



Multimodal Biometrics using Score Level Fusion

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ABSTRACT

Unimodal biometric system has attracted various researchers and achieved great success. Unimodal system alone may not be able to meet the increasing requirement of high accuracy in today's biometric system. Unimodal biometric systems suffer from many challenges such as noisy data and spoof attacks. Multimodal biometric systems can solve these limitations effectively by using two or more individual modalities. In this method fusion of iris, fingerprint and face traits are used at score level in order to improve the accuracy and security of the system. The main purpose is to look over whether the combination of fingerprint, iris and face biometric can achieve performance that may not be possible using a single biometric technology. Gabor filter and local binary pattern is used for fingerprint, iris and face images. Scores which obtained from the classifiers are normalized first using min-max normalization. This system can be offers the high performance and to overcome the limitation of single modal biometrics. This proposed system is producing more reliable results than the existing system.

Keywords:-Score level fusion, multimodal biometric, fingerprint recognition, iris recognition, face recognition.

1. INTRODUCTION

Biometrics is the science and technology of measuring and analyzing biological data. In information technology, biometrics refers to technologies that measure and analyze human body characteristics, such as DNA, fingerprints, eye retinas and irises, voice patterns, facial patterns and hand measurements, for authentication purposes. There are three general categories of user authentication: something you know such as passwords and Personal Identification Numbers(PINs),something you have such as token and something you are such as biometrics. The dominant approach on current control access is a password or PIN ,but its weaknesses are the most clearly documented :if it is easy to remember ,it is usually easy to guess and hack

into ,but if it is difficult to attack ,it is usually difficult to remember; hence, a lot of people write them down and never change them. The problem with to kensis that they authenticate their presence, but not the carrier; they can be easily forgotten, lost, or stolen, and ,as it happens with the credit cards, can be fraudulently duplicated. As a result, biometry appears as a good solution, which is generally used ,in addition to the previous authentication methods, to increase security levels. Another very well-known and important area of application is the one used by the police to identify suspects. Here, fingerprints and DNA are the most-commonly used ones. False Accept Rate or False Match Rate (FAR or FMR): The probability that the system incorrectly matches the input pattern to a non-matching template in the database. It measures the percent of invalid inputs which are incorrectly accepted. In case of similarity scale, if the person is imposter in real, but the matching score is higher than the threshold, then he is treated as genuine that increase the FAR and hence performance also depends upon the selection of threshold value. False Reject Rate or False Non-Match Rate (FRR or FNMR): The probability that the system fails to detect a match between the input pattern and a matching template in the database. It measures the percent of valid inputs which are incorrectly rejected. Receiver Operating Characteristic or Relative Operating characteristic (ROC): The ROC plot is a visual characterization of the trade-off between the FAR and the FRR. In general, the matching algorithm performs a decision based on a threshold which determines how close to a template the input needs to be for it to be considered a match. If the threshold is reduced, there will be fewer false non-matches but more false accepts. Correspondingly, a higher threshold will reduce the FAR but increase the FRR. A common variation is the Detection Error Trade-off (DET), which is obtained using normal deviate scales on both axes. This more linear graph illuminates the differences for

higher performances (rarer errors). Equal Error Rate or Crossover Error Rate (EER or CER): The rate at which both accept and reject errors are equal. The value of the EER can be easily obtained from the ROC curve. The EER is a quick way to compare the accuracy of devices with different ROC curves. In general, the device with the lowest EER is most accurate. Failure To Enroll Rate (FTE or FER): The rate at which attempts to create a template from an input is unsuccessful. This is most commonly caused by low quality inputs. Failure To Capture Rate (FTC): Within automatic systems, the probability that the system fails to detect a biometric input when presented correctly. Template Capacity: The maximum number of sets of data which can be stored in the system.

2. PROPOSED WORK

Biometric systems contains number of modal like iris, fingerprint, face, palmprint and signature recognition systems are used to individually or integrate for authentication purpose. These authentications are offering the improvement of performance of the systems. In biometrics, both single and multiple modals contain different algorithms. These algorithms are used to recognize the person and also evaluate the performance of each algorithm. At first to capture the images of the modals by number of sensors based on the physiological or behavioral traits. These sample images like iris, fingerprint and face are added to the database and used to compare with the query database. Different algorithms are applied to extract and recognize the images of the given modals. Finally verdict are prepared by score level fusion at support vector machine is used to identify whether the person is authorized or not. This algorithm is giving the quality matching value of experimental image and original, and matching the value query and template database individually. Finally fusing three modal for security purpose and to check the person authorized or not. Multimodal biometric systems are used to eliminating the limitation of single modals. Number of single modal like iris, palmprint, fingerprint, face, signature, eye etc. integrated and to form multimodal biometric system. In here three modals like iris, fingerprint and face are integrated for the designing of multimodal biometric system. In this algorithm, compare the quality of the query and template images. Verdicts are prepared by results of score level fusion at support vector machine. This algorithm is used to ensure the security and recognize the genuine user. In iris, fingerprint

and face by multi channel feature extraction using Gabor filters. These three models corresponding poor result (marked with ellipse) by interpolation is individually check the quality and matching of experimental image and original by score level fusion at support vector machine algorithm.

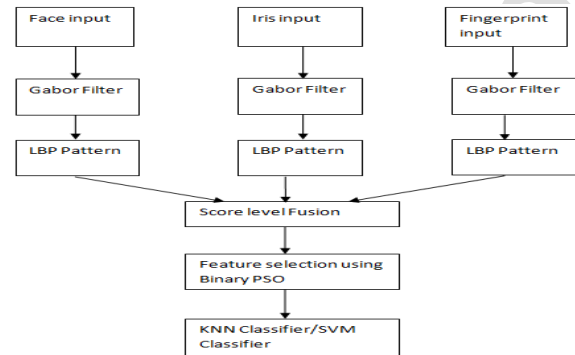


Figure1: Proposed multimodal stages

3. Fingerprint Pattern

The analysis of fingerprints format ching purposes generally requires the comparison of several feature so print pattern. These include patterns, which area characteristics of ridges and minutia points, which are unique features found within the patterns. It is also necessary to know the structure and properties of human skin in order to successfully employ some of the imaging technologies. The three basic patterns of finger print ridges are the arch, loop, and whorl. Anarchis a pattern where sent erfromoneside of the finger ,rise in the center forming an arcand the nexi the other side of the finger. The loop is a pattern where the ridges enter from one side of afinger, form a curve and tend to exit from the same side they enter. In the whorl pattern ,ridges form circularly around a central point on the finger. Scientists have found that family members of ten share the samegeneral finger print patterns, leading to the belief that these patterns are inherited



Figure 2: Arch, Loop and Whorl

3.1 Fingerprint Recognition System

Fingerprint recognition is the process of comparing with known fingerprint against another fingerprint to determine if the impressions are from the same finger or palm. It includes two sub-domains: one is fingerprint verification and the other is

fingerprint identification. In addition, different from the manual approach for fingerprint recognition by experts, the fingerprint recognition here is referred as Automatic Fingerprint Recognition System (AFRS), which is program based.

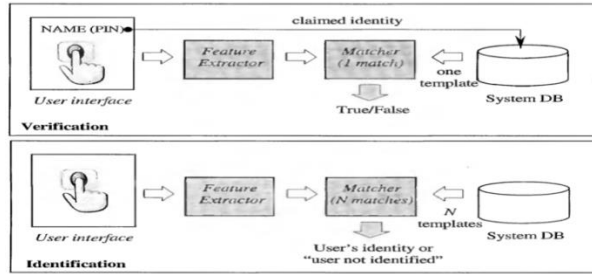


Figure 3: Verification Versus Identification

3.2 Fingerprint Acquisition

Image capture devices include special categories of fingerprint capture devices, such as: optical, solid-state and ultrasonic. Optical fingerprint capture devices have the longest use history of these categories.

3.3 Feature Extraction

In this work minutia based algorithm are used, in this method, the resulting feature vector is containing for each minutia point the following parameters: 1) x-coordinate, 2) y-coordinate, and 3) orientation. Feature extraction part can be summarized as follow:

3.3.1 Preprocessing

Histogram equalization and Fast Fourier transform (FFT) are used for image enhancement. Histogram equalization is employed to expand the pixel value distribution of an image so as to increase the perceptual information. FFT is used to connect false broken points of ridges and increase the contrast between ridges and furrows. Binarization is then performed using locally adaptive thresholding to transform the 8-bit grayscale fingerprint image into a binary image where 0s specify ridges and 1s furrows. Image segmentation is attained through a three step approach: block direction estimation, segmentation by direction intensity and morphological open and close operations to extract regions of interest (ROI).

3.3.2 Minutia Extraction

Before minutia extraction, Ridge thinning is achieved first to remove the redundant pixels of ridges till the ridges wide is just one pixel. Now fingerprint image is ready to extract minutia. The simple algorithm for

minutia extraction is: if a pixel with 1 value has one neighbor with 1 value in its 8 neighbors, it is conclude and if it has three neighbors with 1 value it is bifurcation.



Figure 4: The left form is bifurcation and the right is termination

3.3.3 Post-processing

This stage is to remove false minutia to reduce the complexity of computation and enhance the accuracy of the system. The false minutia are defined as seven types, most of them can be removed by proposing a threshold D, if the distance between minutiae less than D, these minutiae will be removed.

3.4 Fingerprint Matching

An alignment-based match algorithm includes two consecutive stages: first is alignment phase and the second is match phase. In alignment phase each set of minutia is transformed to a new coordination system with the orientation points to coincident with the direction of the referenced points. For each fingerprint, translate and rotate all other minutia with respect to the references minutia according to the following formula:

$$\begin{pmatrix} x_i - new \\ y_i - new \\ \theta - new \\ i \end{pmatrix} = TM * \begin{pmatrix} x_i - x \\ y_i - y \\ \theta - \theta \\ i \end{pmatrix}$$

Where (x_i, y_i, θ_i) is the parameters of the reference minutia and

$$TM = \begin{pmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 1 & 1 & 0 \end{pmatrix}$$

the last phase is the matching process, where we use elastic match algorithm to count the matched minutia

pairs of two fingerprint images. In this system bounding box around each template minutia is assumed. If the minutia to be matched is within the rectangle box and the direction discrepancy between them is very small, then the two minutias are regarded as a matched minutia pair.

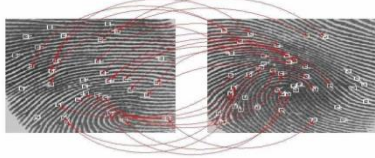


Figure5: Matching process between minutiae pairs

4. Iris Recognition

Iris recognition systems, in particular, are gaining interest because the iris's rich texture offers a strong biometric clue for recognizing individuals. Located just behind the cornea and in front of the lens, the iris uses the dilator and sphincter muscles that govern pupil size to control the amount of light that enters the eye. Near Infra Red (NIR) images of the iris anterior surface exhibit complex patterns that computer systems can use to recognize individuals. NIR lighting can penetrate the iris surface, it can reveal the intricate texture details that are present even in dark-colored irises. The iris's textural complexity and its variation across eyes have led scientists to postulate that the iris is unique across individuals. The iris is the only internal organ readily visible from the outside. Fingerprints or palm prints, environmental effects cannot easily alter its pattern. An iris recognition system uses pattern matching to compare two iris images and generate a match score that reflects their degree of similarity or dissimilarity.

4.1 Iris Segmentation

The first stage of iris recognition is to isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary. The eyelids and eyelashes normally occlude the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artifacts as well as locating the circular iris region.

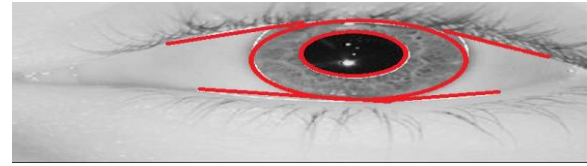


Figure6: Iris segmentation

4.2 Image Normalization

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket. The iris region is modelled as a flexible rubber sheet anchored at the iris boundary with the pupilcentre as the reference point. The pupil is smaller in the bottom image, however the normalization process is able to rescale the iris region so that it has constant dimension.

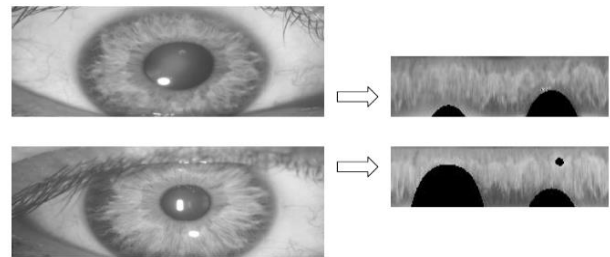


Figure 7: Illustration of the Normalization Process for Two Images

4.3 Iris Enhancement

Applying histogram equalization (HE) improves the distinction of the image by enhancing the normalized pattern. Equalization implies mapping one distribution (the given histogram) to another distribution. HE enhances the global contrast of image, when the pixel values of the image are represented by Convergent contrast values. In this process, the intensity values can be better distributed on the histogram by redistributing the most frequent intensity values. This action pushes the areas of lower local contrast to gain a higher contrast without affecting the global contrast

4.4 Feature Encoding

In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Only the

significant features of the iris must be encoded so that comparisons between templates can be made. Most iris recognition systems make use of a band pass decomposition of the iris image to create a biometric template. The template that is generated in the feature encoding process will also need a corresponding matching metric, which gives a measure of similarity between two iris templates. Each isolated iris pattern is then demodulated to extract its phase information using quadrature 2D Gabor wavelets. This encoding process amounts to a patch wise phase quantization of the iris pattern, by identifying in which quadrant of the complex plane each resultant phasor lies when a given area of the iris is projected onto complex valued 2D Gabor wavelets. The phase bit settings which code the sequence of projection quadrants. The extraction of phase has the further advantage that phase angles are assigned regardless of how poor the image contrast.

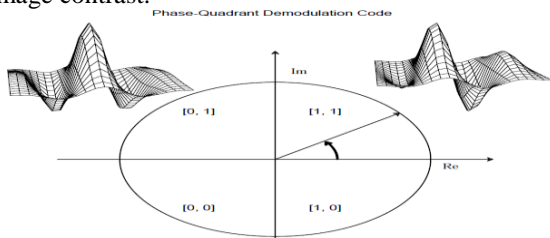


Figure 8: Phase Demodulation Process

The phase demodulation process used to encode iris patterns. Local regions of an iris are projected onto quadrature 2D Gabor wavelets, generating complex-valued projection coefficients whose real and imaginary parts specify the coordinates of a phasor in the complex plane. The angle of each phasor is quantized to one of the four quadrants, setting two bits of phase information.

4.5 Iris Matching

Matching is a process to establish whether two iris templates are from the same individual or not. Hamming distance is applied for bit-wise comparisons of images. Noise in the iris image is masked and only significant bits produced from the true iris region are used in the Hamming distance calculation between two iris templates [22], [23].

$$HD = \frac{\| (codeA \otimes codeB) \wedge (maskA \wedge maskB) \|}{\| maskA \wedge maskB \|}$$

where HD is the Hamming distance, A and B are two normalized iris images, $code A$ and $code B$ are the

bit-codes of A and B , $mask A$ and $mask B$ are respectively the masks of noise of A and B which produced by eyelashes or eyelids. The hamming distance between the templates, which have deployed the best bits is reduced comparing with the use of full iris code. If two irises are identical then HD will give 0 results.

5. Face Recognition

The face is our primary focus of attention in social life playing an important role in conveying identity and emotions. It can recognize a number of faces learned throughout our life span and identify faces at a glance even after years of separation. This skill is quite robust despite of large variations in visual stimulus due to changing condition, aging and distractions such as beard, glasses or changes in hairstyle. Computational models of face recognition are interesting because they can contribute not only to theoretical knowledge but also to practical applications. Computers that detect and recognize faces could be applied to a wide variety of tasks including criminal identification, security system, image and film processing, identity verification, tagging purposes and human computer interaction. Unfortunately, developing a computational model of face detection and recognition is quite difficult because faces are a complex, multi-dimensional and meaningful visual stimuli. Face detection is used in many places nowadays especially the website hosting images like picassa, photo bucket and facebook. The automatically tagging feature adds a new dimension to sharing pictures among the people who are in the picture and also gives the idea to other people about who the person is in the image. In this project, we have studied and implemented a simple and very effective face detection algorithm which takes human skin colour into account. Main aim is to develop a method of face recognition that is fast, robust, reasonably simple and accurate with a relatively simple and easy to understand algorithms and techniques.

5.1 Face Recognition System with LBP

The face recognition algorithms used here are Principal Component Analysis (PCA), Multilinear Principal Component Analysis (MPCA) and Linear Discriminant Analysis (LDA). Every algorithm has its own advantage. While PCA is the most simple and fast algorithm, MPCA and LDA which have been applied together as a single algorithm named MPCALDA provide better results under complex circumstances like face position, luminance variation etc. The original LBP operator was introduced by

Ojala et al. It is a powerful means of texture description. The face area is first divided into small regions from which Local Binary Pattern (LBP) histograms are extracted and concatenated into a single vector.



Figure9: Facial image divided into 5x5 regions

$$LBP = \sum_{p=0}^{P-1} s(f(x,y) - f(x_p, y_p)) 2^p$$

In each region the operator labels the pixels of an image by threshold the 3x3-neighbourhood of each pixel with the center value and allowing the result as a binary number or a decimal number. Then the histogram of the labels can be used as a texture descriptor. Later the operator was extended to use neighborhoods of different sizes. Using circular neighborhoods and bilinearly interpolating the pixel values allow any radius and number of pixels in the neighborhood. For neighborhoods the notation (P, R) are used which means P sampling points on a circle of radius of R. See Figure (10) as an example of the circular (8, 2) neighborhood.

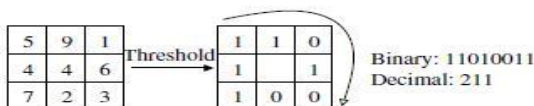


Figure10: Basic LBP operator

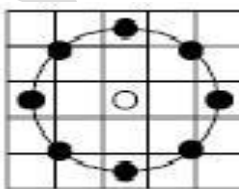


Figure11: Circular (8, 2) neighborhood

Another modification to the original operator uses so called uniform patterns [30], [31]. A Local Binary

Pattern is called uniform if it contains at most two bitwise transitions from 0 to 1 or vice versa when the binary chain is considered circular. For example, 11100000, 00011110 and 11000001 are uniform patterns. Ojala et al. noticed that in their experimental results with texture images, uniform patterns account for a bit less than 90 % of all patterns when using the (8, 1) neighborhood and for around 70 % in the (16, 2) neighborhood. Shengcai Liao et al. planned an improved method over the basic LBP in which multi-scale block LBP are used. Multiscale LBP is an extension to the basic LBP, with respect to neighborhoods of different sizes. In MB-LBP, the comparison operator between individual pixels in LBP is simply replaced with comparison between average gray-values of sub-regions. Each sub-region is a square block containing neighboring pixels (or just one pixel particularly). The whole filter is composed of 9 blocks. We take the size s of the filter as a parameter, and s x s denoting the scale of the MB-LBP operator (particularly, 3x3 MB-LBP is in fact the original LBP). Note that the scalar values of averages over blocks can be calculated very efficiently from the summed-area table or integral image. For this reason, MB-LBP feature extraction can be very fast, and it only incurs a little more cost than the original 3x3 LBP operator. Other different version of LBP which outperform the original LBP are proposed by researches like completed LBP (CLBP), dominant LBP (DLBP) and LBP Histogram Fourier (LBP-HF). For matching two facial images there are several possible dissimilarity measures have been proposed for histograms. Histogram intersection:

$$D(S, M) = \sum_i \min(S_i, M_i)$$

Log-likelihood statistic:

$$L(S, M) = - \sum_i S_i \log M_i$$

Chi square statistic:

$$\chi^2(S, M) = \sum_i \frac{(S_i - M_i)^2}{S_i + M_i}$$

Where S and M represent the matched face images, in our work chi square static measure have been used.

6. Unimodal Biometric System

Biometric characters need the individuality and stability to recognize an individual distinctively and dependably, they present some proof about the user

To extract the features of sample images of the face and to check both face is matched or not. Figure 15 shows the simulation window of face.

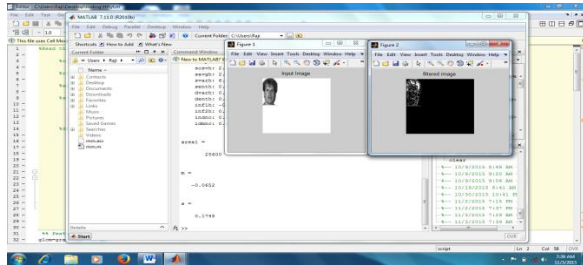


Figure 15: Simulation Window of Face

9. Conclusion

Fusion of fingerprint, iris and face systems at score level was proposed. This platform is necessary if we have treat huge databases that contain hundreds millions of users. In this method fusion of iris, fingerprint and face traits are used at score level in order to improve the accuracy and security of the system. The main purpose is to look over whether the combination of fingerprint, iris and face biometric can achieve performance that may not be possible using a single biometric system. Scores which obtained from the classifiers are normalized first using min-max normalization. Weighted sum rule outperformed both sum and product rules and presents significantly better results. This proposed system is producing more reliable results than the existing system.

In the future we may use other process to identify fingerprint, iris and face recognition. These methods will take less computational time and give more accuracy.

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