SEPARATION OF OVERLAPPED FINGERPRINTS FOR FORENSIC APPLICATION

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Abstract: Fingerprint is a unique identity of every person and it is a basic tool in crime investigation. Latent fingerprints lifted from crime scenes often contain overlapping prints, which are difficult to separate and match by the state-of-art fingerprint matchers. Overlapped fingerprints constitute a serious challenge to existing fingerprint recognition algorithms, It is necessary to separate such overlapped fingerprints into component fingerprints. The challenging work in separating overlapped fingerprint is the separation of mixed orientation field into its component orientation field. In this paper, Relaxation labelling algorithm is proposed to perform the task of separation. Initially, we use Local Fourier analysis method in order to estimate the initial orientation field. Then Relaxation labelling algorithm is employed to detach the initial orientation field. Finally, by using Gabor filter the required component fingerprints are obtained. Experimental results on both real and simulated overlapped fingerprints show that the proposed algorithm gives both accuracy and efficiency.

I. INTRODUCTION

Fingerprints are widely used for personal authentication in both forensic and civilian applications. Given a fingerprint image, fingerprint matchers extract features from it, and match the features against the reference feature templates to identify or verify the identity associated with the fingerprint. Latent fingerprints lifted from crime scenes may contain overlapping fingerprints. Forensic scientists have proposed a method to separate overlapped fingerprints using the gold material. This technology is very interesting and is not convenient since it works only for some specific fingerprints. Fan et al. proposed an algorithm to separate overlapped fingerprints based on image enhancement using a manually marked orientation field. However, it is tedious and time consuming for us to manually mark the orientation field of each component fingerprint in the overlapped fingerprint image. Geng et al. proposed to use morphological component analysis to separate overlapped fingerprints. Experimental results showed that their algorithm can only separate that component fingerprint which dominates the overlapped image. Singh et al. suggested the use of independent component analysis (ICA) to separate overlapped fingerprints, but they did not provide a separation algorithm. In this paper, we proposed an algorithm to separate 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 three steps:

1. Region segmentation: The overlapped fingerprint image is divided into background region, overlapped region, non-overlapped regions of two component fingerprints.
2. Initial orientation field estimation: By using Local Fourier analysis method the initial orientation field of the given overlapped fingerprint image is estimated.
3. Orientation field separation: A relaxation labelling method is then employed to label the initial orientation field in to two classes. Based on the result, the initial orientation field is decomposed into two component orientation fields.
4. Fingerprint separation: Finally, the two component fingerprints are separated by employing Gabor filters.

Fig.1 (a) Fig. 1(b)

Fig.1 (a) input overlapped image and (b) input binary image

Fig 1 is a fingerprint which is lifted from a crime scene and contains a two overlapped fingerprints. It is then converted into the binary form for further processes.

II. OVERLAPPED FINGERPRINT SEPARATION

A. Region Segmentation

The overlapped fingerprint image consists of three regions, the overlapped region and the non-overlapped region and background 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. For segmentation, background noise of an image is removed first then image is segmented in overlapped and non-overlapped regions by manual marking. And then entire non-

overlapped region and overlapped region of both the fingerprints is obtained.

Fig.2(a)

Fig.2(b)

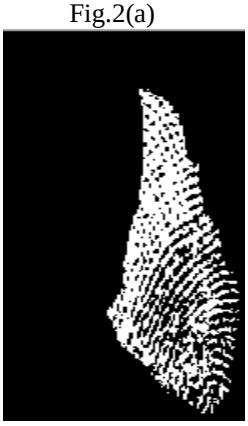

Fig.2(c)

Fig.2(d)

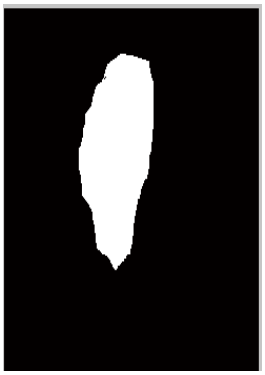

Fig.2(e)

Fig.2(f)

Fig .2(g)

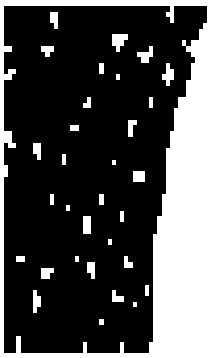

Fig.(h)

Fig.2 (a) selected left fingerprint (b) selected right fingerprint (c) right finger non-overlapped image (d) left finger non-overlapped image (e) intersected mask (f) multiplication of non-overlapped fingers(g) overlapped image (h) region of interest.

In fig.2(a) we selected left fingerprint manually same way in fig 2(b) we selected right fingerprint manually .Then we will get non-overlapped region of right fingerprint which is shown in fig.2(c) In fig. 2(d)left non-overlapped is shown. fig. 2(e) gives idea about intersected mask of two fingerprints .fig. (f) Multiply both the images so that we will get non-overlapped part of both images. In fig 2(g) we get overlapped part of both the images. In fig. 2(f) select region of interest manually.

III. INITIAL ORIENTATION FIELD ESTIMATION

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. Here we have assumed that the region masks of the component fingerprints have been manually marked. After the creation of region mask we have used Discrete Fourier Transform method in order to extract the initial orientation field. We have taken the input overlapped fingerprint image and then is divided in to non-overlapping blocks of 16x16 pixels. The ridge present in an each block can be represented by a 2D sine wave. Centred at each block, the local image in the 64x64 window is then multiplied by a Gaussian function (σ = 16). The discrete Fourier transform (DFT). The amplitude of the low frequency components is set to zero. Also, the local maxima points with the largest amplitude are found in the frequency domain

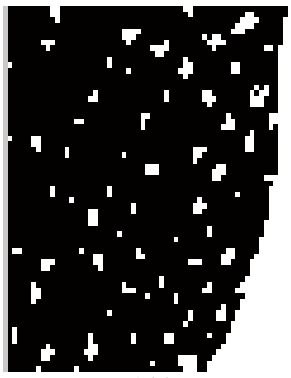

Fig. 3(a)

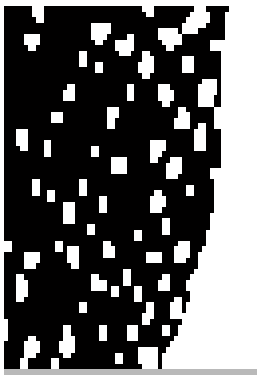

Fig. 3(b)

Fig.3 (a) Sharp image and (b) Gaussian filtered image

In Fig.3(a) we get sharp image by using unsharp filter. In fig 3(b) Here Gaussian filter is used as low pass filter .It is used to boost low frequency component.

IV. ORIENTATION FIELD SEPARATION

After orientation field estimation, constrained relaxation labeling will be used to determine the labels of overlapped blocks. The block orientation in each overlapped block is modified as the mean orientation of all block orientations in the 5*5 block wise square area cantered at the block being

considered. After constrained relaxation labeling the orientation fields of two component fingerprints are obtained. But errors may occur in some area of orientation field. Then error correction algorithm is utilized to smooth orientation field.

V. FINGERPRINT SEPARATION

After the two component orientation fields are smoothed, the two block-wise frequency maps are calculated using the signature approach. Finally, two component fingerprints are obtained by filtering the overlapped fingerprint image within Gabor filters tuned to the corresponding orientation field.

Fig.4 (a)

Fig. 4(b)

Fig.4 (a) separated right fingerprint and (b) separated left fingerprint.

Finally two overlapped fingerprints are separated into left fingerprint and right fingerprint.

VI. ACKNOWLEDGMENT

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VII. CONCLUSION

Fingerprint recognition systems have made lot of advancements in personal identification systems for controlled environment. Fingerprints collected from an uncontrolled environment such as crime scene often contain complex background and need lot of processing and hence obtaining valid fingerprints is a very serious difficult task. Overlapped fingerprints occur due to multiple touches to the objects. There is a need of separation of overlapped fingerprints into individual fingerprints. we proposed robust and efficient relaxation labelling algorithm to estimate the component orientation field of latent overlapped fingerprints. Experiments on both simulated and real overlapped fingerprint databases demonstrated that the basic algorithm outperforms the state of the art method in both accuracy and efficiency In this paper, as a first step, a method of segmentation of overlapped region is presented. Method id tested on fingerprints from simulated overlapped fingerprints database. The results indicate that the proposed algorithm is satisfactory for fingerprints with good continuity in ridge lines. Our long term goal is to develop a fully automatic separating algorithm which requires no input from human. But because the quality of latent fingerprints varies significantly, it is impractical to develop a single separating algorithm that works for all latent overlapped fingerprints. Thus as a short term goal, we will also explore more efficient human interaction.

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