ACEEE Proc. of Int. Conf. on Recent Trends in Signal Processing, Image Processing and VLSI, ICrtSIV

Simulation of Gabor Filter for Fingerprint Recognition using Verilog HDL

[1]Geetha M.N and [2]Jagadeesh.B
[1, 2] Vidyavardhaka College of Engineering, Dept of E&C, Mysore, India.
[1]Geethashekar73@gmail.com, [2] jagadeesh.vvce@gmail.com

***Abstract*— This paper presents the Simulation of Gabor filter for fingerprint recognition using Verilog HDL. The application of Gabor Filter technique to enhance the fingerprint image and it is used to define the ridges and valley regions of fingerprints is by convoluting the image pixel with Gabor filter coefficient. The experimental result was the signal convoluted with the Gabor coefficient.**

***Index Terms*— Gabor filter, digital filter, fingerprint, image processing, biometric, digital design.**

I. INTRODUCTION

Fingerprint enhancement is a process for fingerprint verification. The texture of the fingerprint is the most important element in fingerprint recognition process, because of the imperfect live-scan in fingerprint sensor [1].Fingerprint enhancement using Gabor filter is one of highly computational complexity in fingerprint verification. A critical step in automatic fingerprint matching is to automatically and reliably extract minutiae from the input fingerprint images. However, the performance of a minutiae extraction algorithm relies heavily on the quality of the input fingerprint images. In order to ensure that the performance of an automatic fingerprint Identification/verification system will be robust with respect to the quality of that scan people's fingers to identify them and call up payment information. The Systems are already in use at some supermarket chains, and aim to answer privacy Concerns by storing just certain measurements of a person's fingerprint, rather than the Entire fingerprint itself .The Company that makes the equipment pitches benefits to Consumers of faster checkout and higher security, but enough questions have been rose about fingerprint scanners, that the security claims deserve closer security. Gabor filter have a complex valued convolution kernel and a data format with complex values is used. So implementing Gabor filter is very significant in fingerprint verification process[2]. Designing Gabor filter will help enhancing the quality of fingerprint image. In the digital signal processing the digital filter is the most important part to filter out the signal noise thus eliminating the unwanted image in fingerprint image. This project used Gabor type filter to segment the finger print texture. Texture segmentation is the most important in fingerprint recognition process. This project only focus on designing the filter compares to other part. This filter enhances the image quality as its make ridges clearly differentiated from each other. The designing of Gabor filter for fingerprint recognition using verilog HDL, this filter can be run using full version software. Other aspect is to change the coefficient. This filter is reconfigurable filter. The coefficient can be change to suit to the Implementation. This filter uses the previous work on Gabor algorithm. If later someone come up with improve Gabor coefficient than the coefficient can simply stored into the ROM of the filter.

DOI: 03.AETS.2014.5.376
© Association of Computer Electronics and Electrical Engineers, 2014

II. GABOR FILTER

A Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. Because of the convolution property, the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. Gabor filters are directly related to Gabor wavelets, since they can be designed for number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of biorthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex. The Gabor space is very useful in e.g., image processing applications such as iris recognition and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation. The Gabor Filters have received considerable attention because the characteristics of certain cells in the visual cortex of some mammals can be approximated by these filters. In addition these filters have been shown to posses optimal localization properties in both spatial and frequency domain and thus are well suited for texture segmentation problems. Gabor filters have been used in many applications, such as texture segmentation, target detection, fractal dimension management, document analysis, edge detection, retina identification, image coding and image representation. A Gabor filter can be viewed as a sinusoidal plane of particular frequency and orientation, modulated by a Gaussian envelope.

III. METHODOLOGY

The focus of this work was not to study on the result of filtered image. This would also be the result of the characteristics of the Gabor filter, but it was to implement the filter. Since the studied has been done on the characteristics of Gabor filter, this work used the suggesting coefficient and implemented it to the filter design. The 5 variable (as shown in the table 1.1) of the filter was set up based on the previous work. Below were the table shows the value setup for the variable. The variable then was implemented into the Gabor equation. By applying the variable into the equation, the coefficient or the kernel of the Gabor filter can be determined. The kernel values are shown in the Table 1.2. 3X3 kernel is used for this work.

TABLE I.I VARIABLE VALUE

Variable	Frequency (f)	Angle (θ)	Standard Deviation (σ_x)	Standard Deviation ($\sigma_{y)}$
Value	1/3	45	0.5	0.5

TABLE I. II KERNEL VALUE

G(X,Y)	1	2	3
1	000673793	1.29E-05	-4E-08
2	235672-07	4.14E-08	1.45E-12
3	-135859E-11	2.65E-14	8.53E-17

A. Filter design

In digital signal processing, the output of the signal was the convolution between the input signals with the filter Coefficient. So mainly, the digital filter circuit was the circuit to convolute the input signal with the filter coefficient. In digital image processing, the image was presented in matrix form or in pixel. So basically the convolution involves the matrix convolution-convolution between image pixels with coefficient kernel. Difference filter have difference method of filtering or sampling input signal. A Gabor filter is linear filter whose impulse response is defined by a harmonic function multiplied by Gaussian function. The Fourier transform of a Gabor filter's impulse response is the convolution of Fourier transform of harmonic function and the Fourier function of Gaussian function. This is the formula of the complex Gabor function:

$$g(x, y) = s(x, y)\ wr\ (x, y) \qquad (1)$$

Where s(x, y) is a complex sinusoidal, known as the carrier, and wr(x, y) is a 2-D Gaussian-shaped function, known as the envelop. The flowchart of Gabor filter is shown below figure1. Firstly the input data which was in pixel format will enter the filter and store it in the memory. The size of the memory was depending on the pixel size. If the pixel was 16x16 then the memory size would be 16x16 too. It means that every memory

location will store for value for 1 image pixel. After the image had been stored in the memory then it would start the convolution process. The control unit would call the data from determine memory location and sent it to the multiplication-accumulator (MAC).

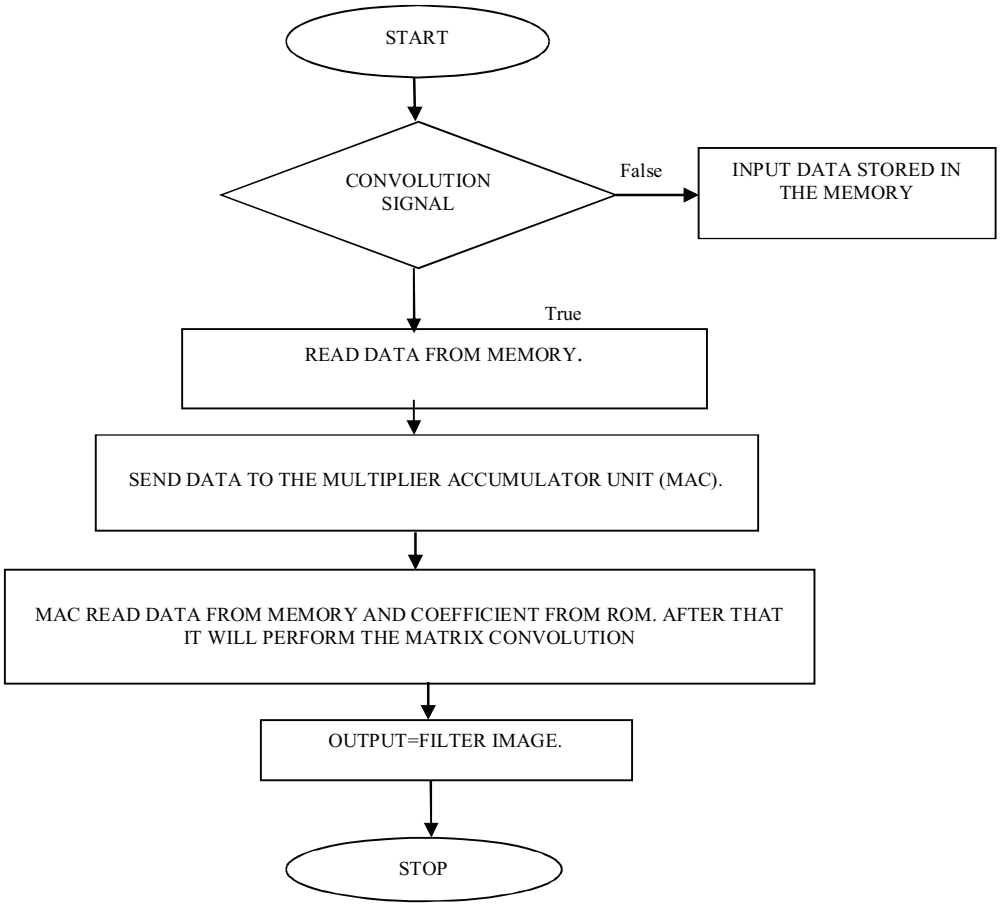

Figure1. Flow chart of Gabor Filter

In MAC there was also a ROM which would permanently store the coefficient kernel value. The value of kernel would also be called by the control into the convolution circuit. When both data had entered the convolution circuit the process of multiplication and accumulation would take place. The result of MAC was the result of filtered image. This would also be the result of the filter.

IV. EXPIEREMENTAL RESULTS

After transforming the design into verilog language using Xilinx software and synthesize the code, the simulation will generate the schematic according to the code. Process took place. Below are the result of synthesize of the design. Figure1 shows the input image acquired.

V. CONCLUSION

The objective of implementing Gabor Filter in fingerprint recognition was to segment the texture of fingerprint. Texture segmentation was the process of partitioning an image into regions based on their texture. The reason using Gabor filter was due to it characteristic. Gabor filters have the properties of spatial localization orientation selectivity and spatial frequency selectivity. The filter was successfully design and verified. The filter functioned as expected. Even though the verification for the top level cannot be done

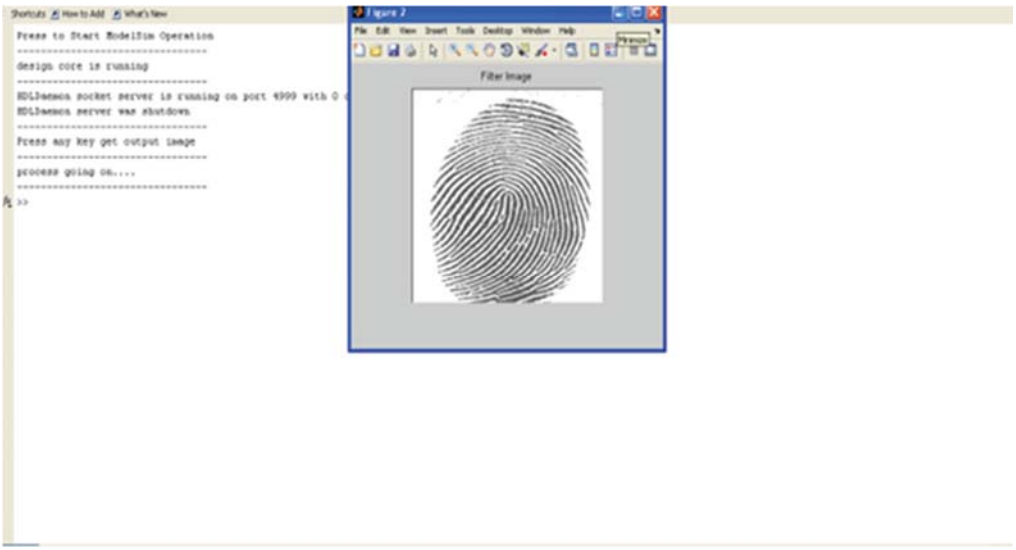

Fig (a)

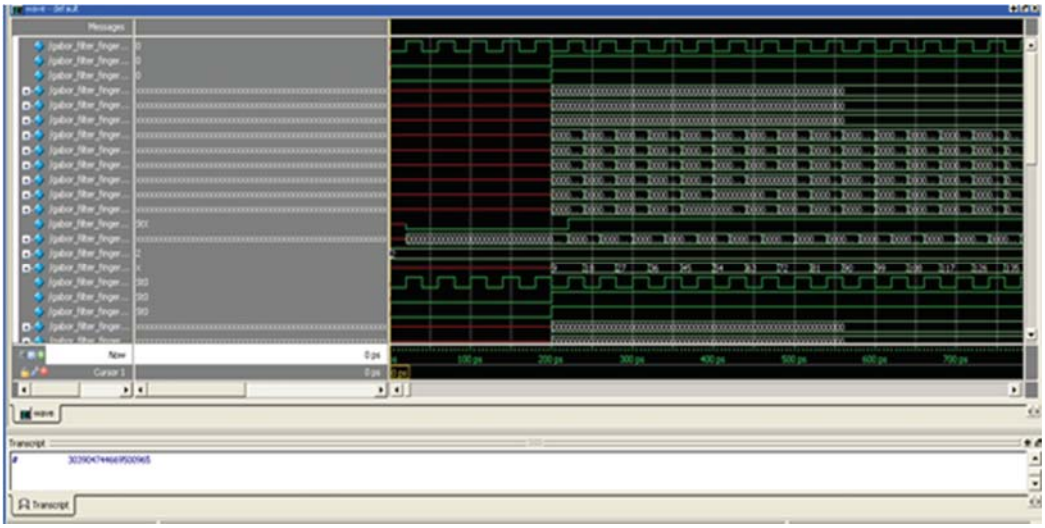

Fig (b)

Fig: a-b shows the Simulation waveform of filtered output

because of the software limitation, but the filter can produce expected result based on the every part verification. The primary focus of the work in this project is on the enhancement of fingerprint images, and the subsequent extraction of minutia. Firstly, the implementation of a series of techniques for fingerprint image enhancement to facilitate the extraction of minutia is done effectively with well know algorithms after referring so many papers .The most important part was the ALU. Based on the verification on ALU, it produced expected result. In developing new approaches to the single-filter multi-texture and multi-filter multi-texture Gabor filter design problem. The previous discussion has focused on the design of Gabor filters. The methods, however, should be applicable to other types of filters. This may be accomplished by replacing the kernel values stored in the ROM.

ACKNOWLEDGEMENT

The authors would like to thank the anonymous reviewers for their constructive comments. This research was supported in part by VVCE, Mysore, India.

REFERENCES

[1]. U. W. Vutipon Areekul, Kittiwat Suppasriwasuseth,Saward Tantaratana, "Seperable Gabor Filter Realization for Fast Fingerprint Enhancement," 2005.

[2]. P. H. W. L. Ocean Y. H. Cheung, Eric K.C. Tsang,Bertam E.SHi, "Implementing Of Gabor-type Filters on Field Programmable Gate Arrays," 2005.

[3]. P. E. J. Khaled Hammouda, "Texture Segmentation Using Gabor Filters."

[4]. L. L. Jianwei Yang, Tianzi Jiang,Yong Fan, "A modified Gabor filter design method for fingerprint image enhancement," 2003.

[5]. Y. W. Lin Hong, Anil Jain, "Fingerprint Image Enhancement Algorithm and Performance Evaluation," vol. 2, 1998.

[6]. F. V. Sanderson L. Gonzaga de Oliveira, Aura Conci, "Enhancing Fingerprint image by an adaptive Gabor filter," 2006.

[7]. K. S. Vasily G. Moshnyaga, Keikichi Tamaru, "A Memory based architecture for real-time convolution with variable kernels," 1998.

[8]. A. P. Arrigo Benedetti, Nello Scarabottolo, "Image Convolution o FPGAs:the implementation of a multi-FPGA structure," 1998.

[9]. Abdul Hadi Abdul Razak, Muhamad Iqbal Abu Zaharin and Nor Zaidi Haron, "Implementing Digital Finite Impulse Response Filter Using FPGA", Asia-Pacific Conference on Applied Electromagnetics (APACE2007), 2007.