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COMPARISON OF FINGERPRINTS USING CORDIC ALGORITHM AND THINNING ALGORITHM

R.Sudha, K.Meena Alias Jeyanthi

***Abstract*— Most fingerprint matching applications rely heavily on efficient and fast image enhancement algorithms. Fingerprint matching is considered one of the most reliable and nature technologies and has been extensively used in personal identification. In this paper, we propose a fingerprint comparison using THINNING algorithm and CORDIC algorithm. It describes and compares some of the fingerprints with the fingerprint images in database. These algorithms targets real time application. Thinning is a very important role in fingerprint matching process. We present a VHDL description of CORDIC algorithm. It is used to reduce the error. These algorithms are proposed, those is efficient and fast and give better results.**

***Index Terms*— Fingerprint matching, CORDIC, THINNING, VHDL.**

I. INTRODUCTION

Recently, biometric technologies have shown more important in various applications. Among them, fingerprint matching is considered one of the most reliable and nature technologies and has been extensively used in personal identification. The process of acquiring fingerprint samples is simple and believed to be unique among individual person. Fingerprint based identification is used in both civilian and military applications. The project aims to develop a fingerprint matching.

Real time application of student attendance is mainly based on finger print matching. The steps involve can be classified as Reference database, Grayscale ,Grayscale to 1D array, Thinning, CORDIC, FPGA hardware output, Frontend(VB.NET).

Among these steps, we exploit upon fingerprint matching. The fingerprint images are taken from the database. By using MATLAB, input image transferred as 1D array value. It is very important stage in the fingerprint matching. The VHDL output image is given as the input for thinning. Image thinning is a very important stage and it preserves the structure of the original image, reduce the amount of data needed to process. CORDIC is used to reduce the error. We can find the accurate position of the ridge point. It works based on the iterative formulation. FPGA is an integrated circuit designed to be configured by the designer. It is specified using HDL. It consist of an array of logic blocks (CLB, LAB), I/O pads.VB.NET is the frontend which is used to produce the results. FPGA is based on real time which is more expensive. The cost of the system is very low compared to other methods. The goal of this paper is to execute the MODELSIM of fingerprint matching which exhibits the good result.

II. RELATED WORKS

In finger print matching many algorithms and method are used to find out the power consumption, area, throughput and latency.

[1] In Fingerprint matching the ridge features with minutiae Breadth First Search (BFS) technique is used. It is used to detect the matched ridge based coordinate pairs. It checks the relative position and compares the matching score. Advantage of this paper is, it gives higher matching scores and less area. Disadvantage is, only small foreground area and low quality images are used. Alignment feature extract have large time to

compile it. The error rates of comparison of two fingerprint minutiae are more. An experiment was conducted on PC with core2 Duo2. The matching time was 83ms and frequency was4GHZ.

[2] Fingerprint matching using model based density map is used in this paper. It utilized into the matching stage with a low additional storage cost. Matching scheme is proposed for density map between two fingerprints. This method is used to matching the score of fingerprints. It is a novel feature to represent a kind of global character of a fingerprint. It gives the better result than BFS and the cost is small. The main drawback of this paper is more error. The accuracy achieved is about only 40%. This model based density map method is used only for fewer amounts of data. It is implemented on a Pentium4 which gives 1500HZ feasibility. The extraction is about 0.19s.

[3] Fingerprint image processing acceleration through run time reconfigurable hardware implements the fingerprint based authentication system under FPGA. Thinning process is used in runtime application. Execution time and performance has been evaluated. Fingerprint matching was done only through hardware but it does not indicate any real time application can do by this hardware, it can easily match the fingerprint performance. Thinning process is used. So the complete ridges and valleys can be calculated. Disadvantage is, equal error rate is maximum. Execution time is high. They did not specify the software and the cost is high. It is implemented in virtex4 FPGA. Compared to other EER is 2.92%.Power consumption of FPGA is 2.055w. Total execution time 3274.380ms.

[4] A modified fingerprint image thinning algorithm paper just discussed the most used fingerprint thinning algorithm and their comparison. ZhangSuens algorithm proves to be the most efficient and with the proposed modification shows the best result. Disadvantage is, fingerprint recognition software solution and based on minutiae matching and thinning algorithm is not used. In this Abdulla etal, Guo Hall, Hall, Zhangsuens algorithms are compared.

[5] An improved fast thinning algorithm for fingerprint image process referred to as “thinning” is image process. Thinning is the main preprocessing stage in fingerprint, to accelerate the thinning process; an improved fast thinning algorithm is proposed and implemented in MATLAB. Best image quality is the main advantage of this algorithm because it uses image binarization. The accurate results are shown by using this MATLAB. But compared to other works it was done only by matlab. So it cannot use for real time application. Just give only fingerprint matching. Simulation result of binarization and thinning was done.

[6] FPGA implementation of the CORDIC algorithm for fingerprint recognition system has a low cost sequential architecture for the implementation of cordic algorithm in two computation modes. The error is calculated .It uses trigonometric and hyperbolic function. These functions only propose cordic architecture as an approach to implement some operators. It uses only 14 bits. No real time finger print matching was done. Only they developed a cordic architecture. Slow rate of convergence. It was implemented with Quartus2 (32bits) of Altera. Latency of sin/cos 78ns. Arctangent 108ns. Exponential 168ns.

In contrast to these methods, new algorithms are proposed in which avoids the direction of rotation using intermediate results of steering variable. This new THINNING and CORDIC algorithm are presented to detect the right ridge point of fingerprint. In fingerprint matching, cordic is used to liken the two fingerprints, which show the correct region of those fingerprints. The ridge point and valley point are also calculated by using these new two algorithms.

III. THINNING ALGORITHM

Thinning is a morphological operation which is used to remove selected foreground pixels from binary image, it is used to reduce the “threshold output”. The image has a pixel value ‘1’ and the background point has a value’0’. It has a structuring element.

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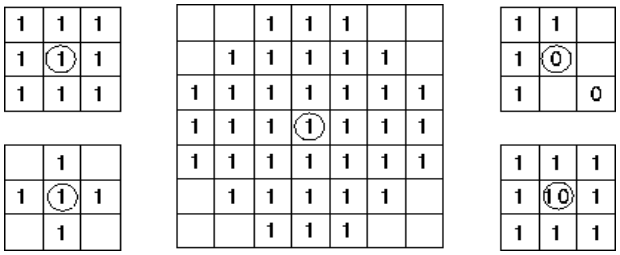

Figure 3.1 Structuring Element

Each point in the structuring element may have a value. In the simplest structuring elements used with binary images for operations such as erosion, the elements only have one value, conveniently represented as a one. More complicated elements, such as those used with thinning or greyscale morphological operations may have other pixel values. In the structure element 1's are represented as the foreground pixels and 0's are represented as the background pixels. The Blanks are indicated as "don't care". The origin of the structuring element is typically translated to each pixel position in the image in turn, and then the points within the translated structuring element are compared with the underlying image pixel values. The details of this comparison and the effect of the outcome depend on which morphological operator is being used.

There are two methods used in this thinning process.

1. Iterative

2. Non-iterative

Mostly, iterative methods are used in various applications because it gives the accurate result. Non – iterative methods are rarely used.

Compared to iterative method non –iterative method is faster but has no accurate result.

IV. CORDIC ALGORITHM

The CORDIC computing technique was developed by J. E. Volder in the late 1959's for the computation of trigonometric functions, multiplication and division operations. Walther, in 1971, has generalized this algorithm to implement hyperbolic, logarithm and exponential functions.

CORDIC (coordinate Rotation Digital Computer) is commonly used when no hardware component is not available (eg.in simple microprocessor and FPGA). It is a "mathematical approach". Recently, cordic algorithm has been used extensively for various biomedical applications, especially in FPGA implementation.

CORDIC evaluation is used to calculate the output as fixed point. The error is calculated which is compared to other method error. This makes this project an attractive solution for real time application.

A. CORDIC modes

CORDIC method can be differentiated in two different modes.

1. Rotation mode
2. Vectoring mode

In rotation mode, vector coordinate component and rotation angle are given and these are computed.

In the vectoring mode, the coordinate components of a vector are given, and the magnitude and angular argument of the original vector are computed.

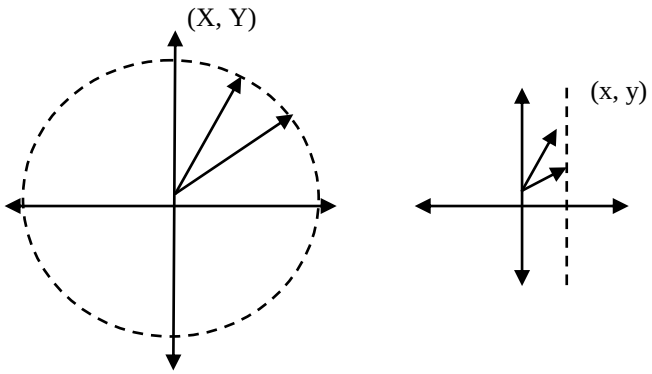

Figure 4.1. Graphical representation of circular and linear CORDIC

The circular CORDIC computes trigonometric function and magnitude of a vector.

The linear mode of CORDIC computes linear functions such as multiplication and division in different mode of operation i.e. rotational and vectoring mode respectively.

The main aim of the cordic algorithm in fingerprint matching is to detect the region of the fingerprint images. It uses the sine and cosine function

Owing to its simplicity the CORDIC algorithm can be easily implemented on a VLSI system. Hardware requirement and cost of CORDIC processor is less as only shift registers, adders and look up table (ROM) are required number of gates in hardware implementation, such as on an FPGA, is minimum as hardware complexity is greater reduced compared to other processor such as DSP mulpliers. It is relatively simple in design. No multiplication only addition, subtraction and bit shifting operation ensures simple VLSI implementation. The algorithm was basically developed to offer digital solutions to the problems of real time applications.

CORDIC algorithm has also been described for the calculation of DFT DHT, Chirp Z-transforms filtering singular value decomposition and solving linear systems. Most calculators especially the ones built by Texas Instruments and Hewlett- Packard use CORDIC algorithm for transcendental functions.

To implement this cordic, Phase angle and magnitude scaling are used.

Phase angle and sine magnitude are represented as 16bits.

Magnitude is represented as 16bits; output value is the 0 to 1.

Phase angle and sine magnitude are represented in this implementation with 16 bits, scaled value of 360O is 2^{16}.

Magnitude is represented with 16 bits, out of these MSB is used to represent sign and rest 15 bits are used to represent the magnitude. Output represents the values in the 0 to +1 range

A main advantage of CORDIC algorithm is used for a large class of applications for its efficient and low cost implementation where trigonometric function is used. The cordic algorithm has implemented using branching method for best VLSI implementation.

CORDIC can evaluate using the trigonometric functions accurately with minimal hardware. Therefore, CORDIC architecture can be adapted in the ASIC implementations used for the applications like finger print recognition.

V. RESULTS

In fingerprint matching process thinning and cordic plays the main role. These algorithms is developed and tested in MATLAB. And then the same algorithm is calculated in VHDL using MODELSIM. The result of the thinning is important for the next stage of fingerprint matching. After that CORDIC algorithm is presented to calculate the ridge point as well as the position, these are implemented in modelsim. The simulation results of modelsim are depicted in figure.

By using MATLAB, first we have to select the original image. Then this image is stored in database. The original image has to crop and that cropped image is saved as a BMP image. This image is converted to 1D array value. Totally 40000 array value is get from one fingerprint image. The original image and cropped image and some of the array value are shown in below tabulation,

Table 5.1 1D array value

ORIGINAL IMAGE	CROPPED IMAGE	1D ARRAY VALUE
		175 172 140 155 216 237 207 191 180 153

The simulation result will useful for the new user to understand the future steps.

To get the simulation results in modelsim the codes are created. Here separated codes are created for fingerprint matching. This simulation result was done by using MODELSIM. It will show the CORDIC and THINNING output.

Figure 5.2 is CORDIC output. It has two inputs which is the 8 bit binary value. We have to give the binary value as input of CORDIC. It will show how the cordic processor is done. Set the first input and second input. For every 2ns clock cycle the values will change automatically. If it will change for every 2ns then we can say the CORDIC will run accurately.

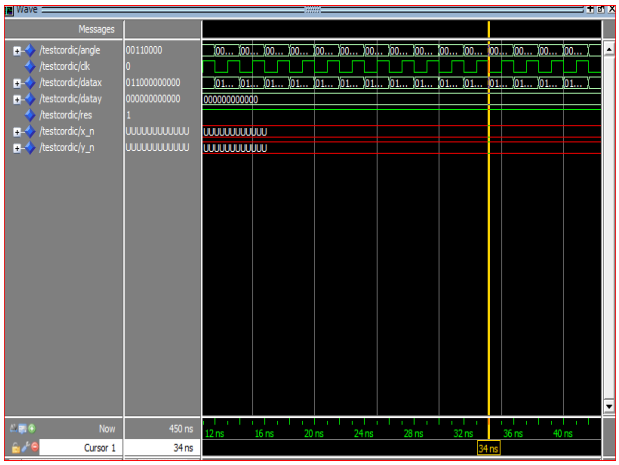

Figure 5.2 Cordic Process

Figure 5.3 is Thinning simulation result. Converted array value is the input of thinning. Two fingerprint images are taken. First the image has to binaries and this value is converted to hexa decimal value by VHDL which is done by IEEE library. TEXT I/O header file will computes all the process. There is 'n' number of blocks in one fingerprint image. Depends upon the RAM value the input values are stored. Thinning output shows two fingerprint values, line number and 'n' blocks. This line number is nothing but it calculates the how many lines are there in the given array value and line 'n' number of line number is used in bit value. We have to set the clock value, if our given input has any noise or if it exceeds the clock value means then it will store in TEMP (temporary) file. It will compare those two fingerprint array value and an output value will shown in the output text document.

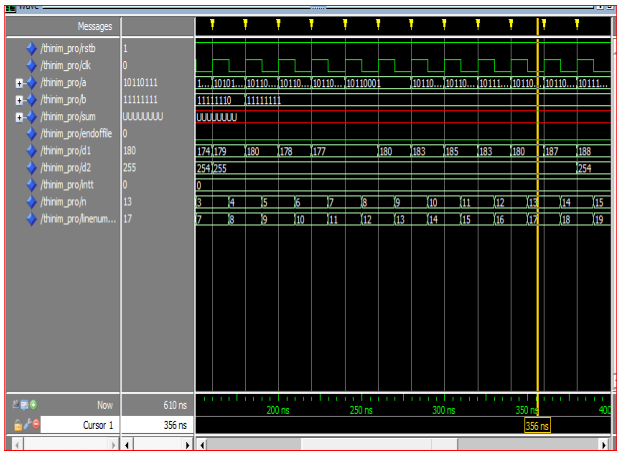

Figure 5.3 Thinning Process

The above two simulation are only the part of result. Comparison of above two will give the exact output. In this the SIN and COS value is used to give the correct point of fingerprint.

LED is nothing but is a light emitting diode. Output has been expressed in form of 0's and 1's. If the two fingerprints are same the output value will be 1 or if the two fingerprints are different then the output will be 0.Figure 5.4 shows the simulation result of comparison,

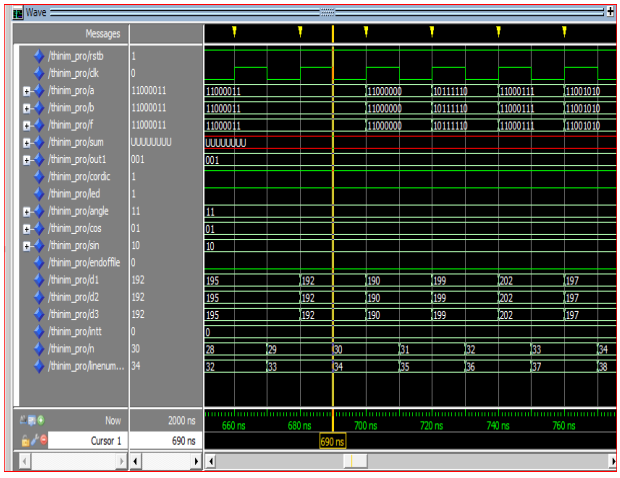

Figure 5.4 Comparisons of Fingerprints

In the below list shows the overall list of two fingerprint matching. When the two input array value d1, d2 is equal means the out1 value is 001, but here the two values are not equal so out1 is 000. If out1 is 000 then the led output is 0.

Below list have all details about the required ouput.

Table 2 LEDoutput

NS	RST	CLK	A	B	OUT1	LED	D1	D2
100	1	1	10111000	11111111	000	0	176	255
110	1	0	10101000	11111111	000	0	168	255
120	1	1	10100111	11111111	000	0	168	255
130	1	0	10101110	11111111	000	0	168	244
140	1	1	10100011	11111111	000	0	167	244
150	1	0	10110100	11111111	000	0	167	244
160	1	1	10111000	11111111	000	0	167	244
170	1	0	10101000	11111111	000	0	167	244
180	1	1	10100111	11111111	000	0	174	244
190	1	0	10101110	11111111	000	0	174	244
200	1	1	10100011	11111111	000	0	174	255
210	1	0	10110100	11111111	000	0	174	255
220	1	1	10101110	11111111	000	0	174	255
230	1	0	10100011	11111111	000	0	174	255

VI CONCLUSION

In this paper, thinning algorithm and cordic algorithm was used for fingerprint matching. This algorithm was implemented using MODELSIM and MATLAB. Experimental results show that the algorithm is more efficient than the referred algorithm. In the proposed work the two new steps are included along with the already existing steps. Completing and enhancing the input image and thinning it. Output result will display in the FPGA kit. And finally an attempt can be made which computes the FPGA input and show the result is whether matched or not.

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R.sudha, currently pursuing M.E., Applied Electronics in PSNA College of Engineering and Technology, Dindigul.

K. Meena Alias Jeyanthi., PhD. , currently working as a Professor, ECE in PSNACollege of Engineering and Technology, Dindigul.