**LITERATURE SURVEY**

**1. Fingerprint image enhancement: Algorithm and performance evaluation**

**AUTHORS**: L. Hong, Y. Wan, and A. Jain

In order to ensure that the performance of an automatic fingerprint identification/verification system will be robust with respect to the quality of input fingerprint images, it is essential to incorporate a fingerprint enhancement algorithm in the minutiae extraction module. We present a fast fingerprint enhancement algorithm, which can adaptively improve the clarity of ridge and valley structures of input fingerprint images based on the estimated local ridge orientation and frequency. We have evaluated the performance of the image enhancement algorithm using the goodness index of the extracted minutiae and the accuracy of an online fingerprint verification system. Experimental results show that incorporating the enhancement algorithm improves both the goodness index and the verification accuracy .

**2. Segmentation and enhancement of latent fingerprints: A coarse to fine ridge structure dictionary**

**AUTHORS**: K. Cao, E. Liu, and A. K. Jain

Latent fingerprint matching has played a critical role in identifying suspects and criminals. However, compared to rolled and plain fingerprint matching, latent identification accuracy is significantly lower due to complex background noise, poor ridge quality and overlapping structured noise in latent images. Accordingly, manual markup of various features (e.g., region of interest, singular points and minutiae) is typically necessary to extract reliable features from latents. To reduce this markup cost and to improve the consistency in feature markup, fully automatic and highly accurate (“lights-out” capability) latent matching algorithms are needed. In this paper, a dictionary-based approach is proposed for automatic latent segmentation and enhancement towards the goal of achieving “lights-out” latent identification systems. Given a latent fingerprint image, a total variation (TV) decomposition model with L1 fidelity regularization is used to remove piecewise-smooth background noise. The texture component image obtained from the decomposition of latent image is divided into overlapping patches. Ridge structure dictionary, which is learnt from a set of high quality ridge patches, is then used to restore ridge structure in these latent patches. The ridge quality of a patch, which is used for latent segmentation, is defined as the structural similarity between the patch and its reconstruction. Orientation and frequency fields, which are used for latent enhancement, are then extracted from the reconstructed patch. To balance robustness and accuracy, a coarse to fine strategy is proposed. Experimental results on two latent fingerprint databases (i.e., NIST SD27 and WVU DB) show that the proposed algorithm outperforms the state-of-the-art segmentation and enhancement algorithms and boosts the performance of a state-of-the-art commercial latent matcher.

**3. Orientation field estimation for latent fingerprint enhancement**

**AUTHORS**: J. Feng, J. Zhou, and A. K. Jain

Identifying latent fingerprints is of vital importance for law enforcement agencies to apprehend criminals and terrorists. Compared to live-scan and inked fingerprints, the image quality of latent fingerprints is much lower, with complex image background, unclear ridge structure, and even overlapping patterns. A robust orientation field estimation algorithm is indispensable for enhancing and recognizing poor quality latents. However, conventional orientation field estimation algorithms, which can satisfactorily process most live-scan and inked fingerprints, do not provide acceptable results for most latents. We believe that a major limitation of conventional algorithms is that they do not utilize prior knowledge of the ridge structure in fingerprints. Inspired by spelling correction techniques in natural language processing, we propose a novel fingerprint orientation field estimation algorithm based on prior knowledge of fingerprint structure. We represent prior knowledge of fingerprints using a dictionary of reference orientation patches. which is constructed using a set of true orientation fields, and the compatibility constraint between neighboring orientation patches. Orientation field estimation for latents is posed as an energy minimization problem, which is solved by loopy belief propagation. Experimental results on the challenging NIST SD27 latent fingerprint database and an overlapped latent fingerprint database demonstrate the advantages of the proposed orientation field estimation algorithm over conventional algorithms.

**4. Reconstructing orientation field from fingerprint minutiae to improve minutiae-matching accuracy**

**AUTHORS**: F. Chen, J. Zhou, and C. Yang

Minutiae are very important features for fingerprint representation, and most practical fingerprint recognition systems only store the minutiae template in the database for further usage. The conventional methods to utilize minutiae information are treating it as a point set and finding the matched points from different minutiae sets. In this paper, we propose a novel algorithm to use minutiae for fingerprint recognition, in which the fingerprint's orientation field is reconstructed from minutiae and further utilized in the matching stage to enhance the system's performance. First, we produce "virtual" minutiae by using interpolation in the sparse area, and then use an orientation model to reconstruct the orientation field from all "real" and "virtual" minutiae. A decision fusion scheme is used to combine the reconstructed orientation field matching with conventional minutiae-based matching. Since orientation field is an important global feature of fingerprints, the proposed method can obtain better results than conventional methods. Experimental results illustrate its effectiveness.

**5. An improved scheme for full fingerprint reconstruction**

**AUTHORS**: S. Li and A. C. Kot

Different fingerprint recognition systems store minutiae-based fingerprint templates differently. Some store them inside a small token; some can be found in a server database. As the minutiae template is very compact, many take it for granted that the template does not contain sufficient information for reconstructing the original fingerprint. This paper proposes a scheme to reconstruct a full fingerprint image from the minutiae points based on the amplitude and frequency modulated (AM-FM) fingerprint model. The scheme starts with generating a binary ridge pattern which has a similar ridge flow to that of the original fingerprint. The continuous phase is intuitively reconstructed by removing the spirals in the phase image estimated from the ridge pattern. To reduce the artifacts due to the discontinuity in the continuous phase, a refinement process is introduced for the reconstructed phase image, which is the combination of the continuous phase and the spiral phase (corresponding to the minutiae). Finally, the refined phase image is used to produce a thinned version of the fingerprint, from which a real-look alike gray-scale fingerprint image is reconstructed. The experimental results show that our proposed scheme performs better than the-state-of-the-art technique.