvectors various steps involved in face recognition and its significance with results.

Artificial Intelligence made rapid progress along with its allied fields over the last three decades such as Computer

Vision, Machine Learning, Speech Processing, Natural Language Processing and Neural Networks which helped to build autonomous intelligent systems. These observations made it possible to build a security system based on face authentication.

There was and is extensive work carried out and is still on by keeping pose variation, Illumination conditions, Partial or full occlusions, Image orientation and Facial expressions in mind. The observations drawn by researchers that the faces are the one which are recognized under all sorts of facial variations are illustrated to be having unique SVD values and value of amplification factor. It is pointed out by researchers till now that every face will be having one and only one amplification factor and its respective classified face

This paper counter this aspect and adds another problem in face recognition area by illustrating that there is every likely hood of having more than one value of amplification factor along with classified faces.

II. CHALLENGES IN FACE RECOGNITION

Face detection is one of the most complex and intriguing problems but it is exiting. Face detection systems has now became the heart of many intelligent vision-based human computer interaction systems. Based on face authentication state of art video surveillance systems and security systems are now implemented at various places particularly at airports throughout the world.

Faces are non-rigid objects and have a high degree of variability with respect to size, shape, color and texture which create a challenge for face detection system. More precisely the challenges associated with face detection are due to:

a) Pose**:** The images of a face vary due to the relative camera-face pose and the facial features such as an eye or the nose may be partially or wholly occluded.

b) Presence or absence of structural components: Glasses, beards, and mustaches may or may not be present and there is a great deal of variability among these components including shape, color, and size.

c) Facial expression: The appearances of faces are directly affected by a person's facial expression.

d) Occlusion: Faces may be partially occluded by other objects. In an image with a group of people, some faces may partially occlude one another.

e) Image orientation**:** Face images vary directly for different rotations about the camera's optical axis.

f) Imaging conditions**:** Factors such as lighting (spectra, source distribution and intensity) and camera characteristics with respect to sensor response, lenses affect the appearance of a face.

The varying conditions and expressions do affect the recognition process which is evident from the fact that many intellectuals are holed up at many places in recent times for want of exact recognition.

III. ALGORITHM REVIEW

This section deals with the algorithm used so far and points out that by using such algorithm one gets more than one recognized face and its respective amplification factor whereas it is needed to have only one recognized image and its only one amplification factor.

Moreover it is not easy to evaluate the effectiveness of a recognition algorithm. Core factors such as hit ratio, Error rate, Computational speed, Memory usage are unavoidable. There could be other system dependent factors such as Illumination, occlusion, expression, pose invariability, scalability, adaptability, automatism, probability which may define algorithm effectiveness. The most used face recognition algorithm testing standards evaluate the pattern recognition related accuracy and the computational cost.

The steps undertook by researchers till now is given below with assumptions.

Let the face image in the data Base be represented as F (i) K, where (i) represent the total number of samples for Kth class face image. Then the SVD feature for the given face image is calculated as

1. Apply SVD on each of the face image for each class in the database, such that $\Psi i = UiSiVi^t$. where, U = $[u_1, u_2, u_m]$, V = $[v_1, v_2, v_n]$, 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 modified SVD values are obtained as, $Bi=Ui\ Si^{\alpha}Vi^t$
3. Each training face image $F_i^{(k)}$ is then projected using the 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 ~ $\epsilon\ R^{m\times n}$ is transformed into a face feature matrix Yr $\epsilon\ R^{r\times c}$ 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 traning face images $X_i^{(j)}$ is

calculated by $R_{ji} = \delta(Y,X_i^{(j)}) = \|Y - X_i^{(j)}\|_F$ a Frobenius norm.

8. Retrieve the top 8 subjects of the database according to the rank of Rji given by arg Rank $_j$ $\{R_{ji} = \delta(Y, Xi^{(j)}), 1 \leq i \leq N_j\}$. The image with the highest Rank is obtained as the recognized image.

This algorithm gives out redundant faces and redundant values of amplification factor which is illustrated in this paper.

IV. RESULTS AND DISCUSSIONS

CASE 1: Query Image and its redundancy with α=0.5, α=0.6.

Fig. 1: Query Image

Redundant Recognized Images

Fig. 2: Redundant Recognized Image with alpha=0.5.

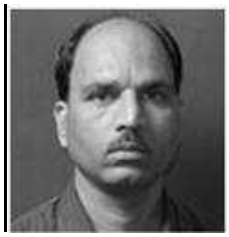

Fig.3: Redundant recognized Image with alpha=0.6

CASE2: Query Image and its redundancy with α=0.5, α=0.8.

Fig. 4: Query Image

Redundant Recognized Images

Fig.5: Redundant Recognized Image with alpha=0.5

Fig.6: Redundant Recognized Image with alpha=0.8

The two illustrative cases show that there indeed exists redundancy in recognition with respect to faces recognized and its amplification values. As a matter fact it should not be the case since it is required that there must be one and only one recognized face with its particular amplification value. This is the added problem which is required to be solved by modifying the designed algorithm.

V. CONCLUSION

It has been found that there are algorithms which when applied to some class of faces which are able to give good classification rates even under variations for such class of faces, but there definitely exists redundancy with every designed algorithm. The work was prompted to call on such redundancy. The work also added that the singular values which are computed by the algorithm are indeed unique but they too can be said to be redundant with each different recognized face. It has been illustrated that the amplification factor is also found to be redundant for each class of recognized faces. Hence this paper and it is indeed prompting the researchers to design a new algorithm so that this sort of redundancy can be eliminated.

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AUTHOR PROFILES

Dr.Raghavendra Kulkarni Working as Professor in ECE department at Khader Memorial College Engineering & Technology, Devarkonda, Nalgonda (Dist), Telengana, India. He received B. Tech. (ECE) from Gulbarga University, M. Tech (DS & CE) from JNTU Hyderabad. Ph.D. from Mewar University. He is having 22 years of experience. His area of research is Signal Processing and Image processing. He has authored and coauthored 32 research papers in National and International Conferences &Journals.

Dr.S.G.Hiremath working as H.O.D at East West Institute of Engineering, Bangalore, Karnataka, India. He received B.E from Bangalore University, M.Tech from Mysore University & Ph.D. from Anna University. He published nearly 18 papers. His area of Research is Signal Processing, Electronic circuit Design and Neural Network Modeling, Mathematical Modeling and Simulation