International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

Segmentation Techniques for Overlapped Latent Fingerprint Matching

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Abstract: ***Image processing is the technique used for analyzing the images by converting them into a digital form so that analysis on the images can be done for some purpose. Forensic department uses the images for identifying the suspects based on their biometric information. The biometric information can be anything such as, fingerprints, iris or may be heart beat. Fingerprint is one of the largely and widely used biometric in major areas. The fingerprint information collected at the crime scene is useful for identifying the victim who have been committed the crime. In case of the rolled or plain fingerprint, it is easy for the analyst to find out the one who is found guilty. But it is not the case in latent. The latent fingerprints are noisy, blurred and smudgy. For which the technique known as Descriptor Based Hough Transform is used. By using the minutiae information the fingerprint can be matched with the rolled or plain fingerprints and identified after fingerprints are segmented from the background.***

Index terms- Image processing, Biometric, Fingerprint, Latent, Descriptor Based Hough Transform

I. INTRODUCTION

The Latent fingerprints are the one which provides least information regarding the person who is responsible for that fingerprint. Forensic department searches for the culprit by searching for the exact match of the fingerprint which is collected at the site where they have searched for the identification. It is easy for the people with the rolled or plain fingerprints. The rolled or plain fingerprints are the fingerprints which provides "nail-to-nail" information[Alessandra A. Paulino, Jianjiang Feng and Anil K.Jain, 2013]. So the information can be collected briefly. It is impossible to gather the full information from the latent fingerprints. Hence a special concept named Descriptor Based Hough Transform is used. By using this, the minutiae information is extracted and matched with the ones collected from the rolled fingerprint. Then, the matching score is calculated and based on that the results are verified.

Revised Manuscript Received on October 30, 2019.
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Segmentation is the process of dividing the image into multiple blocks each can be represented by using the pixels. By using the segmentation concept, the fingerprint images extracted from the background noises [S. Thilagamani and N. Shanthi, 2011]. Also, the Overlapped fingerprints are segmented from each other by using the ROI extraction which is a part of the segmentation[Aleksandar Neskovic, Branka Stojanovic and Oge Marques, 2016].

II. EXISTING SYSTEM

In the previous approaches, the latent fingerprints are identified manually. For this purpose, the technique known as ACE-V is used. ACE-V represents Analysis, Comparison, Evaluation and Verification. But this requires a lot of human intervention[Alessandra A. Paulino, Jianjiang Feng and Anil K.Jain, 2013]. Also, the accuracy and speed of this approach is inefficient. An automated algorithm is developed which focus only on minutiae. The latent fingerprints are matched based on the minutiae points in the fingerprints. The minutiae points are the special features in the fingerprints[Ajay Kumar and SinghVaibhav, 2015]. It is the collection of ridge endings and bifurcation. There are three major steps in matching the fingerprints. First and foremost step is that the alignment of the fingerprints. Second is the matching of the minutiae points and the third one is the score computation. Based on the score, the matching percentage is calculated.

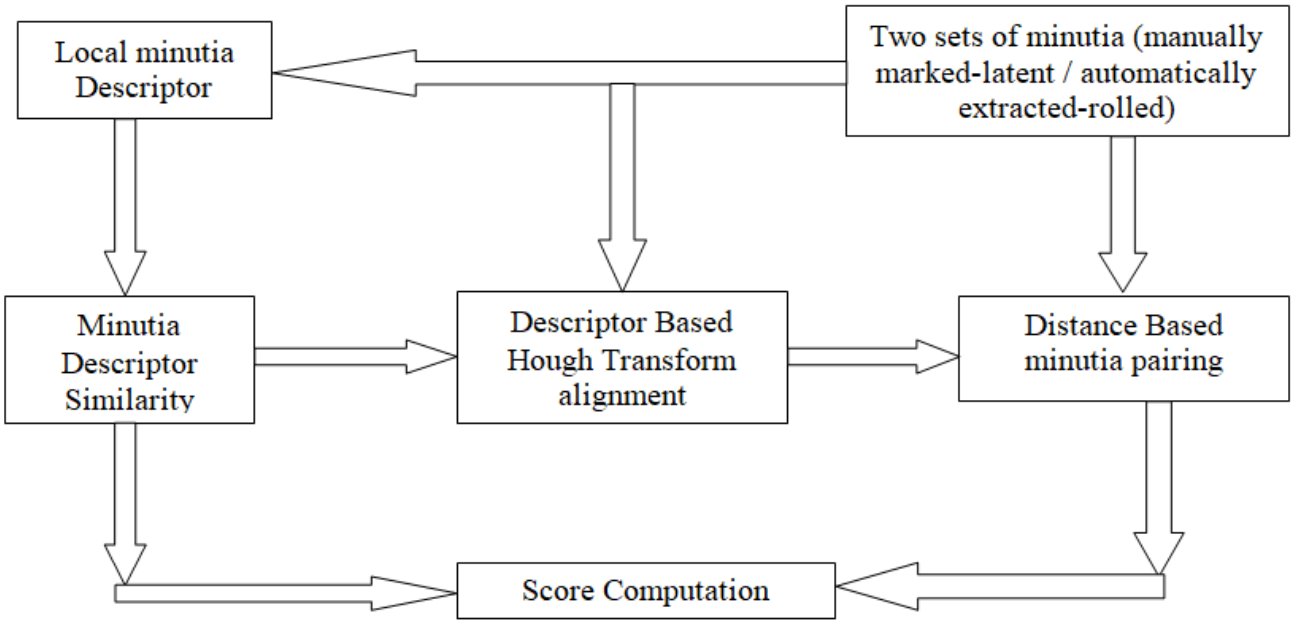

Figure 1. Existing System model

III. PROPOSED SYSTEM

Once after the fingerprints are collected, there are four major steps involved in the matching process. First step is the segmentation. In the segmentation phase, the latent fingerprints are segregated from the background data particularly from the noisy environment. It can be obtained by creating the Region of Interest (ROI)[S. Thilagamani and N. Shanthi, 2011] which marks the foreground ie., the fingerprint regions accurately[S. Thilagamani and N. Shanthi, 2011]. The second step is the enhancement. Enhancement, as the name says, improves the fingerprint image by removing the noise and increasing the clarity across the ridges and bifurcations. Along with this the "matchability" of the fingerprint is included by quality assessment stage[Ajay Kumar and SinghVaibhav, 2015]. The third step is the feature extraction. It is the most important step in which fingerprints are aligned and the minutiae points are collected. Final step is the fingerprint matching. Here, the score is computed by matching the minutiae points and match percentage is calculated. In case of any overlapped fingerprints, same as segmenting the fingerprints from the background and noisy environment, the fingerprints need to be separated. In the segmentation phase, the fingerprints are separated by their region marks[S. Thilagamani and N. Shanthi, 2011]. In the Enhancement phase some more additional steps are included for fingerprints separation.

IV MODULES

SEGMENTATION

Image Segmentation is the process of dividing the original image into multiple no. of segments in order to view the clear regions of the objects and its boundaries. The image referred here is the fingerprints. The fingerprints collected at the scenes are gathered along with the background. Hence Segmentation part is included. The previous step before doing the actual segmentation is the separation of the overlapped fingerprints. It can be done by using the Region of Interest (ROI) extraction[Alessandra A. Paulino, Jianjiang Feng and Anil K.Jain, 2013]. Next, the background noises are eliminated in order to get clear picture of the fingerprint[S. Thilagamani and N. Shanthi, 2011].

FEATURE ENRICHMENT

The overlapped fingerprints are separated from the background as well as the fingerprints itself are separated. After the segmentation, the features of the fingerprints need to be enhanced for clarity of the fingerprint. The fingerprint information can be enhanced by improving the ridge structures across the images. With the help of these ridge structures, the minutia points can be gathered easily.

MINUTIAE POINTS EXTRACTION

The ridge structures provide the proper information about the minutiae points and hence it can be used for the matching with the rolled fingerprints[S. Thilagamani and N. Shanthi, 2011]. Before that the fingerprints need to be aligned. The alignment can be done by estimating the parameters such as rotation, translation and scale.

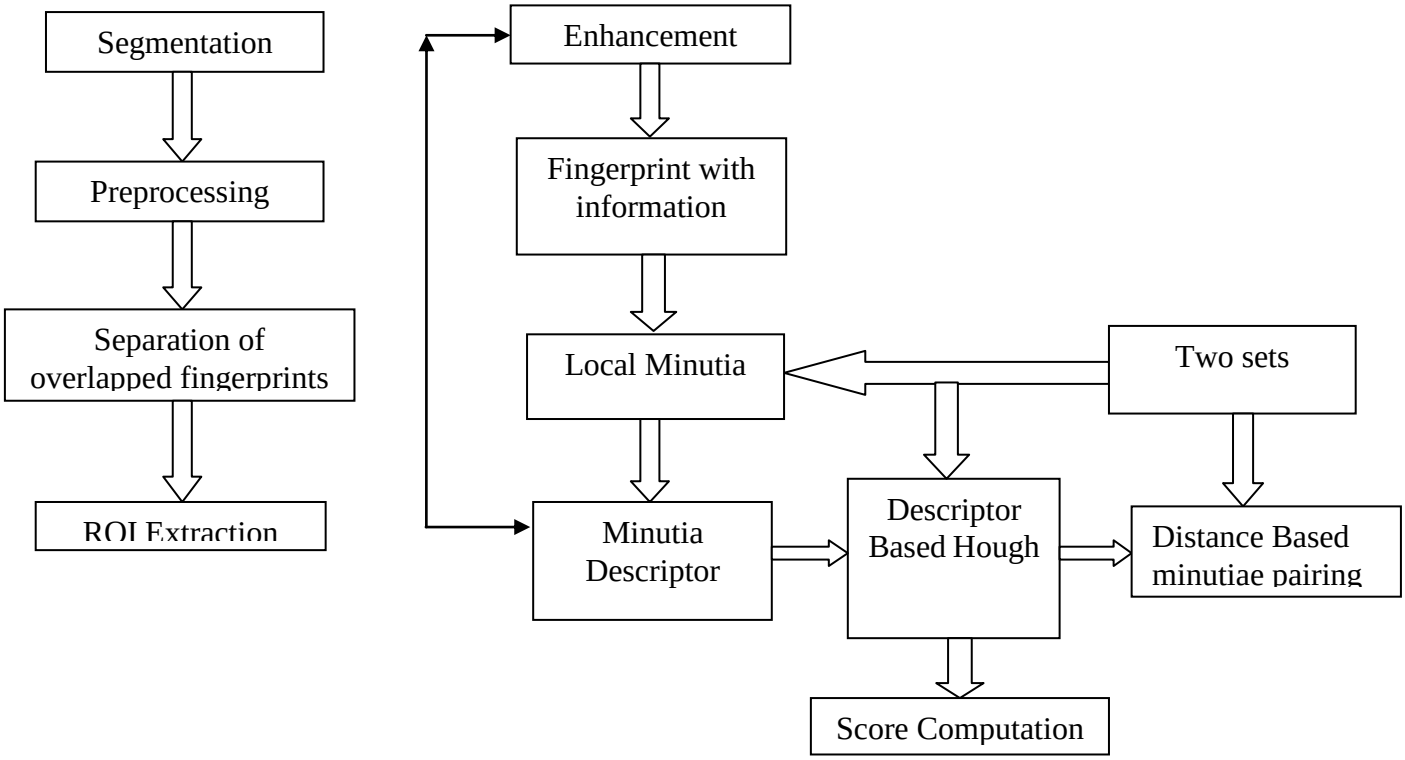

Figure 2. Overlapped Latent fingerprint matching

These parameters are considered for both the rolled and latent fingerprints. Consider the minutiae sets as (p_l, q_l, Θ_l) for the latent fingerprints and (p_r, q_r, Θ_r) for rolled fingerprints[Alessandra A. Paulino, Jianjiang Feng and Anil K.Jain, 2013].
For each minutiae pair, the scale value will be

$$\Theta = min\ (||\Theta_l - \Theta_r||, 360 - ||\Theta_l - \Theta_r||)$$

$$\begin{pmatrix}\Delta p \\ \Delta q\end{pmatrix} = \begin{pmatrix}pr \\ qr\end{pmatrix} - \begin{pmatrix}cos\theta & sin\theta \\ -sin\theta & cos\theta\end{pmatrix}\begin{pmatrix}pl \\ ql\end{pmatrix}$$

The aligned minutiae pairs are taken the distance value is calculated. If the distance between both the rolled and latent minutiae are less than d_0, then it is considered as the matched pairs.

V. SCORE CALCULATION

Once a set of matched minutiae points are collected, the final score can be calculated. Consider M as the set of matched minutiae points which have been collected from both fingerprints[1]. Each pair in M can be represented as $\{m_i\}^n_{i=1.}$ The singularities associated with them can be denoted as $\{S_i\}^n_{i=1.}$
Let N be the no. of minutiae in latent fingerprint. The score can be computed for referring the matching capability as

$$\text{score} = \frac{\sum S}{N} \forall m_i \epsilon M$$

Based on the score value, the matching frequency is obtained and compared with verifinger for accuracy calculation.

VI. EXPERIMENTAL RESULTS

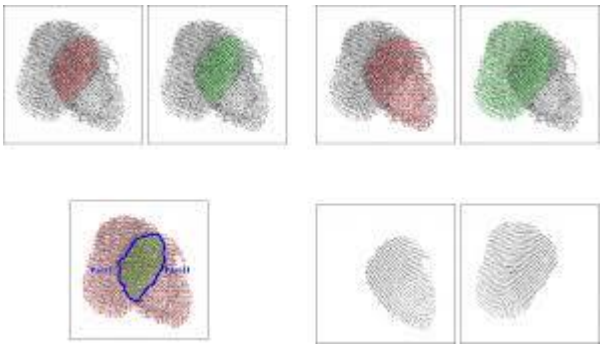

Figure 3. Overlapped fingerprint separation

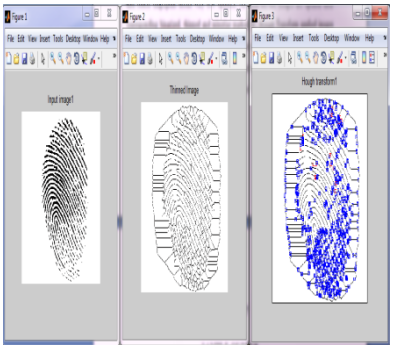

Figure 4. Rolled Fingerprint

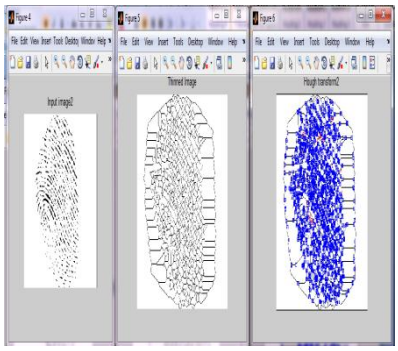

Figure 5. Latent Fingerprint

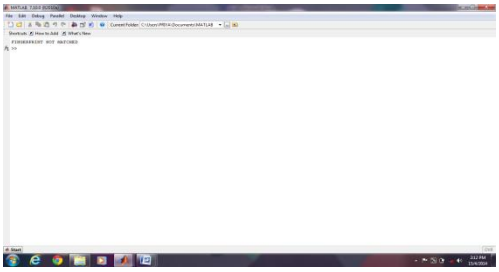

FIGURE 6. MATCHED FINGERPRINTS

VII. PERFORMANCE ANALYSIS

Table 1. Verifinger vs Proposed Matcher

Quality	Verifinger (%)	Proposed Matcher (%)
All	45.2	62.5
Good	75.0	78.4
Bad	57.0	65.4
Ugly	40.9	63.4

VIII. CONCLUSION

Biometric information provides a detailed knowledge about the person who has been involved in the act. Fingerprints are major important factors which has been mostly considered as the biometric. These are mainly used for identifying the suspects. In case of fingerprints with clear information, it is easy for the specialists to identify the culprits or any other persons. But this is not case in most of the times. In this approach, the overlapped latent fingerprints are segmented and taken for analysis. This provides a detailed report regarding the suspect without any clarity about the fingerprint. For this purpose, a framework named Descriptor based Hough Transform is used. As a result, the wide information can be obtained by matching the latent and rolled fingerprints.

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