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Efficient Bio Metric IRIS Recognition System Using Fuzzy Neural Network

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ABSTRACT

The High protection mechanism and security is very essential things in a grow of computer world. Biometric Authentication is in rider seat of the computer society. Authentication and security based on "what you are?" rather than what you have? Like Identity Card, Physical Key and what you know? Like Password. Iris recognition a relatively new biometric technology, has great advantages, such as variability, stability and security, thus it is the most promising for high security environments. To determine the performance and recognition system a database grayscale eye images were used. Iris is part of eye between eyelids and surrounding. Four different algorithms were designed for verifying Irises viz., 1. Circular-Mellin algorithm, 2. Canny edge detection algorithm, these two algorithms are used for detect the Iris boundaries, 3. Harr wavelet algorithm, 4. Embedded-tree zero wavelet algorithms, 5. Fuzzy neural network algorithm used to extract the deterministic patterns in a person's Iris in the form of feature vector. Identity is done with the help of the Hamming Distance operator.

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1. INTRODUCTION

In recent years, biometric personal Identification is in growing state of world, not only that it is the hot cake of both academician and Industry [1]. Traditional methods for personal identification are based on what a person possesses (Identity Card, a physical key, etc.) or what a person knows (a secret password, etc.) any how these methods have some pitfalls. ID cards may be forged, Keys may be lost, and passwords may be forgotten. In 1988, Gallant made one of the first attempts to make neural networks more comprehensible [12, 13]. This was done by accompanying each output determined by the network with a rule that summarized the reasoning behind the output.

Basically there are two types of biometric features: (i) physical like figure prints, facial characteristics, Iris recognition. (ii) Behavioral biometric like voice recognition, signature recognition. Among these two methods physical biometric has more secure and accurate than the behavioral method.

Iris is a part of eye between eyelids and surrounding. The iris as shown in Figure-1as an internal (yet externally visible) organ of the eye, the iris is well protected from the environment and stable over time. The function of the iris is to control the amount of light entering through the pupil and this is achieved with the help of sphincter and the dilator muscles, which adjust the size of the pupil.

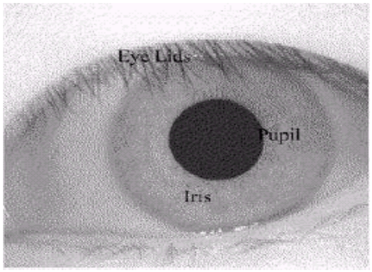

Figure 1: Eye Image

Due to epigenetic nature of iris patterns each and every individual has a unique Iris compared with other biometric features such as face recognition and fingerprints. Even the two eyes of an individual contain completely independent iris patterns, and identical twins posses uncorrelated iris patterns. Figure-2 shows the different iris of different persons.

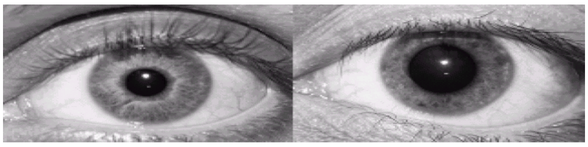

Figure 2: Different Human Iris

The Iris recognition becomes a hot topic in pattern recognition and machine learning research area because of the following advantages: (1) the iris patterns are unique in nature [3]. (2) The Iris formation starts at third month of born, and the structures creating its pattern are largely complete by the eighth month of born, and this formation wouldn't be changed though out the human being life [2].The inner organs of iris are protected by aqueous humor and cornea from the environment. (4) The forming of iris depends on the initial environment of embryo, so the iris texture patterns don't correlate with genetic determination [4]. (5) The iris recognition is non-invasive and don't cause the damage to identifier. Figure-3 gives the general view of authentication system using the Iris.

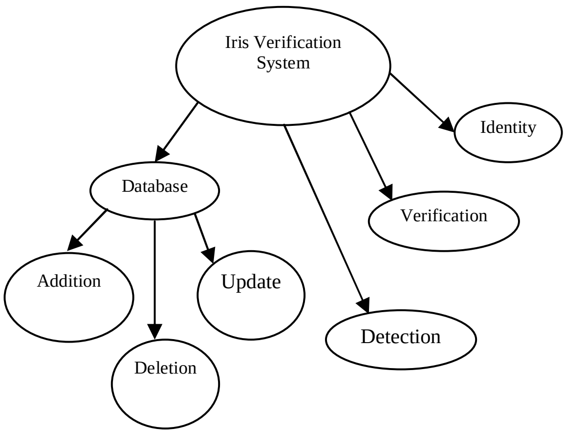

Figure 3: Iris Recognition System

The content of this paper are as follows: In Section 2 introduce the Iris Image acquisition device, including Iris preprocessing, Iris representation, and mapping. In Section 3 discuss about "feature Extraction". Section 4 gives the laboratory view involved in this proposal view. The binary coding will show in section 5. In section 6 test of statistical independence is discussed. Section 7 shows the experimental results & achievement. Our conclusion and our future work will show under section 8.

2. IMPLEMETATION

2.1 IMAGE ACQUISTION

An Important & difficult step of an iris recognition system is image acquisition. Since Iris is small in size and dark in color (especially for Asian people), it is very difficult to acquire good image without good camera. In order to accomplish this, we used a CCD camera. We set the resolution to 640x480, the type of the image to jpeg, and the mode to white and black for greater details. Furthermore, we took the eye pictures while trying to maintain appropriate settings such as lighting and distance to camera.

2.2 IRIS PREPROCESSING

The acquired images always contain not only the "useful" parts, but it is having some irrelevant parts (Ex. Eyelid, pupil etc) [5]. Under some conditions brightness may not be same and eye to camera distance may change the size of iris. To get an iris free of noise, independent on illumination and size iris image preprocessing is done. For the purpose of analysis, the original image needs to be preprocessed. Inner boundary of iris is detected by switching the pupil.

First the gray scale input image as shown in Figure-4 is changed to binary format (image having only black and white pixels) by using a suitable tighter threshold as shown in Figure-5. Both the inner boundary and the outer boundary of a typical iris can be taken as circles. But the two circles are usually not co-centric compared with the other part of the eye, the pupil is much darker.

Assuming that circular area of pupil is the largest black circular part, pupil is detected by searching for largest black circular part in binary image. Points are evenly initialized on image for searching largest black circular area around it. Points are initialized such that at least one point will be in pupillary circular part. Figure-6 shows the result of pupil detection. We then use the canny operator with the default threshold value given by Mat lab to obtain the gradient Image.

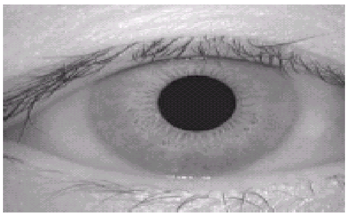

Figure 4: Input Eye Image

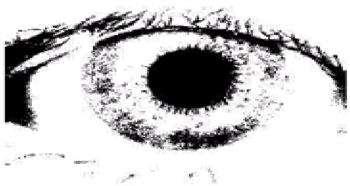

Figure 5: Binary Image

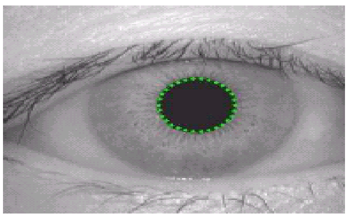

Figure 6: Detected Pupil

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2.3 MAPPING

After determining the limits of the iris in the previous phase, the iris should be isolated and stored in a separate image. The factors that we should watch out for are the possibility of the pupil dilating and appearing of different size in different images. For this purpose, we begin by changing our coordinate system by unwrapping the lower part of the iris (lower 180 degrees) and mapping all the points within the boundary of the iris into their polar equivalent (Figures 7 & 8). The size of the mapped image is fixed (100x402 pixels) which means that we are taking an equal amount of points at every angle. Therefore, if the pupil dilates the same points will be picked up and mapped again which makes our mapping process stretch invariant.

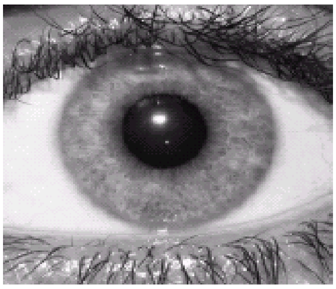

Figure 7: Original Image

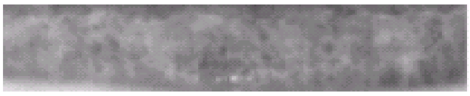

Figure 8: Iris Isolated Image

When unwrapping the image, we make use of the bilinear transformation to obtain the intensities of the points in the new image. The intensities at each pixel in the new image are the result of the interpolation of the grayscales in the old image. [6]

3. FEATURE EXTRACTION

In Iris based Authorization system one of the most important as well as interesting aspects is generating the patterns. A pattern is essentially an arrangement. It is characterized by the order of the elements of which it is made, rather the by the intrinsic nature of these elements. This definition one of the most interesting aspects of the world is that it can be considered to be made up of patterns. A pattern is essentially an arrangement. It is characterized by the order of the elements of which it is made, rather than by the intrinsic nature of these elements [6]. This definition summarizes our purpose in this part. In fact, this step is responsible of extracting the patterns of the iris taking into account the correlation between adjacent pixels. After performing lots of research and analysis about this topic, we decided to use wavelets transform, and more specifically the “Haar Transform”. The Haar wavelet is illustrated in Figure 9.

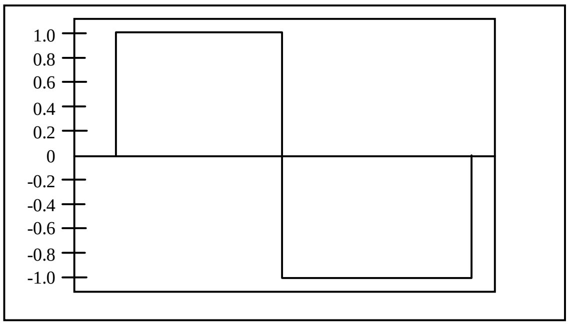

Figure 9: Harr Wavelet

4. 1. HARR WAVELET

Most previous implementations have made use of the famous wavelet called Gabor wavelets to extract the iris patterns [7], [8], [6]. But, some of the researchers are feel that it is time consuming. So we are very keen on keeping our total computation time as low as possible, we decided that building a neural network especially for this task would be too time consuming and selecting another wavelet would be more appropriate. We comparing the results using the Haar transform with the wavelet tree obtained using other wavelets we found that the Haar wavelet gave slightly better results. Our mapped image is of size 100x402 pixels and can be decomposed using the Haar wavelet into a maximum of five levels. These levels are cD1 h to cD5 h (horizontal coefficients), cD1 v to cD5 v (vertical coefficients) and cD1 d to cD5 d (diagonal coefficients). We must now pick up the coefficients that represent the core of the iris pattern. Therefore those that reveal redundant information should be eliminated.

Figure 10: Five Level Harr Wavelet

In fact, looking closely at Figure-10 it is obvious that the patterns in cD1 h, cD2 h, cD3 h and cD4h are almost the same and only one can be chosen to reduce redundancy. Since cD4 h repeats the same patterns as the previous horizontal detail levels and it is the smallest in size, then we can take it as a representative of all the information the four levels carry. The fifth level does not contain the same textures and should be selected as a whole. In a similar fashion, only the fourth and fifth vertical and diagonal coefficients can be taken to express the characteristic patterns in the iris-mapped image. Thus we can represent each image applied to the Haar wavelet as the combination of six matrices:

- cD4 h and cD5h
- cD4 v and cD5v
- cD4 d and cD5 d

All these matrices are combined to build one single vector characterizing the iris patterns. This vector is called the feature vector [10]. Since all the mapped images have a fixed size of 100x402 then all images will have a fixed feature vector. In our case, this vector has a size of 702 elements. This means that we have managed to successfully reduce the feature vector of Daugman who uses a vector of 1024 elements [8]. This difference can be explained by the fact that he always maps the whole iris even if some part is occluded by the eyelashes, while we map only the lower part of the iris obtaining almost half his feature vector's size.

4.2 EZW CODING

Better Image compression can be done with the help of EZW encoding. An EZW encoder was specially designed to use with wavelet transformation. In fact, EZW coding is more like a quantization method. It was specially designed to operate on images like (2D Signals), but it can also be used on other dimensional signals. The EZW encoder is based on progressive encoding to compress an image into a bit stream, the decoded image will contain more detail, a property similar to JPEG (Joint Picture Experts Group) encoded images. Progressive encoding is also known as embedded encoding,

Coding an image using the EZW scheme, together with some optimizations, results in a remarkably effective image compressed data stream can have any bit rate desired. Any bit rate is only possible if there is information loss somewhere, so that the compressor is lossy. However, loss-less compression is also possible with an EZW encoder, but of course with less spectacular results.

For every pass, a threshold is chosen against which all the wavelet coefficients are measured. If a wavelet coefficient is larger than the threshold, it is encoded and removed from the image; if it is smaller it is left for the next pass. When all wavelet coefficients have been visited, the threshold is lowered, and the image is scanned again to add more detail to the already encoded image. This process is repeated until all the wavelet coefficients have been encoded completely or another criterion has been satisfied.

A zerotree is a quad-tree of which all nodes are equal to or smaller than the root. The root is coded with a single symbol and reconstructed by the decoder as a quad-tree filled with zeroes. The EZW encoder exploits the zerotree based on the observation that wavelet coefficients decrease with scale. It assumes that there will be a very high probability that all the coefficients in a quad tree will be smaller than a certain threshold if the root is smaller than this threshold. If this is the case, then the whole tree can be coded with a single zerotree symbol.

4.3 FUZZY NEURAL NETWORK ALGORITHM

This algorithm can extract rules that yield much higher accuracy and robustness. Their technique consists of several steps. In the first step, given *n*-continuous-valued input parameters Ii, i=1,2,…,n, each input parameter is classified into two or more equally populated sets. Then each set is represented with a binary scheme. For example, if each input parameter is divided into two sets, small and large, the set {Ii is small} is represented as [1 0], and the set {Ii is large} is represented as [0 1]. As a result, a problem of n continuous valued input parameters is transformed into a problem of $2n$ input parameters where each input is binary.

Next, a two layer feed-forward back-propagation neural network is constructed, with $2n$ inputs and as many output nodes as the number of classes in the data. Once the network is trained, the most dominant rule from each output neuron is extracted. This is done by determining, for each input Ii, its binary input with the highest weight and assuming that input to be 1. Therefore, the antecedents of the extracted rule include all input parameters, some of which can then be pruned. The pruning process allows for the rule to be more general and therefore yield more accurate results. The pruning algorithm first sorts the input parameters in ascending order of their maximum weights. Then, the algorithm prunes the parameters one at a time, starting with the input parameter with the smallest maximum weight, so long as the neuron remains activated even when the maximum-weight binary input of the input parameter is off and the minimum-weight binary input is on. The main problem with this rule-extraction technique lies in the pruning process: It assumes that how an input parameter affects the activation of an output neuron depends only on the maximum weight of the parameter, and not on the minimum weight. This incorrect assumption causes antecedents that can be pruned to sometimes escape pruning, making the rules less general, and consequently diminishing the accuracy of the fuzzy inference system implementing the extracted rules.

4.4 COMPARISON WITH EXISTING METHODS

Several methods have been proposed for iris recognition. Daugman [3] presented a system for iris recognition and reported that it has excellent performance on a diverse database of many images. Wiledes [9] described a system for personal verification based on automatic iris recognition. Boles [11] proposed an algorithm for iris feature extraction using zero-crossing representation of 1-D wavelet transform. Both systems of Daugman and Wildes employed carefully designed devices for image acquisition to ensure that iris is located at the same location within the image, and the images have the some resolution and are glare free under fixed illuminations. However in both methods they achieve only 70-80 percentage of accuracy in authentication, but in our proposal view we are expecting more than that percentage.

5. BINARY CODING SCHEME

It is very essential thing, obtained the feature vector in a binary code because it is easier to find the difference between two binary code-words than between two number vectors. In fact, Boolean vectors are always easier to compare and to manipulate. In order to code the feature vector we first observed some of its characteristics. We found that all the vectors that we obtained have a maximum value that is greater than 0 and a minimum value that is less than 0.

If “Coefficient (Coef)” is the feature vector of an image than the following quantization scheme converts it to its equivalent code-word:

- If Coef (i) < 0 then Coef (i) = 0
- If Coef (i) >= 0 then Coef (i) = 1

The next stage is to compare two code-words to find out if they represent the same person or not.

6. TEST OF STATISTICAL INDEPENDENCE

When different irises are compared in this manner, the fact that their patterns possess so much random variation makes it nearly impossible for them to agree by chance in more than about two – third of their phase – sequence bits. The main motto of this test involves the comparison of two iris patterns. This test as already proven. The very famous and highlighted person of Iris based Image processing is John Daugman, who is conducted his tests on a very large number of iris patterns (up to 3000000 iris images) and deduced that the maximum Hamming distance that exists between two irises belonging to the same person is 0.32 [7]. Since we were not able to access any large eyes database and were only able to collect 20 images, we adopted this threshold and used it.

The test is conducted based on the following way, initially binary feature vectors are passed to a mathematical function, secondly after getting the numeric value it is compared with the Hamming Distance between the thing. Finally the decision is made up, with the following results.

- If HD <= 0.32 decide that it is same person
- If HD > 0.32 decide that it is different person
  (or left and right eyes of the same person)

7. EXPERIMENT RESULTS & PERFORMANCE

We tested our project on 20 pictures, using a High configuration system, and we obtained average of correct recognition of 93%, with an average computing time of 31ns. We achieved near by good efficiency of some part of the system it shown under Table 1.

	Edge Detection	Mapping	Feature Extraction	Binary Code Generation
Efficiency (%)	96	100	96	100

Table 1: Efficiencies of the Different Part

The main reason of the failures we encountered is due to the quality of the pictures. Some of these problems are bad lighting, occlusion by eyelids, noises or inappropriate eye positioning.

It is planned three modules in our proposal view, namely (1) Identify the person through his/her eye. (2) Verification of the correspondence between the name entered and a chosen eye image. (3) Comparison of two images. Yet now we had completed our first module, with 20 images and we got the results which are shown under Table–1.

Neural learning algorithm is applied in order to solve iris classification. From each set of iris images, two patterns are used for training and two patterns for testing. After training the remaining images are used for testing. The recognition rate of NN system was 99.25%. The obtained recognition result is compared with the recognition results of other methods that utilize the same iris database. The results of this comparison are given in Table 2. As shown in the table, the identification result obtained using the neural network approach illustrates the success of its efficient use in iris recognition.

Methodology	**Accuracy rate**
Wavelet	92.64%
Wavelet with zero tree	94.9%
Fuzzy Neural Network	99.25%

Table-2: The recognition performance of comparing with existing methods

8. CONCLUSION and FUTURE WORK

We have proposed a new "Efficient Biometric visual recognition of human being based on their Iris using Fuzzy Neural Network". The located iris after pre-processing is represented by a feature vector. Using this system, vector as input signal the neural network is used to recognize the iris patterns. The recognition accuracy for trained patterns is 99.25%. This identification system is quite simple requiring few components and is effective enough to be integrated within security systems that require an identity check. The errors that occurred can be easily overcome by the use of stable equipment. Judging by the clear distinctiveness of the iris patterns we can expect iris recognition systems to become the leading technology in identity verification.

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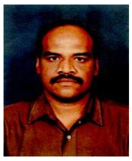

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