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Analysis of Unimodal and Multimodal Biometric System using Iris and Fingerprint

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Abstract: Traditional Biometric Systems that based on a single biometric usually suffer from problems like hacking or imposters' attack, unacceptable error rate & low performance. So, new technology was introduced, a combination of two or more modalities is called Multimodal Biometric System such as Iris & Fingerprint, Speech & Signature, Face & Voice, Face & Fingerprints and Speech, Signature & Handwriting and more. The latest research indicates multimodal person authentication system is more effective and more challenging. The fusion of multiple biometrics helps to minimize the System error rates. In this paper, the performance of unimodal & multimodal biometric system has been compared. In this work, Iris & fingerprint modalities been used and performance analysis is on the basis of FAR, FRR & accuracy.

Keywords: Multimodal; Unimodal; Iris; Fingerprint; Recognition rate

I. INTRODUCTION

Authentication is required when it is necessary to know if a person is who he claims to be. It is a procedure that involves a person making a claim about his identity, and then providing evidence to prove it. This study focuses on the initial authentication procedure that most computer users are accustomed to performing when they log onto a computer system. For a computer system the basic initial protection is considered to be authentication process. It therefore stands to reason that this procedure should be made as accurate and reliable as feasibly possible. Biometrics refers to a technology that demonstrates people by machine controlled means admit anatomical or activity human characteristics. Biometric systems have the potential to try and do the individuals authentication with a high degree of assurance. In global applications, most of the deployed biometric systems for authentication rely on the one supply of data (e.g. Face, fingerprint, voice etc.). These systems' area units are susceptible to sort of issues like shire information, intra-class variations, inter-class similarities, non-universality and spoofing. It results in significantly high false acceptance rate (FAR) and false rejection rate (FRR), restricted discrimination capability, edge in performance and lack of permanency [1]. For identification mistreatment multiple supplies of data will facilitate in overcoming the limitation that come in unimodal biometric system. These systems permit the combination of 2 or a lot of kinds of biometric systems referred to as multimodal biometric systems. These systems area unit have lot of reliable thanks to the presence of multiple, freelance life science. For the increase in accuracy for the process of decision making complimentary information can be provided by the fusion of multiple modalities. For example for detecting events form a team sports video it can be effective by adding some additional textual information with the fusion of audio and visual features, rather than using single medium. Though with use of multimodal fusion it five efficient results but still there is raise in cost and complexity. While using fusion multiple modalities the first basic step is to select what strategy is be followed. The most considered strategy is known as early fusion i.e. fusing the information at the feature level [2]. Other ways is late fusion or decision level fusion that fuses the information at semantic space. Together these two ways are used as hybrid fusion approach.

II. UNIMODAL BIOMETRIC SYSTEM

The unimodal biometric employs single biometric attribute (either physical or behavior trait) to spot the user Physiological life science identifiers embody fingerprints, hand pure mathematics, eye patterns, ear patterns, countenance, etc. [3]. Behavioral identifiers embody voice, signature, typewriting patterns etc. whereas recognizing a person's feature, there are a unit probabilities for the system to choose a real person as associate cheater or associate cheater as a real[4].Example: Biometric system supported Iris or Fingerprint or Voice or Gait etc. Here by taking associate example of Iris recognition & fingerprint recognition system, the performance of unimodal system is compared with multimodal biometric system.

A. Iris Recognition System

Iris recognition is a relatively new branch of biometric recognition. The human iris is the annular part between pupil and sclera. It has distinct feature such as freckles, coronas, stripes, furrows and so on. Iris recognition preferred because of the following reasons:

a) Uniqueness: The chance of 2 persons' irises being constant is less than −35. Although they're twins, their

irises square measure quite totally different [5]. This reality is that the reason why we have a tendency to use iris to acknowledge identity.

b) Reliability: Iris is associate inner organ in our eyes and guarded by lid, lash and tissue layer. Not like finger and palm, it's rarely hurt and therefore the error of recognition caused by scar can ne'er happen. during this sense, iris recognition is way higher than fingerprint and palm-print recognition[6]

Major steps of iris recognition area unit given following:

i) Segmentation: a method is needed to isolate and exclude the artifacts in addition as locating the circular iris region. The inner and therefore the outer boundaries of the iris area unit calculated.

ii) Normalization: Iris of various folks could also be captured in numerous sizes, for constant person additionally size could vary owing to the variation in illumination and alternative factors. This method can generate iris regions having same constant dimensions in order that beneath the various conditions the 2 photograph of same iris can have Characteristic options at constant spatial location.

iii) Feature extraction: For making the comparison between the templates, from the iris necessary feature should be encoded. For creating biometric model several iris recognition system use band pass decomposition of iris pictures. Iris provides copious texture info. A feature vector is created that consists of the ordered sequence of options extracted from the assorted illustration of the iris pictures.

iv) Matching of an Image: To verify via identification (one-to-many template matching) or (one to- one template matching), [8] a template created by imaging the iris is compared to a stored value template in a database. A positive identification is precise only if the Hamming distance is below the decision threshold, e.g. a hamming distance would result in an accurate match.

v) Localization: In the whole iris recognition system, Iris localization is a very important step. Precise result can be obtained only when one segment iris correctly from the original iris image. Iris localization can be defined as a means to detect the location of iris' inner and outer boundaries.

Basic Design of the system

This Iris Recognition System is practically implemented using MATLAB 7.11.0 environment. In this, a database of 70 Iris samples consisting of a Training Set & Test Set is used. Training Set consists of 50 genuine samples from IITD database. Each Person contributes 2 samples. Test Set consists of 70 samples which consist of 50 genuine & 20 forged samples. The result obtained has been measured by calculating FAR as well as FRR. Figure 1 shows the basic design of the Iris Recognition System prepared in MATLAB.

This Iris recognition System is based on canny based method. Here first Training Sample is selected & prepare template of these sample [9]. Here Image sample is segmented & then features can be extracted by using canny based methods. This template is matched with the testing sample. If both samples matched gets a message 'image matched' as shown in Figure 2.

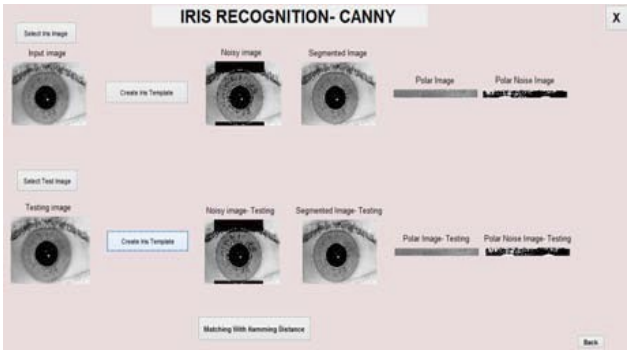

Fig 1. Iris Recognition System

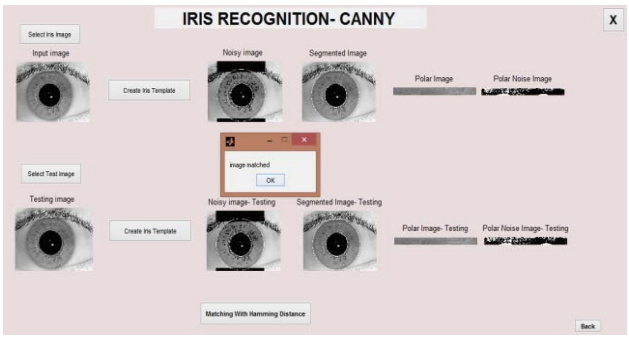

Fig 2. Testing Phase of Iris Recognition System

B. *Fingerprint Recognition*

One of the most publicized and well known biometrics is fingerprint identification. Due to their consistency and uniqueness over the time for identification purpose fingerprints are used over the century, and due to enhancement in computing capabilities it has become more automated [11]. Due to inherent ease in acquisition fingerprint identification have become popular as for collection there are many source (ten fingers) available and their established use and collections by law enforcement and immigration.

a) Fingerprint patterns

The 3 basic patterns of fingerprint ridges area unit the arch, the loop, and also the whorl.

i) Arches: AN arch may be a pattern wherever the ridge enters one aspect of the finger, then rises within the center forming AN arch, and exits on the opposite aspect of the finger. With a loop the ridge enters one aspect of the finger, then forms a curve, and exits on an equivalent aspect of the finger from that it entered. Loops area unit the foremost common pattern in fingerprints. Finally a whorl is that the pattern you

have got once ridges kind circularly around a central purpose.

ii) Minutiae features: Minutiae discuss with specific points in a very fingerprint, these area unit the tiny details in a very fingerprint that area unit most significant for fingerprint recognition. There are unit 3 major varieties of trivia features [14] the ridge ending, the bifurcation, and also the dot (also known as short ridge). The ridge ending is, as indicated by the name, the spot wherever a ridge ends. A bifurcation is that the spot wherever a ridge splits into 2 ridges. Spots area unit those fingerprint ridges that area unit considerably shorter than different ridges.

Basic Design of the System:

This Fingerprint Recognition System is practically implemented using MATLAB 7.11.0 environment. In this, a database of 70 Iris samples consisting of a Training Set & Test Set is used. Training Set consists of 50 genuine samples from IITD database. Each Person contributes 2 samples. Test Set consists of 70 samples which consist of 50 genuine & 20 forged samples. The result obtained has been measured by calculating FAR as well as FRR. Figure 3 shows the basic design of the Fingerprint Recognition System prepared in MATLAB.

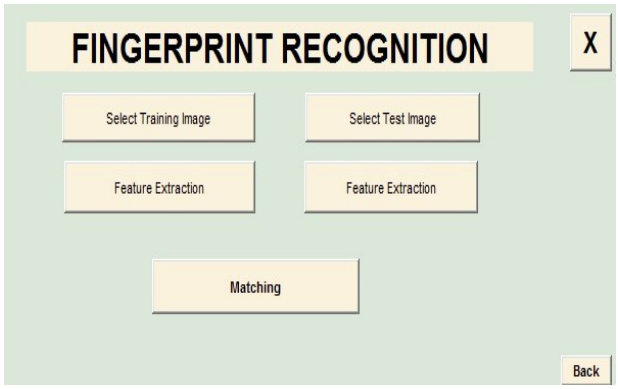

Fig 3. Fingerprint Recognition System

This Fingerprint recognition System is based on core point

Detection method. Here first Training Sample is selected & then features can be extracted by detecting their core points. These features will be matched with the testing sample. If both samples matched gets a message 'sample matched' as shown in Figure 4.

III. MULTIMODAL BIOMETRIC SYSTEM

To determine a person's authentication two or more features of a person to be recognized together are combined in a multimodal biometric system. In order to improve population coverage, deterring spoof attacks, increasing the degrees of freedom, and reducing the failure-to-enrol rate, Multi modal biometric systems can notably improve the recognition performance. the demands of unimodal biometric system can be lower than that of the storage requirements, processing time, and computational demands of a multimodal biometric system.

Advantages exhibited by the multimodal biometric system are more than that of the unimodal biometric system and these are:

- As compared to that of unimodal system, multimodal biometric system obtains more than one type of information and it also provides a substantial improvement in the matching accuracy. By satisfying a wide population of users, Multimodal biometric systems are able to address the non universality issue. User can enter into a system by using another valid biometric trait, if he doesn't have a single valid biometric trait still. Perhaps only a subset of acquired traits is requested for verification and also a certain degree of flexibility can be obtained by enrolling the user by acquiring his multiple traits.
- It is very difficult to hoax the legitimate user enrolled in multimodal biometric system as they are less delicate to imposter attacks. When information acquired from the single biometric trait is falsified by noise, another trait of the same user can be used to perform the verification as Multimodal biometric systems are insensitive to the noise on the sensed data. When a single biometric trait is not enough in continuous monitoring or tracking the person in situation these systems can prove helpful. E.g. tracking a person using face and gait simultaneously.

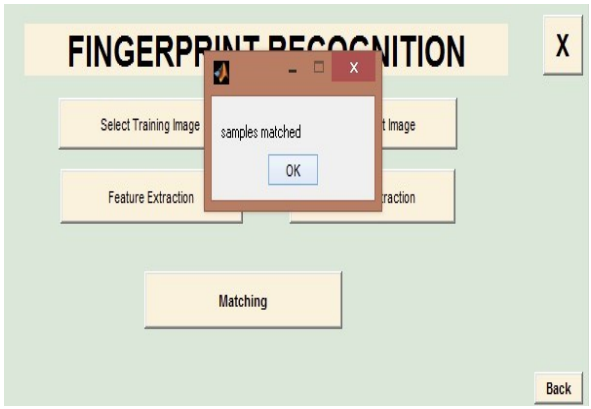

Fig 4. Testing Phase of Fingerprint Recognition System

A. *Need for Multimodal Biometrics*

Many biometric systems established to this point in various applications that believe the proof of single supply of data for authentication (e.g. fingerprint, face, voice etc.) area unit unimodal. These systems area unit unsafe attributable to the incidence of kind of issues like clanging information, intra-class variations, inter-class similarities, non-universality and spoofing because it ends up in high false acceptance rate (FAR) and false rejection rate (FRR), restricted discrimination capability, edge in performance and lack of persistence. For establishing identity few limitations exhibited by unimodal biometric systems maybe overcome by comprising multiple sources

of data [14]. 2 or a lot of styles of biometric systems referred to as multimodal biometric systems area unit allowed to integrate. There responsibleness depends on the presence of multiple, freelance bioscience. information and the potency of the general higher cognitive {process} process may be increased by The fusion of multiple modalities .e.g. potency of police investigation events from a team sports video has solely become attainable by fusion of audio-visual options at the side of alternative matter info Multimodal fusion is useful however with a precise value and problem within the analysis method

B. *Iris & Fingerprint based Multimodal Biometrics System*

Iris & Fingerprint traits are here combined together for the analysis of multimodal biometric system. This paper describes the architecture which uses wavelet & texture based feature extraction method. This Multimodal Biometric System is practically implemented using MATLAB 7.11.0 environment. In this, a database of 70 Iris & Fingerprint samples consisting of a Training Set & Test Set is used. Training Set consists of 50 genuine samples from IITD database. Each Person contributes 2 samples. Test Set consists of 70 samples which consist of 50 genuine & 20 forged samples. The result obtained has been measured by calculating FAR as well as FRR. Figure 5 shows the basic design of the Multimodal Biometric System prepared in MATLAB.

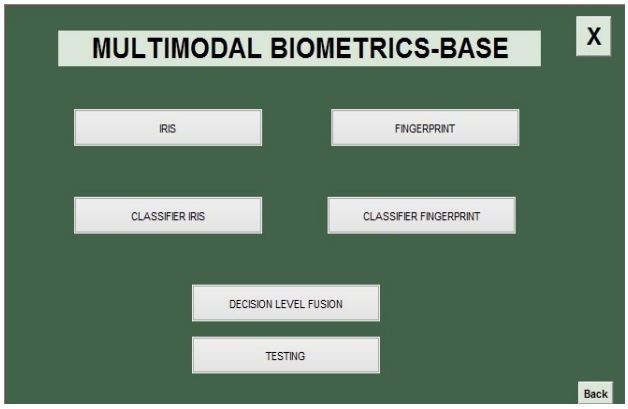

Fig 5. Basic design of the Multimodal Biometric System prepared in MATLAB.

This system uses two biometrics traits that are iris & fingerprints. For both traits, the process flow is as: first capture the biometric trait sample where no. of samples has been collected for both, preprocessing phase where each sample has been normalized and converted into gray scale as required and feature extraction using hybrid wavelets. Here hybrid wavelets [12bp] are generated from Walsh &Kekre [2bp] transforms[15]. The feature vector for the enrolled dataset in given to classifier. The decisions of the classifiers are then fused together using decision fusion.

C. *Feature Extraction phase*

i) *Iris feature extraction:* In this a feature extraction phase is a separate phase. Here first a sample feature has been selected it then converted into grey scale then perform localization and texture features has been extracted. The features values have been saved in .mat file & extrema, centroid and area features has been extracted as shown in figure 6.

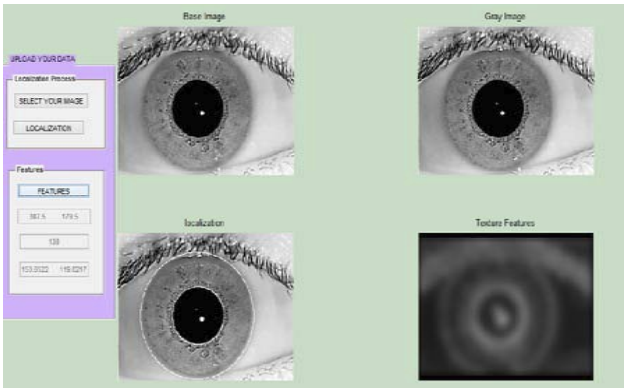

Fig 6. Features of iris

iii) *Fingerprint feature extraction:* In this a feature extraction phase is a separate phase. Here first a sample feature has been selected it then converted into grey scale then texture features has been extracted. The features values have been saved in .mat file & extrema, centroid, perimeter, convex hull, maxima and minima features has been extracted as shown in figure 7.

IV. RESULT ANALYSIS

Performance of the biometric systems is measured by their accuracy in identification, which is calculated using rejection rate and false acceptance rate. As shown in the Table 1, the Accuracy is calculated using all samples on the basis of false rejection rate and false acceptance rate. Tests are run on the dataset of 25 users Accuracy is calculated for iris recognition, fingerprint recognition & for both.

Table 1. Comparison of Performance

Methods	**Iris Recognition**	**Fingerprint Recognition**	**Multimodal Biometrics**
Accuracy	79.32%	78.2%	81.5%

V. CONCLUSION

In this work we check the efficiency of the multimodal biometric system and compare it with unimodal biometric system. In this canny based features are extracted for Iris& core points are extracted for Fingerprint. Here decision level fusion is used in multimodal system after classification of extracted features. The accuracy of given system is 81.5% for multimodal system and 78.2% & 79.32% for iris &

fingerprint respectively. This means a multimodal biometric system works efficiently than unimodal system.

Future works could go in the direction of using more robust techniques against forgeries and hybrid fusion level can be used. Also, the system should be tested on a larger database with noisy samples to validate the robustness of the model.

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