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Extraction of Dual Tree Complex Wavelet Feature for IRIS Recognition

Savita Borole[1], Prof. S. D. Sapkal[2]

M.E. Student (CSE), Professor (Department of CSE)

Government College of Engineering, Aurangabad, Maharashtra, India[1, 2].

Abstract: Biometrics is the science and technology of measuring and analyzing biological data. In Information technology, biometrics refers to technologies that measure and analyzes human body characteristic such as DNA, finger prints, eye retinas and irises for authentication purposes. Biometrics is used in computer science for the identification and access control. A novel descriptor for iris recognition is proposed by using dual-tree complex wavelet feature and Support Vector Machine (SVM). The approximate shift invariant property of the dual tree complex wavelet and directional selectivity in 2D makes it an ideal choice for iris recognition. SVM is used as a classifier and some kernel functions are tested in the experiment. The obtained result showed that the proposed approach enhances the classification accuracy. In this experimental results were also compared with the k-NN and Naïve Bayes classifier to demonstrate the efficiency of the proposed technique.

Keywords: Biometrics, IRIS boundary, IRIS recognition, Support Vector Machine (SVM), Feature Extraction, Hamming Distance, Dual tree complex wavelet transform

I. INTRODUCTION

Biometric system gives great benefits with respect to other authentication technique. They are often more user friendly and guarantee the physical presence of the user. IRIS recognition is one of the most promising biometric technologies in terms of identification and verification performance. The distinguishing trades should have the properties such as uniqueness, stability, collectability, performance, acceptability etc. The iris is delicate circular diaphragm which lies between cornea and the lens of the human eye.The pattern for the human iris varies from person to person. The iris is considered as one of the most stable biometric, as it is believed to not alter significantly during a person's lifetime.Daugman developed the feature extraction method based on 2D Gabor filter which is used for multi-scale quadrature wavelet to extract texture phase structure information of the iris to generate a 256 bytes iris code and compare the iris code using the hamming distance. Complex wavelet transform has been developed in order to overcome DWT's deficiency. Complex wavelet transform (CWT) add some new features such as approximate shift invariance, good directional selectivity for 2D image and limited redundancy. These properties have made CWT applicable to image processing recently. The application of CWT to pattern recognition is a new research. In this paper we propose new feature extraction method for iris recognition, which is based on the CWT.

II. RELATED WORK

Daugman [2, 4, 5] applied Gabor wavelet filtering to encode the iris part and extract the phase information of iris textures to create 256 bytes of iris template. The hamming distance used to compare the stored iris template with the input iris image. Wildes et al. [6] introduced another iris recognition system that decomposed the distinctive spatial characteristics of the iris into four levels Laplacian pyramid and used a normalized correlation for matching. Boles and Boashash [9] detected zero crossings of one-dimensional dyadic wavelet transform with various resolution levels over concentric circles on the iris. Lim et al. [10] used 2D Haar wavelet transform to decompose the iris image into four levels and quantized the fourth-level high frequency information to form an 87-bit code. The researchers improved the efficiency and accuracy of the proposed system by using a modified competitive learning neural network. Sun and Tan [11] proposal is based on using ordinal measures for iris feature representation with the objective of characterizing qualitative relationships between iris region rather that precise measurements of iris image structure. The aim of this paper is to illustrate the importance of 2D DT-CWT and SVM in iris classification.

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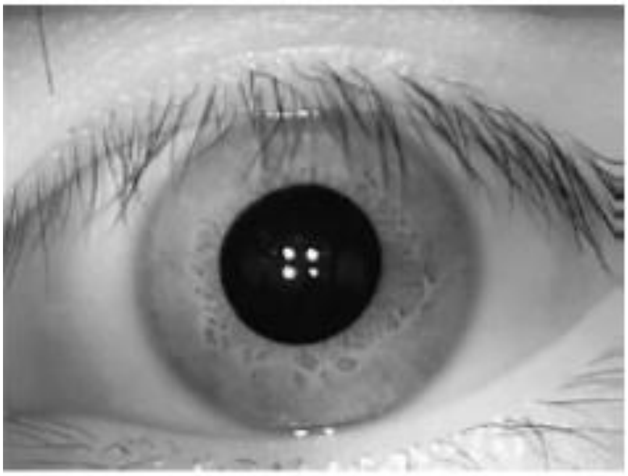
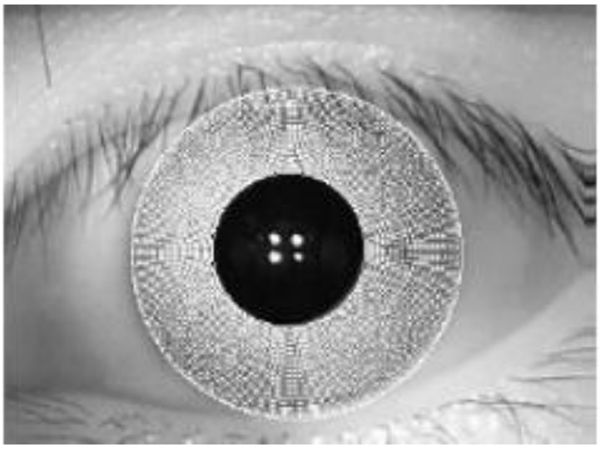
III. PROPOSED APPROACHED

IRIS Preprocessing

The iris is a annular part between the pupil and the sclera i.e. the inner boundary and outer boundary which can be taken as a circle. Researchers have proposed different algorithm for iris detection [4, 5, 6, 8]. Processing iris image is a challenging task and that's for the iris region can be occluded by eye-lids or eye-lashes. This will cause a difference between intra and inter class comparisons. Therefore we decided to isolate the effects of the eye-lid and the effects of the eye-lashes by using only the left and right part of the iris area for the iris recognition. Most of the method extracts the complete iris image, but we extract part of the iris image for the recognition. Extraction is done by trimming the iris area above the upper boundary of the pupil and the area below the lower boundary of the pupil. Then we apply histogram equalization for enhance normalized iris image in order to compensate for the effect of image contrast and illumination. Following figure shows the iris preprocessing results.



(a)



(b)

(c)

(d)

Figure 1. Preprocessing

(a) source image,
(b) localized iris and the normalization region used for recognition,
(c) normalized image,
(d) enhanced normalized image

3.2 Feature Extraction

3.3

Feature extraction is very important step in pattern recognition. Usually good features must satisfy the following requirement. First, intra-class variance must be small, that means features derived from different samples of the same class should be closed. Second, the inter-class separation should be large. i.e. features derived from samples of different classes should differ significantly. Also feature should be independent of the size and location of the pattern. This independence can be acquired by pre-processing or by extracting features which are translation, rotation and scale invariant. Complex filters in two dimensions provide two directional selectivity. So they are able to separate all part of the two dimensional frequency space being implemented separately. It produces six bandpass images of complex coefficient at each level which are oriented at angles of $\pm15^\circ, \pm45^\circ, \pm75^\circ$. These properties are useful for pattern recognition. In this experiment we present a new iris feature extraction method by using 2D_CWT. The feature extraction scheme is to use the multi-level coefficient of decomposition part of normalized iris image via 2D-CWT, which is implemented using dual tree structure. There are many techniques suggested in the literature for extracting unique and invariant feature from iris image[6]. Wavelet techniques are applied to the wide range of problems in classification, data compression, and denoising. Some techniques used to output of the wavelet transform to create a binary feature vector, while other consider real value feature vector as output as a real valued featured vector. But the ordinary discrete transformis not shift invariant because of the decimal operation during the transform. Therefore any minor shift in the input signal can cause different output coefficients.DT-CWT has improved directionality and reduced shift sensitivity and it is approximately invariant [12]. The DT-CWT has two real wavelet transform in

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parallel where the wavelets of one branch are the Hilbert transform of the wavelet in the other. The one directional 2D-CWT has the input signal f(x) by expressing it in terms of complex shifted and deleted mother wavelet ψ(x) and scaling function Φ(x), that is

$$f(x) = \sum_{l\in Z} S_{jo,l}\, \emptyset_{jo,l}(x) + \sum_{j\geq jo}\sum_{l\in Z} C_{j,l}\psi_{j,l}(x) \quad (1)$$

where Z is a set of natural number, j and l refer to the index of shift and dilations, $S_{jo,l}$ is the scaling coefficient and $C_{j,l}$ is the complex wavelet coefficient. In the 1D DT-CWT case, the set $\{\emptyset^r_{jo,l}(x), \emptyset^i_{jo,l}(x), \psi^r_{jo,l}(x), \psi^i_{jo,l}(x)\}$ forms a tight wave frame with double redundancy. The real and imaginary part of one dimensional DT-CWT are calculated using separate filter bank.

The two dimensional DT-CWT decomposes a 2D image f(x,y) through a series of dilations and translations of a complex scaling function and 6 complex wavelet function $\psi^\theta_{j,l}(x)$, i.e.

$$f(x,y) = \sum_{l\in Z^2} S_{jo,l}\, \emptyset_{jo,l}(x,y) + \sum_{\theta\in}\sum_{j\geq jo}\times\sum_{l\in Z^2} C^\theta_{j,l}\psi^\theta_{j,l}(x,y) \quad (2)$$

where $\theta \in \{\pm 15^o, \pm 45^o, \pm 75^o\}$ provides the directionality to the complex wavelet function. Thus the decomposition of f(x,y) by exploiting the DT-CWT produces one complex value low-pass subband and six complex value high-pass subband. And each high-pass subband corresponding to one unique direction θ.

Modeling Support Vector Machines (SVM)

The SVM has a popular tool for solving pattern recognition problem based on the statistical learning theory presented by Vapnik [13]. SVM for pattern recognition has also been proved to be very successful in many other applications such as hand written digit recognition, image classification, face detection, object detection and text classification. SVM has already proved to provide better generalization performance than neural network [16]. To achieve better generalization performance of the classifier original input space is measured into a high dimensional dot product space called the feature space; and in the feature space the optimal hyper-plane is determined. The optimal hyper-plane is searched by exploiting the optimization theory and respecting standards provided by the statical learning theory.

In a training set T= $\{x_i, y_i\}$, i= 1,…,N. The goal is to define a hyper-plane that divides T such that all the points with the same label are on the same side of hyper-plane while increasing the distance between the two classes. For the linearly separable data we have determine the hyper-plane f(x)= 0 which separates the data.

$$F(x) = \omega . x + b = \sum_{i=1}^{n} \omega_i x_i + b = 0 \quad (3)$$

Where ω is an n-dimensional vector and b is a scalar. The vector ω and the scalar b find the position of the separating hyper-plane. Two bounding hyper-planes are opposed and parallel with the hyper-plane satisfies the constraints:

$$W^t.\emptyset(x_i) + b \geq +1 f \; or \; y_i = +1$$
$$W^t.\emptyset(x_i) + b \leq -1 f \; or \; y_i = -1 \quad (4)$$

which is equivalent to:

$$y_i(W^t.\emptyset(x_i) b - 1) \geq 0 \forall i \quad (5)$$

For a better classification result, we maximize the margin of separation between patterns. The calculations can be solved by converting the problem with Kuhn_Tucker condition into equivalent Lagrange dual problem:

$$V(\propto) = \sum_{i=1}^{n} \propto_i - \frac{1}{2}\sum_{i,j=1}^{n} \propto_i \propto_j y_i y_j K(x_i, x_j) \quad (6)$$

subject to:

$$\sum_{i=1}^{n} \propto_i y_i = 0, \propto_i \in [0, C], i \in [1, n] \quad (7)$$

The decision function becomes:

$$f(x) = sign \sum_{i=1}^{n} \propto_i y_i K(x_r . x_i) + b \quad (8)$$

b= $y_r - \sum_{i=1}^{n} \propto_i y_i K(x_r . x_i)$

where$(x_r . x_i)$ is training sample.

The function K$(x_r . x_i)$ that returns a dot product of two measured patterns is called a kernel function. Ideal kernel functions are as follows:

Linear kernel function: K(x,y) = x.y (9)

Gaussian RBF: $K(x, y) = \exp(-\frac{||x-y||^2}{2\delta^2})$ (10)

Polynomial kernel function:

K(x,y) = $(\gamma . x . y + coef)^2$ (11)

whereγ and coef are constant.

IV. EXPERIMENTAL RESULTS

In this paper experiment is performed in order to evaluate the performance of proposed scheme. This proposed scheme is implemented using MatlabR2009b on an Intel Core 2 Duo 1.6Ghz PC with 1Gb memory.

4.1 IRIS Database

A dataset used for study for the proposed system consist of 756 frontal iris images of CASIA database [14].

4.2 Recognition Result

First we normalize images so that it fits into a resolution of 156x100 pixels. Because the dual tree complex wavelet has the property of shift invariance and multi-resolution representation, we perform the 2D dual tree complex wavelet on the normalized images and combine the features at different resolutions scales to form a feature vector to train an test the SVM. In order to compare the performance of the proposed approach we also implement the k-Nearest Neighbor (k-NN) algorithm and Naïve Bayes classifier. We found the classification accuracy of SVM, k-NN and Naïve Bayes classifiers. In all experiments SVM was found to be better that all other

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classifiers. It is clear that dual tree complex wavelet features are very useful in iris recognition. The success of the DT-CWT is due to its approximate shift invariant property and its good directional selectivity in 2D.

V. CONCLUSION

In this paper we used the iris segmentation technique based on the minimizing effect of the eyelid and eyelashes by trimming the iris area above the upper and below the lower boundaries of the pupil. The 2D DT-CWT is extracted from the iris images and train the support vector machine (SVM) as iris classifier. Among the used SVM kernels the Gaussian RBF kernel function is most suitable for iris recognition experiment. Experimental result also indicate that the performance if SVM as a classifier is better than the performance of k-NN and Naïve Bayes classifier. The combination of dual tree complex wavelet with SVM is well suited.

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REFERENCES

[1]WaheedaAlmayyan, Hala S. Own, Hussein Zedan "Iris feature extraction using Dual-Tree Complex Wavelet Transform" in IEEE, international Conference of Soft Computing and Pattern Recognition December 2010.

[2]J. Daugman, How iris recognition works, IEEE Trans. on Circuits and Ststems for Video Technology, Vol. 14, No. 1, pp.21-30, January 2004.

[3]A. Ross, D. Nandakumar, A.K. Jain, Handbook of Multibiometrics, Springer, Heidelberg (2006).

[4]J. Daugman, High Confidence Visual Recognition of Persons by a Test of Statistical Independence, IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 15, No. 11, pp. 1148-1161, 1993.

[5]J. Daugman, C. Downing, Epigenetic Randomness, complexity and singularity of Human iris patterns, Proc. R. Soc. Lond. B 268, pp. 1737-1740, 2001.

[6]R. P. Wildes, J.C. Asmuth, G.L. Green, S.C. Hsu, R.J. Kolczynski, J.R. Matey and S.E. McBride, A Machine Vision System for Iris Recognition, Machine Vision and Applications, Vol.9, pp. 1-8, 1996.

[7]L. Flom, A. Safir, Iris Recognition System, US Patent 4641394, 1987.

[8]K.W. Bowyer, K. Hollingsworth, P.J. Flynn, Image Understanding for Iris Biometrics: A Survey, Computer Vision and Image Understanding, Vol. 110, Issue 2, pp 281-307, 2008.

[9]W.W. Boles and B. Boashash, A Human Identification Technique Using Images of Iris and Wavelet Transform, IEEE Trans. Signal Processing, Vol. 46, no. 4, pp. 1185-1188, Apr. 1998.

[10] S. Lim, K. Lee, O. Byeon, And T. Kim, Efficient Iris Recognition Through Improvement of Feature vector and Classifier, ETRIJ, Vol. 23, no. 2, pp. 1-70, 2001.

[11] Z. Sun, T. Tan, Ordinal Measures for Iris Recognition, IEEE Tran. on Pattern Analysis and Machine Intelligence, V.31, n.12, pp. 2211-2226, 2009.

[12] I.W. Selesnick, R.G. Baraniuk, N.C. Kingsbury, The Dual Tree Complex Wavelet Transform, IEEE Signal Processing Magazine, Vol. 22, 6, S.L. IEEE, pp. 123-151, Nov 2005.

[13] V. N. Vapnik, The Nature of Statistical Learning Theory, Springer-Verlag, New York, 1999.

[14] Center for Biometrics and Security Research, CASIA Iris Image Database: http://www.sinobiometrics.com

[15] MATLAB help, Version R2009b.

[16] S. Haykin, Neural Network-A Comprehensive Foundation (2nd Ed.). Prentiss Hall, 1999

[17]S.P. Narote, A.S.Narote, L.M. Waghmare, An Automated Segmentation Method for Iris Recognition, Proceeding of International IEEE Conference TENCON-2006