International Journal of Signal Processing, Image Processing and Pattern Recognition
Vol.7, No.4 (2014), pp.57-64
http://dx.doi.org/10.14257/ijsip.2014.7.4.05

Enhancing Performance of Iris Recognition Algorithm through Time Reduction

Tajinder pal Singh[1] and Sheifali gupta[2]

[1]Lecturer of Chitkara University (India), tajinderpal.singh@chitkarauniversity.edu.in
[2] Associate Professor of Chitkara University (India), sheifali.gupta@chitkara.edu.in

Abstract

Nowadays, for providing the secure facilities and services to the user, the accurate identification is necessary. The Iris recognition is one of the attractive approach for user's identification, provides high level of security and convenience then the other methods of identification like traditional ID and password, which can be lost or transferred. However, the iris recognition algorithms are implemented on general purpose sequential processing systems, such as generic central processing units (CPUs). Parallel processing is an alternative offers an opportunity to enhance the performance of system by increasing the speed. The most time consuming part of Iris recognition algorithm is matching part, which is implemented using Verilog HDL through ISE Design suit (14.2), achieved significantly reduction in execution time. The proposed design is suitable for integration either in ASIC or FPGA.

Keywords: *Biometric, Iris, identification, parallel processing*

1. Introduction

Biometric technology deals with recognizing the identity of individuals based on their unique physical or behavioral characteristics. Physical characteristics such as fingerprint, palm print, hand geometry and iris patterns or behavioral characteristics such as typing pattern and hand-written signature present unique information about a person and can be used in authentication applications

The developments in science and technology have made it possible to use biometrics in applications where it is required to establish or confirm the identity of individuals. Applications such as passenger control in airports, access control in restricted areas, border control, database access and financial services are some of the examples where the biometric technology has been applied for more reliable identification and verification [9].

The iris recognition is an efficient biometric method for user identification, currently carried out on variety of systems ranging from personal computers to portable iris scanners. These systems use central processing unit (CPU).CPU-based systems are known as sequential processing devices. Instructions are first fetched, decoded, and finally executed by arithmetic logic units. These devices are too slow for applications requiring intensive computations. The parallel processing is good alternative for high-speed processing of the complex computations tasks. With advances in the VLSI (Very Large Scale Integrated) technology, exploiting parallelism and pipelining in algorithms significantly achieve reduction in execution time. The work in this paper is focus on implementation of iris matching phase using verilog HDL due to its large computation

ISSN: 2005-4254 IJSIP

time requirement, Which can further target or implement on hardware devices like FPGA and ASIC..

2. Iris Segmentation

The segmentation is the first step of iris recognition to isolate the iris region in digital image. In this process, firstly iris region is approximated by the two circles drawn on the iris and pupil boundaries as shown in Figure 2.1. After that the artifacts like eyelashes and eyelids are excluded and isolated which occur on the upper and lower parts of iris region. In some cases the iris image can be affected by specular reflection, which can corrupt the iris pattern. So the proper segmentation and isolation is important for minimum false rate recognition (FRR).

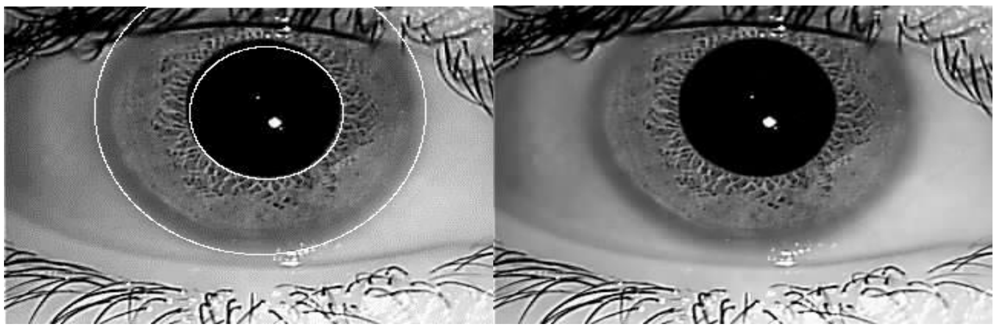

Figure 1. Original Eye Image & Eye Image with Circle Drawn on Iris and Pupil

The overall success of the segmentation process mainly depends upon the image quality. The image taken under the infra-red-light has less chance of occurring the specular reflection. But the imaging under the natural light has maximum chance of specular reflection which makes segmentation more difficult. The segmentation result on this image will give false representation of iris pattern resulting poor recognition. The image data taken in this research is from IITD database, which is free from specular reflection. There are the following different steps of segmentation.

a) **Edge Detection**: The edge detection is basically a technique to find the iris circle. In this method the edge pixel coordinates are detected using different function. Depend upon the strength and intensity value of the pixel the boundary coordinates are getting separated from the rest of the image. There are the many methods for detecting the edges like canny, sobel, prewitt, Robert, zero crossing methods [11]. In our approach we are using one of the most efficient methods known as canny edge detector. The canny edge detector detects the edges in very most robust manner.

b) **Circular Hough transform**: CHT is used to find the circle pattern with in the eye image. The aim of the circular Hough transform is to find the circular pattern and radius. The pervious detected edges are voting for different circles with different radii and centre point. The maximum value of (x, y, r) store in the Hough space gives parameter for circle as shown in the Figure (2.2). The whole algorithm has following steps to accomplish it [11]

- Firstly for every edge point draw a circle with centre in edge point with radius r and increase each and every coordinate that is perimeter of the circle passes through in the accumulator space.
- Secondly find out the maxima in accumulator space.

- At last map the parameter (a, b, r) according to maxima.

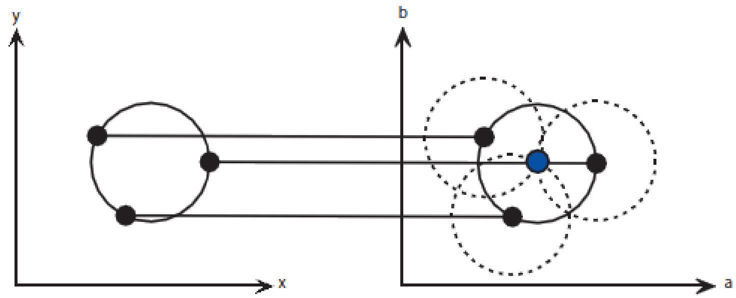

Figure 2. A Circle Hough Transform from the x, y Space

3. Normalization

After segmented the iris region successfully the image is transformed to have fixed dimension for proper iris comparison. The inconsistency is produced in between the images because of stretching of iris region caused by pupil dilation from varying levels of illumination. Some of the other reason of inconsistency can be camera rotation, varying image distance; head tilt *etc.*, the problem of inconsistency can be overcome by normalization. The normalized iris regions will have constant dimensions, so that the picture of same iris taken under different condition will have characteristics features at same spatial locations. The main task of it is to produce a rectangular strip from segmented iris to form a rectangular matrix with consistent value. The method to accomplish this task is known as Daugman's Rubber sheet Model.

a) Daugman's Rubber Sheet Model

The dugman's Rubber sheet Model remaps the each point in the iris area to pair of the polar coordinates (r, ϴ). The ϴ is defined the angle varying from 0 to 2π and r is radius in the interval of [0, 1]. Figure 4 and 5 show the result of normalization of iris image Figure 1.

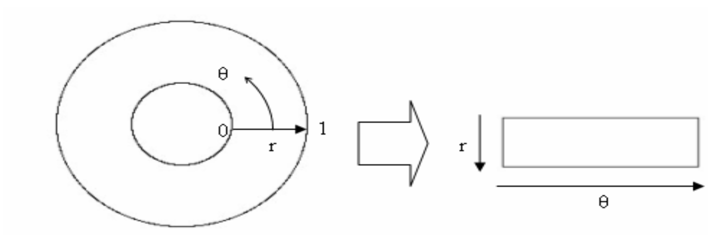

Figure 3. Normalization of Concentric Region to Rectangular Matrix Strip

Figure 4. Normalized Iris Image **Figure 5. Polar Noise Image**

4. Encoding

To provide proper iris recognition of image, the most discriminating information in iris pattern has to be extracted. The encoding process is nothing but it is a process of generating some discriminating pattern or template from the normalized image. Various method are there for this task like wavelet encoding, Gabor filter, zero crossing of 1D wavelet, Haar wavelet *etc.*, The Gabor filter is used in our research work. Gabor filter over an image(x, y) to encode the iris pattern represented by (1)

$$G(x,y) = e^{-\pi[(x-x_0)^2/\alpha^2+(y-y_0)^2/\beta^2]} e^{-2\pi i[u_0(x-x_0)+v_0(y-y_0)]} \quad (1)$$

Where (x_0, y_0) specify the position in image, (α, β) specified the width and length, (u_0 , v_0) specified modulation. The output of the filter is demodulated to compress the data which is accomplished by quantizing the phase information into four levels, for each quadrant in complex plain. The phase information, rather than the amplitude information provides the significant information. By taking only the phase information allows encoding of discrimination information in this iris with discarded information such as illumination *etc.*

Only the two bits are used to represent the four levels, so each pixel in normalized iris pattern corresponds to two bit of data in iris template. The equal amount of code and mask bit are generated, where mask bit mask out corrupting region within the iris.The demodulation and Phase quantization process is represent as (2)

$$h_{\{\mathrm{Re,Im}\}} = \mathrm{sgn}_{\{\mathrm{Re,Im}\}} \int_\rho \int_\phi I(\rho,\phi) e^{-i\omega(\theta_0-\phi)} e^{-(r_0-\rho)^2/\alpha^2} e^{-(\theta_0-\phi)^2/\beta^2} \rho d\rho d\phi \quad (2)$$

Where the $h_{\{\mathrm{Re,\ Im}\}}$ can be regarded as a complex valued bits whose real and imaginary components are depend upon sign of 2D integral and I(ρ,Φ) is raw iris in dimensionless polar coordinate system .

5. Matching via Hamming Distance

The last phase of iris recognition process is matching. The generated feature or template in feature extraction or normalization method is taken as input value for matching the iris image with iris code. Hamming distance calculation is used for this purpose. It is one of the simple methods used than the others methods like weighted Euclidean distance and fragile bit distance *etc.*, The hamming distance gives a measure of the how many bits are same in the bit patterns. This measure of bit difference is done by using the XOR operation. Basically this bit difference or distance is nothing but it is the disagreements in between bits to prove that the two patterns were generated from the same iris or different.

In the comparison of code A and code B the HD represent the dissimilarities between the two iris whose phase bit vector are code A and code B with mask bit vector mask A and Mask B.

$$HD = \frac{\|(codeA \otimes codeB) \cap maskA \cap maskB\|}{\|maskA \cap maskB\|} \quad (3)$$

The denominator tallies the total no of bits that mattered in iris comparison after eyelashes and eyelids are encountered.

The individual iris bits produced have high degree of freedom, which is independent to that produced by other iris. On the other hand the two codes belong to same iris are highly correlated. If the two bits patterns are generated from different iris then the hamming distance between them should be equal to 0.5 due to half of the bits agree and half of the bits disagree. This occurs because independence implies the two bit patterns totally random, so there is 0.5 chance of setting any two bits 1 or vice versa. On the other hand the hamming distance between the two codes derived from same iris should be close to 0.0 because are highly correlated.

The HD calculation, or iris matching, is critical to the throughput performance of iris recognition since this task is repeated many times. Traditional systems for HD calculation have been coded in sequential logic (software); databases have been spread across multiple processors to take advantage of the parallelism of the database search, but the inherent parallelism of the HD calculation has not been fully exploited. In this section we present an approach utilizing parallel logic that can fully exploit the parallelism of the HD computation.

In our research work the matching phase of the iris recognition algorithm is parallelized to speed up the execution. The matching phase of algorithm is containing hamming distance calculations for classification of iris templates. The two templates are found to be match if hamming distance between them is less then specified threshold value .The implementation of this calculation work is done using VHDL (very high speed integrated circuit hardware description languages) code. The VHDL code statements are inherently parallel not sequential which allow the programmer to write a code for number of XOR gates for executing them in parallel. The written VHDL code for the proposed work is containing the process statement. The process is initiated instantly with wait statements written in the code itself. The wait statement is basically an alternative to the sensitivity list which contains sensitive elements to suspend the execution of process. Implementation of hamming distance calculation of purposed algorithm with wait statements shows the matching result of the two templates from different irises within the time requirement of 4ns, which is much less than other executions. Hence the execution time significantly reduced in proposed approach.

Sample database is created by generating the templates for 10 sample eye images taken from IITD database. Segmentation, Normalization and Encoding is done using matlab open source code. Matching module is implemented using verilog HDL. Proposed design is implemented using XOR and AND gates, adders for summing and a magnitude comparator. Xilinx isim (ISE 14.2) tool is used to generate simulation results. The hm_test is the live template given as an input as shown in Figure 5. The Hm_image contain the data of iris codes for matching. The search starts and test image calculate the hamming distance with each image in database and continue till the match not found. According to predefined threshold value the image with HD less the 0.3 is matched with iris code and the name of matched image will display on the simulation screen as per name given in database.

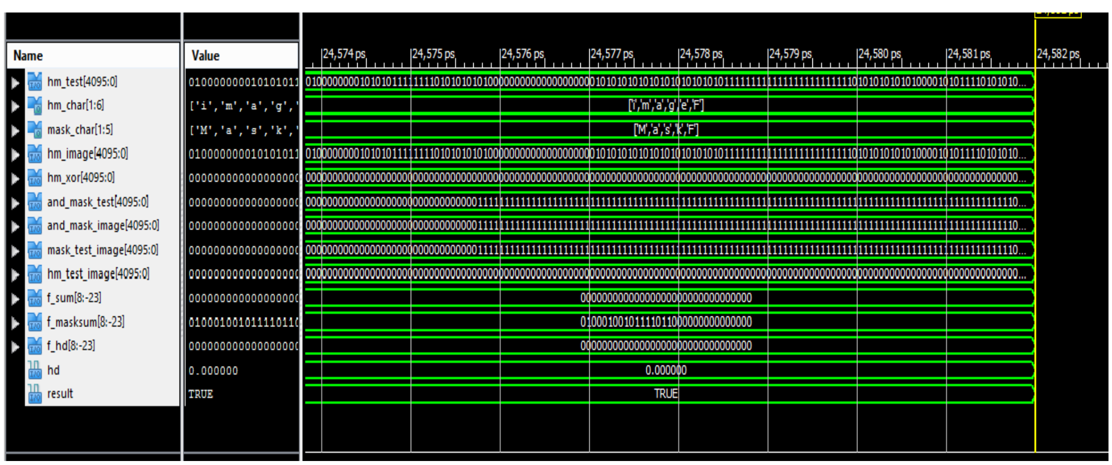

Figure 5. Simulation Result of Matching

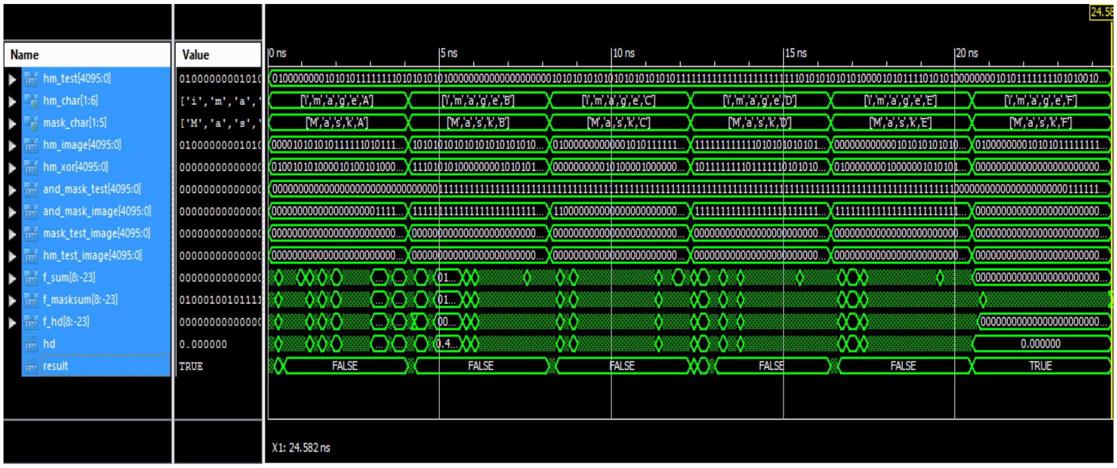

Figure 7. Simulation Result of Hamming Distance Calculation of Test_Image with Different Iris Codes

The written VHDL code for matching module can be further target to FPGA (Field programmable gate array) or ASIC (Application specific integrated circuit) to demonstrate the speedup of algorithm. The FPGA is complex programmable logic device that are essentially a blank slate integrated circuit that can be commonly programmed via VHSIC Hardware description languages (VHDL). VHDL allow the programmer to dictate the type of hardware that is fully synthesis on FPGA. Without any costly process the designer can prototype, simulate and implement parallel logic function on the FPGAs. On the other hand ASIC can be designed further by using the general purpose 32 bit microprocessor and several slave processors programmed by VHDL to accelerate the other most intensive tasks.

6. Conclusion

The iris recognition techniques are developed from last few years to reduce frauds and to make the facilities more secure. Basically the iris recognition is based on biometric characteristics of users that they possess, so that's why it is more securing than the traditional ID or password methods for user authentication. The main purpose of the work described in this paper is to implement most time consuming part of iris recognition algorithm using Verilog HDL code to enhance the system performance by reducing the computation time of HD calculations. This design is suitable for small low cost applications.

For Future improvements in the system we plan to implement presented algorithm or its parts into FPGA chip, or we can be implement the feature extraction task on hardware which can further reduce the identification time.

Acknowledgements

I thankfully acknowledge the Indian Institute of Technology Delhi for providing us the IITD Iris Image Database. I would like to place on record my deep sense of gratitude to Prof. Sheifali Gupta, Dept. of Electronics and Communication Engineering, CHITKARA UNIVERSITY, Rajpura, Punjab, India for his generous guidance, help and useful suggestions.

References

[1] J. Daugman, "How iris recognition works", IEEE Transactions on circuit and system for video technology, vol. 14, no. 01, **(2004)** January.
[2] J. Daugman, "Probing the Uniqueness and Randomness of iris code", IEEE, **(2006).**
[3] J. Liu-Jimenez, R. Sanchez-Reillo and C. Sanchez-Avila, "Full Hardware solution for processing iris biometric", IEEE, **(2005).**
[4] K. Grabowski, W. Sankowski, M. Napieralska, M. Zubert and A. Napieralski, "Iris Recognition Algorithm Optimized for Hardware Implementation", IEEE, **(2006)**.
[5] M. López, J. Daugman and E. Cantó, "Hardware-Software Co-Design of an Iris Recognition Algorithm" IEEE.
[6] K. Grabowski, W. Sankowski, M. Napieralska, M. Zubert and A. Napieralski, "Iris recognition algorithm optimized for Hardware implementation", IEEE, **(2006)**.
[7] R. Hentati, M. Bousselmi and M. Abid, "An Embedded System for iris Recognition", 2010 International Conference on Design & Technology of Integrated Systems in Nanoscale Era. IEEE, **(2010)**.
[8] J. Li, B. Tao, Y. Wang and X. Li, "Research and Implementation of Iris Recognition Algorithm", ELSEVIER, **(2012).**
[9] M. Nabti and A. Bouridane, "An effective and fast iris recognition system based on a combined multiscale feature extraction technique", ELSEVIER, **(2007)**.
[10] J. Daugman, "High confidence visual recognition of persons by a test of statistical independence," IEEE Trans. Pattern Anal. Mach. Intell., vol. 15, no. 11, **(1993)** november, pp. 1148–1161.
[11] J. Daugman, "Statistical richness of visual phase information," Int. J. Comput. Vision, vol. 45, no. 1, **(2001),** pp. 25–38.
[12] F. Hao, J. Daugman and P. Zielinski, "A fast search algorithm for a large fuzzy database," IEEE Trans. Inf. Forensics Security, vol. 3, no. 2, **(2008)** June, pp. 203–212.
[13] J. Huang, Y. Wang, T. Tan and J. Cui, "A new iris segmentation method for recognition," in Proc. 17th Int. Conf. Pattern Recognition, vol. 3, **(2004)** August, pp. 554–557.
[14] W. Kong and D. Zhang, "Accurate iris segmentation based on novel reflection and eyelash detection model," in Proc. 2001 Int. Symp. Intelligent Multimedia, Video and Speech Processing, **(2001)** May, pp. 263–266.
[15] R. N. Rakvic, B. J. Ulis, R. P. Broussard, R. W. Ives, S. Member and Neil Steiner, "Parallelizing Iris Recognition". IEEE Transactions on Information Forensics and Security, vol. 4, no. 4, **(2009)** December.
[16] A. Kumar and A. Passi, "Comparison and combination of iris matchers for reliable personal authentication", Pattern Recognition, ELSEVIER, vol. 43, **(2010)**, pp. 1016–1026.
[17] H. Rai and A. Yadav, "Iris recognition using combined support vector machine and Hamming distance approach", Expert Systems with Applications, ELSEVIER, vol. 41, **(2014)**, pp. 588–593.
[18] A. I. Desoky, H. A. Ali and N. B. Abdel-Hamid, "Enhancing iris recognition system performance using templates fusion", Ain Shams Engineering Journal, vol. 3, **(2012),** pp. 133–140.
[19] K. Miyazawa, K. Ito, T. Aoki, K. Kobayashi and A. Katsumata, "An Iris Recognition System Using Phase-Based Image Matching", IEEE, **(2006)**.
[20] K. Miyazawa, K. Ito, T. Aoki, K. Kobayashi and H. Nakajima, "An efficient iris recognition algorithm using phase-based image matching," Proc. Int. Conf. on Image Processing, **(2005)** September, pp. II– 49–II–52.
[21] IITD iris image Data base, www.comp.polyu.edu.hk/~csajaykr/**IITD**/**Database_Iris**.htm.

Authors

Tajinderpal Singh, he is received the B.tect degree in Electrical and Electronics engineering from Punjab Technical University (India) in 2011, currently pursuing ME degree in Electronics and communication engineering from Chitkara University(India). He is currently an Lecturer in the Department of Electronics and communication engineering at Chitkara University HP campus-India. He has got two and half year of full time teaching experience. Tajinder pal Singh has field of interest is Digital Image processing and VLSI.

Sheifali Gupta, she is an Associate Professor in the Department of Electronics & Communication Engineering at Chitkara University, Punjab Campus-India. She has got over fourteen years of full-time teaching experience. Dr. Sheifali Gupta specializes in the Digital Image Processing & application of software Tools in engineering education. Experimental studies in support of the computational work are also part of his research agenda. She has worked with both undergraduate and graduate students throughout his research career and plans to continue to involve students in his research and is eager to participate in senior design projects and guide independent student research. She has published more than 30 research papers and articles in National & International Journals.