Ain Shams University
Faculty of Engineering
Computer and Systems Engineering Department

Enhanced Secure Algorithm for Fingerprint Recognition

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قسم هندسة الحاسبات والنظم

خوارزم آمن ومحسن للتعرف على بصمة الإصبع

رسالة
مقدمة للحصول على درجة الدكتوراة في الهندسة الكهربية
(هندسة الحاسبات والنظم)

مقدمة من
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Abstract

Amira Mohammad Abdel-Mawgoud Saleh

Enhanced Secure Algorithm for Fingerprint Recognition

Philosophy of Doctoral Dissertation
(Ain Shams University - Faculty of Engineering - 2011)

Recognition of persons by means of biometric characteristics is an emerging phenomenon in our society. It has received more and more attention during the last years due to the need for security in a large range of applications. Among the many biometric features, the fingerprint is considered one of the most practical ones. Fingerprint recognition requires a minimal effort from the user, does not capture other information than strictly necessary for the recognition process, and provides relatively good performance. Another reason for the popularity of fingerprints is the relatively low price of fingerprint sensors, which enables easy integration into PC keyboards, smart cards and wireless hardware.

A critical step in fingerprint identification system is thinning of the input fingerprint image. The performance of a minutiae extraction algorithm relies heavily on the quality of the thinning algorithm. So, a fast fingerprint *thinning* algorithm is proposed. The algorithm works directly on the gray-scale image not the binarized one as binarization of fingerprint causes many spurious minutiae and also removes many important features. The performance of the thinning algorithm is evaluated and experimental results show that the proposed thinning algorithm is both fast and accurate.

The next step after thinning of the fingerprint image is minutiae extraction. These minutiae together with the template obtained from the database are used in fingerprint matching. In this study, a new minutiae-based fingerprint *matching* technique is proposed. The main idea is that each fingerprint is represented by a minutiae table of just two columns in the database. The number of different minutiae types (terminations and bifurcations) found in each track of a certain width around the core point

of the fingerprint is recorded in this table. Each row in the table represents a certain track, in the first column, the number of terminations in each track is recorded, in the second column, the number of bifurcations in each track is recorded. Since neither minutiae *position* nor *orientation* is considered in tables representing the fingerprints in database, the algorithm is rotation and translation invariant, and needs less storage size. Experimental results show that recognition accuracy is 98%, with Equal Error Rate (EER) of 2%.

Finally, the integrity of the data transmission via communication channels must be secure all the way from the scanner to the application. This is typically achieved by *cryptographic* methods. So, a watermarking algorithm is proposed, to hide the minutiae data (proposed minutiae table) in its corresponding fingerprint using two secret keys k_1, and k_2 to increase security. The watermarking algorithm is blind i.e. it does not need the original fingerprint to extract the watermark. Two security watermarking applications are studied which can be used to guarantee secure transmission of acquired fingerprint images from intelligence agencies to a central image database and to eliminate several types of biometric system attacks.

Experimental results show that watermark is both invisible and robust against Gaussian noise addition, and JPEG compression with high and moderate quality factors. After watermarking and without attacks, recognition accuracy does not change and still is 98%. After applying Gaussian noise addition, and JPEG compression with high and moderate quality factors on the watermarked fingerprint images, recognition accuracy decreases slightly to reach 96%.

Keywords:

Biometrics, fingerprints, segmentation, image processing, fingerprint recognition, Gabor filter, fingerprint enhancement, binarization, thinning algorithms, skeleton, direction field analysis, feature extraction, minutiae matching, adaptive singular point detection, core point, fingerprint identification, verification, secure authentication, threat model, watermarking, information security, Data hiding.

List of publications

1. A. M. Saleh, A. M. Bahaa Eldin, and A.-M. A. Wahdan, "A Modified Thinning Algorithm for Fingerprint Identification Systems," in *International Conference on Computer Engineering and Systems ICCES* Cairo, Egypt, December 14-16, 2009, pp. 371-376.

2. Amira Saleh, Ayman Bahaa and A. Wahdan (2011). Fingerprint Recognition, Advanced Biometric Technologies, Girija Chetty and Jucheng Yang (Ed.), ISBN: 978-953-307-487-0, InTech, Available from: http://www.intechopen.com/articles/show/title/fingerprint-recognition

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Statement

This dissertation is submitted to Ain Shams University for the degree of Philosophy of Doctoral in Electrical Engineering (Computer and Systems Engineering).

The work included in this thesis was carried out by the author at the Computer and Systems Engineering Department, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at other university or institution.

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