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A Partial Iris Pattern Recognition Using Neural Network Based FFDTD and HD Approach

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***Abstract*– Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on images of one or both of the irises of an individual's eyes, whose complex random patterns are unique, stable, and can be seen from some distance. An iris recognition system is a highly secure and confidence biometric identification system. In this paper, the partial iris pattern recognition system of template size 10 X 480 is considered by using hamming distance (HD) and neural network based Feed forward distributed time delay (FFDTD). Hough transform is the standard algorithm used for segmenting the iris patterns. Daugman's rubber sheet model is used for normalization and unwrapping. Gabor filter is used for feature extraction. The experimental results shows that the Gabor filter of template size 10 x 480 provides slightly better results when compared to Gabor filter of template size 20 x480 based on HD and FFDTDNN. There are few public and freely available databases. For the purpose of research and development the system is tested on a CASIA database which contains nearly 4500 iris images.**

***Index terms*– Iris Recognition system, Daugman's Rubber sheet model, Feed forward distributed time delay (FFDTDNN), Hamming distance (HD)**

I. INTRODUCTION

IRIS recognition is the process of recognizing a person or an individual by analyzing the random pattern of the iris. It is one of the most reliable biometrics in terms of authentication and identification of an individual. Iris recognition a new biometric technology has been taken in to consideration by researchers which have great advantages such as variability, stability and security. Although the area of the iris is small it has different pattern variability which provides its unique features for a person or an individual and leads to emerging biometric technology with high efficiency and security.

To value and appreciate the richness of the iris as a pattern for recognition, it is useful to consider briefly the eye anatomy which is clearly shown in Fig 1 that states the most important parts of the eye. The iris is the structure behind the cornea of the eye which dilates and constricts. The iris develops during prenatal growth through a process of tight forming and folding of tissue membrane. Although genetically identical, an individual's irides are unique and structurally distinct, which allows for it to be used for recognition purposes. The iris pattern not only differs between individuals but also varies between the left and right eye of the same individual. Even identical twins possess different iris patterns [1].

In this paper, a partial iris pattern recognition using neural network based Hamming Distance and Feed Forward Distributed time delay neural network has be implemented. The iris recognition process is done on two different template sizes namely 20 x 480 which is known as fill template and 10 x 480 known as partial template iris pattern recognition system.

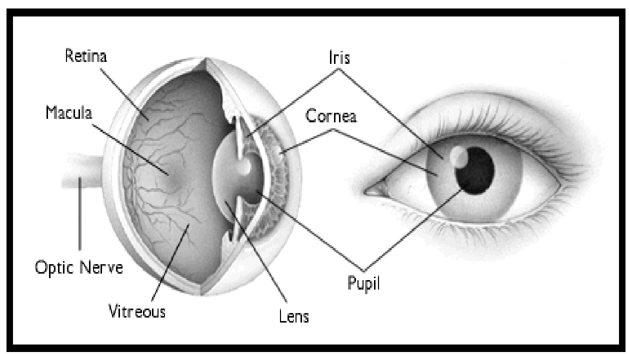

Fig. 1: Cross Section of an Iris

An iris recognition system consists of four major steps namely segmentation, normalization, feature extraction and matching. For analyzing the desired performance of the proposed system, we use CASIA datasets (Chinese Academy of Sciences, Institute of Automation).

II. RELATED WORK

Many studies were made and others are still conducted in order to design and build such recognition systems. Some of them are as follows:

Flom approached Dr. John Daugman to develop an algorithm to automate identification of the human iris. J.G. Daugman proposed Integrodifferential operator approach [2]-

[3] which is regarded as one of the most cited approach in the survey of iris recognition. Daugman uses an integrodifferential operator for segmenting the iris. This algorithm achieves high performance in iris recognition. R.P.Wildes proposed a methodology [4] to perform personal identification and also the verification, an automated iris recognition system has been examined as the biometrically based technology.

Masek introduced an open iris recognition system [5] for the verification of human iris uniqueness and also its performance as the biometrics. The iris recognition system consists of an automated segmentation system, which localise the iris region from an eye image and also isolate the eyelid, eyelash as well as the reflection regions. The drawback of [4] has been recovered

Z.He et al proposed a perfect (accurate) as well as a rapid iris segmentation algorithm for iris biometrics has been developed in [6]. The advantage of PP method is the accuracy and speed. The drawback of this method is that the occurrence of the segmentation error. An efficient as well as robust algorithm for noisy iris image segmentation in the background of non cooperative and less-cooperative iris recognition has been proposed by T.Tan et al [7]. C.W. Tao et al [8] decomposed the normalized iris region using Multichannel Gabor filter.

Li Ma, Yunhong Wang, Tieniu Tan in [9] implemented the multichannel Gabor filter with six frequencies and four orientation bands to decompose an iris image. They have proposed a texture analysis and local variation analysis methods to extract the iris features.

Kaushik Roy and Bhattacharya.P in [10] proposed a iris recognition system as a biometrically based technology for personal identification using support vector machine. K.Roy et al converted the traditional SVM into asymmetrical SVM to treat false reject and accept differently for classification and matching purposes.

M.Gopikrishnan et al implemented the iris recognition system for both partial and full template using Hamming distance and Neural network based techniques in [11]-[16]. They have proposed identification of human iris pattern by reducing the template size and concluded that there is no lose in accuracy and resulted in saving of computation results. In [13], an extended work was proposed for optimization of iris pattern using various neural network techniques.

III. BIOMETRIC SYSTEM

A biometric system is a pattern recognition system which identifies the unique features or characteristics of an individual. There are various types of biometric system which is mainly classified in to two categories: namely Physiological and behavioral. Finger prints, palm print, Face, voice recognition, retina scanning are some types of biometric recognition techniques. Whereas the iris recognition system servers as the leading biometric technique in today’s world which is highly reliable and secure. The developments in science and technology have made it possible to use biometric in applications where it is required to establish or confirm the identity of individuals

The iris is a unique organ present in each and every individual which varies for both left and right eye of an individual. It is composed of several unique features and marks. Its uniqueness increases based on its increased features for iris pattern recognition system. Iris recognition system is viable for its security and stability. Iris of a person is stable over years and does not subject to any change in its environment.

The iris recognition process comprise of two main steps: Enrollment which is the process of recording a digital eye image which is taken using a camera in near infra red rays. In the second step, Identification is the process of taking the decision whether the enrolled individual and the input image are same person or not. The overview of iris recognition system is depicted in the Fig. 2 as shown below:

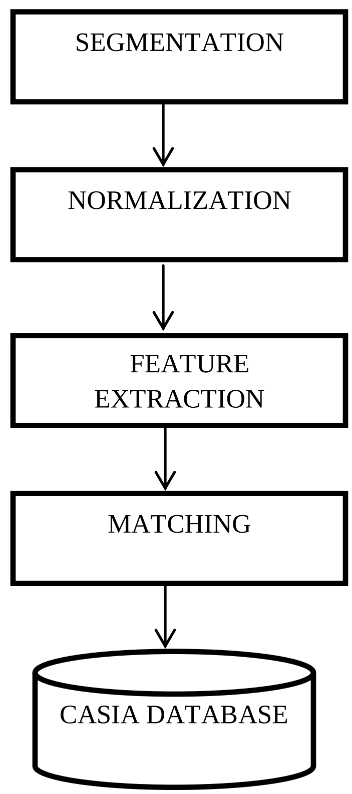

Fig. 2: Overview of Iris Recognition Process

The important steps involved can be demonstrated as follows:

1. Segmentation: Locates the iris region by eliminating the unwanted eyelids and eye lashes.
2. Normalization: Creates a consistent representation of the iris region
3. Feature Extraction and Matching: crates a template and mask of the iris region and matching it.

IV. SEGMENTATION

Segmentation is the process to distinguish an iris pattern or texture from a digital eye image. Detecting the inner and outer boundaries of iris texture is important in all iris recognition system. In this paper, Hough Transform is used for iris segmentation for approximating the two circle namely the iris and pupil boundaries.

Hough transform is a standard computer based algorithm that is used to determine the parameters of geometric objects such as line, circles present in an image. The circular hough transform is used to deduce the radius and center coordinates of the pupil and iris regions and also detects the eyelids and eyelashes. Hough transform can be demonstrated as edge map, horizontal edge map and vertical edge map and provides the required parameters for segmentation for iris region from the digital image. The radius r and the center coordinates (a, b) are defined by the parametric equations as follows:

$$x = a + r\cos\theta \qquad (1)$$

$$y = b + r\sin\theta \qquad (2)$$

The hough function implements the standard hough transform (SHT). The segmented iris and pupil boundaries are shown below in the Fig. 3.

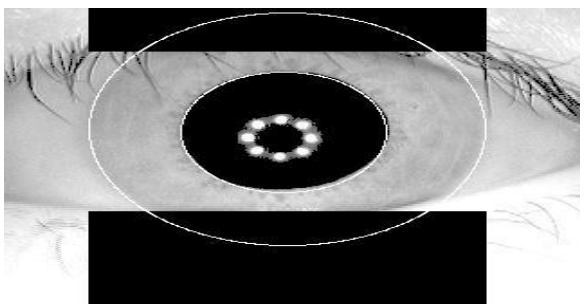

Fig. 3: Segmentation of Iris and Pupil Boundaries

V. NORMALIZATION

The segmented iris region is then normalized in order to obtain a fixed number of features from the iris and to be mapped to a dimensionless fixed coordinated system that is invariant to size change. The process of converting the segmented iris image from Cartesian coordinate to polar coordinate is known as unwarping.

In this paper, Daugman Rubber Sheet Model is used for normalization which maps the coordinates of each Cartesian point from the segmented iris region to polar coordinates (r,θ) where r ranges from 0 to 1 and θ ranges from 0 to 2π.

The Daugman's Rubber sheet model is defined as follows:

$$I\big(x(r,\theta), y(r,\theta)\big) \rightarrow I(r,\theta) \qquad (3)$$

Where, I(x,y) is the iris region image, (x,y) are the original Cartesian coordinates, (r,θ) are the corresponding normalized polar coordinates.

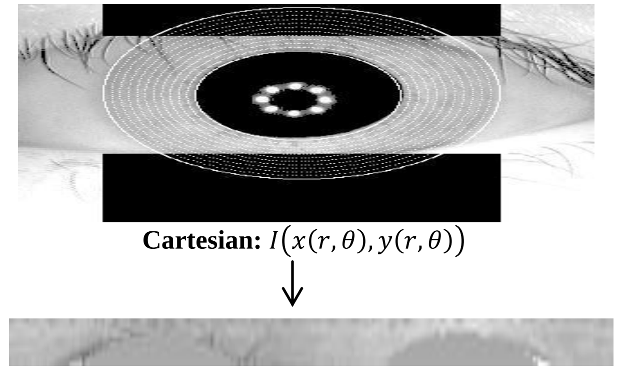

Fig. 4: Conversion of Cartesian to Polar Coordinates

VI. FEATURE EXTRACTION

The normalized image is used to extract the unique features in the iris image. Most iris recognition system make use of Gabor filter of iris image to create a biometric template. The phase information of the normalized image is to encode only distinctive iris region.

Gabor filters are used to convolve the image because they provide phase information and construct the modulating sines and cosines waves.

A two-dimensional (2D) even Gabor filter can be represented by the following equation in the spatial domain:

$$G(x,y;\theta,f) = exp\left\{-\frac{1}{2}\left[\frac{x'^2}{\delta_{x'}^2} + \frac{y'^2}{\delta_{y'}^2}\right]\right\}\cos 2\pi f x' \qquad (4)$$

$$x' = x\cos\theta + y\sin\theta \qquad (5)$$

$$y' = y\cos\theta - x\sin\theta \qquad (6)$$

Where f is the frequency of the sinusoidal plane wave along the direction θ from the x-axis, δ x' and δ y' are the space constants of the Gaussian envelope along x' and y' axes respectively.

In the feature extraction module the phase data from the Gabor filters are quantized to make the biometric templates and noise masks that are used for matching in to binary bits as 0's and 1's.

The pictorial representation of the normalized iris code is shown in the Fig. 5 as shown:

Fig. 5: Iris Template

VII. MATCHING

For comparing the templates obtained by feature extraction process, there are number of design metrics available. In this paper, Hamming distance (HD) and Feed Forward Distributed Time delay Neural Network (FFDTDNN) are implemented.

Hamming Distance: The Hamming distance gives the measure of how many bits are the same between two bit patterns. If x and y are the two bit template patterns generated from the feature encoding, then by comparing these two bit patterns a decision can be made whether they are from same person or not.

The Hamming distance (HD) can be defined as sum of the exclusive-OR between x and y over N where N is the total number of bits.

$$Hamming\ Distance = \frac{1}{N}\sum_{i=0}^{N} x_i \oplus y_i \qquad (7)$$

Feed Forward Distributed Time Delay Neural Network: The FTDTDNN had the tapped delay line memory only at the input to the first layer of the static feed forward network. It also distributes the tapped delay lines throughout the network. The Distributed Time Delay Neural Network was first introduced for phoneme recognition. The original architecture was very specialized for that particular problem. The following fig 6 shows a general two-layer Distributed Time Delay Neural Network.

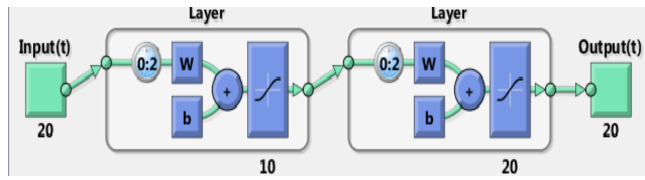

Fig. 6: Structure of Distributed TDNN

VIII. RESULTS AND DISCUSSION

Table 1: Comparison between 200 Binary Template Patterns Experimental Results Of Different Template Size Based On Hamming Distance (HD) and Feed Forward Distributed Time Delay Neural Network (FFDTDNN)

Matching Technique	Performance Metric	Methodology & Template Size	Res1	Res 2	Res 3	Res 4
Hamming Distance	MEAN	Gabor Filter (20 X 480)	0.31653	0.300802	0.28451	0.31212
		Gabor Filter (10 X 480)	0.31636	0.298938	0.28365	0.30572
	STANDARD DEVIATION	Gabor Filter (20 X 480)	0.05419	0.03458	0.03590	0.05358
		Gabor Filter (10 X 480)	0.05022	0.03172	0.03359	0.05354
Feed Forward Distributed Time Delay Neural Network	MEAN	Gabor Filter (20 X 480)	0.15822	0.15233	0.15897	0.15688
		Gabor Filter (10 X 480)	0.14391	0.13886	0.14251	0.15333
	STANDARD DEVIATION	Gabor Filter (20 X 480)	0.01696	0.01558	0.01427	0.05358
		Gabor Filter (10 X 480)	0.01631	0.015355	0.013632	0.013657

This paper work presents an iris pattern recognition system, which was tested on CASIA Iris Image Databases, in order to verify the claimed performance of the iris recognition technology. The performance of the Iris recognition system was calculated in terms of Arithmetic Mean and Standard Deviation.

The proposed method is implemented using MATLAB in the windows 7 operating system with Intel Core i3 Processor, 2.20 GHz and 4GB RAM.

The experimental results are made for 200 binary templates for the CASIA database (Chinese Academy of Science, Institute of Automation) and have been used for training and testing purposes. The partial iris pattern recognition system was compared with the matching algorithms, namely, Feed Forward Distributed Time Delay Neural network and Hamming Distance using Gabor filter. The comparison results of two different template sizes namely 20 x 480 (Full Template) and 10 x 480 (Partial Template) using Gabor filter are implemented and depicted in Table 1.

Table 1 shows that the Partial template 10 X 480 of Gabor filter provides slightly better results when compared to full template recognition system of template size 20 x 480 using Gabor filter.

The Pictorial representations of the comparison results from Fig. 7 through Fig. 10 are shown below:

IX. CONCLUSION

This paper work presents a partial iris pattern recognition system, which was tested on CASIA Iris Image Database, in order to verify the performance of iris recognition technology. Accuracy of biometric identification system is specified in terms of Arithmetic Mean and Standard Deviation.

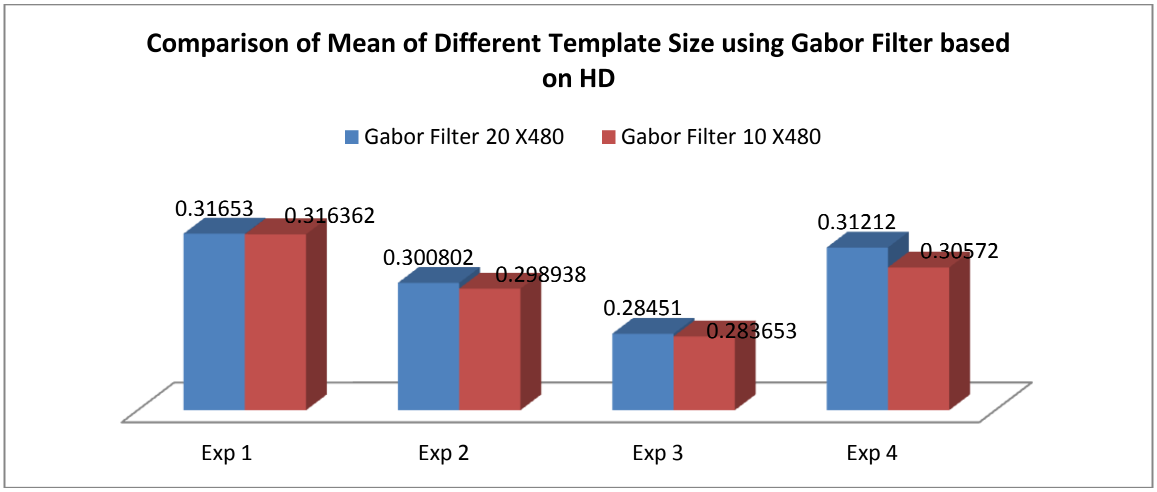

Fig. 7: Comparison of Mean of Different Template Size Using Gabor Filter Based on HD

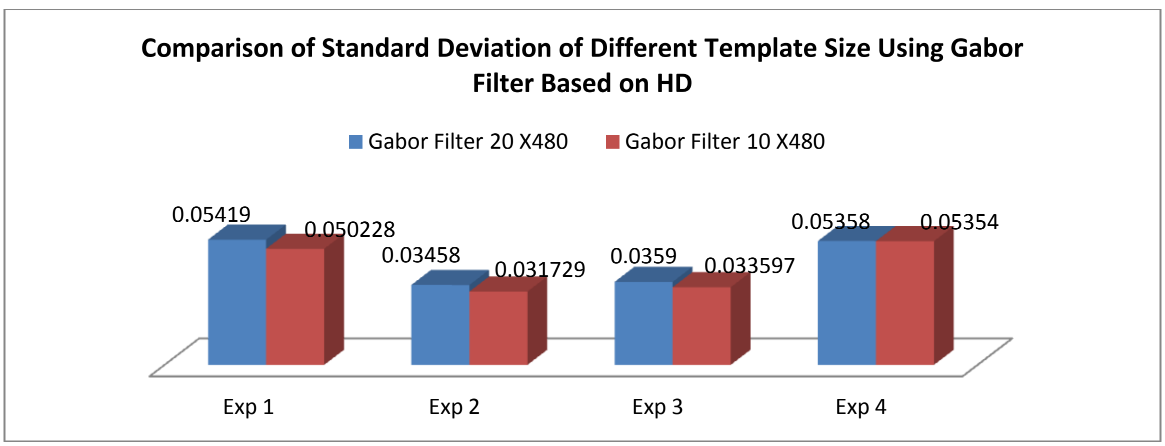

Fig. 8: Comparison of Standard Deviation of Different Template Size Using Gabor Filter

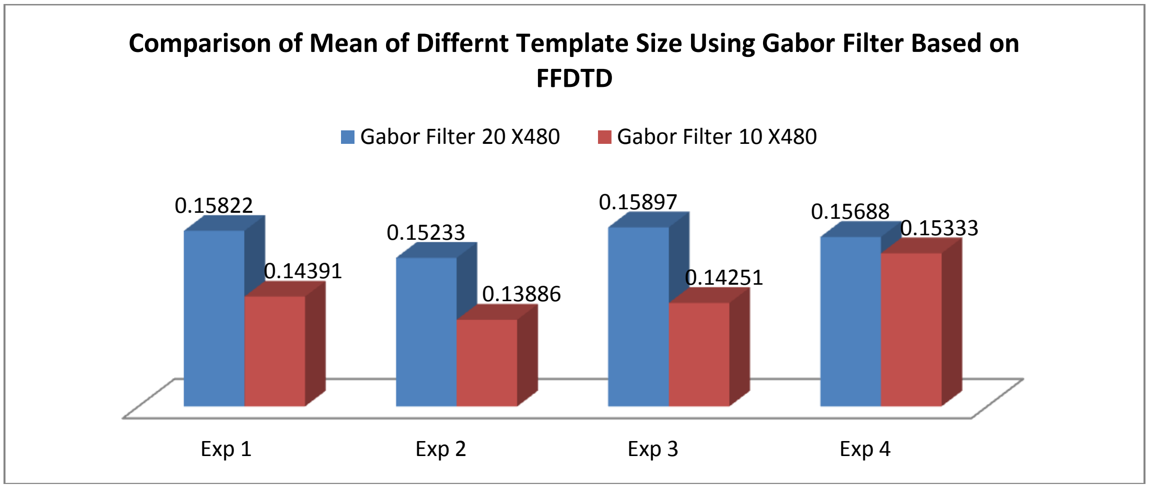

Fig. 9: Comparison of Mean of Different Template Size Using Gabor Filter Based on FFDTD

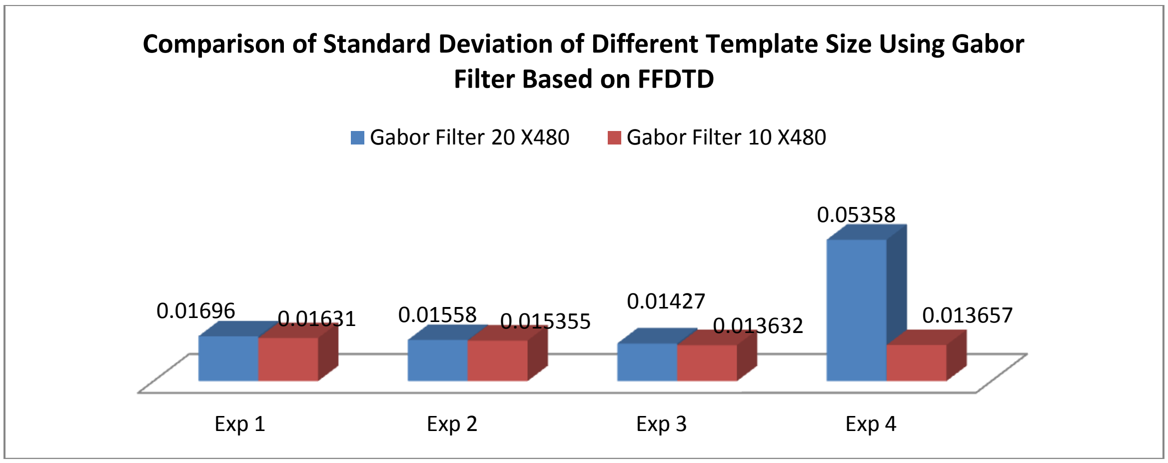

Fig. 10: Comparison of Standard Deviation of Different Template Size Using Gabor Filter Based on FFDTD

In this work the experimental results are made for the Hamming Distance and Feed forward distributed time delay neural network using Gabor filter for different Template Sizes namely 20 X 480 and 10 X 480 to identify the better performance results for iris recognition and identification purposes. Based on the comparison results it is concluded that the partial template of size 10 X 480 may provide slightly better results when compared to Full template (20 X 480).

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