

A Systematic review of different approaches for biometric authentication and identification

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Abstract—Biometric recognition provides a reliable solution to the problem of user's authentication and identification. This paper contains survey of papers which present a range of approaches for the authentication and identification of human beings. This paper seeks to analyze biometrics currently in use across a range of environment and biometrics limited in use or still in research realm. Various biometric approaches are discussed along with their accuracy and efficiency.

Keywords—Biometric, Hand Gemetry, Palm print, Iris; Signature;

I. INTRODUCTION

Biometrics is a science of analyzing and measuring the behavioral and physiological characteristics of human beings. The physical body parts and observable features used for biometric identification are iris, palm print, face, feet, hands, fingers, teeth, ears, retinas, signatures, veins, odors, DNA and voice. Biometric identification provides high level of security by identifying individuals based on anatomic uniqueness. An anatomic uniqueness is a most reliable tool for authentication that cannot be ripped off or lost. A biometric system acquires biometric key from individuals, extracts feature set and recognize the individual based on the extracted feature set. In this modern era, it is a rapidly evolving field with the applications ranging from unlocking the personal device to get entry in any region of world. Biometric systems are being deployed in various common applications including employee attendance system, computer or personal device login, kiosks, airport security, law enforcement, access control and banking transactions etc.

II. CLASSIFICATION OF BIOMETRIC SYSTEMS

Biometric systems are classified into two categories: Biometric Authentication System and Biometric Identification System.

A. Biometric Authentication System

The purpose of this system is to verify the identity of a person and provide access control to the individual. In this system the characteristics of an individual are compared to the biometric template of that individual. The individual is identified based on the result of this comparison.

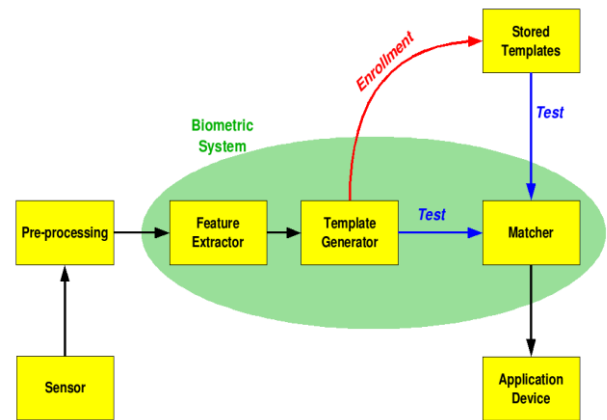


Fig.1 Model of Biometric System

B. Biometric Identification System

This system determines the identity of a person. Typically the enrolled user do not have direct access to this system. The system captures biometric data of an individual and compare it to the data of other individuals saved in the database. The captured data is in the form of voice, fingerprint or image of face etc. Typically such systems are used to find the offender of a crime.

Fig 1, illustrates block diagram of authentication and verification biometric system [1]. This biometric model uses four basic modules: Sensor module, Feature extraction module, matching and decision making module, Database module[1]. Sensor acquires biometric data of an individual. Acquired data from the sensor is processed to extract the features. Feature vectors of the test image and stored templates are compared, as a result matching score is generated. On the bases of matching score claimed identity is accepted or rejected or user's identity is established.

III. LITERATURE REVIEW

Biometrics has quickly established itself as the most appropriate system for identifying and authenticating individuals in a reliable manner with the use of anatomic uniqueness.

The first biometric system was developed by Alphonse M. Bertillon in 1879 [2]. This system used anthropometric features such as length and breadth of head and ear, length of middle finger, eye color, tattoo, scars for ascertaining a person's identity. The Bertillon system was dropped in favor of William Herschel and Francis Galton due to following limitations[2]

- Persistence: The anthropometric features can vary over a period of time. Therefore children before full physical maturity and women with pathological disturbances are completely ignored.
- Distinctiveness: Individuals from same background have same eye or skin color.
- Instruments: The instruments used for measuring may get out of order.

With the increase in security concerns research methods of biometrics has gained renewed attention. There are many biometric systems currently available and many in research realm or under the development process. Based on the literature survey biometric systems can be classified as [3]

TABLE 1. CLASSIFICATION OF BIOMETRIC SYSTEMS

Biometrics currently in use across a range of environment	Biometrics limited in use or still in research realm.
Fingerprints	Ear shape
Face	Knuckle crease
Iris	Brain
Hand Geometry	Heart Sound
Palm print	
Voice	
Signature	

1) *Fingerprints*: The impression left by friction ridges and valleys on the tip of finger is used for personal verification of people. In 1880 Henry Fauld laid the foundation of fingerprint system by introducing minutiae feature of fingerprint matching [4]. According to the present scenario fingerprint techniques can be classified as Minutiae-based, Ridge feature-based, Correlation-based [5] and Gradient based [6]. Table 2 outlines some research work in this biometric recognition area:

TABLE 2. FINGERPRINT RESEARCH WORK

Author	Proposed Method/System	Description
S.Choudhury et al[7]	A Hybrid Approach to Enhance the Security of Automated Teller Machine	In this system instead of scanning the ATM card, the system scans the fingerprint of the user. In the proposed system minutiae extraction from gray scale and binarized image is carried. The fingerprint module of this system is 100% reliable for people of age 10-50 and 88% reliable for the remaining people.
Z. Brijet et al[8]	Vehicle Anti-Theft System Using Fingerprint Recognition Technique.[8]	This system identify the person as the car owner or an unauthorized user. The engine will not start if a transgressor is trying to take control of the car.
Kai Cao et al[9]	Automated Latent Fingerprint Recognition	An algorithm is proposed that utilizes ConvNets for ridge flow estimation and minutiae descriptor extraction, and extract complementary templates to

		represent the latent. The proposed method is 64.7% accurate for NIST SD27 and 75.3% for WVU latent databases.
Parul Wadhwa[10]	Attendance System Using Android integrated Biometric Fingerprint Recognition	The Android application is connected to the Arduino on one side and to the database on the other. When valid fingerprint is entered, the Arduino increments the attendance of the student in the online database. The proposed system is reliable and about 100% accurate but during the enrollment of fingerprints errors are detected
Karnav Shah et al[11]	Secure Examination System using Biometric and QR Code Technology	In proposed system student identity is verified by checking biometric credentials during examination. SecuGen fingerprint SDK is used for fingerprint recognition
Chulhan Lee et[12]	A Study of Touchless Fingerprint Recognition System	This system use a polarizer filter and a band-pass filter in order to acquire a good quality image. Experiments show that the touchless fingerprint system has better performance than the conventional touch based system.

2) *Face*: The face recognition system tracks a person's face from digital image or a from a video frame and identify or verify the person. Face recognition for its easy use and non-intrusion has made it a common biometric technique [13]. The algorithms proposed for face recognition technique can be broadly divided into two categories appearance based algorithms and geometry based algorithms. Table 3 outlines some research work in this biometric recognition area:

TABLE 3. FACE RESEARCH WORK

Author	Proposed Method/System	Description
L.B. Neto et al[14]	A Kinect-Based Wearable Face Recognition System to Aid Visually Impaired Users	This system uses a Microsoft Kinect sensor as a wearable device and performs face detection. It uses temporal coherence along with a simple biometric procedure to generate a sound associated with the identified person, virtualized at his/her estimated 3-D location. [14]
D. Crispell et al[15]	Dataset Augmentation for Pose and Lighting Invariant Face Recognition	The proposed approach demonstrates how a baseline training set can be augmented to increase pose and lighting variability using semisynthetic images with simulated pose and lighting conditions.
Omkar M. Parkhi et al[16]	Deep Face Recognition	Omkar M. Parkhi et al has contributed how a very large scale dataset can be assembled by a combination of automation and human in the loop, and discuss the tradeoff between data purity and time and presented methods and procedures to achieve comparable state of the art results on the standard LFW and YTF face benchmarks.
Weitao Xu et al[17]	Sensor-Assisted Multi-View Face Recognition System on Smart Glass	The system is based on Multi-view Sparse Representation Classification (MVSRC) algorithm. It is a robust and efficient sensor-assisted face recognition system on smart glasses.

Marian Stewart Bartlett et al[18]	Real Time Face Detection and Facial Expression Recognition: Development and Applications to Human Computer Interaction	The system has been deployed on a wide variety of platforms including Sony's Aibo pet robot, ATR's RoboVie, and CU animator, and is currently being evaluated for applications including automatic reading tutors, assessment of human-robot interaction.
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3) *Iris* :This biometric recognition system identifies people on the bases of unique patterns within the ring shaped region surrounding the pupil of eye. A considerable amount of literature has been published on the iris identification. Table 4 outlines some research work in this biometric recognition area:

TABLE 4.IRIS RESEARCH WORK

Author	Proposed Method/System	Description
Shyam Ji Verma et al [19]	IRIS Recognition System	The proposed technique uses appropriate packets with dominant energies to encode iris texture according the adapted thresholds. The verification result with an EER 0.3% is obtained for packet combination. Thus proposed system is appropriate for security environments.
Nurul Akmal Hashim et al[20]	Iris Feature Detection using Split Block and PSO for Iris Identification System	The authors has proposed a model of iris recognition using combinational approach of a split block and particle swarm optimization (PSO) in selecting the best crypt among unique iris features template. A new model of feature extraction is contributed.
R. Bremanan th[21]	A Robust Eyelashes and Eyelid Detection in Transformation Invariant Iris Recognition: In Application with LRC Security System	The authors has contributed two primary paradigms to Iris recognition : Robust Eyelash Detection (RED) using pathway kernels and hair curve fitting synthesized model .The results revealed that the methodology can deploy in the process on LRC management system and other security required applications.
Nianfeng Liu et al[22]	A Code-Level Approach to Heterogeneous Iris Recognition	The proposed model transforms the number of iris templates in the probe into a homogenous iris template corresponding to the gallery sample.
Syed Arslan Ali et al[23]	Iris recognition system in smartphones using light version (LV) recognition algorithm	The proposed algorithm yields better results in terms of response time, computing time and CPU usage.

4) *Hand Geometry*:Hand Geometry Verification System uses geometric measurements of hand for authentication of individuals. Table 5 outlines some research work in this biometric recognition area:

TABLE 5.HAND GEOMETRY RESEARCH WORK

Author	Proposed Method/System	Description
Puneet Gupta et al[24]	An accurate infrared hand geometry and vein pattern based authentication system	A personal authentication system is designed that uses hand dorsal images acquired under infrared light. Many post processing techniques are introduced in this system for accurate feature extraction of infrared hand geometry.
Ravinder Kumar [25]	Hand Image Biometric Based Personal Authentication System	The proposed system computes contour of the hand region from Region of Interest (ROI) and extract structural information to describe the shape of the hand.
Pavan K Rudravaram et al [26]	Peg-Free Hand Geometry Verification System	Significant geometric features of the hand are extracted from the image using peg free hand image acquisition. The recognition process involves matching various weighted features with pre-stored templates.
Marek Klonowski et al[27]	User authorization based on hand geometry without special equipment	The system utilizes data acquired by a standard office scanner. Experimental results have determined False Acceptance Rate equal to 0.0% and False Rejection Rate at the level of 1.19%, with Equal Error Rate (EER) 0.59%.
Akshay Bapat et al [28]	Segmentation of hand from cluttered backgrounds for hand geometry biometrics	The proposed system can be efficiently implemented in smart buildings for contactless and low-cost biometric recognition.

5) *Palm print*:Palm print recognition is a biometric authentication method based on the unique patterns of various characteristics such as palm area, palm length and palm width in the palms of an individual’s hand. The following table outlines some research work in this biometric recognition area:

TABLE 6.PALM PRINT RESEARCH WORK

Author	Proposed Method/System	Description
Shruti Bhilare et al [29]	A study on vulnerability and presentation attack detection in palmprint verification system	Shruti Bhilare et al has proposed a novel presentation attack detection (PAD) approach to discriminate between real biometric samples and artefacts.Experimental results has determined spoof acceptance of 84.56% and is effective against both print and display attacks, in both same-device and cross-device scenarios and provides an average improvement of 12.73% in classification error rate over LBP-based PAD approach.
Bing Yang et al[30]	3D palmprint recognition using shape index representation and fragile bits	The proposed method has discovered that the performance of coding strategy related 3D recognition method can be improved by incorporating fragile bits information

Hengjian Li et al [31]	Biometrics encryption combining palmprint with two-layer error correction codes	The proposed method bridges the gap between fuzziness of biometric and exactitude of cryptography. The experimental results and security analysis demonstrates that the system can recover the original keys completely.
David Zhang et al [32]	Line Scan Palm print Recognition System	As compared to other palm print systems the volume of the proposed system is over 94% smaller, without compromising its verification performance.
A.Maniraj et al [33]	Biometric Security System Using Palm print	The proposed system uses Discrete Cosine Transform energy features, Wavelet Transform energy features and Sobel Code to extract palm features

6) *Voice* :Voice Biometric Identification system is often used where voice is the only source of identification, such as over the telephone to verify the claimed identity or to identify the individual. Table 7 outlines some research work in this biometric recognition area:

TABLE 7. VOICE RESEARCH WORK

Author	Proposed Method/System	Description
Rohan Kumar Das et al [34]	Development of Multi-Level Speech based Person Authentication System	The proposed system combines three modules namely voice-password, text-dependent and text-independent speaker verification that helps in achieving better performance.
Hairol Nizam Mohd. Shah et al [35]	Biometric Voice Recognition in Security System	The proposed system is a medium range security level system that converts speech waveform to parametric representation for further analysis and processing.
Rozeha A. Rashid et al [36]	Security system using biometric technology: Design and implementation of Voice Recognition System (VRS)	The proposed system has implemented the door opening mechanism using voice commands the works for authenticated persons.
Seung-eun Ji et al [37]	Whispered Speech Recognition for Mobile-Based Voice Authentication System	The speech recognition performance over whispered speech for voice authentication system was improved by employing high-pass filter and acoustic model adaptation algorithm.
Umar Faizel Amri et al [38]	Speech-based Class Attendance	The system uses PSD and Transition Parameter for feature extraction of the voices. Experimental results have shown that system is 60 % accurate in term of recognition rate.

7) *Signature*:Signature based biometric authentication system has received much attention in recent years due to its applications in many fields. Table 8 outlines some research work in this biometric recognition area:

TABLE 8.SIGNATURE RESEARCH WORK

Author	Proposed Method/System	Description
Srikanta Pal et al [39]	Signature-Based Biometric Authentication	The authors has presented a detailed study on signature based biometric authentication and is helpful to the researchers as reference material
Ankit Chadha et al [40]	Biometric Signature Processing & Recognition Using Radial Basis Function Network	The method provided for signature recognition successfully identifies the original image with recognition rate of approximately 80% for 200 samples.
Alireza Alaei et al [41]	An Efficient Signature Verification Method based on an Interval Symbolic Representation and a Fuzzy Similarity Measure	The Authors has proposed an off-line signature verification method and the proposed method outperforms when the number of training samples is more than seven.
Srikanta Pal et al [42]	Multi-Script Off-line Signature Identification	The proposed system identifies that whether the claimed signature belongs to Hindi, Bengali or English signatures with 92.14 % accuracy
Ankan Kumar Bhunia et al [43]	Signature Verification Approach using Fusion of Hybrid Texture Features	Wavelet and Local Quantized Patterns features are used to characterize signature images in the proposed system. Experimental results has shown that the proposed method provides better results compared to the state-of-the-art methods considering different off-line signature datasets

8) *Ear Shape*:Human ear is a good source of biometric identification since it is clearly visible and structure of ear does not change radically over time Biometric authentication using ear image is new research technique receiving much attention. Table 9 outlines some research work in this biometric recognition area:

TABLE 9.EAR SHAPE RESEARCH WORK

Author	Proposed Method/System	Description
Neha Kuduk et al [44]	Biometric Ear Recognition System	The proposed system focused on authentication using ear image. The image of ear is captured from camera and is converted to 3D and is processed.
Santosh H.Suryawanshi [45]	Ear as a biometric	The development process has explained steps from the image development to the point where not negative identification is made. An invariant geometrical method is used in order to extract features needed for classification.

Gopal Singh Tandel et al[46]	Human Recognition through Ear Biometrics using Average Ear Approach	The Authors have implemented human recognition system through 2D ear images and proposed a novel algorithm for human recognition by ear based on average ear method. Experimental results are performed considering query images from 180 ear data set and has shown 100% correct recognition rate
Lin zhang, Zhixuan Ding et al [47]	3D ear identification based on Sparse representation	The Authors have proposed a novel effective fully automatic 3D ear identification system. In order to determine the accuracy of proposed system, experiments are conducted on 2436 ears, detection rate of 90.87% is achieved.
Ajay Kumar et al[48]	Automated human identification using ear imaging	The proposed system investigates a new approach for the automated human identification using 2D ear imaging. Experimental results have provided accuracy of 96.27% and 95.93%, respectively, on the publicly available database of 125 and 221 subjects.

9) *Knuckle Crease*: Knuckles of the human hand are characterized by the creases on them. These creases differ from person to person. Finger knuckle print is a novel biometric trait which is not explored much for real-time implementation. Table 10 outlines some research work in this biometric recognition area:

TABLE 10.KNUCKLE CREASE RESEARCH WORK

Author	Proposed Method/System	Description
P Diviya et al [49]	Identification of Suspects using Finger Knuckle Patterns in Biometric Fusions	Authors have investigated the use of minor and major finger Knuckle patterns .The Research paper presents the correct reliability of finger knuckle patterns
K Kumar Sricharan et al [50]	Knuckle based Hand Correlation for User Authentication	The authors have investigated the possibility of using a new biometric trait - the knuckle for user authentication. There is a sharp decline in accuracy on reduction of size of the knuckle and the fall in accuracy on reduction of resolution is fairly small.
Kyi Pyar Zaw et al [51]	Implementation of Contactless Finger Knuckle Identification System	The Authors have proposed a knuckle surface based biometric identifier for personal identification by using FKP identification algorithm.

10) *Brain* :Brain biometric user authentication is based on the electrical activity of the brain. Table 11 outlines some research work in this biometric recognition area:

TABLE 11.BRAIN RESEARCH WORK

Author	Proposed Method/System	Description
Kusuma Mohanchandra et al[52]	Using Brain Waves as New Biometric Feature for Authenticating a Computer User in Real-Time	The Authors have proposed an Electroencephalogram based Brain Computer Interface as a new modality for Person Authentication and developed a screen lock application that will lock and unlock the computer screen at the users will.
K.C.Reshmi et al[53]	A Novel Approach to Brain Biometric User Recognition	Authors have proposed a novel approach on user recognition using EEG signals of Brain. The Emotiv EPOC EEG neuro headset having 14 saline electrodes with two reference sensors is used for the acquisition of brainwaves.
Pinki Kumari et al [54]	Brainwave based Authentication System: Research Issues and Challenges	The Authors has presented a comprehensive review of well-known methods used in brainwave authentication system and identify the research topics and application of this exciting and challenging field. The challenges that deserve attention are Scalability in dataset, Effect of Emotional state, Novelty in techniques, Electrode placement Paradigm, Customization, Robust against attacks, Selection of cognitive task, Multimodality and Usability.

11) *Heart Sound*:Heart sound is one of the most important physiological signals of human body and can be employed as physiological trait for biometric recognition. Table 12 outlines some research work in this biometric recognition area

TABLE 12. HEART SOUND RESEARCH WORK

Author	Proposed Method/System	Description
Abuagla Babiker et al[55]	Heart Sounds Biometric System	The proposed system provides access control using heart sound biometric signature based on energy percentage in each wavelet coefficients and MFCC feature
Zhidong Zhao et al [56]	Heart Sound Biometric System Based on Marginal Spectrum Analysis	The Authors have proposed a biometric method based on heart sounds by using a novel feature set, with recognition rate of 94.40 %.
Andrea Spadaccini et al [57]	Performance Evaluation of Heart Sounds Biometric Systems on an Open Dataset	The Authors have presented a performance evaluation study of recent heart sounds biometry systems based on the new open dataset HSCT-11 containing data collected from 206 people that can be used for performance evaluation of heart sounds biometric systems .Experimental results have shown that the best performing biometric system has shown error rate of 13.66% on this database.

In the above section various types of biometric identification and authentication means such as fingerprint, iris, face, hand geometry, palm print, voice, signature, ear-shape, Knuckle crease, brain and heart sound are presented with their description and accuracy. The main focus of the work presented is to gain the deep knowledge of various types of biometric systems and their features. Based on the applications and facts presented in the previous sections it can be said that biometric technologies are becoming the foundation of an extensive array of highly secured authentication and identification solutions.

IV. CONCLUSION AND FUTURE SCOPE

Biometric systems are widely used in almost every security related application such as law enforcement, financial services, computer security, immigration and border control, health care, private access control, attendance, telecommunications etc. The basic purpose of every biometric system is to increase security level and reduce false match rate. Experiments conducted by various authors have proved that every biometric system has its pitfalls and advantages. An effective biometric solution does not to be or nor it can be 100% accurate or secure. Thus multimodal biometric systems are used in many real time applications. Many biometric systems have been successfully deployed. The purpose of this research work is to throw light on the literature of various biometric systems available. The current leading biometric discipline for security is still fingerprint biometric recognition. Despite of its accuracy, fingerprint authentication has a pitfall that this type of recognition cannot be used remotely i.e. the person need to be physically present. In future, this research work will be extended to finger vein analysis.

The brain biometric system is much more secure than other currently used biometrics technologies. Only limited works were carried out which gravels way for the researchers to invent new methods to reduce the error rates and to improve the accuracy and speed of the brain biometric system. By considering the technology advancement brain print based applications will be up taken. Furthermore, researchers are moving into new frontiers with the purpose of providing more secure and reliable authentication.

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