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Research paper

The Effect of Image Compression in the Classification of Multimodal Biometrics

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Abstract

A computer-based application is recognition of Biometrics. It determines the authentication for different persons. In this paper the biometrics images are taken for feature extraction and compare it with the registered CASIA Face Image Database, CASIA Fingerprint Image Database, CASIA Fingervein Image Database and CASIA Iris Image Database. In this paper we applied different techniques for biometrics recognition and they were as follows (Principal Component Analysis (PCA) for face recognition - Gray Level Co-Occurrence Matrix (GLCM) Feathers will extraction for fingervein recognition - Minutiae Features will extraction for fingerprint recognition - Gabor filter Features will ex-traction and Hamming Distance for Iris recognition). We then applied the image compression technology using Discrete Cosine Transform (DCT) technology to all databases available for each biometric and then applied the above techniques for biometrics recognition. This was done to determine the effect of image compression on recognition and accuracy rates. The purpose of this paper is to improve the recognition rate of biometrics in the system. The major goal of this study is to make easy implementation and to enhance the efficiency, better recognition rate and high speed by applying Support Vector Machine (SVM).

Keywords: *Biometrics; Authentication; CASIA Database; CA; GLCM; Minutiae; Gabor Filter; Hamming Distance; Support Vector Machine SVM.*

1. Introduction

A recognizing system for Authentication Biometrics is a computer application that detects the face, fingerprint, iris and fingervein for user authentication of different people, for identification of criminal records, for verification of passport, for determining the age of the subject along with the identification of other factors. A graphical user interface identifying individuals based on the biometric property is called as biometrics recognition system. This is how they determine and recognize the target. The study of biometrics recognition has massive theoretical value that involves recognition of subject pattern, a computer vision, a digital image processing (DIP), physiology and machine learning (ML) and so on.

1.1. Previous Approaches to Biometrics Recognition

In [2], a new method was employed known as the feature extraction method- Neighborhood-based binary pattern (NBP). The relation between neighbors of pixel is extracted by it. If it is lower than the central pixel, it will be encoded by 0 and will be encoded by 1 if it is greater than the central pixel. The CASIA iris database is used. The recognition rate with NBP was 76.25%.

In [3], they suggested a new process which was based on the minutiae count for calculating the generated fake fingerprints by employing these methods. The standard FVC (Fingerprint Verification Competition) 2000-2006 dataset was tested by the suggested algorithm and around 85% of accuracy was observed.

In [4], they dealt with the genetic algorithm in face recognition and applied practical application to three databases: UMIST, Indbase and ORL (Olivetti Research Laboratory) took images of the test while changing the changes of light and noise. Rate of face recognition (98.57%) with recognition rate of ORL Database (100%) with database of UMIST and recognition rate (98.33%) with database of Indbase.

In [5] studied the contrast and bilateral limited equalization technique of histogram. According to their study, it was stated that it enhanced the capture of the raw samples of finger veins by suggested acquisition of finger veins. The performance was verified by applying an algorithm- Local Binary Pattern (LBP). The accuracy of recognition was graphically presented (True Acceptance Rate vs. True Rejection Rate). It is observed that TAR vs TRR for own database is 94.34% and for standard data base is 94.5%. It showed the FV's potentiality for personal identification.

1.2. Approach Taken for Biometrics Recognition

In this paper presented a recognizing system for biometrics that can be used in application of computer vision. It contains basic elements apply (Pre-processing – Feature Extraction – recognition and SVM Classifier) and then apply DCT for Compression database images for each biometric. We used it elements for biometrics recognition (such as face, fingerprint, fingervein and iris) as shown in Figure 1.

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2. Biometrics Recognition System

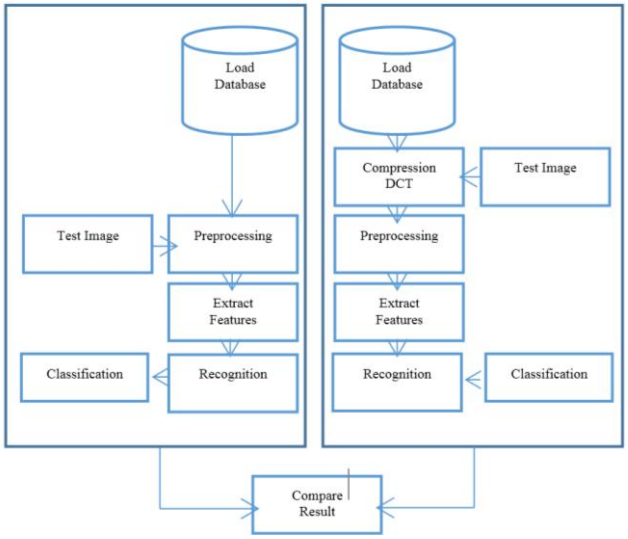
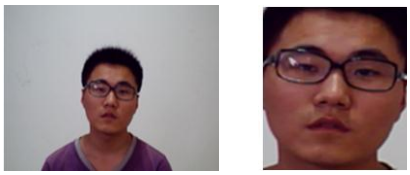


Fig. 1: Overview of proposed system

2.1. Face Recognition

2.1.1. Pre-Processing

Pre-processing stage can be split into three groups achieving the goal of the processing. In this paper, a set of face images is used to generate a Two-D Gray-Scale image to produce collection the face expressions dataset. We will convert RGB image from training database images and test image to gray image. Then, we need to resize the images by using the Crop command in MATLAB. Initially, an automatic approach was used to crop the images. All the images in the database were automatically cropped as shown as in Figure 2. Then, resize all training database images and test image by using the same size 200*180 for all training and test image.



(a) (b)

Fig. 2: (a) Image before cropping (b) Image after cropping

2.1.2. Face based Recognition using Principle Component Analysis (PCA) Algorithm

Extraction of feature in processing image includes reduction of the quantity of resources needed to explain a large data set. At present, Principle Component Analysis (PCA) is employed to extract paper features. It also determines rate of face recognition. CASIA Face Database images were employed to test our system which included 106 face images. Principal Component Analysis (PCA) is a method applied in signal processing and pattern recognition field for feature extraction and reduction of data. The pattern involves massive information, with a plan to decrease dimensionality in a feature space. A 1-dimensional vector of dimensioned N2 is a face image of size N*N. The prime idea of PCA is to figure out the vectors that are responsible for the image allocation of faces in the whole image space.

1) The first step Load M face images from CASIA Face Database
2) Let $X_1, X_2, \ldots, X_M$ be the training of M images for faces. In order to obtain the average (mean) for the training images' face of images, it is calculated by

$$\text{Mean_Image} = \frac{1}{M}\sum_{i=1}^{M} X_i, i = 1,2,\ldots\ldots M \quad (1)$$

3) Find the subtracted between the mean faces from the training face images to find the deviation of each face from the mean face.

$$\text{dev}_i = X_i - \text{Mean_Image} \quad (2)$$

4) After this, we calculated the eigenvalues and eigenvectors for the image using eig() function in MATLAB Program.

[E_VE_D]=eig(covariance_method); (3)

5) Identify the image's Covariance Matrix.

$$\text{cov} = \text{dev} * \text{dev}' \quad (4)$$

6) Then, sorted the eigenvector matrix E_V and eigenvalue matrix E_D's columns sequentially by decreasing eigenvalue.
7) Identify the Image Set containing lower Euclidean distance. The Euclidean distance is calculated by

$$\text{Euclidean_Distance} = \sqrt{\sum (\text{feat_}X_i - \text{feat_test}_i)^2} \quad (5)$$

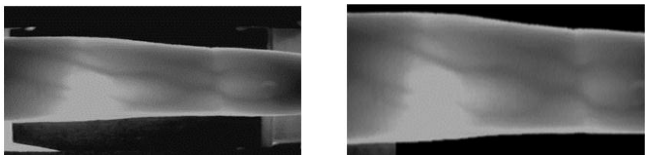
The feat_test is the feature vector of the input test image and the feat_X is the feature for database images, where number of used feature is n. Lowest value is employed to find a match and to get the image having the face closer to the defined image.

8) The eventual face image is the representation of the image containing the lowest Euclidean_distance value in face images.

2.2. Fingervein Recognition

2.2.1. Pre-Processing

In the pre-processing, noise from raw samples (added during acquisition process) is removed and the edges are preserved. The image is cut and desired part is selected as shown as Figure 3 by Region of Interest (ROI) for fingervein [5].



(a) (b)

Fig. 3: (a) Input Finger Vein (b) ROI for Fingervein

2.2.2. Extract Feature of Gray Level Co-Occurrence Matrix (GLCM)

In the present paper, feature extraction is done by applying a method called- the Gray Level Co – Occurrence Matrix (GLCM) method which is a method of feature extraction of texture from finger vein dataset. The finger vein texture measurements were performed on a gray scale version of the finger vein images [7]. These features were computed from the co-occurrence matrixes for each finger vein image. This includes:

- Contrast: A measure of the contrast of intensity between its neighbour over the entire image is called the contrast. Contrast is calculated by

$$\text{Contrast} = \sum_{i,j} |i-j|^2 p(i,j) \quad (6)$$

where p (i, j) = the co-occurrence matrix elements, i.e. the possibility of grey level i pixel movement to a grey level j pixel

- Homogeneity: It is a measure of degree of variation.

$$\text{Homogeneity} = \sum_{i,j} \frac{p(i,j)}{1+|i-j|} \quad (7)$$

- Energy: the energy is used to measure uniformity. A measurement of image homogeneity is the parameter here. Pixel-pair repetitions are reflected here. Energy is calculated by

$$\text{Energy} = \sum_{i,j} p(i,j)^2 \quad (8)$$

- Correlation: This represents the correlation between the pixel values and its neighbourhood. Correlation is calculated by

$$\text{Correlation} = \sum_{i,j} \frac{(i,\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j} \quad (9)$$

- Entropy: It is usually used to measure the randomness [8]. Entropy is defined as follows.

$$\text{Entropy} = \sum_{i,j} p(i,j) \log p(i,j) \quad (10)$$

2.3. Fingerprint Recognition

2.3.1. Pre-Processing

Binarization is considered as the first step. The binarization of fingerprint is an algorithm which generates a 1-bit type image, with 0 as ridges that are black tinted and 1 as valleys which are white tinted [9] as shown as Figure 4.



Fig. 4: Binarization for Fingerprint

Thinning is considered as the last step of the enhancement of fingerprint image prior to extraction of feature as shown in Figure 5, and it is applied to identify the bifurcations and the endpoints in each specific pixel. The pixels are subjected to the pixel numbers belong to the original fingerprints [9].



Fig. 5: Thinning for Fingerprint

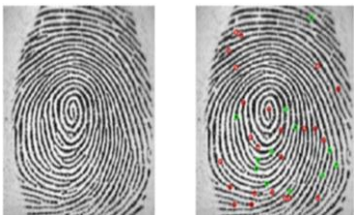
2.3.2. Fingerprint based Recognition using Minutiae Algorithm

Minutiae are bifurcation ridge points or termination points on the fingerprint as shown in Figure 6. Finger print matching is done by applying minutiae mapping. The unique signature is obtained from the finger print distribution. Minutiae location of finger print will be reconstructed from direction. Experimental results showed the correspondence between minutiae distribution and fingerprint classes.

Minutiae Algorithm:

Input: Grey scale Fingerprint image.
Output: Verified fingerprint image with matching score.

1) Binarization of fingerprint.
2) Binarized image reduction.
3) Extraction of minutiae.
4) Generation of matrix to obtain the position, direction and type of minutiae.
5) Fingerprint test matching with template.
6) Calculation of matching score of two images, the images are matched if matching score is 1. They are mismatched if it is 0 [10].



(a) (b)

Fig. 6: (a) Original Image (b) Extracting Minutiae Points

2.4. Recognition of Iris

Several subsystems make up a system, which corresponds to each stage of recognition of iris. Pre- Segmentation - Normalization and Enhancement are the three pre-processing stages. Gabor filter was used for feature sets. Finally, matching was done by hamming distance to take a decision of rejection or acceptance.

2.4.1. Pre-Processing

- Iris Segmentation: The actual iris region from a captured eye image is isolated by iris segmentation. Canny method is known to identifying local maxima of the iris image's gradient and its edges. Gaussian filter's derivative is used to calculate the gradient. Weak and strong edges are detected by applying two thresholds. This method is more capable to identify true weak edges and is considered to be more robust to noise. The orientation image and the edge strength image are the two outputs of the detector. Increase of the intensity value of the images is required to by adjusting the gamma correction factor. The local maxima are suppressed with the adjusted gamma image and the orientation image as the input.
- Iris Normalization: Transformation of the segmented iris region into fixed dimension is known as iris normalization. But, inconsistencies of dimensions arise between eye images due to iris stretching. It is caused by dilation of pupil from different stages of illumination. The result of iris matching will be affected by iris elastic deformation. Therefore, normalization is completed in order to compensate for deformation of iris which is caused by variations of illumination. Daugman's rubber sheet model [11] and this method is used for the normalization process and thus remaps the annular image of iris I(x, y) from raw Cartesian coordinates (x, y) to a dimensionless pseudo-polar coordinate system I(r, θ). Rubber sheet model presents the size inconsistencies and dilation of pupil to produce a normalized representation which has a constant dimension.
- Iris Enhancement: Application of histogram equalization enhances the image contrast by improving the normalized pattern. This method increases the worldwide image contrast, when the usable image data is showcased by close contrast values. The intensities can be greatly distributed on the histogram through this adjustment. This permits lower local contrast areas to gain a higher contrast without affecting the global contrast. Histogram equalization completes this effectively by spreading out the most frequent intensity values. The pattern of iris before and after enhancement is shown in Figure 7.

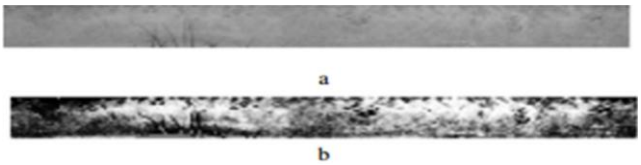


Fig. 7: (a) Normalized image (b) Enhanced image after histogram equalization

2.4.2. Iris based Recognition using Gabor Filter

Feature Encoding: Encoding of feature refers to the extraction of underlying information in a pattern of iris and produces the template of binary iris applied in matching. In regard to the normalized pattern of iris with 1D Log-Gabor filter, forms the set of feature of iris. The Gaussian filter is on a logarithmic scale and is applied to generate zero components of DC for any bandwidth. It is given by:

$$G(f) = exp\left(\frac{-\log(flf_o)^2}{2\log(\sigma lf_o)}\right)$$

Here, f0 represents the frequency of the centre, and provides the filter bandwidth. With the application of 1D Log-Gabor filter, the normalized pattern of 2D is divided into a number of 1D signal, and 1D Gabor wavelets are convolved with these. The rows of the pattern are taken as the 1D signal; each row corresponds to a round ring on the region of iris. The angular direction corresponds to columns of the normalized pattern, since angular direction is responsible for the maximum independence. The construction of filter is done by evaluating the component of radial filter such as-centre filter frequency and normalized radius from the centre of plane frequency. The complicated features are encoded into templates of binary iris and are phase quantized [11].

2.4.3. Matching of Iris

The origin source of two iris templates from the same individual is checked and determined through a process called matching. Distance of hamming is used for bit-wise image comparisons. Noise in the image of iris is masked. Significant bits formed from the true region of iris are utilized in the calculation of Hamming distance between two templates of iris [12].

$$HD = \frac{||(code\ A \otimes\ code\ B) \cap (mask\ A\ \cap\ mask\ b)||}{||(mask\ A\ \cap\ mask\ b)||}$$

Here, HD = Hamming distance, A and B = Two normalized iris images, Code A and code B = Bit-codes of A and B, Mask A and mask B = Mask noise of A and B.
The hamming distance between the templates, is reduced in comparison to the use of the code of full iris [13].

2.5. Compression Image Using Discrete Cosine Transform (DCT)

Nowadays, as information technology progresses, data transfer is of great importance through the network, Internet and mobile environment, through the volume of data transferred which will be stored on the volumes whether it will occupy a large amount of storage media and whether it will take a lot of time for conversion. Therefore, we have applied DCT technology to compress the image databases used in this paper to reach the best results.
This section presents image compression steps as shown as Figure 8:

- Division of blocks 8×8.
- The pixel values within each block range from [-128 to 127] but pixel values of a black and white image range from [0:255], so each block is shifted from [0:255] to [-128 to 127].
- The DCT from left to right, top to bottom thereby if it is applied to each block.
- Compression of each block through quantization.
- Entropy encoding of quantized matrix.
- Reconstruction of compressed image through reverse process. Inverse Discrete Cosine Transform (IDCT) is employed in this process [14].

The equation gives the two-dimensional DCT transformation:

$$f(x,y) = \frac{2}{N}\sum_{u=0}^{N-1}\sum_{v=0}^{N-1} C(u)C(v)F(u,v)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

For x = 0,….N-1 and y = 0. … N-1
where N = 8 and C(K) $\begin{cases} 1/\sqrt{2} & \text{for } k=0 \\ 1 & otherwise \end{cases}$
The equation gives the inverse two-dimensional DCT transformation:

$$F(u,v) = \frac{2}{N}C(u)C(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

For u = 0,….N-1 and v = 0. … N-1
where N = 8 and C(K) $\begin{cases} 1/\sqrt{2} & \text{for } k=0 \\ 1 & otherwise \end{cases}$

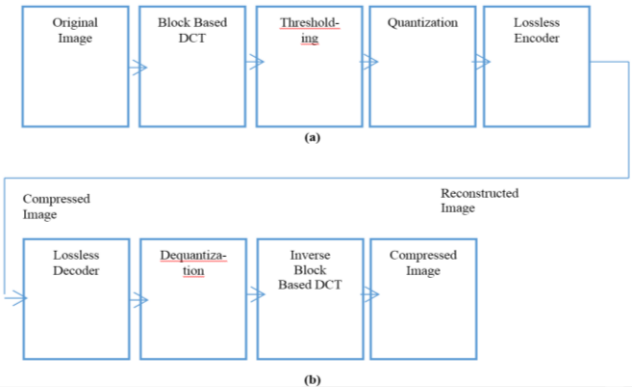


Fig. 8: Compression algorithm scheme (a) Compression step and (b) Decompression step

2.6. SVM Classifier

In the present paper, broadly Support Vector Machine (SVM) Classifier is a popular method of Classification. A linear classifier is attempted to construct Support Vector Machine. It combines between two classes at maximum, also called Optimal Margin Classifier. It was specifically designed for binary classification and here, a multi-class classification was applied. SVM is a widely used powerful tool and is used in many areas but it can solely manage binary classification. Massive effort has been provided to figure out its effective extension of SVM for multi-class classification. Various methods have been proposed [15]. The simplest idea is the division of an n-class problem into a series of binary classifications. “One-against-all" classifications or C_n^2 “one-against-one" problems are either of the two ways that can be considered. Comparison in [15] has shown one-against-one is more suitable. So, in this study, this method was used. 4 groups that training classifier for 4 biometrics is classified as (Face, Finger vein, Fingerprint, and Iris) to determine the biometric.

3. Results and Discussion

The proposed algorithms and classification are used to investigate the efficient of the proposed system. The system was designed under a platform MATLAB 2014 and CASIA Face Image Database, CASIA Fingerprint Image Database, CASIA Fingervein Image Database and CASIA Iris Image Database. In this paper, an approach has been provided to crop a face only from the whole image and resize it by applying the same size is 200×180 for all

test and training image to determine the images. In all the conducted experiments for CASIA database, Using Discrete Cosine Transform DCT for compression image, Principal Component Analysis (PCA) and Euclidean Distances approach for face recognition and Gray Level Co-Occurrence Matrix (GLCM) Features will extraction for fingervein recognition, Minutiae for fingerprint recognition, Gabor filter and Hamming Distance for Iris recognition. SVM classifier has the best result. When SVM Classifier was applied, the best recognition rate recorded is 100% and the Accuracy rate recorded is 96.2264% when DCT was not used before starting the proposed system and got the best accuracy rate 98.5849% when using DCT for compression database as shown as Table 1 in comparison to Table 2. Our method was achieved better results than previous research. In our system, the DCT for compression images is increase the efficiency and implementation easier, high speeds.

Table 1: Accuracy for multimodal biometrics

	Proposed First	Accuracy	Proposed Second	Accuracy
Face	PCA	96.2264%	DCT + PCA	98.1132%
Fingerprint	Minutiae	96.2264%	DCT + Minutiae	100%
Fingervein	GLCM	96.2264%	DCT + GLCM	98.1132%
Iris	Gabor Filter + Hamming Distance	96.2264%	DCT + Gabor Filter + Hamming Distance	98.1132%
Average Accuracy		96.2264%	Average Accuracy	98.5849%

Table 2: Comparison with existing methods

References	Method	Accuracy (%)
[2]	Iris Recognition using Neighborhood-based binary pattern (NBP)	76.25%
[3]	Fingerprint Recognition using Minutiae count	85%.
[4]	Face Recognition using Genetic Algorithm	98.57%
[5]	Fingervein Recognition using Local Binary Pattern	94.34%.
Our Method	Proposed first	Avg. 96.2264%
Our Method	Proposed Second	Avg. 98.5849%

4. Conclusion

This paper included biometrics recognition technique that uses Principal Component Analysis (PCA) and Euclidean Distances approach for face recognition and GLCM. For fingervein recognition, Minutiae for fingerprint recognition, Gabor filter and Hamming Distance for Iris recognition. The system will recognize the human biometrics for both male and female from CASIA Face Image Database, CASIA Fingerprint Image Database, CASIA Fingervein Image Database and CASIA Iris Image Database. We will get excellent classification for all the biometrics using Support Vector Machine (SVM).

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