The Division of Overlapped Fingerprint using Speckle Noise Reduction

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Abstract— A fingerprint in its narrow sense is an impression left by the friction ridges of a human finger. The recovery of fingerprints from a crime scene is an important method of science. Normally, fingerprint images contain a single fingerprint or a set of non-overlapped fingerprints. There may be situations where overlapped fingerprint can be obtained. It can be frequently encountered in the latent fingerprint lifted from crime scenes. It is essential to separate those overlapped fingerprint into its component fingerprints. The challenging work in separating overlapped fingerprint is the separation of mixed orientation field into its component orientation field. The region masks are then further used to separate the fingerprint. This paper proposes a novel algorithm that is fully automated in its approach to region masking the overlapped fingerprint image. The algorithm recognizes a unique approach of using blurring, erosion and dilation in order to attain the desired automated region masks. The experiments conducted visually demonstrate the effectiveness of the algorithm.

Key words: Fingerprint, Speckle Noise Reduction

I. INTRODUCTION

Fingerprint image acquisition is considered to be the most critical step in an automated fingerprint authentication system, as it determines the final fingerprint image quality, which has a drastic effect on the overall system performance. There are different types of fingerprint readers on the market, but the basic idea behind each is to measure the physical difference between ridges and valleys.

All the proposed methods can be grouped into two major families: solid-state fingerprint readers and optical fingerprint readers. The procedure for capturing a fingerprint using a sensor consists of rolling or touching with the finger onto a sensing area, which according to the physical principle in use (optical, ultrasonic, capacitive or thermal) captures the difference between valleys and ridges. When a finger touches or rolls onto a surface, the elastic skin deforms. The quantity and direction of the pressure applied by the user, the skin conditions and the projection of an irregular 3D object (the finger) onto a 2D flat plane introduce distortions, noise and inconsistencies in the captured fingerprint image. These problems result in inconsistent and non-uniform irregularities in the image.[20] During each acquisition, therefore, the results of the imaging are different and uncontrollable. The representation of the same fingerprint changes every time the finger is placed on the sensor plate, increasing the complexity of any attempt to match fingerprints, impairing the system performance and consequently, limiting the widespread use of this biometric technology.

In order to overcome these problems, as of 2010, non-contact or touchless 3D fingerprint scanners have been developed. Acquiring detailed 3D information, 3D fingerprint scanners take a digital approach to the analog process of pressing or rolling the finger. By modelling the distance between neighbouring points, the fingerprint can be imaged at a resolution high enough to record all the necessary detail.

II. LIVE SCAN DEVICES

Fig. 1.1: (a) Fingerprint being scanned

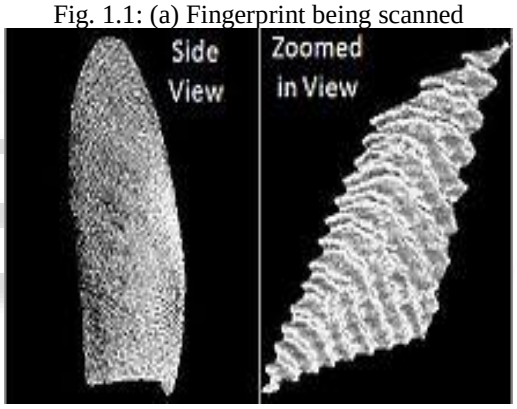


Fig. 1.1: (b) Scanning dead or unconscious people

Placing the hand of a dead or unconscious person on a scanner to gain unauthorized access has become a common plot device. However, a Myth Busters episode revealed that this doesn't work (at least with the scanners available to the program). But Adam Savage and Jamie Hyneman found a way to convert fingerprints lifted from the hand to a photographic form that the sensor would accept. For obvious reasons, they refuse to reveal the technique.

III. LATENT DETECTION

Fig. 1.2: (a) Use of fine powder and brush to reveal latent fingerprints

Fig. 1.2: (b) Fingerprints dusting of a burglary scene

In the 1930s criminal investigators in the United States first discovered the existence of latent fingerprints on the surfaces of fabrics, most notably on the insides of gloves discarded by perpetrator.

Since the late nineteenth century, fingerprint identification methods have been used by police agencies around the world to identify suspected criminals as well as the victims of crime. The basis of the traditional fingerprinting technique is simple. The skin on the palmar surface of the hands and feet forms ridges, so-called papillary ridges, in patterns that are unique to each individual and which do not change over time. Even identical twins (who share their DNA) do not have identical fingerprints. The best way to render latent fingerprints visible, so that they can be photographed, can be complex and may depend, for example, on the type of surfaces on which they have been left. It is generally necessary to use a 'developer', usually a powder or chemical reagent, to produce a high degree of visual contrast between the ridge patterns and the surface on which a fingerprint has been deposited.

Fingerprints at a crime scene may be detected by simple powders, or by chemicals applied in situ. More complex techniques, usually involving chemicals, can be applied in specialist laboratories to appropriate articles removed from a crime scene. With advances in these more sophisticated techniques, some of the more advanced crime scene investigation services from around the world were, as of 2010, reporting that 50% or more of the fingerprints recovered from a crime scene had been identified as a result of laboratory-based techniques.

Fig. 1.3: A city fingerprint identification room

IV. LABORATORY TECHNIQUES

A technique has been developed that enables fingerprints to be visualised on metallic and electrically conductive surfaces without the need to develop the prints first.[29] This technique involves the use of an instrument called a scanning Kelvin probe (SKP), which measures the voltage, or electrical potential, at pre-set intervals over the surface of an object on which a fingerprint may have been deposited. These measurements can then be mapped to produce an image of the fingerprint. A higher resolution image can be obtained by increasing the number of points sampled, but at the expense of the time taken for the process.The reason for this is that the differences in potential that are the basis of the visualisation are caused by the interaction of inorganic salts in the fingerprint deposit and the metal surface and begin to occur as soon as the finger comes into contact with the metal, resulting in the formation of metal-ion complexes that cannot easily be removed.

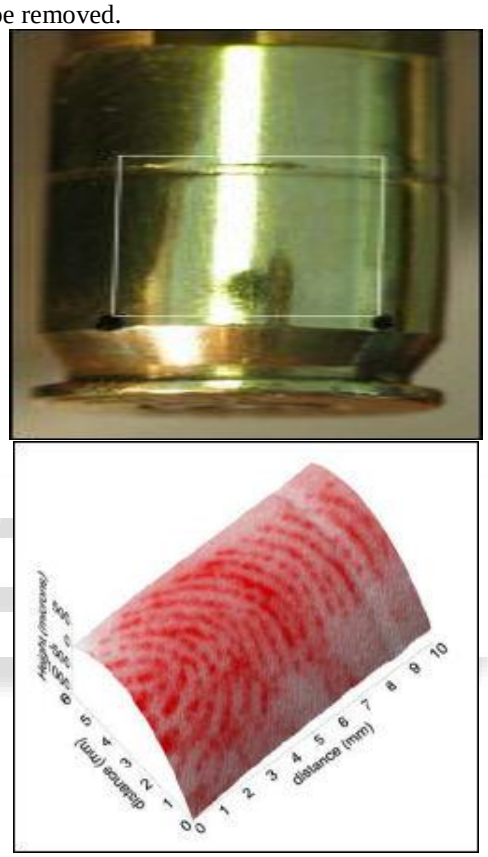


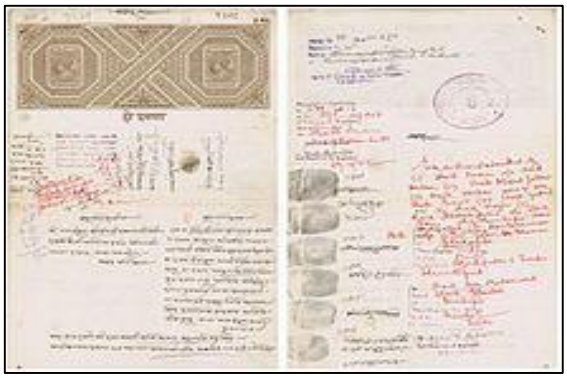
Fig. 1.4: (a, b) Cartridge case with an applied fingerprint

Scanning Kelvin probe scan of the same cartridge case with the fingerprint detected. The Kelvin probe can easily cope with the 3D curvature of the cartridge case, increasing the versatility of the technique.

V. MODERN ERA

(a)

Fig. 1.5: (a) Fingerprints taken by William Herschel 1859/60



(b)

Fig. 1.5: (b) Fingerprints used instead of sign on an Indian legal document of 1952.

VI. METHODOLOGY

The primary step in the separation is region masking. Region masking is the process of separation of an overlapped fingerprint into background and foreground regions, the foreground region is further sub-divided into overlapped region and non-overlapped regions of each individual component fingerprints.

The region mask helps in segregating different regions of overlapped fingerprint, which are further used to estimate the initial orientation field. The research made so far within overlapped fingerprint separation employs the use of a manual approach to carry out region.

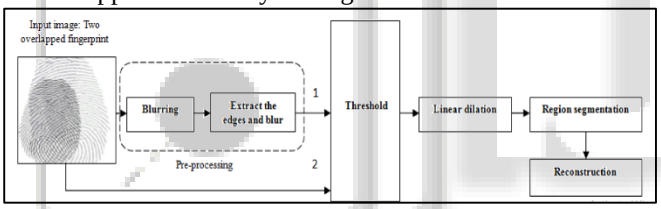


Figure.1.6 Block diagram of proposed region segmentation algorithm; (1) Edge extracted and blurred image; (2) Input gray scale image

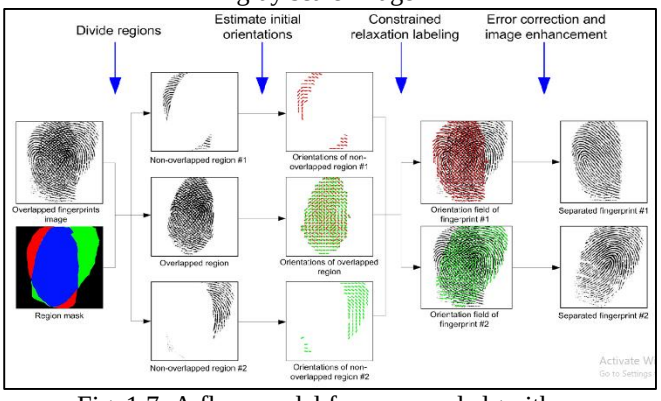


Fig. 1.7: A flow model for proposed algorithm

VII. RESULT & DISCUSSION

So with the advancement of the technology, an algorithm is proposed to separate the overlapped fingerprints and evaluated it using both real overlapped latent fingerprints and simulated overlapped fingerprints. The algorithm is based on two assumptions which are both reasonable and practical.

1) The overlapped fingerprint image consists of at most two fingerprints.
2) There exist differences between the orientation fields of the two component fingerprints in the overlapped area.

The proposed algorithm consists of the following four steps:

1) Region segmentation
2) Initial orientation field estimation
3) Orientation field separation
4) Fingerprint separation

A. Region segmentation

The region masks are manually marked for the two overlapped fingerprints. Manually marking region mask is a common practice in latent fingerprint community. The overlapped fingerprint image consists of two regions, the overlapped region and the non-overlapped region of two component fingerprints. The overlapped region is the common region of the two masks and it contains the overlapped part of the two fingerprints and the non-overlapped region contains only one fingerprint.

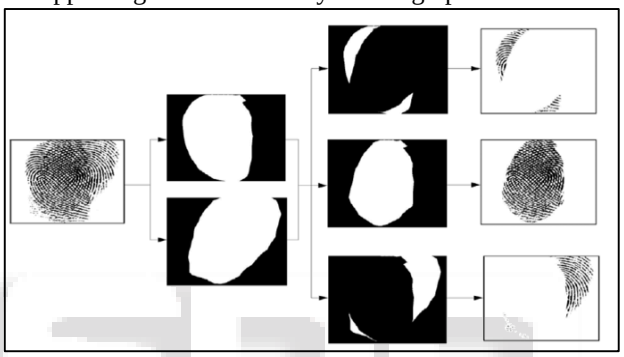


Fig. 1.8: Procedure to divide the regions

An overlapped fingerprint image is segmented into non overlapping blocks of 16x16 pixels. The block in the overlapped region is called overlapped block and the block in the non-overlapped region is called non overlapped block. There exists one dominant orientation in the non-overlapped block and two dominant orientations in the overlapped block.

B. Initial Orientation Field Estimation:

A Fingerprint orientation field is a matrix, whose value at (x, y) denotes the dominant ridge orientation at point (x, y). The orientation field of an overlapped fingerprint image is different from that of the orientation field of a single fingerprint image in that it contains one dominant orientation in the non-overlapped region and two dominant orientations in the overlapped region. In this paper, we have assumed that the region masks of the component fingerprints have been manually marked.

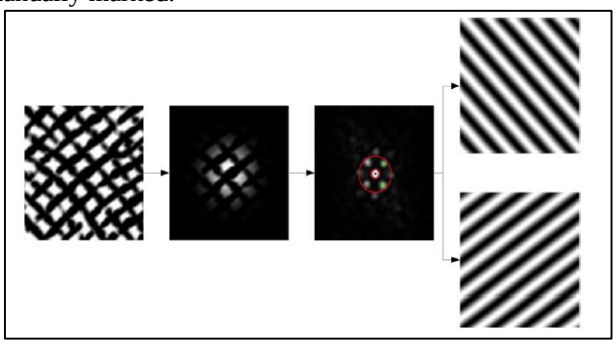


Fig. 1.9: Estimation of two dominant orientations in a overlapped block

C. Orientation Field Separations:

The algorithm is proposed in order to reconstruct the orientation fields. The method used is relaxation labelling method.

Fig. 2: (a) and (b) correspond one merger, while (c) and (d) correspond to another one.

D. Fingerprint Separation:

Contextual filtering using 2D Gabor filters is very effective for fingerprint enhancement. Two important parameters of 2D Gabor filters are local ridge orientation and frequency. When the ridge orientation field and ridge frequency map are obtained, Gabor filtering can connect the broken ridges and remove intervening ridges. Finally, two overlapping fingerprints have been successfully separated. The speckle noise is the environmental noise which generates in the overlapped fingerprint .To get the exact and enhanced image of fingerprint it should be reduced.

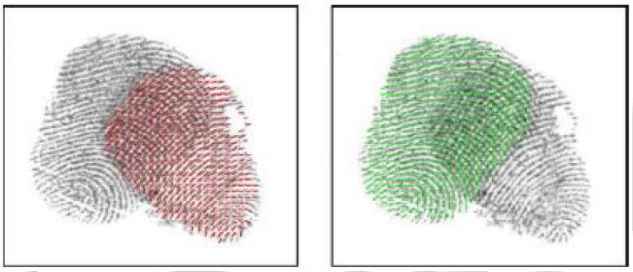


Fig. 2.1: Separated orientation fields of overlapped fingerprint

Fig. 2.2: First enhanced fingerprint and second enhanced fingerprint

VIII. CONCLUSION & FUTURE SCOPE

Fingerprint recognition has been successfully deployed in various applications, such as entry control, time and attendance, computer login, forensics, and airport security. One challenging problem now-a-days is the processing and matching of overlapped fingerprints. When the same location of a surface is touched by two or more fingerprints at different times, the developed latent image may contain overlapped fingerprints. It may also occur in the live scan fingerprint images when the surface of fingerprint sensors contains residue of preceding fingerprints. Overlapped fingerprints which are encountered from the crime scenes are not of good quality. However, separating the overlapped fingerprints is a very challenging problem for the existing algorithms. We have proposed the speckle noise reduction technique which is the environmental noise which generates in the overlapped fingerprint .To get the exact and enhanced image of fingerprint it should be reduced. This study can be extended along the following directions:

1) The proposed algorithm assumes that the component orientation fields should be different or completely separable in the overlapped region. This may not always be the case. The algorithm needs to be improved to handle the more general case.
2) The current algorithm requires manually marked region masks (region of interest or ROI) and singular points as input. There is a plan to develop a fully automatic overlapped fingerprint separating algorithm.
3) Image quality of the overlapped fingerprints used in the current experiments is relatively good. We are in the process of collecting additional latent overlapped fingerprints of various quality that are lifted using different latent development methods.

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