ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Image Quality Assessment for Fake Biometric Detection

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Abstract:
Most real-life biometric systems are still unimodal. Unimodal biometric systems perform person recognition based on a single source of biometric information. Such systems are often affected by some problems such as noisy sensor data, nonuniversality and spoof attacks. Multibiometrics overcomes these problems. Multibiometric systems represent the fusion of two or more unimodal biometric systems.

Such systems are expected to be more reliable due to the presence of multiple independent pieces of evidence. In this paper, we present a multibiometric recognition system using three types of biometrics Face ,Iris and Fingerprint. The fusion is applied at the matching-score level. The experimental results showed that the designed system achieves an excellent recognition rate.

Keywords: ***Biometric Fusion, Iris, Face ,Multi-biometrics, Finger print.***

I. Introduction:

A biometric system is essentially a pattern recognition system that performs recognition based on some features derived from measurements of physiological or behavioural characteristics that an individual has.

Biometric characteristics, including fingerprint, facial features, iris, voice, signature, and Finger print, finger-knuckle, gait etc. are now widely used in security applications. These unimodal biometric systems are faced with a variety of problems, noise in sensed data, non universality, inter-class similarities, and spoof attacks. Multibiometrics are a relatively new approach to overcome those problems. Besides enhancing matching accuracy, the multibiometric systems have many advantages over traditional unibiometric systems [1]. They address the issue of non-universality. It becomes increasingly difficult (if not impossible) for an impostor to spoof multiple biometric traits of an individual. A multibiometric system may also be viewed as a fault tolerant system.

Multibiometric systems depend on representing each client by multiple sources of biometric information [1]. Based on the nature of these sources, a multibiometric system can be classified into one of six categories, Multi-sensor systems; Multi-algorithm systems, Multi-instance systems, Multi-sample systems, Multi-modal systems, Hybrid systems. Multimodal biometric system has the potential to be widely adopted in a very broad range of civilian applications: banking security such as ATM security, check cashing and credit card transactions, information system security like access to databases via login privileges. A decision made by a multimodal biometric system is either a “genuine individual" type of decision or an “imposter" type of decision.

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Modules of multimodal biometrics

Multimodal biometric system has four modules - sensor module, feature extraction module, matching module and decision making module respectively.

- Sensor module: - At sensor module biometric modalities are captured and these modalities are given as inputs for feature extraction module.
- Feature extraction module: - At feature extraction module features are extracted from different modalities after pre-processing. These features yields a compact representation of these traits or modalities and these extracted features are then further given to the matching module for comparison.
- Matching module: - In matching module extracted features are compared against the template(s) which is (are) stored in database.
- Decision making module: - In this module user is either accepted or rejected based on the matching in the matching module.

The advantages of using multimodal biometric [2] are

- Addresses the issue of non-universality encountered by uni-biometric systems.
- Spoofing multiple biometric traits of a legitimately enrolled individual is difficult.
- Addresses the problem of noisy data effectively.
- Possess fault tolerant as the system can operate even when certain biometric sources are not reliable.
- Facilitates filtering or indexing of large-scale biometric databases.
- Enables continuous monitoring or tracking of an individual in situations when a single trait is not sufficient.

The biometric system has the following two modes of operation:

Enrolment mode: In this mode the system acquires the biometric of the users and stores the required data in the database. These templates are tagged with the user's identity to facilitate authentication.

Authentication mode: This mode also acquires the biometric of the person and uses it to verify the claimed identity.

For recognition, features form the basic unit for processing and thus feature extraction plays a major role in the success of the recognition system. When the quality of the input image deteriorates the performance of the recognition algorithms also get affected, which is not desirable in real time applications. To make the system performance invariant to input image quality, techniques for determining the quality of images are incorporated in the system.

Quality of each of the biometrics images (Iris and Finger print) are determined and based on these metrics a decision level fusion strategy is proposed.

II. Proposed Work:

This research work is aimed at developing a framework for multi-modal biometric verification system using multiple sensors, database, multiple matching algorithms and decision processes. The main contribution of the paper is the design of decision level fusion using dynamic weighted average fusion for combined Face , Finger print and iris biometrics to authenticate and identify a person. The influence of environmental conditions and the quality of the input data have been considered for assigning dynamic weights in decision level fusion.

The whole system has been implemented using fusion frame work and found to give better accuracy rates. The application demands very fast execution of the image processing algorithms.

IRIS Feature extraction

- IRIS Recognition.
- IRIS Enhancement.
- IRIS Decomposition by wavelet transforms

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Face Feature extraction

- Face Recognition.
- Face Enhancement.
- Face Decomposition by wavelet transforms

FINGER PRINT Feature extraction.

- FINGER PRINT detection.
- FINGERPRINT Enhancement.
- FINGERPRINT Decomposition by wavelet transforms

Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on video images of the iris of an individual's eyes, whose complex random patterns are unique and can be seen from some distance.—Iris recognition is a method of biometric authentication that uses pattern recognition techniques based on high-resolution images of the irides of an individual's eyes. Iris Image Enhancement and Denoising: The iris image is enhanced by means of local histogram equalization and removes high-frequency noise by filtering the image with a median filter.

(a)Iris Image Decomposition Process:

In wavelet decomposing of an image, the decomposition is done row by row and then column by column. For instance, here is the procedure for an N x M image. You filter each row and then down-sample to obtain two N x (M/2) images. Then filter each column and subsample the filter output to obtain four (N/2) x (M/2) images of the four sub images obtained as seen in Figure 12, the one obtained by low-pass filtering the rows and columns is referred to as the LL image.

The one obtained by low-pass filtering the rows and high-pass filtering the columns is referred to as the LH images. The one obtained by high-pass filtering the rows and low-pass filtering the columns is called the HL image. The sub image obtained by high-pass filtering the rows and columns is referred to as the HH image. Each of the sub images obtained in this fashion can then be filtered and sub sampled to obtain four more sub images. This process can be continued until the desired sub band structure is obtained.

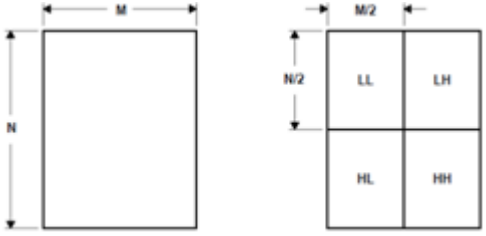

Fig 1: Wavelet Decomposition

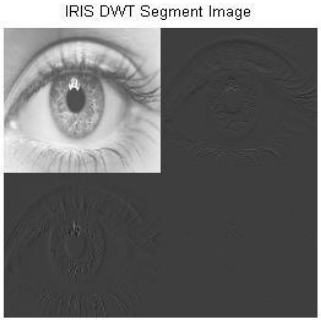

Fig 2: Wavelet Decomposition for Iris Image

(b)FACE IMAGE DWT PROCESS:

It is process to extract face regions from input image which has normalized intensity and uniform in size. The appearance features are extracted from detected face part which describes changes of face such as furrows and wrinkles (skin texture). In this system model, an executable (.dll- dynamic link library) file is utilized to extract face region. It is used for face detection process is based on haar like features and adaptive boosting method.

Fig3:-Face Detection from Input Image

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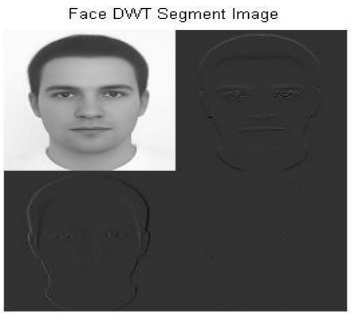

Fig4:-DWT process for Face Input Image

(c)FINGER PRINT DWT Process:

Finger print identification had been introduced a decade ago. It is defined as the measurement of Finger print features to recognize the identity of a person. Finger print is universal because everyone has Finger print. It is easy to capture using digital cameras. Finger print does not change much across time. Finger print has advantages compared to other biometric systems. Iris scanning biometric system can provides a high accuracy biometric system but the cost of iris scanning devices is high. Finger print biometric system can captures hand images using a conventional digital camera.

Finger print biometric system is user-friendly because users can grant the access frequently by only presenting their hand in front of the camera. In face recognition system, users are required to remove their accessories such as spectacles or ear pendant during acquisition. Finger print biometric system can achieve higher accuracy than hand geometry biometric system, because the geometry or shape of the hand for most of the adults is relatively similar.

Finger print contains geometry features, line features, point features, statistical features & texture features. The Finger print geometry features are insufficient to identify individuals. This is because the Finger print geometry features such as palm size, palm width and others for adults are relatively similar. The Finger print line features include principal lines, wrinkles and ridges. Ridges are the fine lines of the Finger print. It requires high-resolution image or inked Finger print image to obtain its features. Wrinkles are the coarse line of the Finger print while the principle lines are major line that is available on most of the palm(headline, lifeline & heart line).The separation of wrinkles & principle line are difficult since some wrinkles might be as thick as principle lines. Finger print point features use the minutiae points or delta points to identify an individual. Point features require high resolution hand image because low-resolution hand image does not have a clear point's location.

Finger print statistical features represent the Finger print image in a statistical form to identify and individual. Some of statistical methods available are Principle Component Analysis (PCA) and Independent Component Analysis (ICA). Finger print texture features are usually extracted using transform-based method such as Fourier Transform and Discrete Cosine Transform. Besides that, Wavelet transform is also used to extract the texture features of the Finger print.

In this work, a sequential modified Haar wavelet is proposed to find the Modified Haar Energy (MHE) feature. The sequential modified Haar wavelet can maps the integer- valued signals onto integer-valued signals without abandoning the property of perfect reconstruction shows the proposed Finger print identification using sequential "S-transform" modified Haar transform. In this work, ten images from the right hand of 100 individuals are acquired using a digital camera.

The hand image is segmented and the key points are located. By referring to the key points, the hand image is aligned and the central of the palm is cropped. The Finger print image is enhanced and resized. The energy features of the Finger print are extracted using sequential Haar wavelet. The Haar (HW) is represented using feature vector and compared using Euclidean distance with the feature vectors stored in the database.

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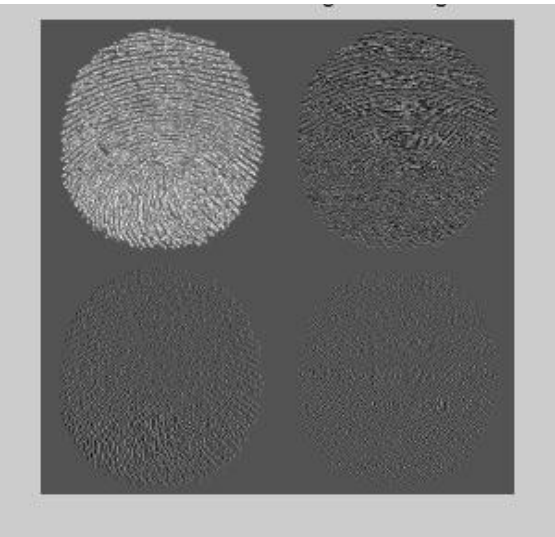

Fig 5: DWT of finger print image

(d)Flow Diagram:

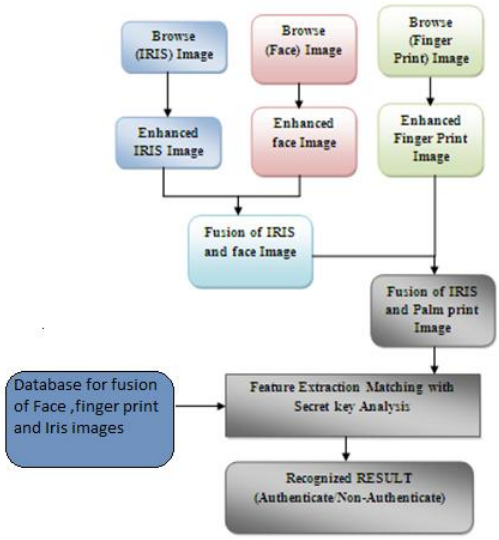

Fig 6: Block Diagram of Proposed system

Fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics.

FUSION:

Image Fusion is the process of combining relevant information from two or more images into a single image. The fused image should have more complete information which is more useful for human or machine perception.

Fusion of low-frequency coefficients

Considering the images' approximate information is constructed by the low-frequency coefficients, average rule is adopted for low-frequency coefficients. Suppose B_F (x, y) is the fused low-frequency coefficients, then

$$B_F(x,y)=\frac{B_1(x,y)+B_2(x,y)}{2}$$

where B_1 (x, y) and 2 B_2 (x, y)denote the low-frequency coefficients of source images.

Fusion of high-frequency coefficients

High-frequency coefficients always contain edge and texture features. In order to make full use of information in the neighbourhood and cousin coefficients in the DWT domain, a salience measure, as a combination of region energy of DWT coefficients and correlation of the cousin coefficients, is proposed for the first time. We define region energy by computing the sum of the coefficients' square in the local window. Suppose C_l^k (x y) is the high-frequency DWT coefficients, whose location is (x,y) in the sub band of k-th direction at l-th decomposition scale. The region energy is defined as follows:

$$E_l^k(x,y)=\sum_{m,n\in S_{M\times N}}\left(C_l^k(x+m,y+n)\right)^2$$

where $S_{M\times N}$ denotes the regional window and its size is M × N (typically 3×3).Region energy, rather than single pixel value, will be more reasonable to extract

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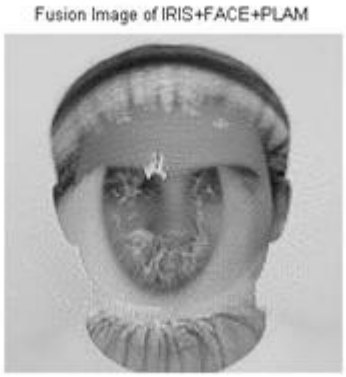
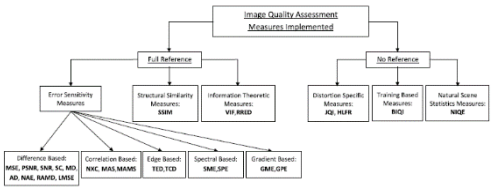
features of source images by utilizing neighbours' information.



Feature extraction:

The problem of fake biometric detection can be seen as a two-class classification problem where an input biometric sample has to be assigned to one of two classes: real or fake. The key point of the process is to find a set of discriminant features which permits to build an appropriate classifier which gives the probability of the image "realism" given the extracted set of features. In the present work we propose a novel parameterization using 25 general image quality measures.

A general diagram of the protection approach proposed in this work is shown in Fig. 8. In order to keep its generality and simplicity, the system needs only one input: the biometric sample to be classified as real or fake (i.e., the same image acquired for biometric recognition purposes). Furthermore, as the method operates on the whole image without searching for any trait-specific properties, it does not require any preprocessing steps (e.g., fingerprint segmentation, iris detection or face extraction) prior to the computation of the IQ features. This characteristic minimizes its computational load. Once the feature vector has been generated the sample is classified as real (generated by a genuine trait) or fake (synthetically produced), using some simple classifiers. In particular, for our experiments we have considered standard implementations in Matlab of the SVM Classifier..



The parameterization proposed in the present work comprises 25 image quality measures both reference and blind (as will be introduced in the next sections). As it would be unfeasible to cover all the immense range of methods, approaches and perspectives proposed in the literature for IQA, the initial feature selection process to determine the set of 25 IQMs has been carried out according to four general criteria, which intend that the final method complies to the highest possible extent with the desirable requirements set for liveness detection systems (described in Section I).

These four selection criteria are:

Performance

Only widely used image quality approaches which have been consistently tested showing good performance for different applications have been considered.

Complementarity

In order to generate a system as general as possible in terms of attacks detected and biometric modalities supported, we have given priority to IQMs based on complementary properties of the image (e.g., sharpness, entropy or structure).

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Complexity

In order to keep the simplicity of the method, low complexity features have been preferred over those which require a high computational load.

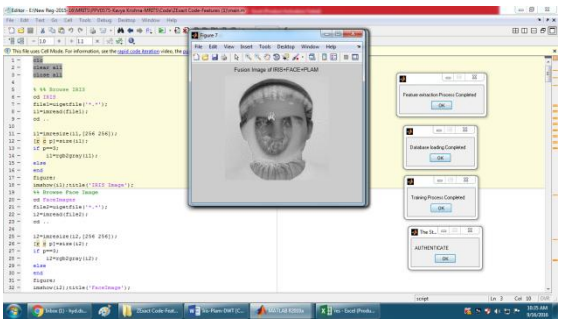
Speed

This is, in general, closely related to the previous criterium (complexity). To assure a user-friendly non-intrusive application, users should not be kept waiting for a response from the recognition system. For this reason, big importance has been given to the feature extraction time, which has a very big impact in the overall speed of the fake detection algorithm.

III. Results:

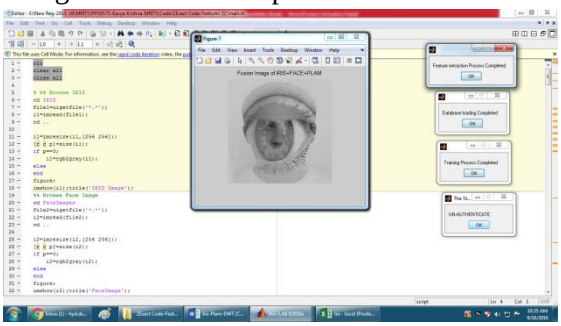
(a)Authentication

The fused image of face ,finger print and iris images is compared with database images to get the result. Here we are using SVM classifier to classify the input image. For authenticated image the following is the result.



(b) Un authentication

If any spoof images is applied for access the SVM classifier shows the un-authentication by comparing the 25 features of input image to database images. The following is the result for spoof access.



IV. Conclusion:

A multi modal biometric technique which combines multiple biometrics in making person identification can be used to overcome the limitation of individual biometrics. We have developed a multimodal biometric system which integrates decisions made by iris,face and Finger print to make person authentication. In order to demonstrate the efficiency of such an integrated system, experiments which simulate the operating environment on a small data set which is acquired in a laboratory environment were performed. The experimental results show that our system performed well. However, the system needs to be tested on a large dataset in a real operating system.

We can add another biometric feature like voice, finger knuckle for identification so that we can achieve better security.

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