ISSN: 2278-0181
NCSPC - 2016 Conference Proceedings

Multifeature Human Authentication using Score Level Fusion of Ear and Helix

S. Bhuvaneshwari, R. Gayathri and A. MariyaPrincy
Department of ECE
Sri Venkateswara College of Engineering

Abstract— **With the advancement of technology in every field, security can be enhanced by means of using biometrics through which a person can be uniquely identified. Distinguishing biological traits can be used as unique identifiers. Biometric identifiers should satisfy properties such as universality, uniqueness, permanence and collectability. Among various biometrics, ear biometric plays a vital role since it has a rich, stable and unique structure which varies among individuals even among twins, triplets, etc. Unlike other traits ear does not vary much with age and does not vary with any facial expressions. This paper deals with unique feature such as ear and tragus feature. Gabor filter can be used to extract the ear and tragus feature. Gabor filter is a linear filter which is used for edge detection whose representations are similar to human visual system. In this paper, ear and helix feature can be extracted at different frequencies and orientations using SIFT descriptor and Modified Hessian Transform which are then fused using score level fusion. Finally they are matched and classified using Artificial Neural Networks (ANN).**

Index Terms— Biometrics, biological traits, helix, SIFT descriptor, modified Hessian Transform and Artificial Neural Networks.

I. INTRODUCTION

Nowadays, with the advancement of technologies, authentication plays a major role. Hence authentication involves biometrics which deals with the authentication of the people based on their physiological and behavioural characteristics.

Ear biometric can be considered as one of the most important biometrics since it satisfies all the biometric characteristics such as universality, uniqueness, permanence and collectable in nature. They have rich and stable structure which will not change with any facial expressions and will change little with age.

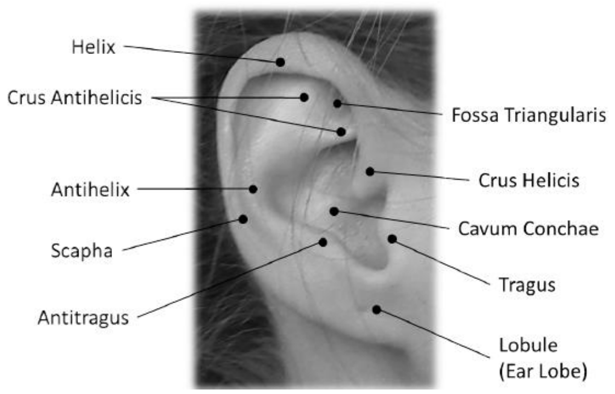


Fig. 1. various parts of ear

Various parts of ear can be shown in fig 1, in which shape of ear and helix are considered to be the region of interest.

II. RELATED WORKS

Many biometrics such as finger print, palm print, face, iris, retina, speech, etc. are available. Among these biometrics, ear biometric can be considered as one of the most unique, rich, stable and reliable.

In image processing, among various processing stages, feature extraction plays a major role. Some of the techniques used for the feature extraction are PCA (Principal Component Analysis) based which is suited for 2D images which provides limited performance under limited conditions [1]. We can go for some other technique like ICP (Iterative Closest Point) based approach which can be suited for 3D images which provides limited performance under some conditions [1],[2]&[3]. The above approaches are not robust. Hence we can go for the approaches which are robust. In this paper, techniques used are SIFT and modified Hessian transform which are robust, scale and rotation invariant. Generally SIFT gets used in pattern matching which can be used in a water marking method [7], in which it was robust to geometric distortions.

III. PROPOSED WORK

In this paper, we have proposed distinctive techniques such as SIFT (Scale Invariant Feature Transform) and modified Hessian transform for extraction of feature in which SIFT is used to extract shape of ear feature and modified Hessian transform is used to extract helix feature. Both the techniques are robust and scale invariant. Generally SIFT descriptor is used in image matching [4] and image search [5]. Here in proposed system, SIFT descriptor and modified Hessian transform are used to extract shape of ear and helix respectively. The proposed system is shown in fig 2, which consists of the following steps: ROI extraction, Pre-processing, Feature extraction, fusion, classification and matching.

In ROI extraction, shape of ear and helix gets extracted from original image. Pre-processing involves Gaussian filter which is done using Eq. (1) and its gets enhanced used image enhancement.

$$G(x,y) = \frac{1}{2\pi\sigma^2} \exp^{-\frac{(x^2+q^2)}{2\sigma^2}} \qquad (1)$$

where x, y are image coordinates and σ^2 is the standard deviation.

After pre-processing, extraction of feature takes place by using techniques such as SIFT descriptor and modified Hessian transform which are used to extract shape of ear and helix feature. Then next step is the fusion of ear and helix features using score level fusion.

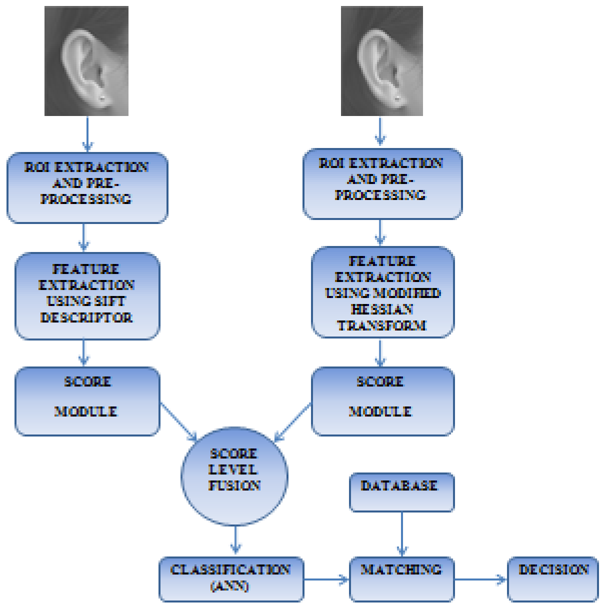


Fig. 2. Block diagram of score level fusion of ear and helix using SIFT descriptor and modified Hessian transform.

Finally classification and matching is done by Artificial Neural Network (ANN) classifier.

IV. METHODOLOGIES

The proposed system involves techniques such as SIFT descriptor and modified Hessian transform for feature extraction, score level fusion for fusion of shape of ear feature, ANN classifier for classification and matching which is shown in fig 2. This section involves the brief description of these techniques.

A. SIFT Descriptor

The SIFT is an algorithm which transforms an image into a large collection of local feature vectors. The steps involved in SIFT algorithm are illustrated in fig 3.

Generation of a SIFT feature point involves the following steps:

To extract the local features of an image, apply the difference-of-Gaussian (DoG) function to the host image. From which we can get the DoG filtered image which can be computed from the difference of two nearby scales separated by a constant multiplicative factor k, which can be computed using the Eq. (4).

$$DoG = (G(x,y,k\sigma) - G(x,y,\sigma)) * f(x,y) \quad (2)$$

$$DoG = G(x,y,k\sigma) * f(x,y) - G(x,y,\sigma) * f(x,y) \quad (3)$$

$$DoG = L(x,y,k\sigma) - L(x,y,\sigma) \quad (4)$$

where $L(x,y,\sigma)$ is the scale space of an image which can be defined as in Eq. (5).

$$L(x,y,\sigma) = G(x,y,\sigma) * f(p,y) \quad (5)$$

where $f(x,y)$ is the input image, * is the convolution operation in p and q, and $G(x,y,\sigma)$ is the Gaussian filter, which can be defined in Eq. (6).

$$G(x,y,\sigma) = \frac{1}{2\pi\sigma^2} \exp^{\frac{-(x^2+y^2)}{2\sigma^2}} \quad (6)$$

To detect the local maxima and minima of DoG, each sample point is compared to its eight neighbors in the current image and the nine neighbors in the scale above and below.

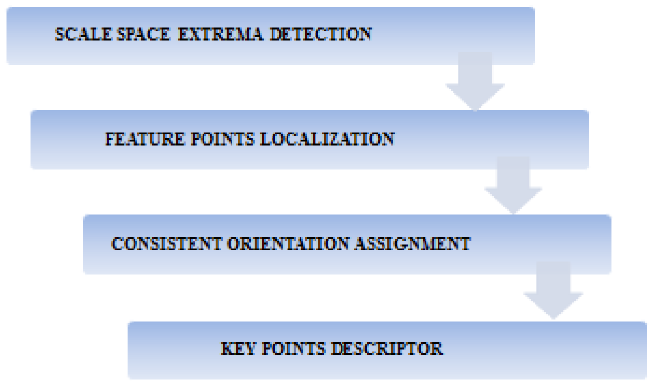


Fig. 3. Scale Invariant Feature Transform (SIFT) Algorithm.

The consistent orientation assignment can be done for the images of the candidates from whom the feature points are selected based on their stability [6]. The gradient magnitude, $m(x,y)$, can be given in Eq. (7) while the orientation , $\theta(x,y)$, can be given in Eq. (8).

$$m(p,q) = \sqrt{L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2} \quad (7)$$

$$\theta(x,y) = \tan^{-1}((L(x,yx+1) - L(x,y-1))/(L(x+1,y) - L(x-1,y))) \quad (8)$$

Create the feature point descriptor by measuring the gradient magnitude and orientation at each image sample point in a region around the feature point location.

B. Modified Hessian Transform

The Hessian matrix is a square matrix of second order derivatives of a scalar valued function. It describes the local curvature of a function of many variables.

Let λ_m denote the eigenvalue with the m_{th} smallest magnitude, for an ideal vessel-like structure in a 2-D image the eigenvalues should have the form as shown follows:

$$|\lambda_1| \approx 0 \quad (9)$$

$$|\lambda_2| >> |\lambda_1| \quad (10)$$

Two local characteristics of image can be measured by analyzing the above two equations. First, the norm of the eigenvalues will be small at the location where no structure information is shown since the contrast difference is low, and it will become larger when the region occupies higher contrast since at least one of the eigenvalues will be large. Second, the ratio between $|\lambda_1|$ and $|\lambda_2|$ will be large when the blob-like structure appears in the local area, and will be very close to zero when the structure shown is line-like.[10]

C. *Score Level Fusion*

In multimodal biometric systems, there are various types of fusion available such as feature level fusion, decision level fusion and matching score level fusion. Feature level fusion becomes more complex when more number of features involved, whereas decision level fusion does not provide much accurate output when compared to the score level fusion [8].

Matching score level fusion involves the following steps:

1. Measure and calculate the score value of each extracted feature.
2. Matching can be done by using the score of measuring the similarity of features between test image and trained image.
3. The matching scores can be fused with the help of the Normalization technique.

Based on the applications used, the normalization technique can be selected and used using table 1.

TABLE 1
VARIOUS NORMALIZATION TECHNIQUES WITH THEIR ROBUSTNESS AND EFFICIENCY

Normalization Technique	Robustness	Efficiency
Min-max	No	N/A
Decimal scaling	No	N/A
Z-score	No	High
Median and MAD	Yes	Moderate
Double sigmoid	Yes	High
Tanh-estimators	Yes	High

By using the normalized value, score level fusion can be done using various methodologies such as:

1. The Simple Product Rule.
2. The Simple Sum Rule.
3. The Simple Max Rule.
4. The Simple Min Rule.

Thus the score level fusion can be done using one of the techniques given above.

V. EXPERIMENT AND RESULTS

Many traits are available for human authentication in which ear can be considered as one of the most prominent biometrics using which the authentication can be done with more accuracy. Various steps are involved in the authentication process. They are as follows:

A. *ROI Extraction*

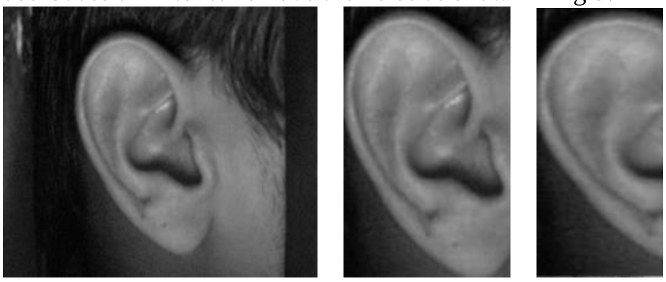
The raw image can be given as input to the system in which Region of Interest (ROI) can be extracted as shown in fig 4.

B. *Pre Processing*

There are various steps involved in pre-processing such as filtering and image enhancement.

1) *Filtering*

If any processing steps are affected by noise then we can use Gaussian filter to remove the noise as shown in fig 5.



(a) (b) (c)

Fig .4. (a) Original image and (b)&(c) ROI images of ear and helix respectively

(a) (b) (c)

Fig. 5. (a) Noisy image and (b)&(c) Filtered images

2) *Image Enhancement*

Various preprocessing steps are increasing contrast, brightness, etc which is known as image enhancement which is shown in fig 6.

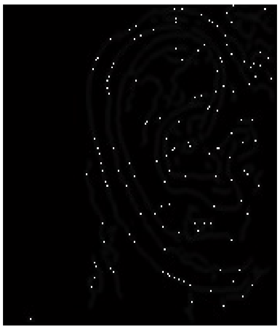
(a) (b) (c)

Fig. 6. (a) Original image and (b)&(c) Enhanced images of ear and helix

3) *Feature Extraction*

Ear and Helix feature gets extracted using techniques such as SIFT descriptor and modified Hessian transform. The edge detection is done by canny edge detector which is shown in fig 7a. The extracted feature using SIFT descriptor and modified Hessian transform are shown in fig 7b and 7c respectively.


(a)


(b)


(c)

Fig. 7. (a) Edge Detected Image, (b) SIFT descriptor image and (c) modified Hessian transform image

C. *Fusion,Classification And Matching*

Fusion is done using score level fusion. Since the performance of neural networks is as good as conventional statistical modeling [9], Artificial neural networks are used for classification and matching..

VI. CONCLUSION

This research deals with the Ear biometric, which can be considered as one of the most unique, reliable, invariant and effective techniques to authenticate the identity of the people. Here distinctive techniques are used for feature extraction. The scores of extracted features are calculated and gets fused using score level fusion which gets classified and matched using ANN classification.

The experimental result is carried out on IIT Delhi ear database. The research is to prove that the accuracy of the ear biometric authentication system using the above mentioned techniques in fused feature is better than the individual feature of the ear shape. Tragus feature can be considered as a part of the fusion to improve the performance and accuracy which can be done as a future work.

ACKNOWLEDGMENT

The authors would like to thank "Sri Venkateswara College of Engineering" to support well to do this work. The authors would also like to thank IIT Delhi to provide Database for this work.

REFERENCES

[1] Banafshe Arbab-Zavar, Mark S. Nixon, 'On guided model-based analysis for ear biometrics', Elsevier, Computer Vision and Image Understanding vol. 115, Dec 2010, pp 487–502.
[2] Ping Yan and Kevin W. Bowyer, 'Biometric Recognition Using 3D Ear Shape', IEEE transactions on pattern analysis and machine intelligence, vol. 29, no. 8, Aug 2007.
[3] Jyoti Joglekar, Shirish S. Gedam, and B. Krishna Mohan, 'Image Matching Using SIFT Features and Relaxation Labelling Technique- A Constraint Initializing Method for Dense Stereo Matching', IEEE transactions on geoscience and remote sensing, vol.52,no.9, Sep 2014.
[4] Zhen Liu, Houqiang Li, Liyan Zhang, Wengang Zhou and Qi Tian, 'Cross-Indexing of Binary SIFT Codes for Large-Scale Image Search', IEEE transaction on image processing, vol. 23, no. 5, May2014.
[5] Javad Haddadnia, Karim Faez and Majid Ahmadi, 'An Efficient Human Face Recognition System Using Pseudo Zernike Moment Invariant And Radial Basis Function Neural Network', International Journal of Pattern Recognition and Arti_cial Intelligence Vol. 17, No. 1, 2003, pp 41-62.
[6] Hae-Yeoun Lee, Hyungshin Kim and Heung-Kyu Lee, 'Robust image watermarking using local invariant Features', SPIE, Optical Engineering, vol. 45, no. 3, Mar 2006.
[7] Hyung Shin Kim and Heung-Kyu Lee, 'Invariant Image Watermark Using Zernike Moments', IEEE Transactions On Circuits And Systems For Video Technology, Vol. 13, No. 8, Aug 2003.
[8] Asmaa Sabet Anwara, Kareem Kamal A.Ghany and Hesham Elmahdy, 'Human Ear Recognition Using Geometrical Features Extraction', Elsevier, 2015.
[9] Sonali. B. Maind and Priyanka Wankar, 'Research Paper on Basic of Artificial Neural Network', International Journal on Recent and Innovation Trends in Computing and Communication, vol. 2, Jan 2014, pp 96-100.
[10] Yingbo Zhou and Ajay Kumar, 'Human Identification Using Palm-Vein Images', IEEE Transactions On Information Forensics And Security, Vol. 6, No. 4, Dec 2011.