VLSI implementation of real-time palmprint recognition system

P.GEETHA
M.E (VLSI Design)
Srinivasan Engineering College
Perambalur, India
geethu0829@gmail.com

PROF. Mrs. B.REVATHI
Associate Professor (ECE)
Srinivasan Engineering College
Perambalur, India
brevathisekar@gmail.com

***Abstract*-Palmprint is one of the new physiological biometrics has been receiving increasing attention due to its stable and unique characteristics. It investigates the feasibility of person identification based on ridge feature extracted from the palmprint images. For large scale person identification applications; the ridge based palmprint matching algorithms have been used. The segment-based matching and fusion algorithm is used to deal with skin distortion and the varying discrimination power of different palmprint regions. The orientation field-based registration algorithm is designed for registering the palmprints into the same coordinate system before matching. The cascade filter is built to reject the non-matched gallery palmprints. The whole palmprint recognition algorithm is implemented in FPGA for achieving significant reduction in execution time and memory. The palmprint matching system is implemented in MATLAB.MATLAB is not suited for strong real-time applications, so in order to address this problem hardware implementation of FPGA is made.**

Index terms- Palmprint; cascade filtering; FPGA implementation.

I. INTRODUCTION

The term biometrics refers to a scientific discipline which involves automatic methods for recognizing (verifying or identifying) people based on their physical and/or behavioral characteristics. In recent years, law enforcement agencies are increasingly using palmprint to identify criminals. In law enforcement palmprint identification systems, the efficiency is a very important factor but challenging problem because of large database size and poor image quality. Palmprint can be used as a reliable human identifier because the pattern of ridges is unique and their details are stable. Compared to other physical biometric characteristics, palmprint biometrics has several advantages they are low intrusiveness, stable line features. The human palm consists of two main features: flexion creases and friction ridges. Flexion creases are made due to the folding of the palm. The three most prominent flexion creases, named as major creases, divide the palm into three regions they are thenar, hypothenar, interdigital. The design of a biometric system takes account of five objectives: cost, user acceptance and environment constraints, accuracy, computation speed and security. The palm also contains many minor creases which are not as permanent as the major creases. Friction ridges are formed as a result of a buckling instability in the basal cell layer of the fetal epidermis. And an imaging resolution of about 500 ppi is required to observe the ridge feature. The patterns made by the friction ridges on the palm are both unique and persistent, making it useful as a biometric trait for person identification.

Existing research on palmprint recognition mainly concentrates on low-resolution palmprint images which can be acquired using cheap cameras. At such low resolution, ridges cannot be observed and matching is mainly based on major and minor creases.

[David Zhang et al 2003] proposed Gabor filter to extract the texture features at different scales and multiple orientations with fewer coefficients to achieve a very high recognition rate.

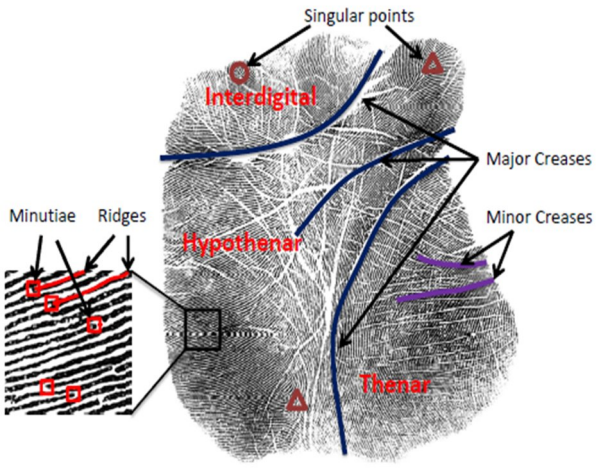

Fig 1.Crease and ridge features in a palmprint

[A.K.Jain et al 2009] proposed minutiae-based palmprint recognition system achieving acceptable accuracy. The region growing algorithm was proposed to extract the ridge orientation.
[J.Dai et al 2011] proposed multi-feature based palmprint recognition system where the multiple features, including minutia points, orientation field, and major creases are extracted and equated to achieve higher accuracy.

In large scale person identification systems such as forensic and border control systems, the major biometric modalities are used that need to be both distinctive and insensitive to changes in age and skin condition. For these applications, the palmprint recognition systems have to be based on ridge features and creases may be used as supplementary features. In reality, the standard resolution for capturing palmprints in forensic applications is about 500ppi and person identification based only on ridge features (such as minutiae) is accepted in courts of law.

It includes:
1) To lead the design and parameter selection of the matching system, a quantitative statistical study of various characteristics of palmprints is carried on.
2) The segment-based palmprint matching and fusion algorithm is used to deal with the distortion and the varying discrimination power of different palmprint regions. The whole palmprint image is divided into small segments which are then individually matched to deal with distortion.
3)In order to reduce the computational complexity, an orientation field based registration algorithm is designed for registering palmprints of different positions and rotations into the same coordinate system before matching. The cascade filter is built to refuse the non-mated gallery palmprints. Implementing palmprint application on a general purpose computer can be easier, but not very time efficient due to additional constraints on memory and other peripheral devices. When compared to software implementation, the application specific hardware implementation offers much greater speed. With advances in the VLSI (Very Large Scale Integrated) technology hardware implementation has become an attractive alternative. By implementing complex computation tasks on hardware and exploiting parallelism and pipelining in algorithms yield significant reduction in execution times. There are more technologies available for hardware design they are Application Specific Integrated Circuits (ASIC) and Digital signal processors (DSPs) and Field Programmable Gate Arrays (FPGA). Field Programmable Gate Arrays (FPGA's) design extends highest performance, but the complexity and the cost related with the design are very high. Hardware design techniques such as parallelism and pipelining techniques can be formulated on a FPGA, which is not possible in dedicated DSP designs. FPGAs are an ideal choice for implementation of real time palmprint recognition algorithms.

II. PALMPRINT MATCHING SYSTEM

A. System Outline

A novel palmprint matching system for 1: N matching is performed. Since different palmprints share a lot of common ridge flow forms, orientation field is used for palmprint registration, in which it transforms palmprints of different rotations and displacements into the common coordinate organization. Thus, tight position constraint can be imposed in the matching algorithm, and so that the matching speed can be greatly improved. Registered palmprints are divided into small segments. During palmprint matching, all the corresponding segments are finely aligned and compared respectively. Figure 3 shows the basics operations of palmprint matching system.

It operates as follows:

The cascade filter is based on the idea of; some segments in palmprints are very distinctive, it is possible to discard many non-mated gallery palmprints by just comparing these distinctive segments.

1) In image acquisition, the palmprint image is captured by using palmprint scanner and then the AC signal is

converted into a digital signal, which is then transmitted to a computer for further processing.

2) In the enrollment stage, the gallery palmprints are performed in the palmprint registration. In the identification stage, the query palmprints are performed separately. The query palmprints are live-scanned full palmprints from unknown aspects and the gallery palmprints are generally full palmprints. The gallery palmprints are automatically registered.
3) The segments between the query and the gallery palmprints are compared sequentially by the cascade filter. Gallery palmprints which are very unlike to the query palmprints are rejected at once. In generally a large portion of the gallery palmprints are rejected after comparing just a few segments.
4) After cascade filtering, the query palmprint is matched with the remaining gallery palmprints, the true mate of the query palmprint is determined by using segment-based matching and fusion algorithm.

B. Image acquisition.

The image is captured using a commercial palmprint scanner. A palmprint image is captured by a palmprint scanner and then the AC signal is converted into a digital signal, which is transmitted to a computer for further processing. The System requirements include Windows XP/Vista compliant, 3GHz CPU with a minimum of 512 MB of RAM. The image is captured using LSCAN 500P.The LSCAN 500P captures forensic quality images at the resolution of 500ppi.The LSCAN 500P has a unique interactive LCD display that makes the scanner very easy to use. The LCD display makes the capture sequence faster and easier. This system uses secured auto capture technology it enabling users to obtain the highest quality palm images in less than one second.

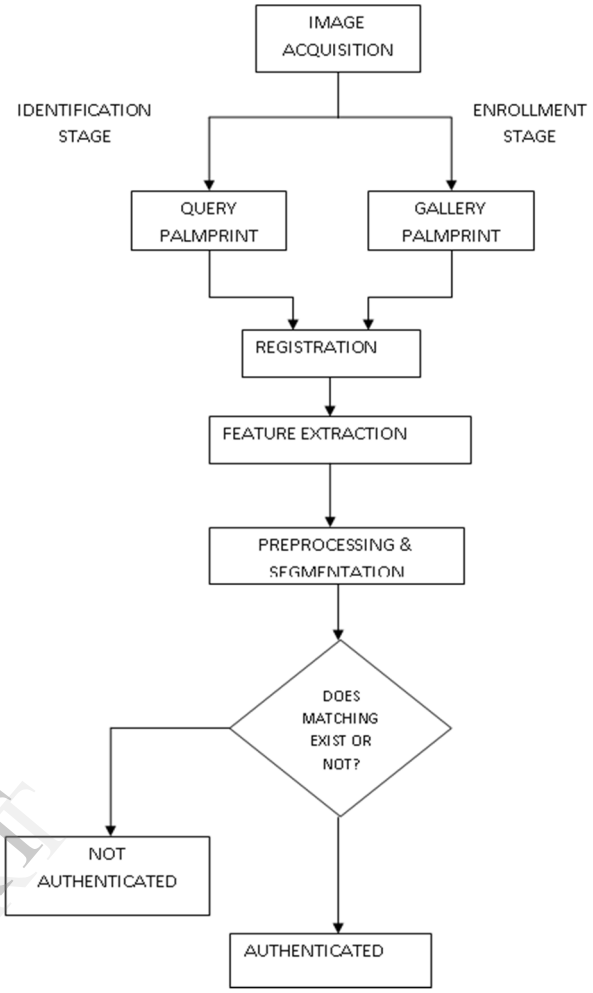

Fig. 2(a) Basics operations of palmprint matching system

C. Registration.

Registration is necessary to bring different palmprints into the same coordinate system to help the matching. Registration is an essential step in most of the biometric recognition techniques such as iris, face. Iris is generally registered by its outer and inner contours and the face is in general registered by the location of eyes .In palmprint registration the gallery palmprints are performed in the enrollment stage and separately the query palmprints are performed in the identification stage. The query palmprints are live-scanned full palmprints from unknown suspects. The gallery palmprints are generally full palmprints. The gallery palmprints are automatically registered. The palmprint registration methods such as intervals between fingers, hand

contour; principal lines are designed for contactless low-resolution palmprint verification organization. The low resolution palmprints are captured by contactless devices (see fig.2 (a)) in which the whole palmar region and the finger roots are visible. The palmprints captured using contact-based techniques such as inking and the FTIR sensors (see fig.2 (b)), in which fingers are not available and hand contours and principle are usually uncompleted or not authentic making the registration as a challenging task. In this system, the registered image is collected at the resolution of 500ppi. Registration is performed with the help of orientation field based registration algorithm. The orientation field based registration algorithm is mainly designed for registering the palmprint into the same coordinate system before matching. The both left and right palmprints per person are also registered.

D. Feature Extraction

Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. The ridge features are extracted from the captured image and then fed to the preprocessing process.

(a)

(b)

Fig.2(b). (a) Palmprint images captured by the contactless techniques in laboratory environment (a).The left one in (a) from the CASIA palmprint database and the right one is from PolyU palmprint database. Contact-based techniques in operational environment fig.2 (b)

E. Preprocessing and segmentation

A key issue to be solved foremost is preprocessing the image to gain a proper sub-area for feature extraction and matching. Due to the images obtained by a digital scanner without any constraint of pegs, distortions including rotation, shift and translation are contained in the palm images which make it hard to locate at correct position in the same direction. Preprocessing is used to correct distortions, align different palmprints, and to crop the region of interest for feature extraction. To deal with the distortion of different palmprint regions a segment-based palmprint matching and fusion algorithm is proposed. After that preprocessing, the whole palmprint image is divided into small segments to deal with distortion. In segmentation process, the palmprint image is divided into blocks of 64*64 pixels respectively.

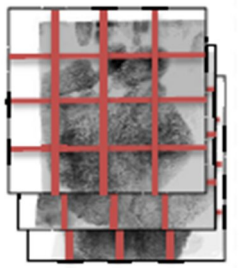

Fig. 2(c) Segment the palmprint image (64*64 pixels)

III. EXPERIMENTS

A. Palmprint Database

To trial the algorithm 1,280 palmprint images are collected from 80 subjects (i.e., two palms per person and eight impressions per palm).The palmprint images are collected using a commercial palmprint scanner of Hisign.

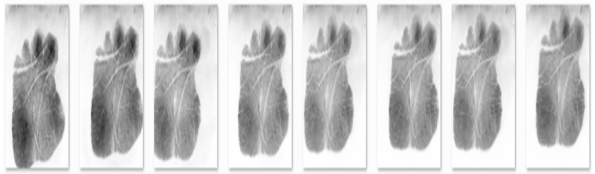

Fig. 3(a) Left palm of a person with eight impressions

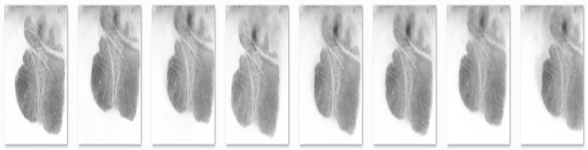

Fig. 3(b) Right palm of a person with eight impressions

All these palmprints are of 2040*2040 pixels and at the resolution of 500ppi.Figure 3.a shows the sample example of left palm of a person with eight impressions.

Figure 3.b shows the sample example of right palm of a person with eight impressions.

B. FPGA Implementation

The VHDL code for whole palmprint recognition algorithm has been developed and implemented in FPGA. The execution time significantly reduced when compared to software implementation. For hardware modules, the execution time is determined using the synthesis and simulation results of the VHDL description. Modelsim tool is used to determine the synthesis and simulation respectively. If the query palmprint and gallery palmprint matches and recognizes, it will generates a signal.

IV.CONCLUSION

For large-scale person identification applications, the ridge based palmprint matching algorithms have been used. By using orientation field-based registration algorithm, the computational complexity is reduced. A segment based matching and fusion algorithm is proposed to deal with skin distortion and the varying discrimination power of different palmprint regions. The whole palmprint image is divided into small segments, which are then separately matched to deal with distortion. The previous works on MATLAB is not suited for strong real-time applications so inorder to address this problem a hardware implementation of FPGA is made. The developed palmprint recognition system will reduces the execution time and it can be implemented in VLSI that can be used as a stand-alone system for high-security applications. Future work will be towards the implementation of palmprint recognition system on ASIC.

REFERENCES

[1] Dai .J and Zhou .J, "Multi-Feature Based High-Resolution Palmprint Recognition," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 33, no. 5, pp. 945–957, 2011

[2] Duta .N, Jain .A.K, and Mardia .K, "Matching of palmprints," Pattern Recognition Letters, vol. 23, no. 4, pp. 477–486, 2002.

[3] Hentati Raida, YassineAoudni, Mohamed Abid "Hw\Sw Implementation Of Iris Recognition Algorithm in the FPGA", International Journal of Engineering Science and Technology (IJEST), Research Laboratory CES, National school of Engineers of Sfax,3000, Tunisia.

[4] Huang .D, Jia .W, and Zhang .D, "Palmprint verification based on principal lines," Pattern Recognition, vol. 41, no. 4, pp. 1316–1328, 2008.

[5] Jain .A.K and Feng .J, "Latent Palmprint Matching," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, no. 6,pp. 1032–1047, 2009.

[6] Jain .A.K, Hong .L, and Bolle .R.M, "On-line Fingerprint Verification," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 19, no. 4, pp. 302–314, 1997.

[7] Jain .A. K and Feng .J, "Latent Fingerprint Matching," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 33, no. 1, pp. 88–100, 2010.

[8] Jain .A .K, Ross .A, and Prabhakar .S, "Fingerprint matching using minutiae and texture features," in Proceedings of the International Conference on Image Processing. IEEE, 2001, pp. 282–285.

[9] Kong .A, Zhang .D, and Kamel .M, "Palmprint identification using feature-level fusion," Pattern Recognition, vol. 39, no. 3, pp.478–487, 2006.

[10] Kong .W, Zhang .D, and Li .W, "Palmprint feature extraction using 2-D Gabor filters," Pattern recognition, vol. 36, no. 10, pp. 2339–2347, 2003.

[11] Li .W, Zhang .D, and Xu .Z, "Palmprint identification by Fourier transform," International Journal of Pattern Recognition and Artificial Intelligence, vol. 16, no. 4, pp. 417–432, 2002.

[12] Ratha .N, Karu .K, Chen .S, and Jain .A, "A real-time matching system for large fingerprint databases," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 18, no. 8, pp. 799–813, 1996.

[13] Shu .W and Zhang .D, "Automated personal identification by palmprint," Optical Engineering, vol. 37, no. 8, pp. 2359 2362, 1998.

[14] Zhang .D, Kong .W.K, You .J, and Wong .M, "Online Palmprint Identification," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 25, no. 9, pp. 1041–1050, 2003.