IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Vol.-6, Issue-6, June 2018 E-ISSN: 2347-2693

Survey on Recent Ear Biometric Recognition Techniques

Uttara Athawale[1*], Manoj Gupta[2]

[1] Bharati Vidyapeeth's Institute of Management and Information Technology, Mumbai University, Navi Mumbai, India
[2] Bharati Vidyapeeth's Institute of Management and Information Technology, Mumbai University, Navi Mumbai, India

[*]*Corresponding Author: uttara.athawale@gmail.com, Tel.: +91-92212-89613*

Available online at: www.ijcseonline.org

Accepted: 12/Jun/2018, Published: 30/Jun/2018

Abstract— Biometric is physical or behavioral characteristics that can be used for human Unique Identification. Biometric verification has become common and refers to an automatic verification of a person predicated on some concrete biometric features derived from his/her physiological and/or behavioral characteristics and is more reliable than the traditional username and password system Applications for biometric ranges from ATM, computers, security installations, mobile phones, credit cards, health and gregarious accommodations. In this paper, we contribute to these surveys by discussing recent ear recognition techniques proposed until the first quarter of 2018 and the applications developed for the same. We pay special attention to the recently developed acoustic and smartphone-based ear recognition techniques.

Keywords—Ear, biometric, ear-acoustics

I. INTRODUCTION

There are many biometric traits likes fingerprint, face, and iris etc. Ear recognition is more powerful biometric because their loss of shaping is less than any of the body part. Ear biometric is one of the passive biometric. One of the several reasons to choose ear biometric over other biometric like face, iris, retina, is that ear does not change during human life as ascertained by the Prague doctor Imhofer whereas face changes more significantly with age than any other part of the human body[1]. It is less affected by cosmetics, emotions express, different states of mind like sadness, happiness, fear or surprise. As well as this, color distribution is more uniform in the ear than in human face, iris, and retina, that is, loss of information is very less when we work with grayscale images of the ear. Size of the ear is smaller than face; thereby the algorithms with ear recognition will work faster and more efficiently than those with face recognition. Also, ear images cannot be disturbed by glasses, beard or makeup makes it stronger for accurate results[1]. This paper surveys recent ear recognition techniques and proposes innovative techniques for improving the accuracy of the ear recognition process.

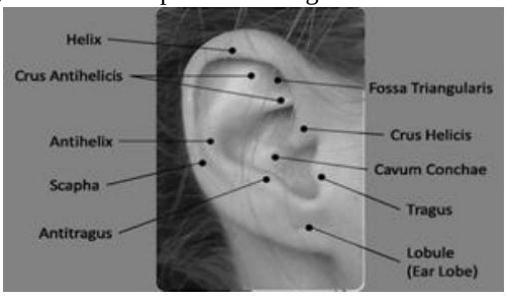
II. RELATED WORK

An ear is a workable class of biometric since the ear has desirable properties such as universality, distinctiveness, and stability. Previous research has suggested the use of ears as a biometric for human identification. Early research was performed by Iannarelli using a manual approach. Burge and Burger proved that ear has a similar performance like a face in personal identification tasks Morena et al. presented a study on personal identification using the helix of an ear Chang, Bowyer et al. compared PCA technique for both face and ear images and showed similar performance as biometric [2]. Michał Chora´ has given an overview of various approaches and solutions to a problem of feature extraction from ear images [3].

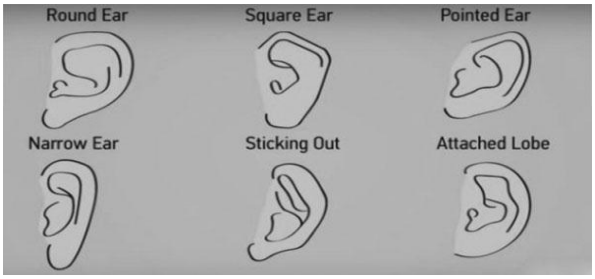
III. DIFFERENT TECHNIQUES

1. EAR RECOGNITION BASED ON SHAPE OF THE EAR

Most of the research done till now uses the shape of the ear for identifying the person uniquely. The commonly used techniques use the curves in the ear images as shown in Figure 1. [4]. Also, 2d images, 3d images of the ear are used, further the ears are categorized as round ear, square ear etc. for faster recognition as shown in Figure 2. In addition to this, we suggest we can also take the back image of the ear for stronger authentication. As the back of the ear is covered mostly, it is less susceptible to changes..



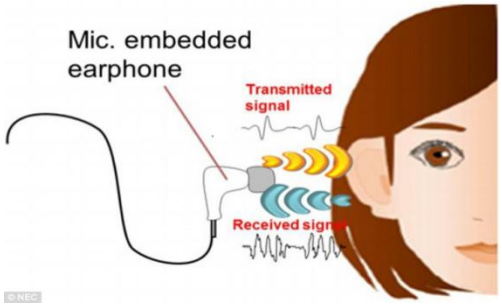
[4, Figure 1] The Terminology Structure of the Ear



[Figure 2] An anatomy of the ear

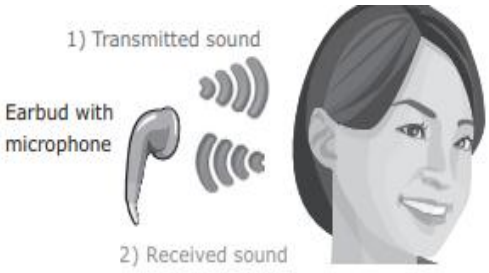
2. EAR RECOGNITION USING EAR ACOUSTICS

Recently ear recognition techniques that use the shapes of ear cavities combined with sound is also used. The human ear cavities determine resonation of sound to distinguish individuals. This system works by measuring the acoustic characteristics which are determined by the shape of an ear. This is unique to individuals. It uses an earphone with a built-in microphone. This collects earphone-generated sounds as they resonate with ear cavities [5].



[6, Figure 3] Features of Hearable

Every person's ear cavities have their own shape, unique to each individual. The system transmits a few hundred milliseconds of sound signals from the earphone speaker into the ear. An embedded microphone then receives the signals. Ear Cavity Biometric Recognition is an enhanced acoustic authentication technology. Individuals are identified by measuring acoustic characteristics that represent the shape of a user's ear canal and captured by microphones, the analysis of the reflected sounds enables the characteristics of an individual's ear canal to be determined [1].



[6, Figure 4] Usage scenario of ear acoustic authentication

The shape of the ear is unique for every individual. Particularly the ear canal varies having different characteristics viz- length, width, number, angles & positions of the bends. Fig.3.The ear canal is as unique as the facial features & individuals can be accurately identified by acoustically measuring. i.e. by using sound to measure the differences in the shapes inside the ear. Each musical instrument has a different tone color depending on its configuration. The ear acoustic technology uses the color tone to recognize the instrument[6].

Based on this principle the user identification is performed by sending the sound wave from outside using an earbud with microphone incorporated with a function to receive sound and the reflected sound is observed , the frequency of reflected sound for about a second is analyzed to compute the respective strengths contained in that sound, ranging from low-frequency to high-frequency components. The computed results are then aggregated into about 20 feature values which are compared to the user's previously obtained feature values to see if there is a match. In this way, it can be determined whether the person wearing the earbud with microphone is the registered user or not[6].

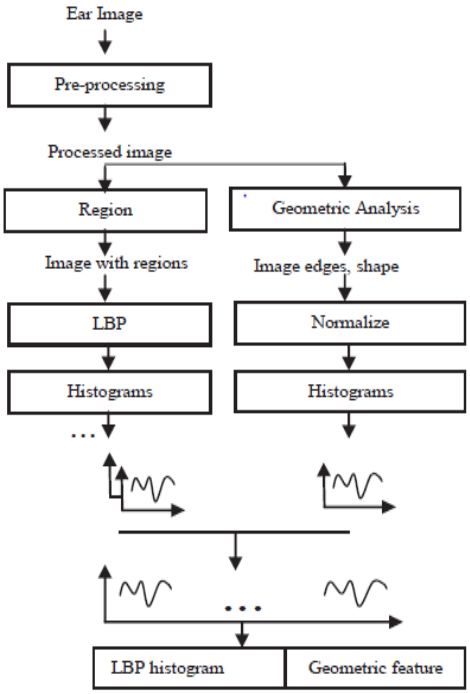
This new biometric model is extremely accurate for achieving a success rate of over 99%. This level of reliability is achieved by extracting values from both external ear signals reflected by the tympanic membrane, and those that pass through the membrane and are reflected within the inner ear cavities[6].

A "hearable device user authentication technology" can be used for authentication. Recently an application is being developed for the same. A new earbud device is announced by NEC that enables biometric authentication via the otoacoustic emission, a short acoustic signal is generated by the earbud. It is a sound made by the inner ear when the cochlea is stimulated, arising from the vibration of hair cells. The headphones adjust their sound signature using the Otoacoustic emissions to the wearer depending on individual, NEC claims that they can be used like a fingerprint or password for a paired phone."otoacoustic authentication technology recognizes the characteristics of a user's ear", the otoacoustic emission can be used to map the shape of the inner ear, which is presumably unique to the individual. The earbud also contains a microphone along with a speaker and can connect to compatible smartphone or computers using Bluetooth Low Energy[7].

3. EAR RECOGNITION USING SMARTPHONE

In today's world smartphones are becoming very popular and widely used form of communication. Another method was proposed in a research paper is to authenticate users during the phone call via image or video. During call interaction, ear image and video are automatically captured using front camera of a smartphone to recognize and authenticate users without their realization. The ear recognition considers both shape and texture information to represent ear image. Local

Binary Pattern (LBP) the ear location center is used for recognition [1].



[1, Fig. 6] The framework of the ear image representation.

The figure 6 shows the framework of ear image representation for the small regions of ear image and make that region to LBP Histogram and also having the Geometric Feature in that. The result of above approach mean recognition rate is around 93%[1].

IV. DRAWBACKS OF EAR BIOMETRIC

During the recognition time of ear image with stored image, it may differ from the real image, because the real image may be hidden by hairs, under the hats, wearing different earrings which cause the change in shape of the ear.
The drawback of ear images that are hidden by hairs image may be overcome by using infrared rays.

- Error in recognition as the images may not be ideal.
- Unclear recognition due to the effect of hair, hats, and earrings.
- Not believed to be very distinctive

V. APPLICATION AREA

In day to day, life security is most important in almost every field. Amongst the numerous application, Ear recognition can be majorly used in the fields such as Banking, ATM, military and in forensics etc. Since every bank, ATM, and highly secured areas are under CCTV, the ear images captured by the CCTV cameras can be used for authentication. Forensics labs can also be use ear images from CCTV camera for identifying criminals. Attendance systems for schools and colleges can use ear images for authentication [8].

- Banks Security.
- ATM locations under CCTV camera.
- Getting access in highly secure areas.
- Forensics labs using images captured by CCTV camera.
- Class attendance.

VI. CONCLUSION AND FUTURE SCOPE

From the survey, we conclude that authentication using ear biometric is either done by using ear images or ear acoustics. Ear recognition techniques that involve a combination of front, side, back ear images, ear texture and ear acoustics can be used for authentication. Applications that use a Smartphone can be developed to authenticate a person using such a combined approach. As ear is least susceptible to change, it can prove to be a stronger biometric, Ear biometric alone, that involves shape, texture, as well as acoustics, will surely prove a more robust method for ear recognition.

REFERENCES

[1] Ali Fahmi P.N. and Elyor Kodirov and Deok-Jai Choi and Guee-Sang Lee and Mohd Fikri Azli A and Shohel Sayeed, "Implicit Authentication based on Ear Shape Biometrics using Smartphone Camera during A Call," *IEEE International Conference on Systems, Man, and Cybernetics*, pp. 2272-2276, 2012.

[2] B Kocaman, M Kirci, EO Gunes, Y Cakir, O Ozbudak, "On ear biometrics", *EUROCON 2009, EUROCON'09. IEEE, 327-332.*

[3] Michal Choras, "Image Feature Extraction Methods for Ear Biometrics--A Survey", *published in 6th International Conference on Computer Information Systems and Industrial Management Applications (CISIM'07).*

[4] Khamiss Masaoud and S. Algabary and Khairuddin Omar and Md. Jan Nordin and Siti Norul Huda Sheikh Abdullah, "A Review Paper on Ear Recognition Techniques: Models, Algorithms and Methods," *Australian Journal of Basic and Applied Sciences*, vol. 7, no.1, pp. 411-421, 2013.

[5] Khamiss Masaoud S. Algabary and Khairuddin Omar and Md Jan Nordin, "3-DIMENSIONAL EAR RECOGNITION BASED ITERATIVE CLOSEST POINT WITH STOCHASTIC CLUSTERINGMATCHING," *Journal of Computer Science*, vol.10, no. 3, pp. 477-483, 2014.

[6] FURUTANI Satoshi and KOSHINAKA Takafumi and OOSUGI Kouji, "Human-Oriented IoT Solutions Using Hearable Technology from NEC," *NEC Technical Journal*,Vol.12, No.1, pp.50-54, 2017.

[7] Article on, "NEC Announces Earbud-based Biometric Authentication Technology" dated May 23, 2017.

[8] Dayanand B.Gore and Seema S. Kawthekar and Vipin Y. Borole, " Ear Recognition Techniques for Biometrics Using Digital Image Processing: A Review," *IOSR Journal of Computer Engineering (IOSR-JCE)*, PP 22-26.

[9] Žiga Emeršič and Vitomir Štruc and Peter Peer, " Ear recognition: More than a survey ," *Elsevier B.V.*, pp. 1-14, 2017.

[10] David J. Hurley and Mark S. Nixon* and John N. Carter, "Force field feature extraction for ear biometrics," *Computer Vision and Image Understanding 98 Elsevier*, pp. 491-512, 2005.
[11] Ni Kadek Ayu Wirdiani and Ni Nyoman Triana Anggra and A. A. K. Oka Sudana, "Application of Android-based Ear Biometrics Identification," *International Journal of Computer Applications (0975 – 8887)*, vol. 172 ,No.10, pp. 11-17, 2017.
[12] Mohd Shafry Mohd Rahim and Amjad Rehman and Fajri Kurniawan and Tanzila Saba," Ear biometrics for human classification based on region features mining," *Biomedical Research*, vol.28, no.10, pp. 4660-4664, 2017.
[13] Neha Kuduk and Akshada Hinge and Kirti Kshirsagar, "BIOMETRIC EAR RECOGNITION SYSTEM," *International Research Journal of Engineering and Technology (IRJET)*, Vol. 04, no. 1, pp.1002-1006, 2017.
[14] Inas Al-Taie and Nassr Azeez and Arwa Basbrain and Adrian Clark, " The Effect of Distance Similarity Measures on the Performance of Face, Ear and Palm Biometric Systems," *IEEE*, 2017.
[15] Himanshu Srivastava, " A Comparison Based Study on Biometrics for Human Recognition," *IOSR Journal of Computer Engineering (IOSR-JCE)*, Vol. 15,no. 1,pp. 22-29 ,2013.
[16] Gursimarpreet Kaur and Dr.Chander Kant Verma, " Comparative Analysis of Biometric Modalities," *International Journal of Advanced Research in Computer Science and Software Engineering vol.4, no.4, pp. 603-613, 2014.*
[17] Srividya R and Ramesh B, "Impregnable Biometric - A Survey," *International Journal of Scientific and Research Publications*, Vol. 8, no 2, pp. 26-30, 2018.
[18] Kalyani Mali and Samayita Bhattacharya, " Comparative Study of Different Biometric Features," *International Journal of Advanced Research in Computer and Communication Engineering*,Vol. 2, no.7, pp.2776-2780, 2013.
[19] AYMAN ABAZA and ARUN ROSS and CHRISTINA HEBERT and MARY ANN F. HARRISON and MARK S. NIXON, "A Survey on Ear Biometrics," *ACM Computing Surveys*, Vol. 45, No. 2, pp. 22:1 – 22:35, 2013.
[20] Ajit D. Dinkar and Shruti S. Sambyal, " Person identification in Ethnic Indian Goans using ear biometrics and neural networks," *Forensic Science International 223*, pp.373.e1- 373.e13, 2012.
[21] Israa M. Alsaadi, "Physiological Biometric Authentication Systems, Advantages, Disadvantages And Future Development: A Review," *INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH*, vol. 4, no. 12, pp. 285-289, 2015.
[22] Sukhdeep Singh and Dr. Sunil Kumar Singla, " A Review on Biometrics and Ear Recognition Techniques," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol.3, no.6, pp. 1624-1630, 2013.
[23] Bahattin Kocaman and Mürvet K_rc_ and Ece Olcay Güne_ and Yüksel Çak_r and Özlem Özbudak, "ON EAR BIOMETRICS", *IEEE*, pp. 327-332, 2009.
[24] S. Gangaram and S. Viriri, "Human Identification based on Ear Recognition," *Recent Advances in Electrical Engineering and Educational Technologies*, pp.230-234.
[25] Santosh H.Suryawanshi, "THE EAR AS A BIOMETRIC," International Journal of Computer Science and Mobile Computing, vol.4, no.2, pp. 61-65, 2015.
[26] SWATI NEWALE and PROF.A.M.RAWATE and PROF. PRAVEEN KAMBLE, "Overview of image based ear biometric with Smartphone app," *International Research Journal of Engineering and Technology (IRJET)*, Vol. 04, no. 07, pp.1265-1268, 2017.
[27] Pedro LuisGaldámez and WilliamRaveane and AngélicaGonzález Arrieta, " A brief review of the ear recognition process using deep neural networks," *Journal of Applied Logic*, pp 1-9,2016.
[28] Shradha Tiwari and Prof. J.N. Chourasia and Dr. Vijay S.Chourasia, "A Review of Advancements in Biometric Systems," *International Journal of Innovative Research in Advanced Engineering (IJIRAE)*, Vol.2, no.1, pp. 187-204, 2015.
[29] Sasan Karamizadeh and Shahidan M. Abdullah and Azizah A. Manaf and Mazdak Zamani1 and Alireza Hooman, "An Overview of Principal Component Analysis," *Journal of Signal and Information Processing*, vol 4, 173-175, 2013.
[30] Ping Yan, "Ear Biometrics in Human Identification," *Graduate Program in Department of Computer Science and Engineering*, pp. 1-152, 2006.
[31] K.H. Pun and Y.S. Moon, "Recent Advances in Ear Biometrics," *IEEE International Conference on Automatic Face and Gesture Recognition*, 2004.
[32] Barnabas Victor and Kevin Bowyer and Sudeep Sarkar, "AN EVALUATION OF FACE AND EAR BIOMETRICS," *IEEE*, pp. 429-432, 2002.
[33] Mauro Conti and Irina Zachia-Zlatea and Bruno Crispo, "Mind How You Answer Me!(Transparently Authenticating the User of a Smartphone when Answering or Placing a Call)," *ACM*, pp.249-260, 2011.
[34] Takayuki Arakawa and Takafumi Koshinaka and Shohei Yano and Hideki Irisawa and Ryoji Miyahara and Hitoshi Imaoka, "Fast and Accurate Personal Authentication Using Ear Acoustics," *NEC*, 2017.
[35] Hui Chen and Bir Bhanu, "Human Ear Recognition in 3D," *IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE*, vol. 29, no. 4, pp. 718-737, 2007.
[36] Andrea F. Abate and Michele Nappi and Stefano Ricciardi, "Smartphone Enabled Person Authentication Based on Ear Biometrics and Arm Gesture," *IEEE International Conference on Systems, Man, and Cybernetics*, pp. 003719 - 003724, 2016.
[37] Shubham Mohurle and Seema Khutwad and Pratiksha Kunjir and Anjali Bhosle, " Review Paper on Ear Biometric Authentication," International Journal of Engineering Science and Computing, vol. 6, no. 10, pp. 2875-2880, 2016.
[38] Amandeep Kaur Bhatia and Harjinder Kaur, "Security and Privacy in Biometrics: A Review", *International Journal of Scientific Research in Computer Science and Engineering*, vol. 1, no. 2, pp. 33-35, 2013.
[39] V.K. Jain and N. Tripathi, "Speech Features Analysis and Biometric Person Identification in Multilingual Environment", *Int. J. Sci. Res. in Network Security and Communication*,Vol.6, no. 1, pp. 7-11, 2018.

Authors Profile

*Mr. Manoj Mohan Gupta*pursed Bachelor of Science (Information Technology) from University of Mumbai, Mumbai, India in 2015. He is currently pursuing Masters Of Computer Applications from University of Mumbai, Mumbai, India.

Prof Uttara Athawale, Master of Computer Application, Master of Science (Mathematics) from Shivaji University, She is currently working as Assistant Professor in Bharati Vidyapeeth's Institute of Management and Information Technology, University of Mumbai, and has 16 years of teaching experience. She has published 5 research papers in reputed journals including IEEE explore and acm digital library. Her major research work area is image processing.

