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NEURAL NETWORK BASED MATCHING APPROACH FOR IRIS RECOGNITION

Anjana Peter[1], Revathi N[2], Ms. Merlin Mercy[3]
1 & 2. PG Scholar,Dept. of CSE, SKCT, Coimbatore.
3. Asst. Professor, Dept. of CSE, SKCT, Coimbatore.

ABSTRACT

Iris recognition has been considered as one of the most reliable biometrics technologies in recent years due to its high reliability in person identification. In this paper, an iris recognition system has been proposed. The recognition system relies on four fundamental steps. The first step consists of iris localization using Circular Hough Transform (CHT). In the subsequent step, image is normalized into a fixed dimension. Then normalized image is decomposed by 2-D Haar wavelet and textural features are extracted. Finally, for matching purposes ArtificialNeural Network (ANN) with back propagation is used. Iris recognition is very effective due to iris' unique features and the protection of the iris from the environment and aging.

Index terms: Iris recognition, Biometrics, Artificial Neural Networks with Back Propagation, Haralick features.

INTRODUCTION

There has been a rapid increase in the need of accurate andreliable personal identification infrastructure in recent years,and biometrics has become an important technology for thesecurity. Iris recognition has been considered as one of the mostreliable biometrics technologies in recent years [1, 2]. Computer vision-based techniques that recognize human featuressuch as faces, finger prints, palms, and eyes have many applications insurveillance and security. Most of the existing methods have limitedcapabilities in recognizing relatively complex features in realisticpractical situations. The objective of this correspondence is to presenta new approach for recognizing humans from images of the iris ofthe eyes under practical conditions. The iris has unique features and is complex enough to be used as abiometric signature. This means that the probability of findingtwo people with identical iris patterns is almost zero. Features extracted from the human iris can be used to identifyindividuals, even among genetically identical twins [3]. Iris image contains not only useful parts i.e.iris but also some irrelevant parts i.e. noise like eyelid, pupil, eyelashes, specular highlight. Theiris is the annular part between black pupil and white sclera is the most part that researchesare focused to determine its details. In general, there are many properties that make an irisideal biometric method , the first is the uniqueness features " no two iris are the same" evenbetween the left and right eye for the same person. Like other biometric systems, Iris recognition system hastwo modes: enrollment process andverification/identification process (say, matching process). Inthe enrollment process iris patterns are added to the databaseand in the matching process input iris pattern is comparedwith the stored patterns. The framework of iris recognitionsystem is shown in Figure 1. Both enrollment and matchingprocess include image acquisition, iris localization, irisnormalization and feature extraction. In enrollment process,extracted feature vector is stored in the database. During thematching, the extracted feature is compared with stored features. In this paper, we have proposed an iris recognition system. The recognition systemrelies on four fundamental steps. The first step consists of irislocalization using Circular Hough transform (CHT) [1]. Inthe subsequent step, image is normalized into a fixeddimension. Then normalized image is decomposed by 2-DHaar wavelet and textural features are extracted. Finally, forthe matching purposes Artificial Neural Network (ANN) is used.

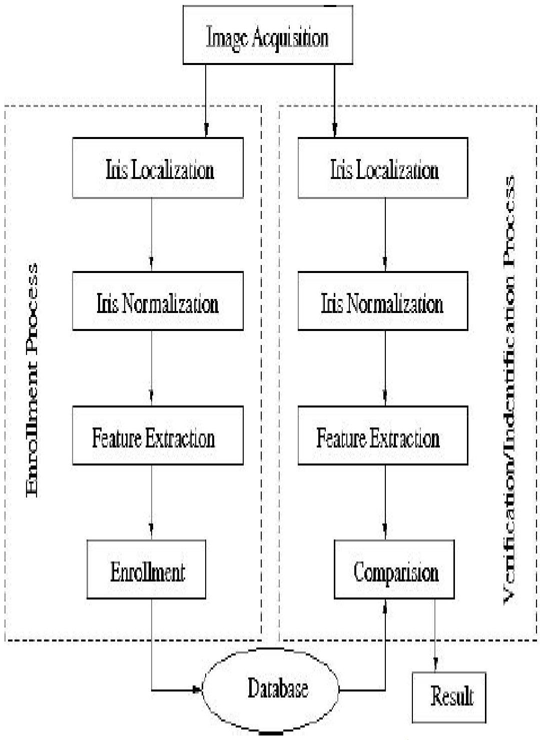

Fig 1. Block diagram of an iris recognition system

RELATED WORK

The major investigation on iris recognition has beenstarted in the last decade. Iris recognition is becoming anactive area of research in biometrics due to its high reliabilityfor personal identification. A variety of techniques have beendeveloped for iris localization. Daugman [5] proposed analgorithm for iris recognition based on Iris Codes. In thisalgorithm, the inner and outer boundaries of the iris had beenlocated using Integro-differential operators. Featureextraction algorithm uses modified complex valued 2DGabor wavelets to demodulate texture structure of the iris.Filtering an iris image with a family of filters resulted in 1024 complex value, which denotes the structure of the iris at different scales. Eachvalue then quantized to one of the four quadrants in thecomplex plane. The resulting 2048-component iris code hadbeen used to describe an iris. Their Hamming distancemeasured the difference between a pair of iris codes.Wildes[6] used the Hough transformto locate the iris and a Laplacian pyramid with four resolution levelsto generate the iris code. Boles [7] obtained an irisrepresentation via zero crossing of the one-dimensionalwavelet transform and iris matching based on twodissimilarity functions. In [8],Ma, Wang, and Tan used twodimensional texture analysis to extract iris texture featuresand several classifiers had been adopted for matchingpurpose.Based on a 2D Haar wavelet, Lim,Lee, Byeon, & Kim [9] extracted high frequency information to generate an 87 binary code and employed an LVQ neural network for classification.[10] represented iris patterns with ICA coefficients, determined the centreof each class by competitive learning mechanism and finallyrecognized the pattern based on Euclidean distances. This methodis insensitive to variant illumination and noise caused by eyelidsand eyelashes, and even for blurred iris image, it can be recognizedwell.

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PROPOSED METHODOLOGY

Figure 2 illustrates the main steps of our proposed Approach.The essential steps of an irisrecognition system include localization of iris, normalization,feature extraction and matching. Irislocalization includes the detection of the iris boundaries andisolation of the collarette region, which is regarded as one ofthe most important areas of the iris complex pattern. In thenormalization step, localized iris is transformed into arectangular block of fixed dimension. To extract the features,the normalized image is processed by 2-D Haar wavelet andfrom the low frequency data Gray level co-occurrence matrix(GLCM) based Haralick features are computed. Finally,ANN is used as classifier for matchingpurposes.

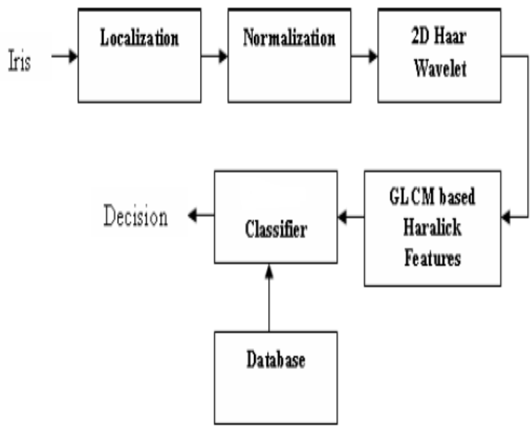

Fig 2.The fundamental steps of the proposed method.

A. Iris Localization

Before performing iris pattern matching, the boundaries of the iris should be located. Iris localization is the detection of the iris area betweenpupil and sclera. Locating the iris is not a trivial task since itsintensity is close to that of the sclera and is often obscured byeyelashes and eyelids. The boundaries of iris can becharacterized by circle, though they may not be concentric.In the present method, to identify the boundaries we relies onCHT [11] based method. First edge detection is performed onthe iris image and a binary edge map is generated. Thepurpose of edge detection is to decrease the number of pointsin the search space for the objects. Then, a voting in circularHough space is analyzed to estimate the center (x0, y0) andradius r of circle. For each edge point draw the circle withcenter in the point with the desired radius. When every edgepoint and every desired radius is used, the accumulator willnow contain numbers corresponding to the number of circlespassing through the individual coordinates. The discretespace constructed through accumulator and detection ofparameters of curves by detecting the peak in the Houghspace [12]. Thus the highest numbers correspond to thecenter of the circles in the image. Therefore, a number ofcircular filters of different radii are tried and the best fit oneis picked out. The Hough transform is defined as

$$H(x_0, y_0, r) = \sum_{i}^{n} H(x_i, y_i, x_0, y_0, r)$$

where (x_i, y_i) is an edge pixel and

$$H(x_i, y_i, x_0, y_0, r) = \begin{cases} 1; \text{ if } (x_i, y_i) \text{ on the circle } (x_0, y_0, r) \\ 0; \text{ otherwise} \end{cases}$$

The location (x_0, y_0, r) with the maximum value of$H(x_0, y_0, r)$ is considered as the parameter for the strongestcircular object.

B. Iris Normalization

After successfully getting iris pattern, next step is tocreate the pattern in a manner that allows comparison withother irises. The irises captured from the different peoplehave different sizes. The size of the iris may change becauseintra-class variability such as illumination, noise andposition and varying of pose and also interclass variabilityfrom person to person. At the same time, the iris andthe pupil are non concentric. These factors may affect theresult of iris matching. In order to get accurate results,localized iris is transformed into polar coordinates system.To do this, in the present method, we follow the Daugman'sRubber sheet model [13] as shown in Figure 3. This Rubber sheet model is basedon the following equations.

$$I(x(r,\theta), y(r,\theta)) \rightarrow I(r,\theta)$$

with

$$x(r,\theta) = (1-r)x_p(\theta) + rx_1(\theta)$$
$$y(r,\theta) = (1-r)y_p(\theta) + ry_1(\theta)$$

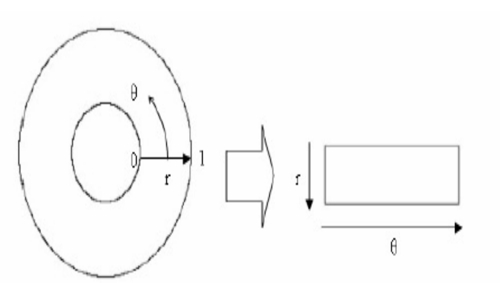

Figure 3.Daughman rubber sheet model.

where$I(x,y)$is the iris region image, (x,y) are the originalCartesian coordinates, (r,θ) are the correspondingnormalized polar coordinates, and x_p, y_p and x_1, y_1 are thecoordinates of the pupil and iris boundaries along the θdirection.

C. Feature Extraction and Matching

Feature extraction is a special form of dimensionalityreduction. In this context, wavelet transform takesadvantage of multi-resolution and multi-scale analysis. Inthe present method, 2D Haar wavelet is employed onnormalized iris image and some statistical features arecomputed from low frequency data [14]. Here, we have usedGray Level Co-occurrence Matrix (GLCM) based features[15] to describe an iris pattern. GLCM based features arewidely used for texture analysis. The GLCM is asquare matrix PN × N, where N is the number of gray levelsin the image. Each element in the GLCM is an estimate ofthe joint probability of a pair of pixel intensities inpredetermined relative positions ((x, y) and (x+dx, y+dy)) inthe image. Here, p (i, j) is the joint probability of the event I(x, y)=i and I (x+dx, y+dy) = j. The dx and dy are definedby considering different scales and orientations. Thespecific features considered in this research are defined asfollows:

$$Energy = \sum_{i,j=0}^{N-1} p(i,j)^2$$

$$Contrast = \sum_{i,j=0}^{N-1} p(i,j)(i-j)^2$$

$$Homogeneity = \sum_{i,j=0}^{N-1} \frac{p(i,j)}{1+(1-j)^2}$$

$$Variance = \sum_{i,j=0}^{N-1} p(i,j)(i-\mu)^2$$

$$Correlation = \sum_{i,j=0}^{N-1} p(i,j)\frac{(i-\mu_x)(j-\mu_y)}{\sigma_x\sigma_y}$$

$$Entropy = \sum_{i,j=0}^{N-1} p(i,j)\, log_2\, p(i,j)$$

$$Dissimilarity = \sum_{i,j=0}^{N-1} p(i,j)|i-j|$$

where

$$\mu_x = \sum_i i \sum_j p(i,j), \;\; \mu_y = \sum_j j \sum_i p(i,j),$$
$$\sigma_x^2 = \sum_i (i-\mu_x)^2 \sum_j p(i,j),$$

$$\sigma_y^2 = \sum_j (j-\mu_y)^2 \sum_j p(i,j)$$

In the present method, for the matching purposecomputed feature values are fed to ANN.Artificial neural networks are biologically inspired; that is, they are composed of elements that perform in a manner that is analogous to the most elementary functions of the biological neuron. The network is trained using back propagation (BP) algorithm so that application of a set of inputs produces the desired set of outputs. Each such input (or output) set is referred to as a vector. Training is accomplished by sequentially applying input vectors, while adjusting network weights according to a predetermined procedure. During training, the network weights gradually converge to values such that each input vector produces the desired output vector.As shown in Figure 4, the Back propagation neural network is based on hierarchical structure, including an input layer, an output layer and one (or more) hidden layer.

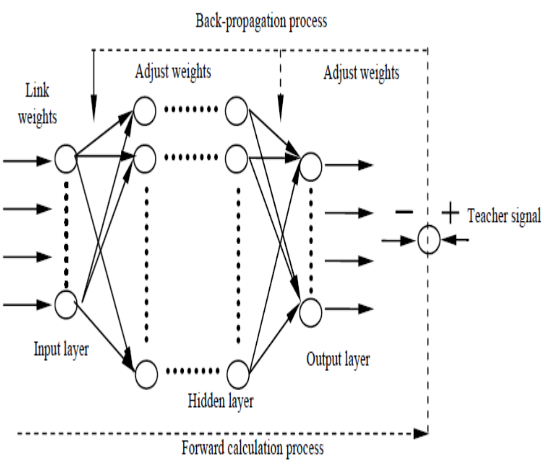

Figure 4. The structure of BP neural network

RESULTS AND DISCUSSION

The significance of this methodology is in identifying accurately the iris of the corresponding persons based on comparison of iris features. To evaluate the performance of this proposed system we useCASIA iris image database. The neural network model for prediction with one number of hidden layer can have better classification specificity. It can be estimated that the model with error back propagation algorithm can operate as an excellent classifier for iris recognition. All the proposed methods in this paper save time in theprocessing and extraction of feature in comparisonwith the known existence methods.

CONCLUSION

In this paper we proposed an effective algorithm for irisrecognition. Present method relies on GLCM based featuresand ANN based classification. On this basis, using MATLAB software with BP Neural Network model, we carried out example simulations and results were analyzed. Accuracy rate of the proposedmethod is 97.00%.

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