SURVEY OF BIOMETRIC RECOGNITION SYSTEMS AND THEIR APPLICATIONS

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ABSTRACT

The term Biometrics is becoming highly important in computer security world. The human physical characteristics like fingerprints, face, hand geometry, voice and iris are known as biometrics. These features are used to provide an authentication for computer based security systems. The existing computer security systems used at various places like banking, passport, credit cards, smart cards, PIN , access control and network security are using username and passwords for person identification. The username and passwords can be replaced and/or provide double authentication by using any one of the biometric features. In this paper, the main focus is on the various biometrics, their applications and the existing biometrics recognition systems.

Keywords: *Biometrics, computer based security systems, Feature Extraction, Biometrics recognition system, false reject rate, false accept rate.*

1.   INTRODUCTION

The biometric is the study of physical or behavioral characteristics used for the identification of a person [1]. These characteristics of a person include the features like fingerprints, face, hand geometry, voice, and iris biometric features. These biometrics features can be used for authentication purpose in computer based security systems.

The identification of a person is becoming highly important as the ID cards, punch, secret password and PIN are used for personal identification [2] .The ID can be stolen; passwords can be forgotten or cracked. The biometrics identification overcomes all the above. Additional security barriers can be provided using any one of the biometrics features [3].

The computers based security systems are used at various places like commercial, civilian and government offices to store information and all processing. It is the primary thing to provide security to the information present on internet. For this purpose the confidential authentication is required by replacing the username and password [4].

The biometric systems offer several advantages over traditional authentication systems. The problem of information security gives the protection of information ensuring only authorized users are able to access the information. They are required the person being authenticated to be present at the point of authentication [5]. Thus biometric-based authentication method is most secure system.

For many applications the system uses the password as well as biometrics for authentication. The biometric characteristics have been used in different applications. According to the requirement of the application suitable biometric can be selected.

In this paper, we have presented the different types of biometrics, their applications and the biometric recognition systems. Section 2 gives brief description and the comparative characteristics of the commonly used biometrics. Section 3 describes biometric recognition system and its various modules. In section 4 we are presenting the various biometric systems and their applications. The biometric system performance depending on the matching score is described in section 5. The conclusion is given in section 6. Finally references and bibliography are given.

2.   BIOMETRICS

The physical characteristics of a person like finger prints, hand geometry, face, voice and iris are known as biometrics. Each biometric trait has its

strengths and weaknesses. The suitable biometric can be selected depending upon the application in various computer based security systems. The important features of the various biometrics are discussed briefly in this section.
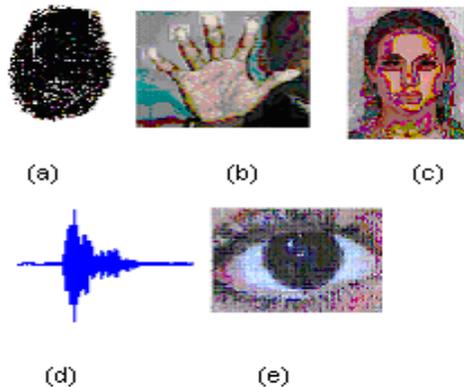

Figure1. Biometrics:

a) Fingerprint (b) Hand Geometry (c)Face (d) Voice (e) Iris

2.1 FINGER PRINTS

The finger prints of a person have been used as person identification from long time. A finger print is the pattern of rids and valley on the surface of a finger tip. The finger prints of the identical twins are different. It is affordable to scan the finger prints of a person and can be used in computer for number of applications. This method is traditional and it gives accuracy for currently available Fingerprint Recognition Systems for authentication [6]. This fingerprint recognition system is becoming affordable in a large number of applications like banking, Passport etc. Figure 1(a) shows a sample finger print image of a person.

2.2 HAND EOMETRY

The hand geometry recognition systems are based on a number of measurements taken from the human hand, including its shape, size of palm, length and width of the fingers. This method is very simple and easy to use. As there is no effect of environment factors such as dry weather or dry skin, this does not appear to have dry negative effects on the authentification accuracy. Also hand geometry information may not be invariant during the growth period of the children [9]. The hand

geometry is scanned as shown in figure 1(b) and used for identification and recognition of a person.

2.3 FACE

The face is the commonly used biometric characteristics for person recognition. The most popular approaches to face recognition are based on shape of facial attributes, such as eyes, eyebrows, nose, lips, chin and the relationships of these attributes. All these attributes of the face image are shown in figure 1 ©.As this technique involves many facial elements; these systems have difficulty in matching face images [11]. The face recognition systems which are used currently impose a number of restrictions on how facial images are obtained. This face recognition system automatically detects the correct face image and is able to recognize the person.

2.4 VOICE

The voice recognition systems have been currently used in various applications. Voice is a combination of physical and behavioral biometrics. The figure 1 (d) shows a sample speech signal. The features of person voice are based on the vocal tracts, mouth, nasal activities and lips movement that are used synthesis of sound. These physical characteristics of human speech are invariant for individuals. The behavioral part of the speech of person changes over time due to age, medical conditions, and emotional state. The speaker dependent voice recognition systems are text dependent; and the speaker independent systems are what he or she speaks [13]. The speaker dependent voice recognition system is more difficult to design but provides more protection.

2.5 IRIS

The iris is biological feature of a human. It is a unique structure of human which remains stable over a person lifetime. The iris is the annular region of the eye. The left and right irises of an individual can be treated as separate unique identifier. A sample human eye image is given in figure 1 (e).The iris information can be collected by iris image. The accuracy of iris based recognition system is promising. Each iris is believed to be distinctive and even the irises of identical twins are also different [15]. The iris recognition system has become more users friendly and cost effective. The iris have a very low false accept rate as compared to other biometrics like finger print, face, hand geometry and voice.

2.6 COMPARISION OF BIOMETRICS

The comparison of the various biometric methods is based on the various factors. The biometric features of fingerprint, face, hand geometry, voice and iris have the characteristics like universality, Uniqueness, permanence, performance and Measurability. These characteristics are different for each biometric type. These can be measured in High, Medium and Low [3]. Any human physiological or behavioral trait can serve as a biometric characteristic as long as it satisfies the following requirements [17]. Table 1 compares the biometric features based on different factors.

Universality: Everyone should have it

Uniqueness: No two individuals should have the same value of characteristics

Permanence: It should be invariant over a given period of time

Performance: It should give accuracy and speed.

Measurability: It must be easy to measure.

3 BIOMETRIC RECOGNITION SYSTEM

The Biometric Recognition Systems are used to identify the person based on the feature vectors of any one of the biometric that the person possesses [16]. These systems are person authorized systems hence offer more secure and convenient process of identification compared to alternative methods of identification. The computer based security systems are used in various commercial, civilian and forensic applications. Each person has to establish the identity ranging from drivers' license to gaining entry into a country to the passport. The biometric system uses the individual's physical characteristics like fingerprint, hand geometry, face, voice or iris. They are more reliable and secure as they provides the access to authorized users in their physical presence [24].

A simple biometric system consists of four modules: Image/Voice acquisition, Preprocessing, Feature extraction and Recognition. The proposed system should be able to collect the biometric image or voice, to perform preprocessing on original input, to encode the input to get feature vector, to match the features to recognize the person.

3.1 IMAGE/VOICE ACQUISITION MODULE

This is the first module to acquire the biometric input. The input can be image or voice according to the selection of biometrics. The sensors like high

TABLE 1

THE COMPARISONS OF BIOMETRIC CHARACTERISTICS

Biometric Characteristics	Universality	Uniqueness	Permanence	Performance	Measurability
Finger Print	M	H	H	H	M
Hand Geometry	M	M	M	M	H
Face	H	H	M	L	H
Iris	H	H	H	H	M
Voice	M	L	L	L	M

resolution CCD camera or recorder can be used to capture the biometric image / voice. The distance between the sensor and human should be constant, the lighting system as well as physical capture system should be constant to acquire standard biometric input.

3.2 PREPROCESSING MODULE

Once the input is captured, the original input image or voice signal is processed to remove the noise and blurring effect. The image is localized to extract the region of interest. The voice signal is framed to extract the desired signal. Then this processed input is given to feature extraction module.

3.3 FEATURE EXTRACTION MODULE

In the feature extraction module, the preprocessed image /voice is used to extract the features. The feature extraction algorithms are applied to get feature vector of the biometric image / voice. There are various feature extraction techniques like Independent Component Analysis, Linear discriminate component, principal component analysis, wavelet transform, LPC, MFCC, etc [10][11][14][15]. According to the biometrics selected and its application the feature extraction technique can be applied.

3.4 RECOGNITION MODULE

The feature vectors, generated in the Feature Extraction Module are used in this module to classify the biometric data. There are the classifiers like hamming distance, Euclidian distance, and Support vector machine classifier. The rules are defined for recognition of a person with his / her

biometrics [27]. According to the biometric applications, the suitable classifiers can be used to get better performance of the system. The feature vectors are used to write the decision making rules. In this module user's identity is established or a claimed identity is accepted or rejected.

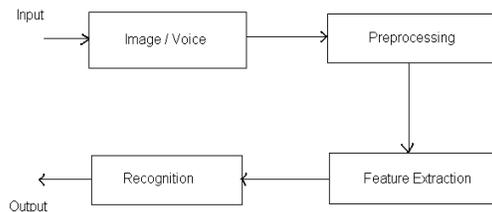## 4 APPLICATIIONS OF THE BIOMETRIC RECOGNITION SYSTEMS

Figure 2. Block Diagram of Biometric Recognition System

The biometric is an emerging field of technology which uses the physical biological or behavioral characteristics that can be processed to perform automatic recognition of a person. Hence this requires achieving low cost, reliable human identification system by using feature set of individual characteristics. The biometric concentrates on physical aspects like finger print, hand geometry, face, voice and iris of a person [19].

4.1 FINGER PRINT

The fingerprint biometric system easy to capture the data, so are very popular. These are used to secure entry devices for building door locks and computer network access. These are used in banks for authorization at ATMs, credit cards. More recent application includes use of fingerprints for administering drugs and controlled substances to patients. The finger print biometric system behaves the following features [7]:

- Fairly small storage space is required for the biometric template, reducing the size of the databases required.
- It is one of the most developed biometrics, with more history, research and design.
- Each and every finger print including all the

fingers are unique, even identical twins have different fingerprints.
- Sound potential for forensic use as most of the countries have existing fingerprint databases.
- Relatively inexpensive and offers very high levels of accuracy.

4.2 HAND GEOMETRY

Hand Geometry Biometric Recognition System uses the geometric shape of the hand to identify the person. This system also uses finger length, thickness, and curvature for the purpose of verification [21]. The hand geometry is not distinctive but it is the ideal choice. The hand geometry data collection is easier and hand geometry can be combined with other biometrics like finger print [20].

The recent applications of the hand geometry biometric systems include the 1996 Olympic Games was controlled , San Francisco International Airport uses hand geometry to restrict access to critical areas, child day care centers use to verify the identity parents, payroll accuracy and access control, the fast gate pilot program to track border crossings for frequent travelers, United States military using for access control and majority of nuclear power plants in US use hand geometry for access control [8]. The hand geometry is used in biometric systems as it behaves the following features:
- Very small template size, easy to maintain and store large database
- High reliability and accuracy
- Robust, user friendly and easy to integrate into existing and third party systems
- Ideal for rough outdoor environments like construction industry and can handle high throughput of people
- Relatively inexpensive offers excellent return on investment.

4.3 FACE

Face recognition biometric systems uses facial characteristics of a person. It measures the overall facial structure, distance between eyes, nose, mouth, and jaw edges. These features are extracted and used for identification of a person [11]. Face recognition systems are using successfully in

verification systems like Document control of passport, drivers licenses, transactional authentication, credit cards, ATMs, physical access
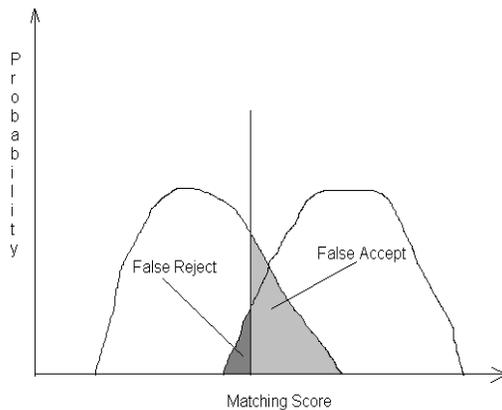
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Figure 3. Biometric System Error Rates

control, smart doors, voter registration, election

accuracy, time and attendance, entry and exit verification. Face recognition biometric systems are strongly recommended as it behaves following features:

- Facial photograph do not disclose information
- The facial image is already socially and culturally accepted internationally.
- It is already collected and verified to produce passport
- The public are already aware of its capture and use for identity as well as verification purpose.
- It is non-intrusive
- Many states have legacy database of facial images
- Human verification of the biometric against the photograph/person is relatively simple and a familiar process for border control authorities.

4.4 VOICE

The speech recognition is most important research area in the today's world. There are various speech recognition approaches; among those are the acoustics phonetic pattern comparisons and automatic speech recognition approach [22]. The performance of speech recognition system depends on various factors some of them are speaker variation, ambient noise, and variation in the tone of the same speaker, sensitivity of phonetic input systems, distance and regular variations. The speaker recognition is most appropriate in phone based applications, the entertainment TV channels [13]. The voice recognition biometric systems are used for access control, banking, government offices and entertainment applications, smart cards, PIN and other security purposes.

4.5 IRIS

The iris image consists of the colored tissue surrounding the pupil .The iris recognition systems are known as real time, high confidence recognition of person identification [25]. These systems are used in many applications like passports, activation security, and controlling access to restricted areas at airports, database access and computer login, access to building and homes, border crossings and other government programme.The iris recognition systems behave following features:

- Perform 1: n identification with no limitation on numbers.
- The most robust biometric technology available in the market today never had a false acceptance.
- Biometric templates once captured do not need to be enrolled again, iris stable throughout a human life.

5 BIOMETRIC SYSTEM PERFORMANCE

The recognition accuracy is depending on the image acquisition, the position of acquiring sensor, intensity of light focusing, environmental changes, noise, and bad user's interaction with the sensor. Therefore the two images acquired by the sensor may not be having same characteristics [26]. The biometric matching systems are used to find the matching score between the two images.
The threshold t is assumed and the matching score is less than t then the image is considered as the different person [25]. Then two errors are measured in terms of false reject (FAR) and false accept rate (FRR).
FAR: The biometric measurement between two persons is same.
FRR: The biometric measurement between two persons is
different.
If the system decreases t to make the system more tolerant to input variation and noise, FAR increases. On the other hand if the system increases t to make the system more secure, FRR increases accordingly [16]. Figure 3 shows the performance of the system which is depending on the matching score between two images and is measured by the errors; false accept rate and false reject rate.

6. CONCLUSION

The Biometric recognition Systems are the automatic recognition systems which uses the physical characteristics of a person like finger print, hand geometry, face , voice and iris. These systems overcomes the drawbacks of the traditional computer based security systems which are used at the places like ATM, passport, payroll, drivers' licenses, credit cards, access control, smart cards, PIN, government offices and network security. The biometric recognition systems have been proved to be accurate and very effective in various applications. The biometric features can be easily acquired and measured for the processing only in the presence of a person. Hence these systems are proved highly confidential computer based security systems.

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