Comparison of Phase Only Correlation and Neural Network for Iris Recognition

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Abstract: ***This paper compares two different techniques of iris recognition and explains the steps of extracting iris from eye image palette formation and conditioning of palette for matching. The focus of the paper is in finding the suitable method for iris recognition on the basis of recognition time, recognition rate, false detection rate, conditioning time, algorithm complexity, bulk detection, database handling. In this paper comparison has been performed two methods feature based and phase based recognition.***

Keywords: Iris recognition, POC (Phase Only Correlation).

1. Introduction

Iris recognition [2] using biometric authentication uses high-resolution images of the irises of individual's eyes for pattern-recognition techniques. The camera technology used by Iris Recognition with restrained infrared illumination reducing specular reflection from the convex cornea, to create images of the detail-rich, complex structures of the iris. Conversion to digital templates, images mathematically represent iris that yield explicit positive identification of an individual [1].

Iris recognition [7] efficiency is rarely restricted on by glasses or contact lenses. It's special characteristics of comparison speed, iris recognition becomes the only biometric technology compatible for one-to-many identification. Stability is the key advantage of iris recognition.

The human iris is the annular part between the dark pupil and the white sclera; it is stable and distinctive throughout life. In an iris recognition system, iris localization is one of the most important steps, and has great influence on the subsequent feature extraction and classification. It aims to find the radii, centre and the parameters for both inner and outer boundaries of the iris. There are many iris localization methods; more algorithms were developed to improve the performance of iris localization. More recently, other algorithms have been presented by many researchers. However, these methods have promising performance; they need to search the iris boundaries over large parameter space thoroughly, which takes more computing time. Moreover, they may result in circle detection failure, because some selected threshold values used for edge detection cause critical edge points being removed. In this paper, we compare two algorithms for iris recognition from iris template images. The paper also explains the iris extraction from eye image. The paper is arranged in following way, section 2 explains the method of iris extraction by using Hough circle method, and then the conversion of circular iris image into rectangular template, section 2.3 explains the methods of iris recognition then after section 4 shows the simulated results and conclusion on the basis of results. Most of the researchers in the field of iris recognition use iris images from the following databases, which are available freely online:

- The Chinese Academy of Sciences database (CASIA)[16]
- The Bath database, produced by the university of Bath[17]

2. Pre Processing For Iris Recognition

The realization of this work supposes the availability of a great number of repetitions of samples responding to the same known theoretical model. In practice, because of unknown theoretical model, the Monte-Carlo method is used based on the generation of the data by computer according to a fixed theoretical model.

2.1. Iris Boundaries Detection

Iris is the area between pupil and white section of eyes, as shown in figures 2.1 the area between two white circles.

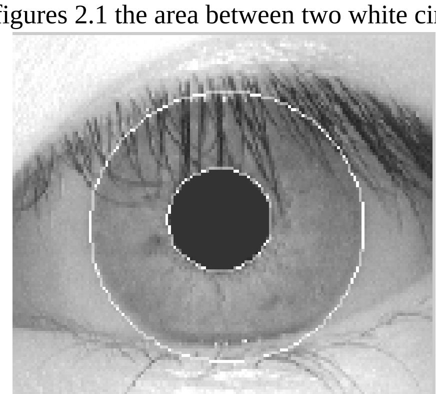

Figure 2.1: Eye and iris

It is clear the iris is a circular strip hence both iris boundaries are circular. Therefore most of the technique [3][4][5][6] utilizes the shades of pupil, iris and other sections, but in proposed technique we preferred Hough circle[3][4] and threshold technique method for detection of correct iris boundaries. Following are the steps used in this paper for detection of correct iris boundaries.

1. Perform the histogram equalization in the iris image.
2. Convert it into edge image using sobel filter.
3. From each point of edge image draw a circle of diameter greater than 10 percentage of image height up to 90 percent of height.
4. Counts the edge travelled by each periphery of each circle and find normalized edge density of each periphery using the formula.
   D_n = edges/total points
5. Now find out the best circle with highest edge density with diameter from 10 to 30 percent, this will denote the inner boundary of the iris, repeat sane for diameter range 50 to 90 percent this will denote the outer boundary.
6. Now crop the image between these circles is the required iris.

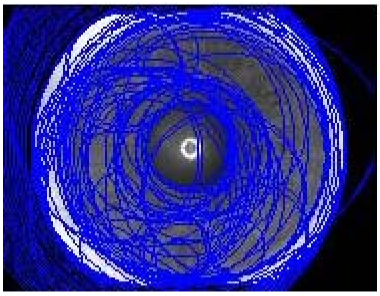

Figure 2.2: Circles drawn all over the image.

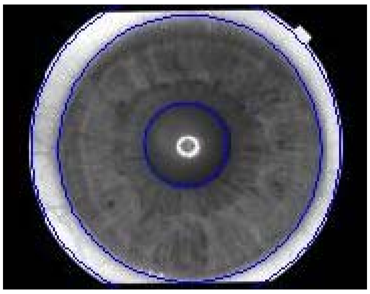

Figure 2.3: Selected circles.

2.2. Circular to Rectangular Conversion

From figure 2.2 we can easily crop iris but for recognition of iris it's much better to deal with Cartesian coordinates than circular, hence a conversion from circular to rectangular is performed, since the image is digital hence inner edge having lower number of points than upper edge. Now the conversion is performed by using formula.

$$x = r\cos\theta$$
$$y = r\sin\theta$$

where θ varies from 0˚ to 360˚ and r varies from inner circle radius to outer circle radius.

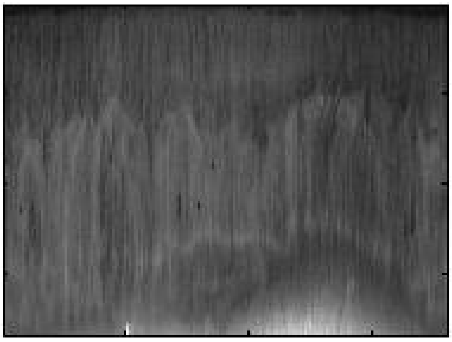

Figure 2.4: Rectangular iris image.

Figure 2.4 shows the rectangular converted image from of iris, since not all image content have important information, therefore we can filter out some unwanted components figure 2.5 shows the filtered image [8].

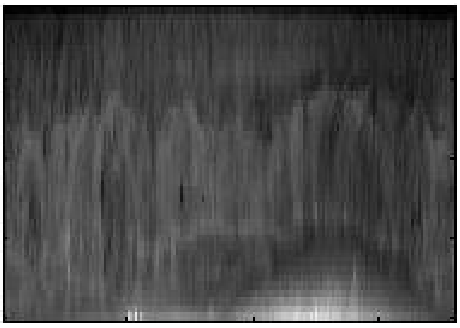

Figure 2.5: Rectangular filtered iris image.

This is called the standard template, which can be used for matching by any technique.

2.3 Iris Matching Methods 2.3.1. POC (Phase Only Correlation)

POC is a method for finding the correlation between two different images in frequency domain; it gives much better results than normal time domain correlation [8] [14].

This section describes the introduction to the principle of phase based image matching using the Phase-Only Correlation (POC) [1] [13] function. Consider two $N_1 X N_2$ images $f(n_1, n_2)$ and $g(n_1, n_2)$,

$$F(k_1,k_2) = \sum_{n_1=-M_1}^{M_1} \sum_{n_2=-M_2}^{M_2} f(n_1,n_2) W_{N_1}^{k_1 n_1} W_{N_2}^{k_2 n_2} = A_F(k_1,k_2)e^{j\theta_F(k_1,k_2)}$$

$$G(k_1,k_2) = \sum_{n_1=-M_1}^{M_1} \sum_{n_2=-M_2}^{M_2} g(n_1,n_2) W_{N_1}^{k_1 n_1} W_{N_2}^{k_2 n_2} = A_G(k_1,k_2)e^{j\theta_G(k_1,k_2)}$$

Here $F(k_1,k_2)$ and $G(k_1,k_2)$ are the 2D DCT transform of function F and g, the cross-phase spectrum R_{FG}(k1; k2) between F(k1; k2) and G(k1; k2) is given by

$$R_{FG}(k_1,k_2) = \frac{F(k_1,k_2)\overline{G(k_1,k_2)}}{\left|F(k_1,k_2)\overline{G(k_1,k_2)}\right|}$$

$$= e^{j\{\theta_F(k_1,k_2)-\theta_G(k_1,k_2)\}}$$

Where G (k1; k2) denotes the complex conjugate of G (k1; k2). The POC function $r_{fg}(n1; n2)$ is the 2D Inverse DFT (IDFT) of $R_{FG}(k1; k2)$ and is given by

$$r_{fg}(n_1,n_2) = \frac{1}{N_1N_2}\sum_{k_1=-M_1}^{M_1}\sum_{k_2=-M_2}^{M_2} R_{FG}(k_1,k_2)\, W_{N_1}^{-k_1n_1} W_{N_2}^{-k_2n_2}$$

When two images are similar, their POC [13] function gives a distinct sharp peak. When $f(n_1,n_2) = g(n_1,n_2)$, the POC function $r_{fg}(n_1,n_2)$ becomes the Kronecker delta function $\delta(n_1,n_2)$ The peak value drops significantly, if two images are not similar. The altitude of the peak can be used as a good similarity measure for image matching and the location of the peak shows the translational displacement between the two images.cx

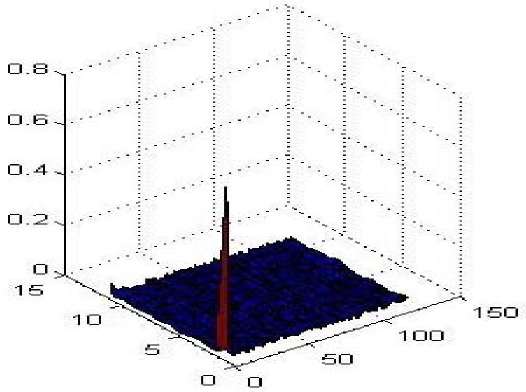

Figure 2.6: POC peak when iris image matched.

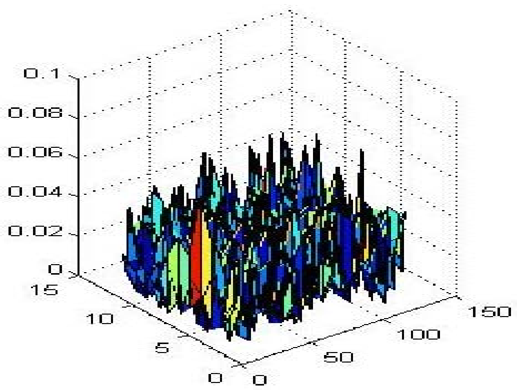

Figure 2.7: POC when iris image not matched.

2.3.2 Neural Network

The term **neural network** [15] was traditionally used to refer to a network or circuit of biological neurons. Often the modern usage of the term refers to artificial neural networks, which have the composition of artificial neurons or nodes. Thus the term has two different usages:

1. Biological neural networks are made up of real biological neurons that are connected or functionally related in the peripheral nervous system or the central nervous system. Very often in the field of neuroscience, they are identified as cluster of neurons that perform a specific physiological function in laboratory analysis.

2. Artificial neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Either the artificial neural networks may be used for solving artificial intelligence problems or to gain an understanding of biological neural networks without necessarily creating a model of a real biological system. The actual, biological nervous system is extremely complex: artificial neural network algorithms try to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view. To support the hypothesis that the abstraction really captured something important from the viewing point of information processing in the brain, good performance (e.g. as measured by good analytical ability, low generalization error), or performance mimicking animal or human error patterns, can then be used as one basis of confirmation. Another reason for these abstractions is to decrease the amount of computation required to simulate artificial neural networks, to permit one to experiment with larger networks and train them on larger data sets

An **artificial neural network (ANN)**, usually called **neural network (NN)** [15], is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network is a group of artificial neurons interconnected, and it processes information collectively for computation. In most of the cases the ANN acts as an adaptive system that changes its structure, during its learning phase, on the basis of external or internal information flow through the network. A modern neural network is a tool for non-linear statistical data modeling. They are usually used to form complex relationships between inputs and outputs or to find patterns in data.

An iris-recognition algorithm first a discrete cosine transform is used in order to extract the spatial frequency range that contains the main abstract of iris image. The result is a set of complex numbers that carry local amplitude and phase information for the iris image which is used as training input for neural network.

In this paper the matrix of discrete cosine transform of Edge of iris images has been used for Iris Recognition using Probabilistic neural networks following figure shows the structure of Iris Recognition system. The output of neural network is the class of iris which is name of the person. This system can classify the noisy iris image very well. The sobel edge detection has been used in this paper. Neural network that has been used in this paper is LVQ. LVQ, or Learning Vector Quantization, is a prototype-based supervise categorization algorithm.LVQ can be understood as a special case of an artificial neural network.LVQ can be considered as one of the competitive neural networks. Subsequent figure shows the organization of neural network:

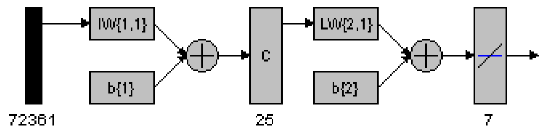

Figure 2.8: Structure of Neural Network

3. Results

For result analysis in this paper, we are considering some parameters shown in table. Average segmentation time refer to average time taken by algorithm to partitioning a iris image into multiple segment of pixel. Segments accuracy rate refer as percentage of images correctly segmented by algorithm. Recognition accuracy means the probability that an authorized person is correctly recognized. It is the percentage of how much time a true iris image is recognized correctly.

Recognition time is refer as time taken to match the captured image with true imaged stored in database. A parameter we are considering for analysis is bulk detection. These parameters reveal the strength of LVQ Based algorithm. This tells us how it will response in heavy load in term of high capturing rate and rich database. The reason behind good performance in heavy load is basic characteristic of neural network that is after a proper training it will response quickly. Last parameter we are considering here is algorithm complexity. Because of neural network LVQ Based algorithm is little bit complex.

Experiment result analysis is shown in table 1.1.It is very clear with result that LVQ based algorithm has better performance than POC based method. Average segmentation time is reduced by 22 percent with LVQ based method. Likewise LVQ based iris recognition provides better Segmentation Accuracy Rates and Recognition time. LVQ is best suitable where bulk detection is required. Because Learning Vector Quantization is a prototype-based supervised classification algorithm based on artificial neural network so once it is trained, it provides accurate and fast result. In figure 3.1 and 3.2, It is shown that the performance of ANN (LVQ) based algorithm is independent of input image load (number of iris need to process). Means LVQ based algorithm gives much better result in bulk detection.

Table 1.1: Result analysis

Parameters	*POC Based*	*LVQ Based*	*Improvement with LVQ*
Avg. Segmentation time	18 Sec.	14 Sec.	22 %
Segmentation Accuracy Rates	98.01	98.62	0.62 %
Recognition Accuracy	98.88	99.25	0.37 %
Recognition time	.17 Sec.	0.07 Sec.	58 %

On the other hand performance is exponentially decrease as input image load is increase in POC based method. Similarly result can be found in figure 3.4 where matching time in LVQ based method is considerable lower than POC based method (approximate 58% better than POC based method).

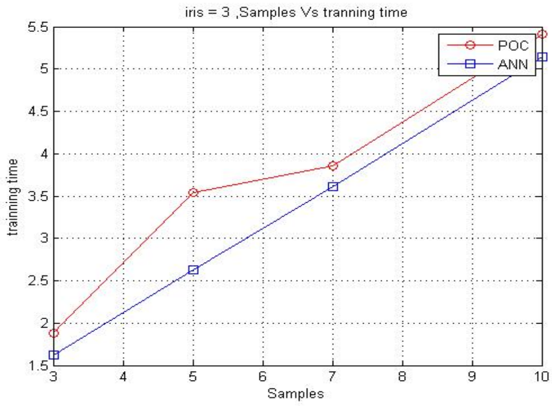

Figure 3.1: Samples vs. Training Time

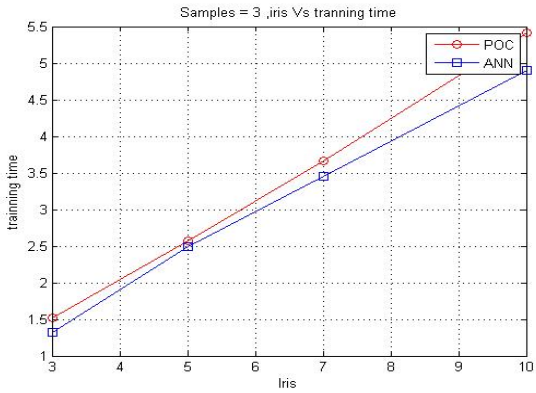

Figure 3.2: Number of iris vs. Training Time

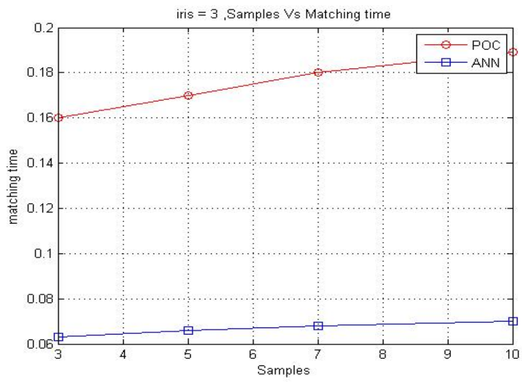

Figure 3.3: Samples vs. Matching Time

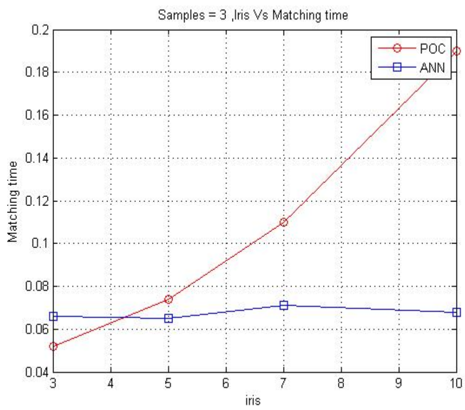

Figure 3.4: Number of iris vs. matching time

4. Discussion and Conclusion

Using neural networks for a personal iris recognition system is presented in this paper. A fast iris localization method using Hough transform is explained. Using this method, iris segmentation is performed in short time. For IRIS segmentation, average time obtained is 14 sec for high resolution image (786x576). Accuracy rate of iris segmentation is about 98.62% is achieved. The located iris after pre-processing is represented by a feature vector. This vector is utilized as input signal the neural network is used to recognize the iris patterns. The accuracy of recognition for trained pattern is about 99.25%, and LVQ based recognition time is increases to 58%.

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