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Fusion of shape of the ear and tragus – A unique feature extraction method for ear authentication system

K. Annapurani [a,*], M.A.K. Sadiq [b], C. Malathy [a]

[a] Department of Computer Science and Engineering, S.R.M University, Chennai 603203, India
[b] Department of Information Technology Ministry of Higher Education, Oman

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ABSTRACT

In the current scenario to access the data securely from wireless network, e-commerce and internet have become a great concern. As the technologies become commercialized in high markets growth, there is a need for effective and secure implementation to authenticate the identity of the people. Several biometric techniques that exploit physiological and behavioral traits of people have been developed for verification and identification of the individuals to make the system more reliable and secure. In this paper a unique method is used to extract the tragus feature of the ear. The proposed method used is an enhanced edge detection method. A line is drawn connecting the maximum coordinate, midpoint and the minimum coordinate. The mid region of this line gives the tragus of the ear. The ear feature tragus is taken because it is almost free from occlusions. In order to develop an efficient ear authentication system the feature level fusion is applied. The shape of the ear is also extracted. Then the tragus and the shape of the ear are combined together to form the fused template. The authentication rate of the system with the features of tragus, shape of the ear and the fused template is calculated using the Hamming distance technique and Euclidean distance method. The experimental result is carried out on two databases of IIT Delhi ear database and Mathematical Analysis of Images (AMI) ear database including occlusion. The proposed system is to prove that the accuracy of the ear biometric authentication system using Hamming distance technique in fused feature is better than the individual feature of tragus and the ear shape. When a single feature tragus is considered tragus is better than the ear shape as it is a unique feature of the ear.

1. Introduction

Nowadays security has become a main concern in all the fields. In general day to day activities like accessing credit cards or logging into the system to access the information proving the validity of the user is must. In traditional methods passwords or secret codes are given which is difficult to remember if the password is too strong. If the password is smaller it is not much secure. Alternate system is biometric authentication refers to establishing identity based on the physiological and/or behavioral characteristics of an individual such as face, fingerprint, iris, ear, voice, keystroke, etc (Jain et al., 1999). Biometric systems are inherently more reliable than password based authentication as biometric traits cannot be lost or forgotten, difficult to copy, share, and distribute. It is difficult to forge biometrics. A biometric based authentication scheme is a powerful alternative to traditional authentication schemes (Jain, Ross, & Pakanti, 2006). Pflug and Busch (2012) in their survey paper discuss almost all works related with identification of the persons expect few papers on authentication and hence in this work we have gone for authentication which is the prime concern in terms of security aspects. Ear trait is taken in this paper to authenticate the person.

1.1. Motivation and related work

Human ear trait is one of the most appealing factors in the biometric verification market because of its stable structure, which varies little with age (Iannarelli, 1989). It is passive in nature; active part of authenticator is not needed. Ear biometrics has the four properties for a potential biometrics: universality, uniqueness, permanence and collectability. Ear does not suffer from changes in facial expression. The feature of the tragus is considered in our work because it is the part of the ear which is free from occlusions like ear rings, hair, spectacle handle and hat.

Unimodal biometrics system relies on a single biometric where as multimodal biometrics relies on two or more biometric traits for

* Corresponding author.
E-mail addresses: annapoorani.k@ktr.srmuniv.ac.in (K. Annapurani), a_k_sadiq@yahoo.com (M.A.K. Sadiq), malathy.c@ktr.srmuniv.ac.in (C. Malathy).

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identifying or verifying the person. There are three fusion levels in multimodal biometrics: feature level, matching score level and decision level (Ross & Jain, 2003). Inter-level fusion is the combination of different biometric traits, Intra-level fusion is the fusion of different feature sets of the same biometric traits. The feature level fusion contains more information than matching score level fusion (Malathy, Annapurani, & Sadiq, 2013). In an ear detection approach template matching with shape index histograms of detection rate 91.5% is described by Chen and Bhanu (2005a, 2005b). Later stage they detected ear images using helix shape model with the detection rate of 92.6% (Chen & Bhanu, 2005a, 2005b). Ansari and Gupta (2007) discuss the edge detection and curve estimation with a detection rate of 93.34%. Ear localization and feature extraction based on edge orientation pattern of 100% detection rate is discussed by Jeges and Mate (2007). New segmentation approach of detection rate 98.05% for ear recognition using edge detection and line tracing is described by Attarchi, Faez, & Rafiei, 2008. Kumar, Hanmandlu, Kuldeep, and Gupta (2011) propose automatic ear detection using edge images and active contours with a detection rate of 94.29%. Ear recognition of 93.3% recognition rate is proposed by Lu et al. (2006) use the active shape model for extracting the outline of the ear. Prakash and Gupta (2012) discuss the efficient ear localization technique using categorization of edges into convex and concave with detection rate 96.63%. But in all these methods the size of the database varies and only detection and recognition rate is carried out. Mamta & Hanmandlu, 2013 discuss about the ear authentication using Local Principal Independent Components an extension of PCA (Principal Component Analysis). In our work ear authentication is done using the new feature extraction technique. It is an enhanced edge detection technique which is used to extract the feature of tragus and classified using Hamming distance and Euclidean method. This is a biometric authentication system based on the local and global features of the human ear, a feature level fusion system. A biometric approach to personal authentication using ear features of global, the shape of the ear and local feature, the tragus of the ear is extracted, using the new feature extraction technique for both shape of the ear and tragus. Both the features are concatenated to form a fused template. Hamming distance technique and Euclidean method is applied to authenticate the person with the features of shape of the ear, tragus and the fused template. The authentication process is divided into the following phases: preprocessing with the normalization technique, median filtering and adaptive histogram equalization techniques, extracting features using a new feature extraction algorithm which extracts the shape of the ear and tragus of the ear including occlusions. Template is generated fusing the landmark of tragus and the shape of the ear. The matcher module compares the extracted features with the features from the enrolled template to generate the decision of whether the person is who he claims to be. Matching based on Hamming distance and Euclidean distance is performed. The performance analysis of the system is done using False Acceptance Rate (FAR), False Rejection Rate (FRR); accuracy and verification rate for the features of shape of the ear, tragus and the fusion of both features.

1.2. Literature survey on ear based authentication

The anatomy of the ear is shown in Fig. 1. Pflug and Busch (2012) provided a survey on ear biometrics and given the anatomy of ear.

Burge and Burger (1998) developed an ear biometric system in which from a Voronoi diagram of the ear curves modeled individual ears with an adjacency graph. Again Burge and Burger (2000) gave a follow-up study to demonstrate ear biometrics as passive identification system. Yuan, Mu, and Xu (2005) discuss the feasibility of ear and biometrics and various recognition methods.

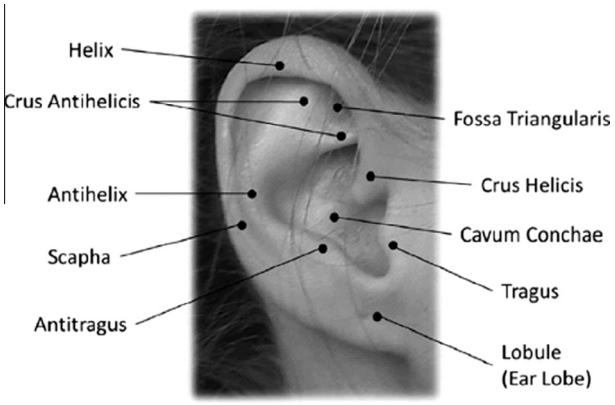

Fig. 1. Anatomy of ear.

Hurley, Arbab-Zavar, and Nixon (2007) performed ear recognition using force field feature extraction. Yan and Bowyer (2007) with 2D color images and 3D range information of the human head profiles developed an automatic ear biometric system. Chen and Bhanu (2007) also used 2D and 3D face – profile images and ear detection by a two step alignment. Rahman, Islam, Bhuiyan, Ahmed, et al. (2007) have described a system that tracks and detects ear features simply and robustly. Arbab-Zavar and Nixon (2011) have done their recent study of ear biometrics for machine vision approach. Abaza, Ross, Hebert, Harrison, and Nixon (2013) provided a detailed survey of ear detection and recognition and also have discussed about the various databases. Islam, Davies, Bennamoun, and Mian (2011) also developed a 3D ear detection and recognition system. Prakash and Gupta (2012) have discussed about the automatic localization of ear from side faces. Mamta and Hanmandlu (2013) developed an ear based authentication using Local Principal Independent Component. The presence of elements like beards, glasses, hats or ear rings introduces high variability in the ear images which are known as occlusions. Even the ambient conditions and different cameras can affect the system. In this paper we have developed an ear authentication system in a different approach using unique feature extraction and fusion of the feature and shape of the ear. Ear samples with occlusions are considered.

2. Proposed feature level fused ear biometric authentication system

In this work, ear is taken as the biometric trait, local and global features are extracted and the two features are combined together to form a fused template which is used to authenticate the person. The Fig. 2 shows the feature level fused ear biometric system. It consists of preprocessing stage, feature extraction of shape of the ear, feature extraction of the tragus, fusion of shape of the ear and tragus and the authentication stage.

2.1. Preprocessing stage

Preprocessing is the phase in which the input is processed according to the need of the next stage. Here the images from the database does have proper brightness and are with occlusions like hair with which it is difficult to extract the required features. Preprocessing is done in three steps. First normalization of the pixels of the ear image is found. Due to normalization each pixel is obtained. It is averaging pixels of the image. Next median filter is applied which eliminates the noises of the image. Then adaptive histogram equalization is used. It improves the contrast of