Abstract

Ear biometric recognition is used in a lot of applications as person identification in criminal cases, investigation, and security purpose. Feature optimization stage has an important role for accuracy of correct recognition. Gabor filter have a problem of high dimension and high redundancy. Sampling filter is a problem of not reducing features optimum way. In the proposed Gabor feature extraction technique the Gabor features are filtered using proposed mean filter and obtained optimum features for ear biometric dataset.

1. Introduction

Authentication of a person's identity is a very old but challenging problem. There are three common ways which are used for authentication

(i) Possessions, like cards, badges, keys.
(ii) Knowledge, like user id, password, Personal Identification Number.
(iii) Biometrics like fingerprint, face, ear.

Compared to the other biometric technologies, such as ear, speech and fingerprint recognition, ear recognition can be considered as the most reliable form of biometric technology, because ear is a unique identity of a person.
1.1 Elements of Ear Recognition System

- The **acquisition** module obtains a 2D image of the ear using a monochromatic CCD camera sensitive to the NIR light spectrum.
- The **segmentation** module localizes the ear’s spatial extent in the ear image by isolating it from other structures in its vicinity, such as the sclera, pupil, ear lids, and ear lashes.
- The **normalization** module invokes a geometric normalization scheme to transform the segmented ear image from Cartesian coordinates to polar coordinates.
- The **encoding** module uses a feature-extraction routine to produce a binary code.
- The **matching** module determines how closely the produced code matches the encoded features stored in the database.

Real-world ear recognition applications have been implemented for airport and prison security, automatic teller machines, authentication using single sign-on, to replace ID cards, and to secure schools and hospitals.

Here this paper proposes a methodology to recognize online ear with a better accuracy. This paper contains related work, methodology of the ear recognition system, experimental analysis, conclusions in the next section.

2. Methodology of Ear Recognition

The basic methodology of ear recognition includes following stages:-

3. Related Work

This section summarises the state of the art in automatic ear detection in 2D images, respectively. Basically all ear detection approaches are relying on mutual properties of the ears morphology, like the occurrence of certain characteristic edges or frequency patterns.

The first study is made by Alfred Iannarelli at 1989[3], when he gathered up over 10,000 ears drawn from a randomly selected sample in California and found that they all were different, and the second study examined fraternal and identical twins, in which physiological features are known
to be similar. There are also persons in crime laboratories that assume that the human external ear characteristics are unique to each individual.

### 3.1 Gabor Filter

This section describes Gabor filters and the proposed Gabor feature extraction of input ear images.

A Gabor filter is a complex exponential modulated by a Gaussian function in the spatial domain. A Gabor filter can be represented by the following equation [6]:

\[
\Psi (x, y, \lambda, \theta) = \frac{1}{2\pi \sigma_x \sigma_y} e^{-\frac{1}{2} \left( \frac{x'^2}{\sigma_x^2} + \frac{y'^2}{\sigma_y^2} \right)} e^{ij \pi \lambda'/\lambda}
\]

where \((x,y)\) is the pixel position in the spatial domain, \(\lambda\) is the wavelength (a reciprocal of frequency) in pixels, \(\theta\) is the orientation of a Gabor filter, and \(\sigma_x, \sigma_y\) are the standard deviation along the x and y directions respectively. The parameters \(x\) and \(y\) are given as equation 3.2

\[
x' = x \cos \theta + y \sin \theta \quad y' = -x \cos \theta + y \sin \theta
\]

The amplitude and phases of Gabor filter bank both provide valuable cues about specific pattern present in images. The amplitude contains directional frequency spectrum information and a phase contains information about the location of edges and image details. Gabor filters with different frequencies and orientations are very effective in capturing local information present in images. The Gabor features are calculated by convolution of input image with Gabor filter bank. \(I(x, y)\) is a grey-scale ear image of size M* N pixels. The feature extraction procedure can then be defined as a filtering operation of the given ear image \(I(x, y)\) with the Gabor filter \(u, v(x, y)\) of size \(u\) and orientation.

\[
G_{u,v}(x, y) = I(x, y) \ast \Psi(x, y, \lambda, \theta)
\]

In Gabor feature extraction approach Holistic approach is used in which the features are extracted from the whole image. Gabor filters are applied on images to extract features aligned at particular angle (orientation). The most important parameter of Gabor filter is orientation and frequency. Certain features that share the similar orientation and frequency can be selected and used to differentiate between different ear biometrics depicted in image [7].

The Gabor feature representation \(|o(x,y)|_{m,n}\) of an image \(I(x,y)\), for \(x=1,2,...,N\), \(y=1,2,...,M\), \(m=1,2,...,M\), \(n=1,2,...,N\), is calculated as the convolution of the input image \(I(x,y)\) with Gabor filter bank function \(\Psi(x, y, \lambda_m, \theta_n)\). The convolution operation is performed separately for real and imaginary part.

\[
\text{Re}(O(x,y))_{m,n} = I(x, y) \ast \text{Re}(\psi(x, y, \lambda_m, \theta_n))
\]

\[
\text{Im}(O(x,y))_{m,n} = I(x, y) \ast \text{Im}(\psi(x, y, \lambda_m, \theta_n))
\]

This is followed by the amplitude calculation,

\[
O(x,y)_{m,n} = ((\text{Re}(O(x,y))_{m,n})^2 + (\text{Im}(O(x,y))_{m,n})^2)^{1/2}
\]

The Gabor feature matrices are multidimensional and have high redundant features so redundancy
and dimensions is reduced using filter [8]. The filtered features are kept in feature vector which is passed to classifier for classification [9]. Classification is a supervised leaning process of data mining which is used to determine the class of test data after training [10].

3.2 Flowchart of the basic Gabor feature extraction technique

![Flowchart of the basic Gabor feature extraction technique](image)

Figure 3.1: Flowchart of the basic Gabor feature extraction technique

4. Proposed Gabor Feature Extraction Technique

To overcome loss of large feature vector dimension, decrease the size of feature vector by executing down sampling without losing any information. For this purpose, the proposed feature selection method calculates consolidate value of Gabor feature matrices along orientation for each scale for reducing features and redundancy without losing feature values. In the proposed system, 3 scale and
9 different orientations or total 3*9= 27, Gabor matrices are generated. Thus process applied a feature reduction of Gabor feature matrices by 9 without losing any information using proposed Mean calculation of different Gabor matrices. This Gabor Mean matrix is converted into one dimension vector which is called \(G\) mean feature vector and passed to second phase optimization. Second pass feature extraction technique is sampling filtering. After sampling, this is final optimized feature vector which is passed to classifier.

5. Experiments Setup

- Personal Computer having core 2 duo or above processor, 1GB RAM running Windows XP or above.
- Simulation Tool: Simulation will be done on MATLAB.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>A.</td>
<td>Dataset</td>
<td>AMI</td>
</tr>
<tr>
<td>B.</td>
<td>Training Testing Ratio</td>
<td>70/30</td>
</tr>
<tr>
<td>C.</td>
<td>Pre-processing</td>
<td>RGB to Gray Scale</td>
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<tr>
<td>D.</td>
<td>Classifier</td>
<td>Adaboost</td>
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A. Dataset: - **AMI Ear Database** (Mathematical Analysis of Images (AMI) Ear Database)) will be used which have around 700 images that has been sequentially numbered for every subject with an integer identification number. The resolution of these images is 492 x 702 pixels and all these images are available in jpeg format [11].

![Sample Image from AMI Database](image)

B. Training & testing ratio of dataset is divided into 70/30 (approx).
C. Pre-processing convert image RGB to Gray Scale. This step reduces the dimension of facial image from 3D RGB matrix to 2D gray scale pixel matrix without losing any features of shape.
D. Classifier: - **Adaboost** is used to select a combination of weak classifiers to form a strong classifier it used to boost the classification accuracy of a single classifier, such as a perception, by combining a set of classification functions to form a strong classifier. As applied to this experiment.
5.1 Comparison of result of propose technique with other technique

Table 5.2 Comparative Analysis Of Proposed Technique For Ear Recognition With Other Technique

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Feature Extraction Method</th>
<th>Recognition Rate</th>
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<tbody>
<tr>
<td>1</td>
<td>Gabor Sampling Filter method</td>
<td>65.00%</td>
</tr>
<tr>
<td>2</td>
<td>Gabor Mean Feature Extraction Method</td>
<td>83.00%</td>
</tr>
</tbody>
</table>

Figure 5.2: Comparative Analysis of proposed Technique for ear Recognition with other technique

6 Conclusion & Future Scope

The results shows that the ear biometric recognition system using Gabor sampling filter have 65% recognition rate while proposed gabor filter have 83% recognition rate. So the performance of proposed Gabor Filter is better than compared to gabor sampling feature extraction technique for ear biometric recognition system and proposed Mean Gabor filtering provide better and unique shape pattern about ear classes compared to Gabor sampling Filter. The features selected from proposed technique can be further reduced with new feature reduction technique and optimized towards increasing the recognition rate of system.

References


