Biometric Fusion and Recognition

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Abstract: Biometric is the science and technology of measuring and analyzing biological data of human body, extracting a feature set from the acquired data and comparing this set against the template set in the database. In this paper, Recognition through fusion of face and iris biometric images based on wavelet features and Kernel Fisher Discriminant Analysis (KFDA) is developed. Discrete Wavelet Transform (DWT) of face and iris image is used to reduce the dimensions which help to prevent from requirement of storage space of database. Nearest Neighbour classifier is selected to assign class to its nearest neighbour. Then, nonlinear original input space can be converted through a nonlinear map function into a linear high-dimensional feature space with the use of KFDA.

Key Words: *Face Recognition, Iris Recognition, Feature level fusion, Singular Valued Decomposition (SVD), Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) , Normalized Cross-Correlation (NCC) and Normalized Absolute Error (NAC), Kernel Fisher Discriminant Analysis (KFDA), Discrete Wavelet Transform (DWT),NNC(Nearest Neighbor Classifier).*

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I. INTRODUCTION:

The term “Biometric” highlights the use of biological or physical or behavioral traits of a person to identify or verify his/her identity. A biometric is defined as “life measure” and biometric technology uses images of human body parts, captured through cameras and scanning images. Biometrics is the science and technology of measuring and analyzing biological data of human body, extracting a feature set from the acquired data, and comparing this set against the template set in the database. Like other systems, biometric based security systems have vulnerabilities that attackers can exploit to gain unauthorized access. Various kinds of fusion biometrics or behavior features were used in identification, which improved the accuracy and the credibility of the identification system effectively.

Biometric systems based on single source of information are called uni-modal systems. Although some uni-modal systems have got considerable improvement in reliability and accuracy, they often suffer from enrolment problems due to non-universal biometrics traits, susceptibility to insufficient accuracy caused by noisy data. Hence, single biometric may not be able to achieve the desired performance requirement in real world application and standardize the design of the secure biometric systems. We have concentration on multimodal with the use of face and iris features of human body. Face recognition is the most natural and easiest acceptable method about identification, while iris recognition is a biometric feature with a higher accuracy than others. Both of them are very potential identification technologies. Feasibility and advantage of multimodal system over uni-modal system is better performance, user friendly and more secure.

II. PREVIOUS WORK:

1). Fusion and recognition of face and iris feature based on wavelet feature and KFDA (Jun-Ying Gan.(2009))

In this paper author, suggested the research on Face and Iris feature recognition based on 2-DDCT and Kernel Fisher Discriminate Analysis method for feature fusion. This fusion method not only overcomes the "small sample" shortcoming, but also the higher correct identification rate than individual biometric face recognition or iris recognition, it is an effective method of feature fusion and recognition.

[2].Different Image Fusion Techniques- A Critical review (Mr. Deepak Kumar Sahu, (IJMER) VOL.2)-

Author review on some of the image fusion techniques for image fusion like, primitive fusion (Averaging Method, Select Maximum, and Select Minimum), Discrete Wavelet transform based fusion, Principal component analysis (PCA) based fusion etc. Comparison of all the techniques concludes the better approach for its future research. Finally he, review that a image fusion algorithm based on combination of DWT and PCA with morphological processing will improve the image fusion quality and may be the future trend of research regarding image fusion.

[3]A Review: Analysis of SVD based image Fusion Method by Mr.Indeevar Thakur (Department of ECE, Chandigarh engineering collage, Landren) –

In this paper author explain different types of Image fusion techniques based on Singular Value Decomposition (SVD) technique. She also focused on, Image fusion is a technique which is used to generate a single good quality image from one or more images. Image fusion can be applied at many levels viz. pixel level, feature level, signal level and decision level. Image fusion can be applied in many areas like recognition of patterns, to enhance visual features, detection of objects, area surveillance etc.

[4] Low Quality Image Information Enhancement Using SVD Fusion Technique by Gagandeep Kour, Sharad P. Singh (Department of Electrical & Electronics Engineering, Arni University, Kathgarh, Himachal Pradesh)- In this paper author explain that, Images fusion technique based on Singular Value Decomposition (SVD) has been done on the blurred images with different level of blurring. Five different set of images were taken and on these images SVD based fusion implemented on the images. The content of the image were calculated with respect to reference image on the blurred image and fused image. PSNR value for highest blurred image come out to be for blurred and fused image 13.27 dB and 12.61 dB respectively. SNR value for blurred image is -10.85 and fused image -11.51. Image quality is enhanced by SVD fusion technique.

III. METHOD

We select Face and Iris biometrics feature because face and iris is most reliable and accurate human biometric. Performing DWT (Discrete wavelet transformation) for feature extraction as it provides higher compression ratio & also provide good localization than other fusion techniques. Most of the image information is retained in the low-frequency component [LL], it is considered as the approximate amount of the original image. For each low-frequency component, LL can be done by DWT once again, and the dimension will be reduced further. Afterword's taking SVD's of both face and iris images i.e. coefficients U,V,S(encrypted) are combined, encryption ratio will be set according requirement of application and finally formation of fused image is done.

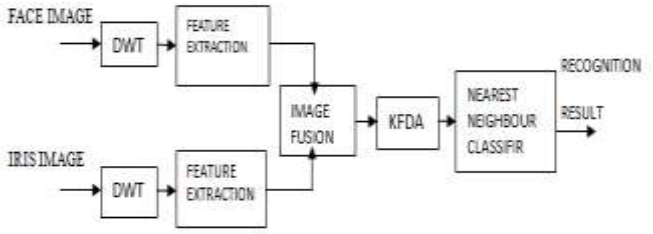

Figure 1: Block Diagram of Face and Iris Fusion Model

The technique used for image fusion is SVD (Singular Valued Decomposition). It is a method to identify and order the dimensions along which data points have the most variations. With SVD, we can find the best approximation of the original data points with minimum dimensions

Nowadays, SVD is becoming very popular technique for image fusion due to many factors like conceptuality, stability and it is also a robust and reliable orthogonal decomposition technique. A huge advantage of SVD is that it can also adjust the variations that are present in the local statistics of an image.

We evaluate the parameter to check the quality of fused image by Image Quality Measurement (IQM). It is vital in the development of image processing algorithms such as enhancement, deblurring, denoising etc. The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) & Normalized Cross-Correlation (NCC) and Normalized Absolute Error (NAE) are parameters used to performance evaluation of system.

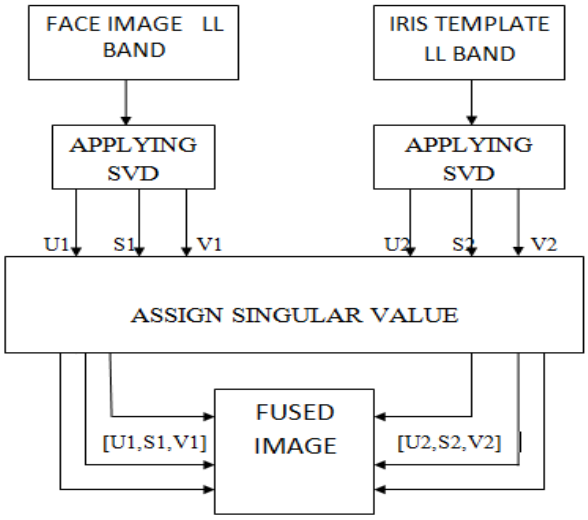

Figure 2: Block Diagram of SVD

Using KFDA (Kernel Fisher Discriminant Analysis) and NNC (nearest neighbour classifier) reconstruction of image is done.

KFDA (Kernel Fisher Discriminant Analysis)-

In statistics, kernel Fisher discriminant analysis (KFD), also known as generalized discriminant analysis and kernel discriminant analysis, is a kernelized version of linear discriminant analysis (LDA). It is named after Ronald Fisher. Using the kernel trick, LDA is implicitly performed in a new feature space, which allows non-linear mappings to be learned.

Principal component analysis (PCA) and Fisher linear discriminant analysis (FLD) are two classical techniques for

linear feature extraction. In recent years, the nonlinear feature extraction methods, such as Kernel principal component analysis (KPCA) and Kernel Fisher discriminant analysis (KFD) have been of wide concern. KPCA was originally developed by Scholkopf, and KFD was subsequently proposed by Mika and Baudat. Mika's work is mainly focused on two-class problems, while Baudat's algorithm is applicable for multi-class problems. KFD turns out to be effective in many real-world applications due to its power of extracting the most discriminatory nonlinear features.

However, KFD always faces the ill-posed difficulty in its application. The reason is that KFD is implemented in the space spanned by all M mapped training samples. This means we are required to estimate an M ×M within-class covariance matrix using M samples; this covariance matrix is always singular (its rank is usually M −c, where c is the number of classes). Regretfully, the present KFD algorithms (Mika, Baudat and Yang) all throw away the discriminant information contained in the null space of the within-class covariance matrix; this discriminant information turns out to be very important for face recognition.
Let,

$$\mathcal{X}_1 = \{x_1^1, \ldots, x_{\ell_1}^1\}$$
$$\mathcal{X}_2 = \{x_1^2, \ldots, x_{\ell_2}^2\}$$

be the samples from two different classes and with some use of notation

$$\mathcal{X} = \mathcal{X}_1 \cup \mathcal{X}_2 = \{x_1, \ldots, x_\ell\}.$$

Then,
Fisher's linear discriminant is given by the vector ***w*** which maximizes

$$J(w) = \frac{w^T S_B w}{w^T S_W w}$$

Where,

$$S_B := (m_1 - m_2)(m_1 - m_2)^T \text{ and}$$
$$S_W := \sum_{i=1,2} \sum_{x \in \mathcal{X}_i} (x - m_i)(x - m_i)^T$$

S_B =between class covariance
$S_{W=}$ total with-in class covariance matrix
Idea of LDA is to find a projection where class separation is maximized.
Given, 2 sets of labelled data C_1, C_2 define class mean m1 and m2 to be –

$$m_i := \frac{1}{\ell_i} \sum_{j=1}^{\ell_i} x_j^i$$

Where, l_i is no of examples of class C_i, intuition behind maximizing ***J(w)*** is to find a direction which maximizes the projected class means (the numerator) while minimizing the classes variance in this direction (the denominator).

NNC (Nearest Neighbor Classifier) –

In image processing, the ***k*-Nearest Neighbor algorithm** (or ***k*-NN** for short) is a non-parametric method used for classification and regression. In both cases, the input consists of the *k* closest training examples in the feature space. The output depends on whether *k*-NN is used for classification or regression:

In k-NN classification, the output is a class membership. An object is classified by a majority vote of its neighbors, with the object being assigned to the class most common among its *k* nearest neighbors (*k* is a positive integer, typically small). If *k* = 1, then the object is simply assigned to the class of that single nearest neighbor.

In k-NN regression, the output is the property value for the object. This value is the average of the values of its *k* nearest neighbors.

IV. RESULTS

As explained earlier, how face and iris images goes through fusion and recognition process. We create a GUI (Graphical User Interface) in MATLAB 7.0 which shows what exactly the changes are happened on image after each step of processing.

Step 1-Open face and iris image from database

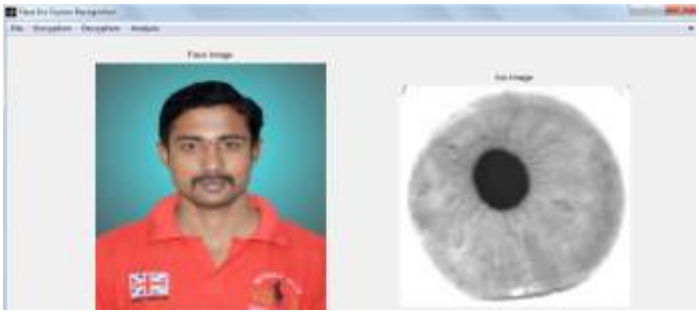

Figure 3 – Source Image - Face and Iris image

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Step 2-Decomposition of face and iris image

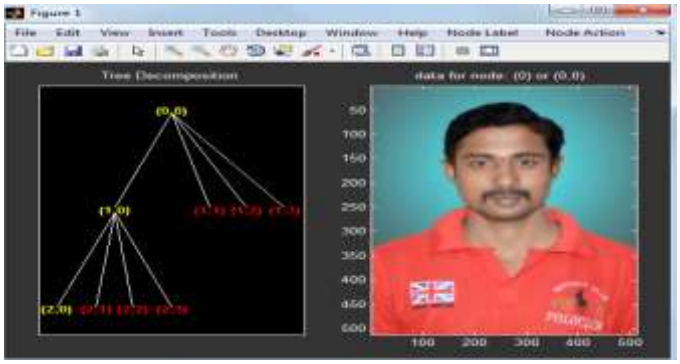

Figure 4 - Face Image after DWT

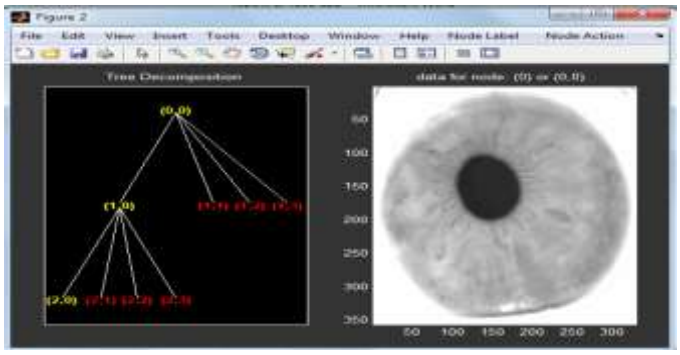

Figure 5- Iris Image after DWT

Step 3-Creating iris template-

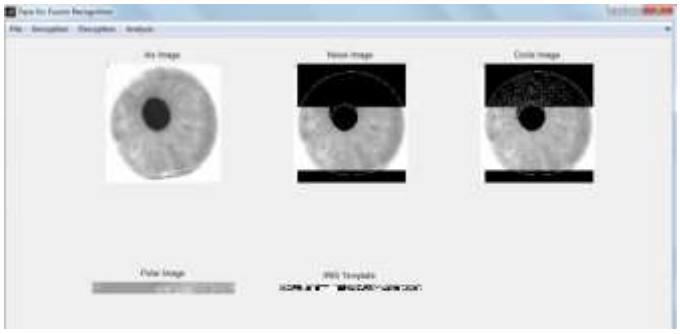

Figure 6- Iris template

Step 4- Image fusion-

Face and iris template are fused using SVD (Singular Value Decomposition)

Figure 7- Image fusion

Step 5- IDWT (Inverse discrete wavelet transformation)-

After image fusion fused image is ready. Now for recognition process we used KFDA (**Kernel Fisher Discriminant Analysis**) and this discriminant analysis is carried out with the use of nearest neighour classifier (NNA) which help to find closest similar image from database and recognize, the person is authenticate or not.

Figure 8 - Extraction of iris template

Figure 9 - Recognition of image

RECOGNITION RATE -

As seen earlier recognition is the ultimate goal of work. We have 40 images in database. If we consider nearest neighbour classifier output and draw the table of distance of image which is going to be recognise from each image of database then, it is clear that, Out of 40 images 38 images

get recognise correctly, which means the recognition rate is as follows-

Recognition rate= no of recognise images correctly/ no of total images*100%

= 38/40*100

= 95%

Recognition rate = 95%

V. CONCLUSION

Multimodal Biometric Systems are expected to be more reliable. Based on the study of multimodal biometric system, the features of face and iris are extracted separately using DWT. The feature extraction of face and iris are very complex and non linear. These images are first decomposed for feature extraction and later the extracted images are fused. The fused image can be further used for watermarking and authentication purposes. Feature fusion algorithm is developed with use of DWT and KFDA for multi-biometric identification for future work.

DWT were applied in image processing area widely. As face and iris are highly complex and nonlinear, KFDA is chosen to extract contours and curves of the image with which the available nonlinear feature is extracted. Experimental results show that by using DWT and KFDA for feature fusion algorithm not only the recognition rate is enhanced but also quality of image is maintained, than individual biometric face recognition or iris recognition. It is easier to implement due to simplicity of algorithm framework. This work improves image fusion quality and may be future trend of research regarding image fusion. The application based on SVD fusion method provides recovery of image content efficiently. Around 95% accuracy of recognition is achieved.

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