Fingerprint Combination for Privacy Protection

[1] THUKARAM GUGULOTHU,
ASSISTANT PROFESSOR,
DEPARTMENT OF ECE,
NALLA NARASIMHAREDDY EDUCATION SOCIETY'S GROUP OF INSTITUTIONS, HYD

[2]KURUMAIAH.N,
ASSISTANT PROFESSOR
NALLA NARASIMHAREDDY EDUCATION SOCIETY'S GROUP OF INSTITUTIONS, HYD

Abstract

We propose here a novel framework for securing fingerprint privacy by joining two distinct fingerprints into another personality. In the enlistment, two fingerprints are caught from two distinct fingers. We extricate the minutiae positions from one fingerprint, the introduction from the other fingerprint, and the reference focuses from the two fingerprints. In view of this separated data and our proposed coding methodologies, a joined minutiae format is produced and put away in a database. In the verification, the framework requires two question fingerprints from a similar two fingers, which are utilized as a part of the enlistment. A two-arrange fingerprint coordinating procedure is proposed for coordinating the two inquiry fingerprints against a joined minutiae layout. By putting away the consolidated minutiae format, the total minutiae highlight of a solitary fingerprint won't be traded off when the database is stolen.

Index Terms : fingerprint, Combination, minutiae, privacy, protection.

I. INTRODUCTION

Recognizable proof frameworks depend on three key components: 1) quality identifiers (e.g., Social Security Number, driver's permit number, and record number), 2) true to life identifiers (e.g., address, calling, instruction, and conjugal status), and 3) biometric identifiers (e.g., fingerprint, iris, voice, and step). It is fairly simple for a person to distort property and true to life identifiers; in any case, biometric identifiers rely upon inherent physiological attributes that are hard to misrepresent or change.

Robotized human distinguishing proof utilizing physiological or potentially behavioral qualities, biometrics, is progressively mapped to new regular citizen applications for business utilize. The colossal development in the interest for more easy to use and secured

biometrics frameworks has propelled analysts to investigate new biometrics highlights and qualities. The life systems of human fingers is very muddled and to a great extent in charge of the independence of fingerprints and finger veins. The high distinction of fingerprints has been credited to the arbitrary defects in the grating edges and valleys, which are generally alluded to as minutiae or level-2 fingerprint highlights. Hence, a few live ness countermeasures to distinguish such sensor-level farce assaults have been proposed, e.g., finger reaction to electrical drive, finger temperature and electrocardiographic signs, time-shifting sweat designs from fingertips, and a level of oxygen-soaked hemoglobin in the blood. Regardless of the assortment of these recommendations, just a couple have been discovered appropriate for online fingerprint recognizable proof, and these procedures require close contact of separate sensors with the fingers, which makes them inadmissible for unconstrained finger pictures or when the exhibited fingers are not in nearness with the sensors.

As biometrics is picking up fame, there is expanded worry over the loss of privacy and potential abuse of biometric information held in focal storehouses. The relationship of Fingerprints with criminal raises additionally concerns. Then again, the option recommendation of keeping biometric information in brilliant cards does not take care of the issue, since counterfeiters can simply guarantee that their card is broken to maintain a strategic distance from biometric check by and large. So it is essential to produce a superior and powerful fingerprint privacy protection framework.

II. THE PROPOSED FINGERPRINT PRIVACY PROTECTION SYSTEM

Fig. 1 demonstrates our proposed fingerprint privacy protection framework. In enlistment stage, the framework catches two fingerprints from two distinct fingers, say fingerprints A&B from fingers An and B, individually. We remove the minutiae positions from fingerprint An and the introduction from fingerprint B utilizing some current methods . At that point, by utilizing our proposed coding systems, a consolidated minutiae format is produced in view of the minutiae positions, the introduction and the reference focuses recognized from the two fingerprints. At long last, the joined minutiae layout is put away in a database. In the verification stage, two inquiry fingerprints are required from a similar two fingers, say fingerprints A_and B_ from fingers An and B . As what we have done in the enlistment, we extricate the minutiae positions from fingerprint An and the introduction from fingerprint B . Reference focuses are recognized from both inquiry fingerprints. These removed data will be coordinated against the relating layout put away in the database by utilizing a two-organize fingerprint coordinating. The verification will be effective if the coordinating score is over a predefined limit.

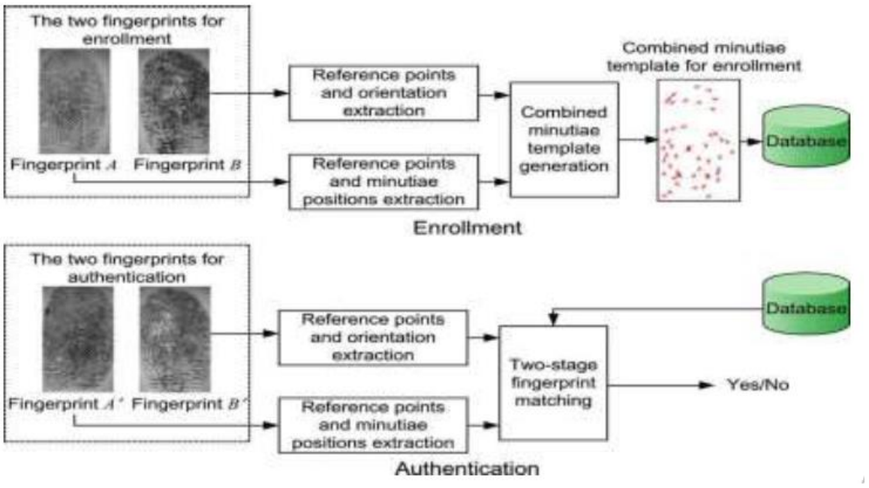
The two fingerprints for enrollment
Fingerprint A
Fingerprint B
Reference points and orientation extraction
Reference points and minutiae positions extraction
Combined minutiae template generation
Combined minutiae template for enrollment
Database
Enrollment
The two fingerprints for authentication
Fingerprint A'
Fingerprint B'
Reference points and orientation extraction
Reference points and minutiae positions extraction
Database
Two-stage fingerprint matching
Yes/No
Authentication

Fig. 1. Proposed fingerprint privacy protection system.

A. Reference Points Detection

The reference focuses location process is spurred by Nilsson et al. , who initially propose to utilize complex channels for solitary point recognition. Given a fingerprint, the principle ventures of the reference focuses location are abridged as takes after:

Given a fingerprint, the principle ventures of the reference focuses identification are abridged as takes after:

1)Compute the orientation from the fingerprint. The orientation in complex domain, where

$$Z = \cos(2O) + j\sin(2O).$$

2) Calculate a certainty map of reference points

$$C_{ref} = Z * \bar{T}_{ref}$$

Where "*" is the convolution operator and is the conjugate of

$$T_{ref} = (x + iy) \cdot \frac{1}{2\pi\sigma^2} \cdot \exp\left(-\frac{x^2 + y^2}{2\sigma^2}\right)$$

This is the kernel for reference point detection.

3)Calculate the reference points using following equation:

$$C'_{ref} = \begin{cases} C_{ref} \cdot \sin(Arg(C_{ref})) & \text{if } \mathrm{Arg}(C_{ref}) > 0 \\ 0 & \text{otherwise} \end{cases}$$

A. Combined Minutiae Template Generation

Here the joined minutiae layout is produced in light of the extricated data from the fingerprints and by minutiae position arrangement and minutiae bearing task

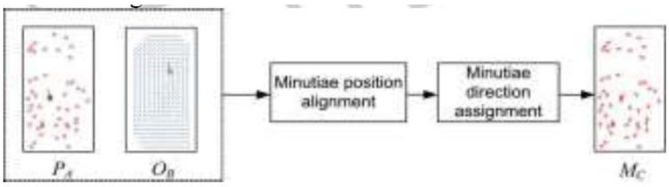

Fig. 2. Combined minutiae template generation process.

B. Minutiae position alignment

The arrangement is performed by deciphering and pivoting each minutiae point. Two essential reference focuses are covered both in the position and the edge after the minutiae position arrangement. Minutiae bearing task Here each adjusted minutiae position is appointed with a heading. When all the adjusted minutiae positions are doled out with headings, a consolidated minutiae format is made for enlistment.

C. Two-Stage Fingerprint Matching

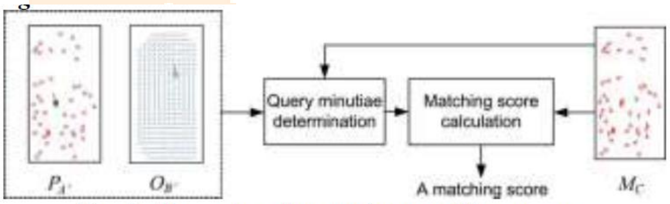

Fig. 3. Two-stage fingerprint matching process.

Given the minutiae positions P of fingerprint A , the introduction Ω of fingerprint B and the reference purposes of the two question fingerprints. With a specific end goal to coordinate the put away in the database, we propose a two-organize fingerprint coordinating MC process including inquiry minutiae assurance and coordinating score estimation as appeared in Fig. 3.

1) Query Minutiae Determination

The question minutiae assurance is a vital advance amid the fingerprint coordinating. So as to disentangle the depiction of our calculation, we initially present the neighborhood highlights separated for a minutiae point in MC. The neighborhood highlight extraction is like the work proposed in past paper. Given a minutiae point $\boldsymbol{m}ic$ and another minutiae point $\boldsymbol{m}jc$ in MC we characterize

1) L_{ij} as the distance between $\boldsymbol{m}_{ic}$ and $\boldsymbol{m}_{jc}$.

$$L_{ij} = \sqrt{(x_{ic} - x_{jc})^2 + (y_{ic} - y_{jc})^2}$$

2) γ_{ij} as the difference between the directions (after modulo π) of $\boldsymbol{m}_{ic}$ and $\boldsymbol{m}_{jc}$

$$\gamma_{ij} = \theta_{ic} \bmod \pi - \theta_{jc} \bmod \pi$$

3) σij as a radial angle:

$$\sigma_{ij} = \Re\left(\theta_{ic} \bmod \pi, \operatorname{atan2}\left(y_{jc} - y_{ic}, x_{jc} - x_{ic}\right)\right)$$

Where a tan $2(y, x)$ is a two-argument arctangent function in the range $(-\pi, \pi)$ and

$$\Re(\mu_1, \mu_2) = \begin{cases} \mu_1 - \mu_2 & \text{if } -\pi < \mu_1 - \mu_2 \le \pi \\ \mu_1 - \mu_2 + 2\pi & \text{if } \mu_1 - \mu_2 \le -\pi \\ \mu_2 - \mu_1 + 2\pi & \text{if } \mu_1 - \mu_2 > \pi. \end{cases}$$

For the i^{th} minutiae point $\boldsymbol{m}_{ic}$ in M_C, we extract a set of local features $\boldsymbol{F}_i$ as follows:

$$\mathbf{F}_i = (L_{ij}, L_{ik}, L_{il}, \gamma_{ij}, \gamma_{ik}, \gamma_{il}, \sigma_{ij}, \sigma_{ik}, \sigma_{il})$$

Where we accept $\boldsymbol{mjc}$ is the closest, $\boldsymbol{mkc}$ is the second closest and $\boldsymbol{mlc}$ is the third closest minutiae purpose of $\boldsymbol{mic}$. Assume we identify $(k1 \geq 1)$ reference focuses from fingerprint An' and $k2(k2 \geq 1)$ reference focuses from fingerprint B'. The inquiry minutiae is resolved as takes after:

1)Select a couple of reference focuses: one from fingerprint A' (say Ra') and the other from fingerprint B' (sayRb'). Expect Ra' is situated at $\boldsymbol{r}a' = (\boldsymbol{r}xa', \boldsymbol{r}ya')$ with the point $\beta a'$, Rb' is situated at $\boldsymbol{r}_b' = (\boldsymbol{r}_{xb}', \boldsymbol{r}_{yb}')$ with the edge β_b', individually.

2) Perturb β_a' by $\tau = \beta_a' + k.\ \Delta$, where k is a number and Δ is a bother measure. We pick $\Delta = 3 \times \pi/180$ radians (i.e., 3 degrees) and$-5 \le k \ge 5$. In this manner, we have $k = 11$ irritated plots for the reference point R_a'.

3) Generate a consolidated minutiae layout $MC\ '\ (\tau)$ for testing (hereinafter just named as a testing minutiae) from $Pa','Ra'$, (with a bothered point τ) and utilizing the proposed joined minutiae format age calculation. Note that a similar coding system ought to be embraced for producing $MC\ '\ (\tau)$ and MC. Altogether, we produce K testing minutiae $MC\ '\ (\tau)$.

4) Suppose $\boldsymbol{Fu}$ are the nearby highlights removed for the uth minutiae point in $MC\ '\ (\tau)$, while are the neighborhood highlights extricated for the vth minutiae point in MC. Compute the distinction amongst $\boldsymbol{Fu}$ and $\boldsymbol{Fv}$ by

$$D_\tau(u,v) = w_1 \cdot \sum_{j=1}^{3} |\mathbf{F}_u(j) - \mathbf{F}_v(j)| + w_2 \cdot \sum_{j=4}^{9} |\mathbf{F}_u(j) - \mathbf{F}_v(j)|$$

Where $\boldsymbol{F}_{ij}$ refers to the j^{th} component of $\boldsymbol{F}_i$, $\omega 1$ and $\omega 2$ are the weights for different features. We follow the same weight settings as in existing, where $\omega 1$ and $\omega 2$ are empirically set as $\omega 1 = 1$ and $\omega 2 = 0.3 \times \pi/180$. Then, we define the difference between

$M_C\ '\ (\tau)$ and M_C as

$$d_\tau = \min_{u,v} D_\tau(u,v).$$

5) Repeat stages 1) to 4) until the point when all the conceivable sets (in all out sets) of reference focuses are chosen and prepared. Among all the testing minutiae ($K \times k1 \times k2$ altogether), the one which has the base distinction from MC (i.e., the base $d\tau$) will be considered as the question minutiae

B. Matching Score Calculation:

For the consolidated minutiae layouts that are produced utilizing Coding Strategy 1, we do a modulo π for all the minutiae headings in Mk and MC , in order to expel the haphazardness. After the modulo operation, we utilize a current minutiae coordinating calculation to ascertain a coordinating score amongst Mk and MC for the verification choice. For other joined minutiae layouts, we straightforwardly ascertain a coordinating score amongst M_k and M_C utilizing a current minutiae coordinating calculation

III. COMBINED FINGERPRINT GENERATION

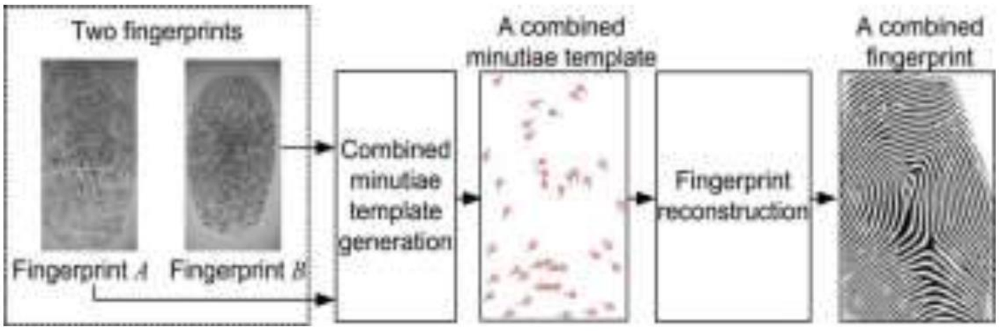
Two fingerprints
Fingerprint A
Fingerprint B
Combined minutiae template generation
A combined minutiae template
Fingerprint reconstruction
A combined fingerprint

Fig. 5. Generating a combined fingerprint for two different fingerprints.

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In a consolidated minutiae format, the minutiae positions and bearings (after modulo π) are removed from two distinct fingerprints independently. These minutiae positions and bearings share a comparable topology to those from a unique fi ngerprint. In this way, the consolidated minutiae layout has a comparable topology to a unique minutiae format. Some current works have demonstrated that it is conceivable to remake a full fingerprint picture from a minutiae format. By receiving one of these fingerprint recreation approaches, we can change over our consolidated minutiae layout into a joined.

IV. EXPERIMENTAL RESULTS

The test is led on the initial two impressions of the database, which contains 200 fingerprints from 100 fingers (with 2 impressions for every finger). The VeriFinger is utilized for the minutiae positions extraction and the minutiae coordinating. The calculation is utilized for the introduction extraction.

The reference focuses identification significantly affects the precision and proficiency of our proposed framework. Keeping in mind the end goal to assess the execution of our framework, we arbitrarily match the 100 fingers in the database to create a gathering of 50 non covered finger sets, where each finger combine contains two unique fingers. The arbitrary blending process is rehashed 10 times to have 10 gatherings of 50 non-covered finger sets. For the two fingerprints caught from two distinct fingers, we can produce two joined minutiae formats altogether, where one fingerprint A fills in as fingerprint B, alternate fills in as fingerprint or the other way around. The framework fashioner can enlist either of the two layouts in the database, which relies upon the applications. In this manner, we consider the accompanying two cases in building the framework database for each gathering of finger sets:

1) The early introductions of each finger match are utilized to master duce just a single consolidated minutiae format for enlistment. Along these lines, there are 50 formats put away in the database. To process the False Rejection Rate (FRR), the second impressions of a finger combine are coordinated against the correacting selected format, creating 50 veritable tests. To process the False

Acknowledgment Rate (FAR), the early introductions of a finger combine are coordinated against the other 49 enlisted layouts, creating 40X19-21:10imposter tests.

Fingerprint A

Fingerprint B

(1) The initial introductions of each finger match are utilized to deliver two joined minutiae formats for enlistment. In this way, there are 100 layouts put away in the database. Thus, 100 honest to goodness tests are performed to figure FRR and 100X99-9900 fraud tests are performed to register FAR.

Keeping in mind the end goal to demonstrate the adequacy of the proposed two-arrange fingerprint coordinating, we assess the execution of our framework by utilizing a regular minutiae coordinating strategy for the fingerprint coordinating. In other words, amid the verification, we create a joined minutiae format from two inquiry fingerprints, which is then coordinated against the comparing selected layout by utilizing an ordinary minutiae coordinating calculation . Under such a suspicion, the execution of our framework is appeared in Fig. 6. Note that the joined minutiae layouts produced utilizing Coding Strategy can not be coordinated straightforwardly utilizing a customary minutiae. After that we get a reproduced picture which is appeared in fig7

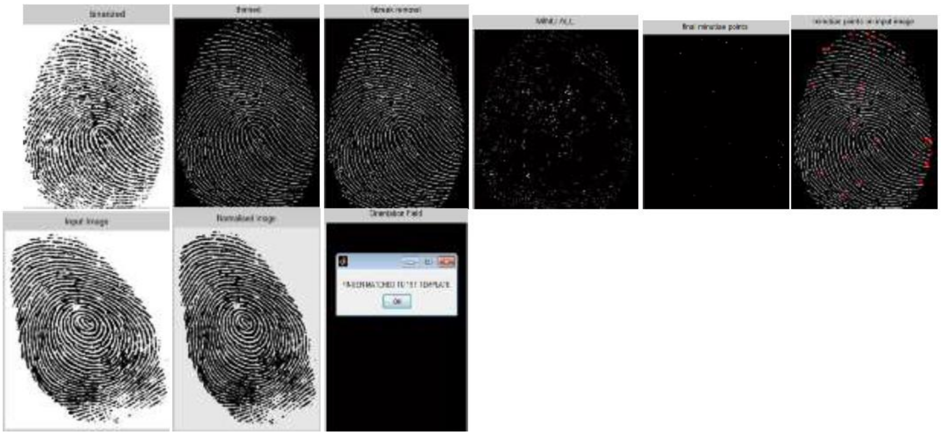

Fig. 6. Representations of the reference focuses recognition. Fingerprint with just a single reference point in (a)binarized (b)thinned (c) Hbreak Removal (d)All Minutiae position.(e) Final minutiae points(f) Minutiae focuses on input image(g)Input image(h)Normalised picture (I) Actual outcome

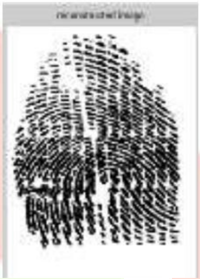

Fig7 Reconstructed image

V.CONCLUSION

In this paper, we present a novel framework for fingerprint privacy protection by consolidating two fingerprints into another identi ty. In the enlistment, the framework catches two fingerprints from two distinct fingers. A consolidated minutiae layout containing just an incomplete minutiae highlight of each of the two fingerprints will be produced and put away in a database. To make the consolidated minutiae format look genuine as a unique minutiae layout, three distinctive coding techniques are presented amid the joined minutiae format age process.

In the validation procedure, two inquiry fingerprints from a similar two fingers are required. A two-arrange fingerprint coordinating procedure is proposed for coordinating the two question fingerprints against the enlisted format. Our consolidated minutiae format has a comparative topology to a unique minutiae layout. Accordingly, we can consolidate two distinct fingerprints into another virtual character by recreating a genuine clone joined fingerprint from the consolidated minutiae format. The exploratory outcomes demonstrate that our framework accomplishes a low blunder rate.

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