International Journal of Emerging Science and Engineering (IJESE)
ISSN: 2319–6378, Volume-3 Issue-5, March 2015

An Approach for Human Identification by Ear Biometric System

P. Swapnil, Devesh Narayan, Sipi Dubey

Abstract*— Ear biometric for identification of human is quite complex task. It's use either uni-modal or multi-modal approach in order to authenticate a person. A uni-modal biometric system involves a single source of biometric to identify a person. This paper is based on uni-modal approach with ear as a biometric trait for recognizing a person. In this paper, an experimental approach is used for identifying a person based by their ear structure. As researchers suggest that ear is a physiological biometric that is quite reliable source of identifying human, we here, present the work related to this field of ear biometrics. Firstly, we will discuss about identification process of our ear biometric system that includes pre-processing, edge detection using canny edge detection method and then extracting farthest boundary points that form a maxline. Now this maxline is divided into multiple points to extract geometrical intersecting points on the outer edge. Then finally template matching is done for identification.

***Index Terms*— Biometrics, ear biometrics, canny edge detection, maxline and template matching.**

I. INTRODUCTION

A. Ear Biometrics

The advancement in technologies has led to an increasing demand of security. The authentication of individuals is necessary to maintain the security. Over the course of last decade, tremendous work is going on in the field of biometrics. Biometric systems perform identification and recognition of an individual on the basis of biometric characteristic, trait, or feature. The means of identification can be possession based like token or identity cards and knowledge based like password or code word. But there is possibility of hacking or sometimes forgetting password or providing fake information. The main steps involved in biometric systems are: enrollment, verification and identification. Ear biometrics is gaining high acceptance for human identification in high security areas. And it has been found from the research work that ear has a structure which does not change with facial expressions or time. Also ear biometric is convenient as their acquisition is quite easy and participation is not necessary, hence it can be used in passive environment also. The shape of the outer ear of every individual is unique and quite relatively unvarying with respect to time or age.

Manuscript Received on March 2015.

P. Swapnil, Computer Science and Engineering, Rungta College of Engineering and Technology, Bhilai, India.

Devesh Narayan, Assoc. Prof., Computer Science and Engineering, Rungta College of Engineering and Technology, Bhilai, India.

Dr. Sipi Dubey, Chairperson, Board of Studies, Computer Science and Engineering, CSVTU, Bhilai (C.G.), Professor in Department of CSE, at RCET, Bhilai, India.

B. Overview of proposed work

In the security areas, authentication of a person using ear biometrics by image processing has become a key issue for verification and recognition and it is gaining high attention due to its uniqueness, permanence and universality. So in this paper we present an implementation of the approach for human identification by using ear biometric. For this we take side face images and crop the ear portions manually and perform preprocessing the ear image by removing unwanted areas in the inside portions of the ear and then finding inner and outer edges of the ear by using Canny edge detection method. After this we need the boundary points that are obtained by finding a maxline and drawing normal lines that intersect the outer edge of the ear. The feature points of the subject are stored and then compared to that of input samples to identify the person.

II. SHORT LITERATURE REVIEW ON EAR BIOMETRICS

Ear act as a physiological biometric trait that is related to the shape of the body, and thus a challenging field for identification.

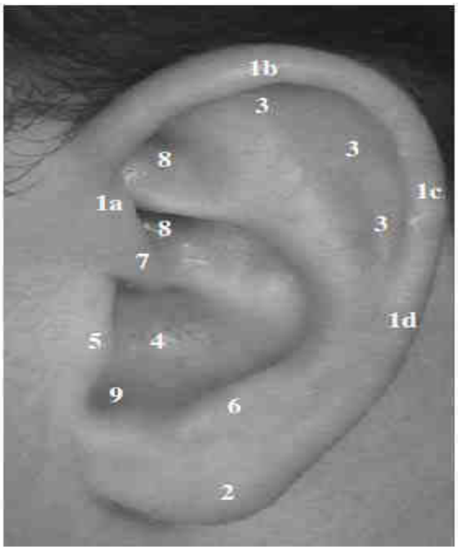


Fig. 1 Anatomy of Ear [9]

In 1949, Iannarelli developed the first recognition system based on ear biometrics based on 12 measurements by anthropometric technique for identifying human ear along with the analogy of the parts of the ear that can be used as parameters for feature extraction.

Ear act as a passive biometric that can be identified without active participation of the individual. Figure 1 shows the anatomy of the ear with label 1 Helix Rim, 2 Lobule, 3

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

Antihelix, 4 Concha, 5 Tragus, 6 Antitragus, 7 Crus of Helix, 8 Triangular Fossa and 9 Incisure Intertragica.

In the following section, we present a review on various techniques and methods used in the previous research work done in the field of ear biometrics:

In [1], it is revealed that ear shape and structure of outer ear are different for different human beings. Researchers have found that ear is an invariant and unique biometric trait that is least affected with factors like ageing or facial expressions. Ear is thus considered as a valuable means for personal identification especially used in criminal investigation or in surveillance areas. It suggested that future work can be done on multimodal recognition systems with gait & keystroke, ear & gait, or tri-modal system with gait, ear & keystroke recognition as biometric trait.

According to [2], ear is quite stable and robust to changes in facial expressions that makes it a relatively exploring field for biometric identification. Different means of identification can be: a) ear images, b) thermo graphic images of ear and c) ear prints that are retrieved by pressing ear against a flat paper. The technique of ear recognition is based on calculating and comparing distance among salient points on pinna from a particular location of ear.

[3] presents a survey on multimodal biometrics for identification and verification and elaborate the uni-modal system and their drawbacks that lead to the need of using multiple traits for identification and it suggests that it is better to use multiple traits in place of single biometric trait. It revealed the need for multimodal biometric system by highlighting the problems related to the uni-modal systems like noise in the data, non-particular and manipulating data. It discussed various fusion methods: rule-based, classification-base and estimation- based.

In [5] a robust and reliable feature extraction technique is developed for ear biometrics that is force field transform also called invertible linear transformation that consist of an array of Gaussian attractors acting as source of force field. The work is extended to include face recognition. It received a remarkable invariance to initialization with good noise tolerance. The contribution involves a force field transformation and the directional properties are taken into account to locate potential energy channels.

According to [6], ear is a class of biometrics that is not affected with facial expressions, or eye glasses or makeup. It introduced an approach to 3D ear recognition by a two- step Iterative Closest Point (ICP). The method involves iterative steps of detection of helix in 3D ear images followed by transformation applied to selected ear locations. For matching error criterion, root mean square (RMS) parameter is used. The experiments done on 3D ear of 30 subjects and achieved 93.3% recognition rate.

[7] proposed a new approach to 3D ear recognition by local surface patch (LSP) representation computed at feature points. A transformation is applied on selected location by ICP algorithm that iteratively works for refining the transformation. For experiments, UCR datasets of 155 subjects with 902 images of ear under pose variation and Univ. of Notre Dame dataset of 302 subjects are used. The cumulative matching performance (CMP) on UCR and UND datasets demonstrate the effectiveness of the proposed system with recognition rate of 96.4% on rank 1 and 98% on rank 2 UND dataset and 94.4% on UCR dataset.

[8] introduced a new ear recognition method in which Haar wavelet transform of level two is used for feature extraction. Classification is based on Euclidean distance measure. A database of 32 people is taken and it observed that recognition time varies in accordance with number of training images being used. The experimental results give 94.3% recognition rate.

[9] implemented the concept of multi-modal biometric by using face and ear to identify person. Different modules were evaluated and Principle Component Analysis technique and Euclidean distance were used. The fusion was done at the time of matching to obtain final score.

[10] presented work on the geometric feature by finding Euclidean distance and angles of the triangle made by joining the lines formed between the farthest end points and the ear boundary. An angle between the lines joining the midpoints of the maxline and the point of intersection on the ear curve are calculated and stored as feature vector.

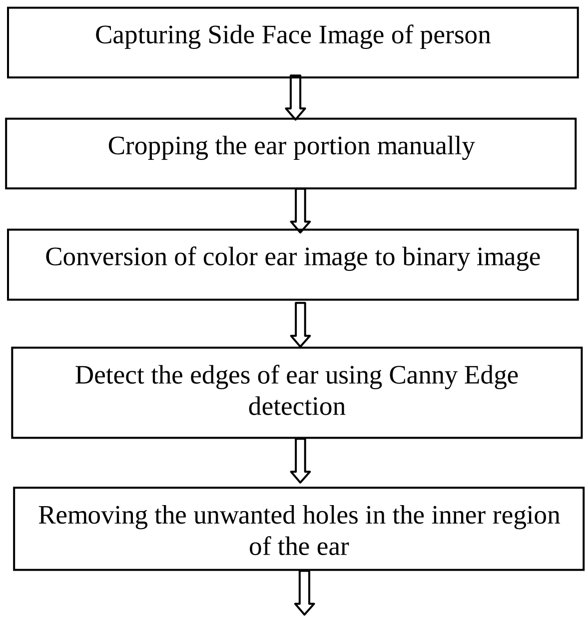
[11] implemented a technique based on the distance transform and templates by automatically locating the ear portions by computing skin and non-skin regions. A distance transform is calculated from the binary image using Euclidean distance approach. For verification, a shape analyzer based on Zernike moment is used for extraction of features from the ear.

[14] investigated the problem with Mid-wave infrared spectrum. For detection of ear they used AdaBoost framework and also they examined various feature extraction techniques and mentioned the drawbacks of thermal images.

III. METHODOLOGY

The proposed work involves various steps to recognize a person by extracting the feature points on the outer curve of the ear. In the previous work done, less number of feature points on the ear curve was calculated. Here in our work we focus on the extraction of more points on the outer curve of ear to obtain better results to identify a person.

The following flowchart shows the various steps to taken in our proposed methodology:



Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

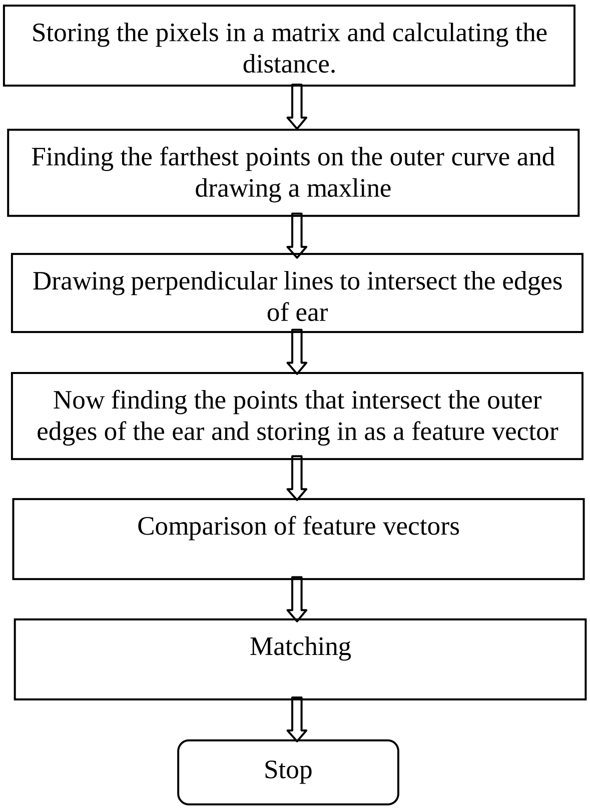


Fig. 2 Main flow diagram of proposed methodology

A. *Image Acquisition*

In this step a set of 5 side face images of the person were captured. For this a Digital camera of 5.0 megapixels was used and similar conditions of light were maintained in the room. These images were captured from the right side of the face. All the images were then saved in 'jpeg' format. And the distance between the subject and the camera is to be maintained between 25cm to 30 cm.

B. *Pre-processing*

After acquiring the side face images, the ear portions were manually cropped such that the crop handler was set to a resolution of 90 by 160 pixels.

Fig. 3 Cropped Ear images of the subject

Then the next step in preprocessing is conversion of color ear images to binary images. In the proposed methodology, the features of the ear include the outer edges points so for that we obtained the outer edge points by using Canny edge detection method with a threshold value of 0.33.This method finds the edges by finding local maxima of the gradient of the binary image and efficiently detects the weak edges of the outer ear. Our concern in this methodology is to work on the outer ear edges only so the holes found in the inner portions of the ear are to be removed by initially filling these holes and then removing them in order to get fine and smooth edges.

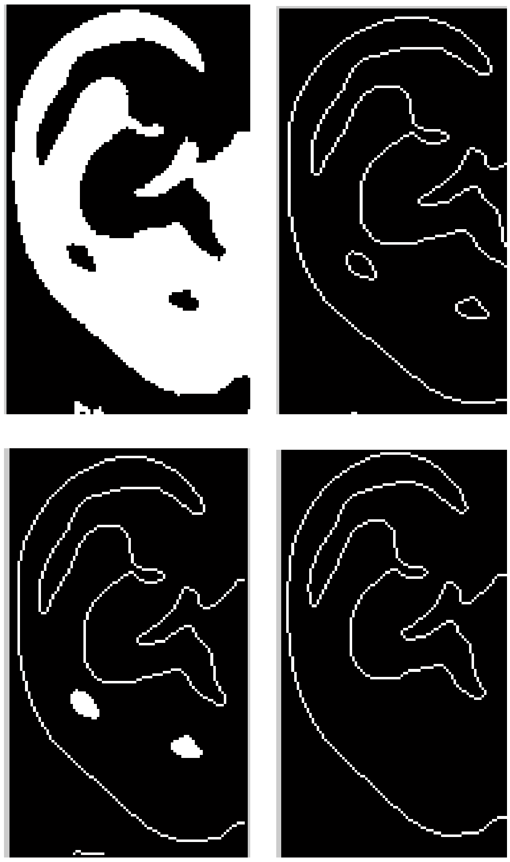


Fig. 4 Pre-processing of ear images

C. *Feature Extraction*

1) *Computing Label Matrix and distance between pixels of the matrix*

The ear images so obtained after preprocessing undergo feature extraction. In the proposed work, the outer ear edge points or the boundary points are extracted to find the feature points. To do so, we need a matrix that contains labels of the 8-connected points in the preprocessed image. This matrix contains elements with integer values 0 or 1 such that pixels with label 0 are the background whereas label 1 are the points or the object.

Now after getting the matrix we compute the pixels having label 1 and store them in separate matrix that contains the row and column values to get the boundary pixels. The matrix obtained so contains all 1s that means the white pixels in the binary image of the ear. Now we calculate the distance between the boundary pixels so obtained and store them in another matrix.

2) *Computing Maxline and drawing perpendicular*

Our aim is to find the points on the outer curve of the ear that are farthest from each other or we can say we need to find the farthest endpoints on the boundary curve which when connected forms a Maxline. The endpoints of the maxline are stored and then midpoint of this line is calculated to draw a perpendicular that intersects the outer curve of the ear.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

Fig. 5 Finding Maxline and drawing normal from the midpoint of the line.

3) Boundary Point Extraction & Matching

Finally we get the seven intersection points on the outer curve by the normal line shown in the figure given below as FP1, FP2, FP3, FP4, FP5, FP6 and FP7. These are stored and compared for identification.

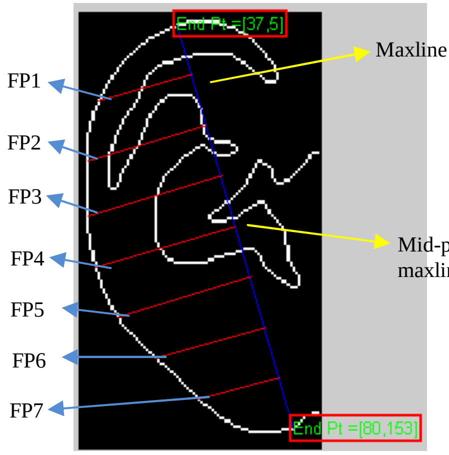


Fig. 6 Normal lines intersecting the outer curve of the ear

IV. EXPERIMENTAL RESULTS

In the front end we have used MATLAB with version 7.10.0 and the database consist of a set of 5 sample side face images of the subject which are saved in JPEG format. Then we manually cropped the ear part which is our desired area of interest and stored in a folder. Now we performed pre-processing, edge detection via canny edge method and find the farthest points having maximum distance, on the outer edge of the ear to draw seven normal lines from the maxline intersecting the outer boundary of the ear. These points are stored in a feature vector. The comparison of 4 input samples was done with 5 samples of the subject.

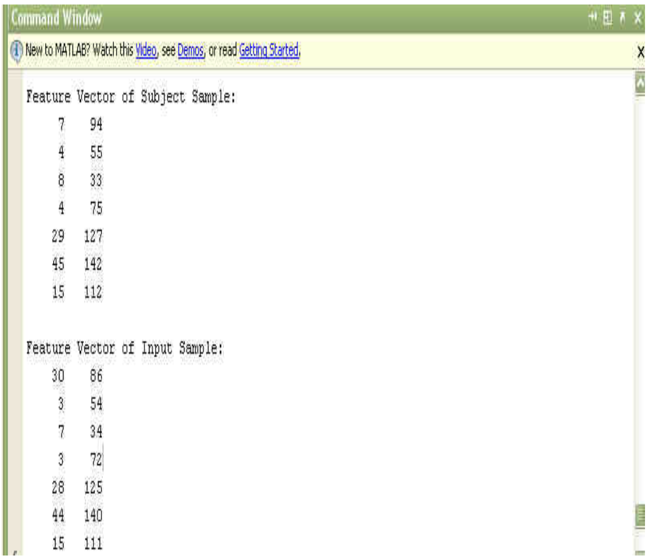


Fig. 7 Showing Feature vectors of subject and input samples consisting of seven feature points

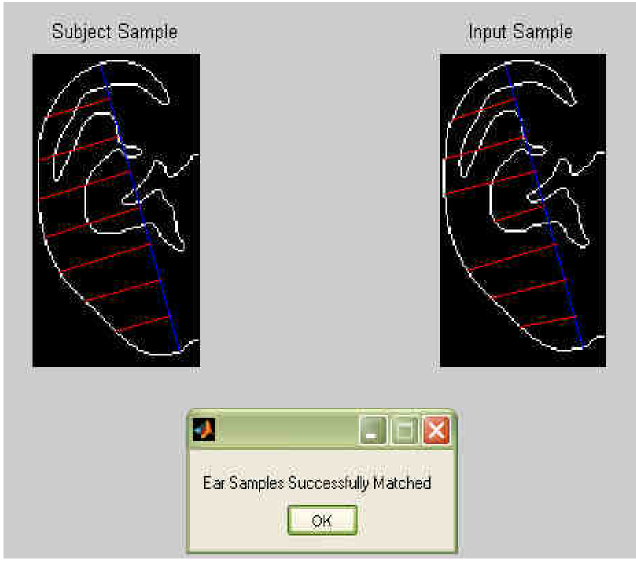


Fig. 8 Showing final matching result

We found that out of 4 input samples, 3 were matched successfully.

A. Advantages

In the proposed methodology, we have implemented a system that uses multiple feature points of the ear to enhance the possibility of matching with input samples. As we have focused mainly on the outer edge of the ear, so even for a low resolution image, our system will work to get feature points.

B. Disadvantage

Our system might not be able to work in case of occlusions such as ear rings, hairs or clothes on the ear. So it is required that ears must not be occluded.

V. CONCLUSION

The approach of our system is to extract multiple geometric features of the ear that are boundary points intersected by the normal lines drawn from the maxline by using canny edge detection and calculating farthest distance among the boundary pixels to give satisfactory results. But further improvement can be done by adding more features to identify a person.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

REFERENCES

[1] Human Computer Interpreting with Biometric Recognition System, Gajanan Pandurangrao, Khetri, Satish L.Padme, Dinesh Chandra Jain, IJARCSSE, Volume 2, Issue 12, December 2012.

[2] A Review on Biometrics and Ear Recognition Techniques, Sukhdeep Singh, Dr. Sunil Kumar Singla, Volume 3, Issue 6, June 2013, ISSN: 2277 128X

[3] Automated Biometric Verification: A Survey on Multimodal Biometrics, Rupali L. Telgad, Almas M. N. Siddiqui,Dr. Prapti D. Deshmukh, International Journal of Computer Science and Business Informatics, ISSN: 1694-2108, Vol. 6, No. 1. October 2013.

[4] A Review Paper on Ear Biometrics: Models, Algorithms and Methods, Khamiss Masaud, S.Algabary, Khairuddin Omar, Md. Jan Nordin, Siti Norul Huda Sheikh Abdullah, Aust. J. Basic & Appl. Sci. 7(1): 411-421,2013.

[5] A New Force Field Transform for Ear and Face Recognition, David J. Hurley, Mark S. Nixon and John N. Carter, IEEE, 2000.

[6] Contour Matching for 3D Ear Recognition, Hui Chen and Bir Bhanu, Proceedings of the Seventh IEEE Workshop on Applications of Computer Vision (WACV/MOTION'05) 0-7695-2271-8/05, IEEE.

[7] Human Ear Recognition in 3D, IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 29, No. 4, April 2007.

[8] Ear Recognition Using Wavelets, M. Ali1, M. Y. Javed and A. Basit, Proceedings of Image and Vision Computing New Zealand 2007, pp. 83–86, Hamilton, New Zealand, December 2007.

[9] Robust Multi-biometric Recognition Using Face and Ear Images", Nazmeen Bibi Boodoo, R K Subramanian, IJCSIS, Vol. 6, No. 2, 2009.

[10] The Human Identification System Using Multiple Geometrical Feature Extraction of Ear –An Innovative Approach, Jitendra B. Jawale, Dr. SMT. Anjali S. Bhalchandra, IJETAE, ISSN 2250-2459, Volume 2, Issue 3, March 2012.

[11] Ear Localization from Side Face Images using Distance Transform and Template Matching, Surya Prakash, Umarani Jayaraman and Phalguni Gupta, Proceedings of IEEE Int'l Workshop on Image Processing Theory, Tools and Applications, IPTA 2008, Sousse, Tunisia, pp. 1-8, Nov 2008.

[12] Ear Recognition for Automated Human Identification, Singh Amarendra and Verma Nupur, Research Journal of Engineering Science, ISSN 2278 – 9472, Vol. 1(5), 44-46, November (2012)

[13] Ear Biometrics: A Survey of Detection, Feature Extraction and Recognition Methods, Anika Pflug, Christoph Busch, , IET Biometrics, July 2012.

[14] On ear-based human identification in the mid-wave infrared spectrum, 2013, Ayman Abaza, Thirimachos Bourlai, Image and Vision Computing 31 (2013) 640–648, Elsevier.

[15] A Book on Biometric Technology Application Manual,(2008), National Biometric Security Project(NBSP).

P. Swapnil, completed B.E. in Information Technology from CSVTU, India in 2010. Currently persuing M.Tech in Computer Technology from CSVTU, India under the guidance of Mr. Devesh Narayan, Assoc. Prof, Dept. of CSE.

Devesh Narayan, received B.E. and M.Tech degree in CSE and Computer Technology from Amravati University and Pt. RSSU, India in 2000 and 2006 respectively. Currently persuing his Ph.D from CSVTU (C.G), India. He is currently woking as Assoc. Prof. in CSE Dept at RCET, Bhilai, India.

Dr. Sipi Dubey, appointed as Chairperson, Board of Studies, CSE, CSVTU, Bhilai(C.G.), India, presently working as Professor in CSE Dept. at RCET, Bhilai, India. Her qualifications B.Tech (Computer Technology), M.Tech (Computer Technology), Ph.D (CSE) from Pt. RSSU, Raipur, C.G., India in year 2010 in Image Processing. She also has experience in teaching with 16+ years.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.