Preprocessing and Feature Extraction in Ear Biometrics

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Abstract
Ear feature extraction is a crucial step of ear biometrics. Image preprocessing and normalization of ear image are very important steps of ear feature extraction but Ear recognition system still facing the problem of noise on the ear image. In this paper we have implemented a simple method to extract ear features using two feature extraction methods i.e., Radon feature extraction and a Texture based feature extraction technique using RLBP method and we have used KNN classifier in the recognition. For this we use MATLAB as a processing tool. We did image preprocessing to remove unwanted information of ear images, and also performed steps like image segmentation and feature extraction to get desirable shape of ear for ear recognition system purpose. By comparing the accuracy of two feature extraction techniques we could determine which technique gives better recognition.

Keywords
Segmentation, Preprocessing, Feature Extraction, Radon transformation, Texture feature extraction, RLB, KNN Classifier.

I. Introduction

Ear Biometrics is latest trend in biometric technology. Ear biometrics has attracted attention of many researchers in recent years.Ear Biometrics is a technique of identifying, verifying, and comparison of person on the basis of typical physiological Structure of ear. Ear biometric is used in human identification and verification. There are three ways of ear biometrics recognition Using ear photographs, ear prints and thermograph picture of ear image . Common method of biometrics is by taking photographs of ear image. Ear biometrics is preferred over face biometrics as shape and outer structure of ear is unique for each for each individual, outer structure of ear is permanent. Features of ear are fixed causes less time preprocessing work and saves time in preprocessing. In general ear biometrics system consists of following steps:

1. Ear sample capture and preprocessing
2. Feature extraction of Ear
3. Storage
4. Comparison of Ear shapes.

Out of these four steps Image preprocessing and Ear feature extraction are major steps. Ear Recognition system has to face problems due to improper capture of images. Blurred image does not give good result. Noise generated due to hair occlusion and improper lighting are also the problems. We are going to work for image processing and feature extraction in order to increase the accuracy in feature extraction.

II. Application of Ear Biometrics

Ear Biometrics is used for application in:

- Security purposes in banks, ATM or for getting access in highly secure areas.
- For any active identification.
- In forensics to solve a crime if there is picture of ear in the tape of CCTV camera.
- Class attendance system.

III. Related Works

A. Significant Feature Selection Techniques

Pudil P et al. (1995) proposed an feature selection algorithm about the class conditional densities. Bins J et al. (2001) worked on a three step feature selection algorithm which was more effective in reducing the large feature set to about 5% of its original size with a small information loss. The proposed three step algorithm used a RELIEF filter to reduce irrelevancy, K-means clustering to reduce redundancy and a standard combinatorial feature selection algorithm. The RELIEF filter will assign relevance values to training features and the irrelevant features were filtered out. This three step feature selection algorithm was found to be robust in the presence of noise.

Dy JG et al. (2004) explained the need for feature selection and proposed a new feature selection technique called Feature Subset Selection using Expectation-Maximization (EM) clustering (FSSEM). Two performance measures namely scatter separability and maximum likelihood were used for evaluating the resultant feature subsets. Yet this research paper opened up scope for the development of algorithm which selects a new feature subset for every cluster.

A robust feature selection technique was proposed by Lai PH et al. (2008) for a new biometric using cardiovascular signals and this technique consisted of quantification of data distribution across persons, quantification of distinguishability & instability of every feature per person and finally selection of robust features. It was found that the EER with robust feature selection was less than 10%.

Feature selection algorithms were proposed for specific biometric modalities including Kanan HR et al. (2008) and Xiao L et al. (2013) for face recognition and cross-sensor iris recognition respectively. Song et al. (2010) investigated about feature selection using Principal Component Analysis (PCA) and experimented this for face recognition. It was established that PCA based feature selection is effective in reducing the dimensionality of features without any reduction in recognition accuracy.

Huang K et al. (2008) explored wavelet based feature selection by investigating the statistical dependence between different sub bands separately. Kanan HR et al. (2008) developed a feature selection method based on Ant Colony Optimization (ACO). Unlike conventional ACO based feature selection approaches, classifier performance and feature vector length were the prominent parameters in this feature selection technique.

B. GA Based Feature Selection Techniques

Altun AA et al. (2008) presented Genetic Algorithm (GA) based feature selection of iris features and fingerprint features in a multi-sensor multi biometric recognition system.

The combined features from iris and fingerprint sensors were optimized using GA with above parameters and the optimized features were trained using ANN. The training time was reduced four times in the case of GA optimized features when compared to actual features. It was observed that the reduction in training time took place without any loss in performance.

Ludwig O et al. (2009 & 2010) proposed feature selection methodology based on Genetic Algorithm which was intended for supervised learning. The proposed methodology consisted of three training algorithms, two based on back propagation networks & Maximum Margin (MM) and the third based on mutual information. The third approach of GA and mutual information based feature selection contributed the best framework of the above two by constructing a neuron model with neurons extracted from previously trained networks of MICI, MMGDX and LM. The resultant neuron model was termed as Assembled Neural Network (ASNN). The time complexity and space complexity of training in all these three algorithms were reduced by factors of 3 and 2 respectively when compared to the normal SVM based training.

IV. Methodology

Effectiveness of a biometric recognition system depends on preprocessing and feature extraction techniques employed in it. Although the pre-processing technique used is independent of the recognition approach, the feature extraction and biometric template generation techniques are consistent with the recognition approach. The work is to be done with IIT Delhi database. The database provides 3 to 6 images of same person's Right and Left ear. The Procedure starts with training a set of images. The trained set of image is arranged in such a way that each folder consist of subset with two images in Left and Right each named as 001_1,000-2 in Left and 001_3,001_4 in right folder. Similarly 25 set of datasets with 4 images in each folder of 100 images is arranged and is trained. The training process includes preprocessing and implementing two methods of feature extraction and KNN classifier in recognition part. An testing folder with about 46 images from same database is used for further steps and thus we can determine the accuracy of two feature extraction technique. And finally with the rate of accuracy we can determine the better feature extraction technique.

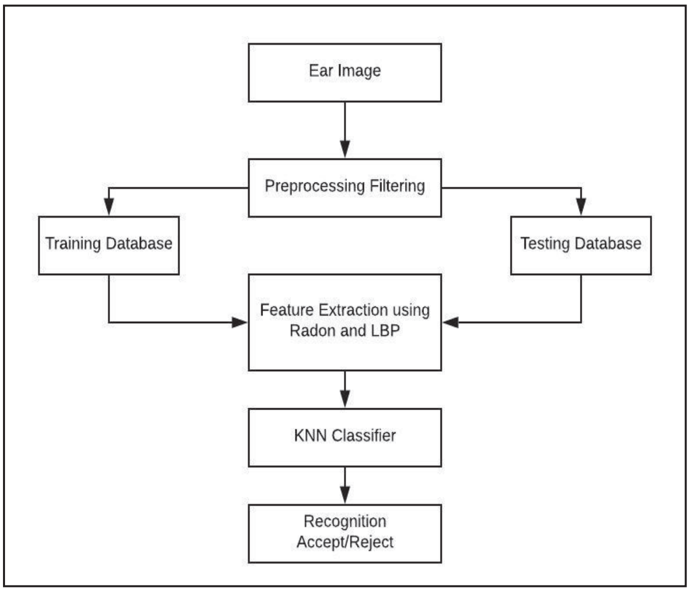

Fig. 1: Overview of Work

A. Image Preprocessing

Initially the image is taken from IIT delhi database set. Ear image size normalization and ear image processing are the prerequisite for our proposed ear feature method. Image processing is done to remove unwanted information from ear image, recovery of important feature and strengthening of information to increase rate of extraction.

Here image is resized to fixed size it includes steps like:

- Image enhancement
- Image filtering
- Image segmentation and Edge detection

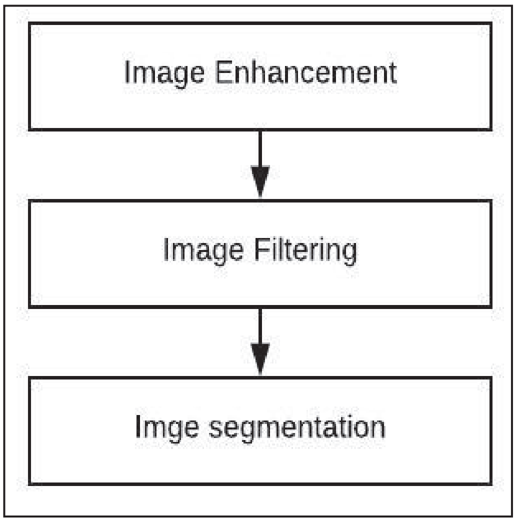

Fig. 2: Preprocessing Steps

1. Image Enhancement

It is process to adjust the images to get suitable structure of ear image Adjustments includes change in intensity adjustment and contrast adjustment. Contrast enhancement is done by scaling all images by constant k to get enhanced version. We did contrast with the histogram equalization method .Generally histogram of image is the graph which gives the distribution of image intensity and its count.This distribution of image intensity helps to analyse image quality .In histogram of image x- axis indicates intensity level and y-axis indicates number of pixels in the image. Histogram equalization adjustes image intensity for enhancement purpose. Then image cropping and gray scale enhancement is done and then we proceed to towards image enhancement.

2. Image Filtering

Removal of unwanted noise and sharpening of contrast of image is done using median filter. Median Filter seperates the noise features such as prominent lines and edges .Instead of taking average of pixels in image this filter take median value.

3. Image segmentation

It is a technique to partition digital images into multiple segments ie set of pixels. Image segmentation is done to get region of interest of the ear image .In feature extraction process ear outer image is necessary .In this work we have used thresholding as a simplest method of image segmentation. In thresholding method threshold value T is used to convert grayscale image to binary image. To extract objects from the background image is to select threshold value T which is minimum value.If intensity goes above T value then image appear as white.

B. Feature Extraction Method:

Radon Transform:The reduced features of ear image can be formed using the Radon transformation to extract the directional features of an image. The Radon transform is a line integral and computes the projection of the image matric to detect the local features of an edge. The pixel intensity values of the image given is the projection of the image intensity along radial line at different orientations.It transforms the 2D image with lines and converts the rotation of f(x,y) into translation of R(r,θ) and based on the parameterization of straight lines.

aThe Radon transform of 2 D function f(x,y) is defined as

$$R(r,\theta)=\iint f(x,y)\,(r\text{-}x\cos\theta - y\sin\theta)dxdy$$

Where r is the perpendicular distance of a line from the origin and θ is the angle between the distance vector and x-axis.The mean value of the white noise is zero and the Radon transform improves the signal to noise ratio.The main key feature of the radon transform is the ability to extract lines from noisy images.It is feasible to evaluate the Radon transform of any rotate,translate, and scaled image as knowing the radon transform of the original image and the parameters of the transformation applied to it.

RLBP is a method for texture feature extraction.An important property of a feature descriptor is to be robust against image rotations which is not supported by the basic LBP descriptor.The first rotation invariance attempt for the basic LBP descriptor is introduced in pietikamen ojala andxu.

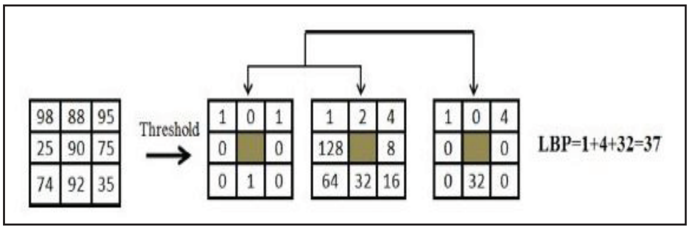

Fig. 3: Basic LBP computation for a 3*3 Image Patch

First we obtain the binary patterns of the threshold neigbour around the centre pixel represented as 8 bit strings in clockwise direction.Then an arbitrary number of binary shifts is made until the pattern matches one of the 36 possible patterns of "1" and "0" an 8 bit string can form under rotation.The matching pattern index is returned as feature value describing a rotation invariant LBP of this particular neighbourhood.Even though the descriptor inherits some of the LBP properties such as invariance to monotonis gray scale variation computationaly efficient and produces shorter histogram than the basic LBP operator.However the RLBP descriptor is found to give poor discriminative ability even for rotated images.This is attributed to two main reasons first quantizing the angular space at restricted 45 intervals.Second varying the frequency of occurance for the 36 RLBP patterns.

C. KNN Classifier

The Euclidean distance metric is often chosen to determine the closeness between the data points in KNN. The distance is assigned between all pixels in above dataset. Distance is defined as the Euclidean distance between two pixels. The Euclidean distance is given by:

$$D(X,Y)=\sqrt{(x_1-y_1)^2 \dots\dots\dots\dots (x_n-y_n)^2}$$

This Euclidean distance is by default in a KNN classifier. But the distance between two features can be measured based on one of the distance cosine and correlation.

K-NN Algorithm

The k-nearest neighbour algorithm (k-NN) is a method for classifying objects based on closest training examples in the feature space. K-NN is a method of instance-based learning, or lazy learning where the function is only approximated locally and all computation is deferred until classification. The k-nearest neighbour algorithm is the simplest method of all the machine learning algorithms: an object is classified by a majority vote of its neighbours, with the object being assigned to the class most common among its k nearest neighbours (k is a positive integer, typically small). If k = 1, then the object is assigned to a class of its nearest neighbour.

1. Each data pixel value within the data set has a class label in the set, Class = {c1,..., cn}.
2. The data points, k-closest neighbors (k being the number of neighbors) is then found by analyzing the distance matrix.
3. The k-closest data points is then analyzed to determine which class of label is the most common among the set.
4. The common class label will be then assigned to the data point being analyzed.

We have implemented two methods of feature extraction for ear database in frequency domain using Radon Transformation and texture feature extraction using RILBP and further recognition is done using classifier named KNN classifier .On calculating the rate the Radon Transform gives more accurete result as compared to RILBP method.

V. Experimental Result:

Our approach is implemented is in MATLAB R2014a. The approach is evaluated on the widely used dataset of IIT delhi ear database. It includes 471 ear images of 121 different subjects with at least three ear images per subject. We use Ear images of 25 persons each with two images for right and Left side (100 images) for the training set and all these images are trained with necessary Preprocessing and Feature extraction Techniques. The evalutation of the system is carried out with the help of a testing database with 46 images. The image is Preprocessed and Features are extracted and the recognized image is obtained.

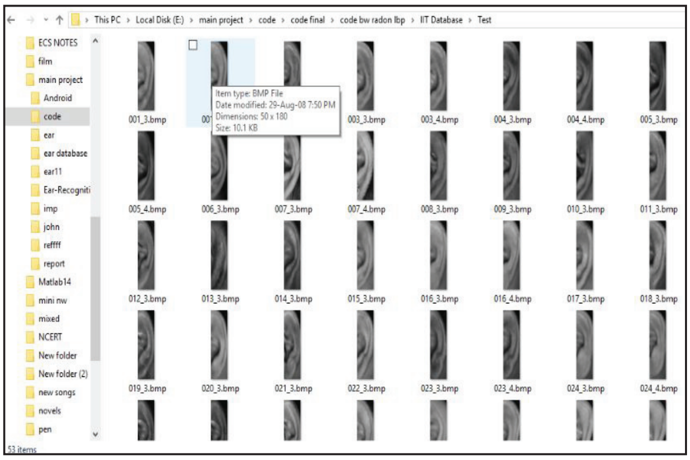

Fig. 4: Testing Data Set

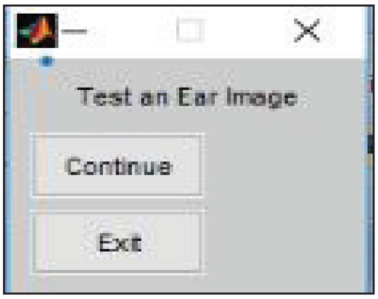

Fig. 5: Dialog Box for Test Image Selection

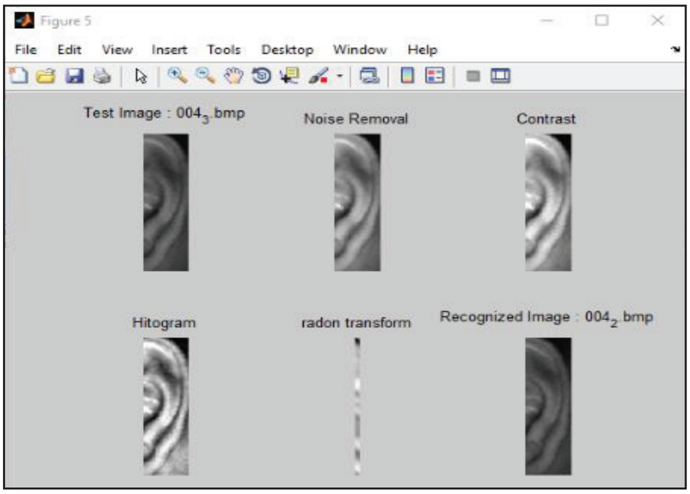

Fig. 6: Ear image Recognised using Radon Transform

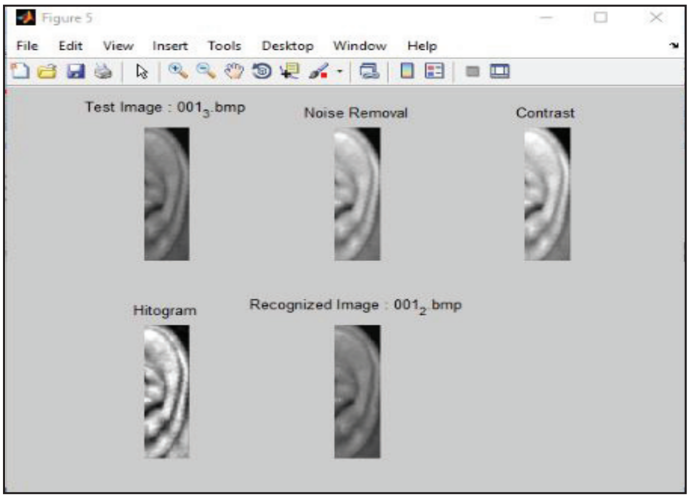

Fig. 7: Ear Image Recognized using RILBP

SL NO	METHODS	NO OF TESTING IMAGES	RECOGNITION RATE	EXECUTION TIME
1	KNN Classifier+ Radon Transformation	46	96%	low
2	KNN Classifier+ RILBP	46	92%	High

Fig. 8: Performance Comparison

On evaluating the working of two feature extraction techniques in the database set the Radon Transform works better with high accuracy than the RLBP Texture feature extraction

VI. Conclusion and future work

This chapter summarizes the major important facets of the present research work. In general, it is concluded that the proposed human recognition methodology using ear biometrics by extracting Features by Radon Transform and RILBP , is really a potential technique. The present investigation is summarized as follows: Various conventional ear recognition techniques were discussed in section III. Their pros and cons were also listed out. The necessity to propose a new feature extraction technique for ear recognition is also emphasized in this work. The Biometric system can be built either as a verification or an identification system depending upon the application .The effectiveness of the proposed ear biometric recognition methodology is tested using one of the benchmark ear databases, IIT Delhi ear image database. Biometric data to be trained and tested is put into separate datasets .Ear images in the training, test datasets are preprocessed before extracting feature from them. The size of ear images in the IIT Delhi ear database version (1.0) is 272*204 pixels .We have implemented two feature extraction technique to testing datasets containing 46 images in which Radon Transformation extracts the feature better than Texture based feature extraction. Preprocessing is done on the ear images of all the three of testing training and recognition phases to segment out the desired Region-Of-Interest (ROI). Recognition of ear images in test and evaluation datasets are carried out by constructing classifier based on KNN classifier. The classifier is tested using Euclidean distance. On working with these feature extraction technique the Radon feature extraction gives more accuracy rate as compared to RILBP.

As a future work the proposed ear biometric recognition system is developed to recognize human based on ear biometric images which are still, it is also suggested to extend the efficiency of the proposed ear biometric recognition system for security, intelligence work etc. The classifiers such as SVM, Neural Network classifier, multi class classifiers can be used for this purpose. If the classifiers were trained they can exactly recognizes the person. Various feature extraction technique can also be implemented like UMRT etc

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