FINGERPRINT DATASET DEVELOPMENT FOR BIOMETRIC RECOGNITION SYSTEM EVALUATION

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Abstract- The evaluation of biometric recognition system must be done to know the system performance. Dataset of fingerprint with various deformations needed to perform this evaluation. The deformation of fingerprint known as impression. In thi research, 8 impressions were taken to obtain FAR and FRR characteristic. This article proposed the process of developing fingerprint dataset.

Keywords- Fingerprint, FAR and FRR, Impression, Performance Evaluation, Biometric Recognition, Deformation.

I. INTRODUCTION

Nowadays, the demand of using biometric recognition system in many applications grows rapidly. This swift growing demand has triggered many research in this area. A number of research has been published that offered novel methods in biometric recognition systems which lead to some improvements to the methods. Biometric identification or verification system are applied on several applications such as,

1. Commercial applications including building access, computer system, laptop, hand phone, ATM, etc.
2. Government application, personal ID, driving license, passport control, etc.
3. Forensic applications, dead person identification, crime investigation, terrorist identification, parental identification, etc. A growing interest in fingerprint recognition algorithm was indicated by the increasing number of participants in fingerprint verification contest held in year 2000 (11 algorithms), 2002 (31 algorithms), 2004 (67 algorithms) and 2006 (70 algorithms) as described in.

Typical biometric systems use pattern recognition which takes biometric datafrom specific individual and then extracting the feature of this biometric data, which so called template, and comparing it with other features from the database as reference. Fingerprint matching can be separated into two categories, which are verification and identification. It is the comparison of a claimant fingerprint against an enrolled fingerprint, where the intention is that the claimant fingerprint matches the enrolled fingerprint. To prepare for verification, a person initially enrolls his or her fingerprint into the verification system.

A representation of that fingerprint is stored along with the person's name or other identity. Each access is authenticated by the person identifying him or herself, then applying the fingerprint to the system such that the identity can be verified. Verification is also termed, one-to-one matching. On the other hand, identification is a fingerprint matching process where fingerprint of unknown ownership is matched against a database of known fingerprints to associate with an identity. Identification is also termed, one-to- many matching. In other ways, identification is to search who owns this biometric data, while the verification is to make sure that biometric data belongs to specific person. In hardware implementation of fingerprint recognition system, a number of requirements must be fulfilled. These requirements are:

1. real-time,
2. portable,
3. embedded,
4. small size, and
5. low power consumption.

The algorithm must be optimized when it is implemented in FPGA device due to some limitations or constraints, such as memory capacity, components, power consumptions, cost, module dependencies and development dificulties. In order to reduce dificulties during the development phase, a number of research has been done using soft-core (soft processor). However, by using soft-core, more FPGA resources are needed as well as module dependency. Additionally, the use of translation algorithm in the soft-core increases the computational time. Another approach is the development of logical component/module for each process directly in the FPGA without using soft-core. It is more dificult, but the utilization of FPGA resources can be reduced. Moreover, since there is no dependencies with other module, the process becomes faster.

II. FINGERPRINT TEMPLATES STANDARDIZATION

Fingerprint templates in local structure is collection of minutiae points. Minutiae points are various anomalies in terms of ridge bifurcations, ridge

endings, ridge crossovers, and small ridges. These points, for automatic feature extraction and matching are usually restricted to two types of minutiae: ridge terminations/endings (EP, End Points) and ridge bifurcations (BP, Bifurcations Points). Also, the valley structure can be used for minutiae points, valley ending or valley bifurcations. A minutiae is identified by its position (x-y coordinate) and the angle of dominant ridge makes with the x-axis at the point of interest.

Minutiae type (ridge/valley bifurcation or ridge/valley terminations) is also very important, and this information increases the accuracy of the fingerprint identification. Each minutiae point has a "type" associated with it. There are two major types of minutiae: a "ridge skeleton end point" and a "ridge skeleton bifurcation point" or split point. There are other types of "points of interest" in the friction ridges that occur much less frequent and are more dificult to define precisely. More complex types of minutiae are usually a combination of the basic types defined above. Some points are neither a ridge ending nor a bifurcation.

Therefore, the following types are distinguished:

- Ridge ending (also identiable as a valley skeleton bifurcation point);
- Ridge bifurcation (also identiable as valley skeleton end point);
- Others. The minutiae angle is measured increasing counter- clockwise starting from the horizontal axis to the right. There are three possibilities, such as:

1. The minutiae point for a ridge ending is defined as the point of forking of the medial skeleton of the valley area immediately in front of the ridge ending. If the valley area were thinned down to a single-pixel-wide skeleton, the point where the three legs intersect is the location of the minutia. In simpler terms, the point where the valley "Y"'s, or (equivalently) where the three legs of the thinned valley area intersect. A ridge ending (encoded as valley skeleton bifurcation point) has three arms of valleys meeting in one point. Two valleys encompass an acute angle. The tangent to the third valley lying opposite of the enclosed ridge denes the direction of a valley bifurcation. The direction is again measured as the angle the tangent forms with the horizontal axis to the right (see figure 1a.).
2. A ridge bifurcation (encoded as valley skeleton end point) has three arms of ridges meeting in one point. Two ridges encompass an acute angle. The tangent to the third ridge lying opposite of the enclosed valley defines the direction of a ridge bifurcation. The direction is again measured as the angle the tangent forms with the horizontal axis to the right (see figure 1b.).
3. The direction of a ridge skeleton endpoint is defined as the angle that the tangent to the ending ridge encompasses with the horizontal axis to the right (see figure 1c.). Ridge skeleton end points are only used in one type of the card formats, whereas in the other type ridge ending and ridge bifurcation is used as in the record format.

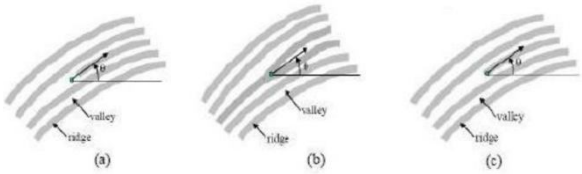


Fig 1: Minuteae Points Parameter [5]

III. BIOMETRIC PERFORMANCE EVALUATION

As described in, a typical biometric verification system that commits two types of errors, such as: mistaking biometric measurements from two different fingers to be from the same finger (called false match) and mistaking two biometric measurements from the same finger to be from two different fingers (called false non-match). To be remember that these two types of errors are also often denoted as false acceptance and false rejection; a distinction has to be made between positive and negative recognition; in positive recognition systems (e.g., an access control system) a false match determines the false acceptance of an impostor, whereas a false non-match causes the false rejection of a genuine user. On the other hand, in a negative recognition application (e.g., preventing users from obtaining welfare benefits under false identities), a false match results in rejecting a genuine request, whereas a false non-match results in falsely accepting an impostor attempt. The notation "false match/false non-match" is not application dependent and therefore, in principle, is preferable to "false acceptance/false rejection." However, the use of false acceptance rate (FAR) and false rejection rate (FRR) is more popular and largely used in the commercial environment. There are some error rates in finger print identification system that usually evaluate to see the performance of the system, such as:

1. FAR, false acceptance rate or there is a mistake when accepting fingerprint template that should not belong to the same fingerprint.
2. FRR, false rejection rate or there is a mistake when rejecting fingerprint template that should belong to the same fingerprint.
3. EER, equal error rate or when FAR and FRR are at the same value.

Some others are: ZeroFMR, ZeroNFMR, Failure to Capture (FTC), Failure to Enroll (FTE), and Failure to

Match (FTM). Of course quality of the image and threshold value setting affects these performance. From several threshold values, the graphic of FAR and FRR also ERR value are drawed. A system designer may not know in advance the particular application for which the system may be used (or a single system may be designed for a wide variety of applications). Usually, they report system performance at all operating points (threshold, t). They will plot a Receiver Operating Characteristic (ROC) curve. A ROC curve is a plot of FMR against (1 - FNMR) for various decision thresholds (often FNMR is reported along the vertical axis instead of (1- FNMR)). Some others are: ZeroFMR, ZeroNFMR, ailure to Capture (FTC), Failure to Enroll (FTE), and Failure to Match (FTM). Figure 2 shows graphically illustrates the computation of FMR (FAR) and FNMR (FRR) over genuine and impostor distributions, it is evident that FMR is the percentage of impostor pairs whose matching score is greater than or equal to t, and FNMR is the percentage of genuine pairs whose matching score is less than t.

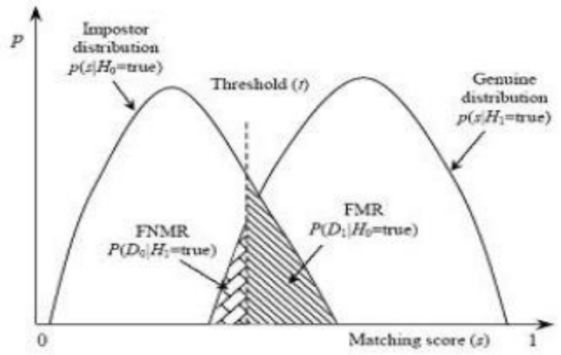


Fig 2: FMR and FNMR for a given threshold t are displayed over the genuine and impostor score distributions t. [5]

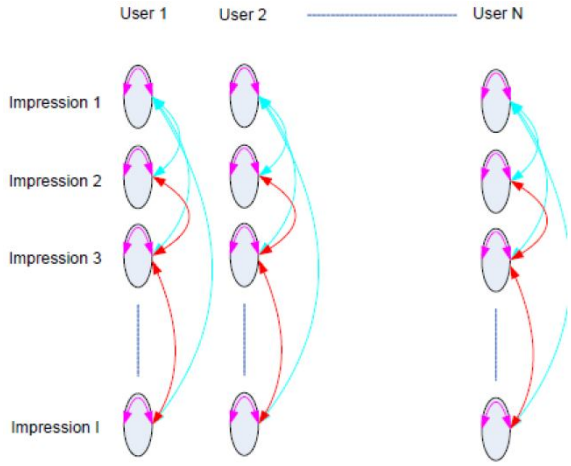
It is difficult to have the same environment in testing or evaluation scenario of the algorithm. As described in, there are many academic and industrial research and development groups have created new measurement techniques and new

IV. PERFORMANCE EVALUATION RULE

For calculating the FAR, FRR and EER this rule is used :
Each sample in the subset A is matched against samples of the same finger to compute the False Non Match Rate FNMR (also referred to as False Rejection Rate - FRR). The total number of genuine tests (in case no enrollment rejections occur) is:

(Impression * (Impression)) * Number of Data
Each sample of each finger in the subset A is matched against each sample of the remaining fingers in A. The total number of false acceptance tests (in case no enrollment rejections occur) is:
((Number of Data * Impression) * (Number of Data* Impression)) Genuine Test

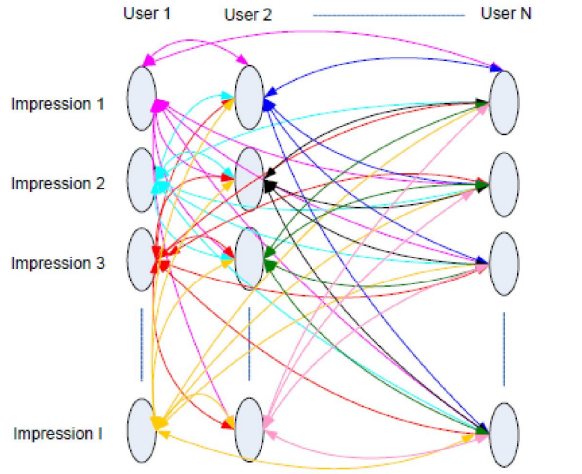
Figure 3 and Figure 4 show performance evaluation for FRR and FAR.



Number of Matching Proccess = ((I * (I – 1)+ I) * N
For Example 10 User with 8 impression = ((8 * 7) + 8) 10 = 640

Fig 3: FRR Performance Evaluation (Geuine Test)

The number of possibility in matching process for genuine and impostor than can be calculated for every fingerprint image in data , which are 640 and 5760.



Number of Matching Proccess = ((I * N) * (I * N)) – Genuine Test
For Example 10 User with 8 impression = ((10 * 8) * (10 * 8) - 640 = 5760

Fig 4: FAR Performance Evaluation (Impostor Test)

V. FINGERPRINT DATASET

To perform the algorithm performance evaluation, fingerprint consisting images are used as dataset. This fingerprint images data was captured using USB Fingerprint reader from all fingerprint of 10 person, it means that 100 users are obtained. 8 impression every fingerprint with some deformation are taken. Every person were asked to put the finger at a slightly diferent vertical position and to alternate low and high

pressure against the sensor surface also make some rotations of 45 degree (left and right direction) then 180 degree. At the end of the data collection, totally 800 fingerprint images are collected. research has been developed the fingerprint dataset for biometric Figure 5 and figure 6 show collection of data set of from one finger of a person with 8 impressions.



Fig 5: Fingerprint from one finger with 8 impressions.



Fig 6: Another fingerprint from one finger with 8 impressions.

The minutiae point detect from image fingerprint is as the figure 7.

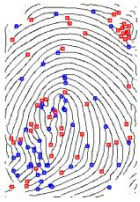


Fig 7: Example of minutiae point detection.

CONCLUSION

This research has been developed the fingerprint dataset for biometric recognition system evaluation which will be used for FPGA Devices. The 800 data from 100 fingers (10 persons) were collected with 8 impressions each finger. These data set will be used for the next step of research, that will be implemented in the development of FPGA device.

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