Fingerprint indexing based on minutiae pairs and convex core point

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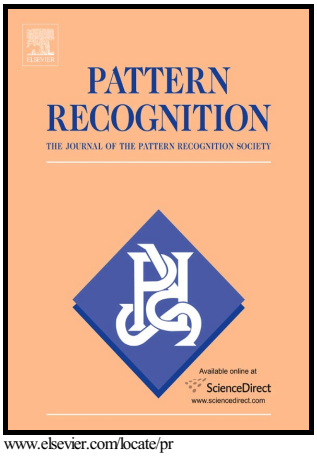

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Abstract

Fingerprint matching is an important issue for identifying fingerprints and plays a key role in the fingerprint recognition systems. However, performing a fingerprint identification over a large database can be an inefficient task due to the lack of scalability and high computing times of fingerprint matching algorithms. Fingerprint indexing is a key strategy in automatic fingerprint identification systems (AFISs) which allows us to reduce the number of candidates, the search space, and the occurrences of false acceptance in large databases. In this paper, an efficient indexing algorithm is proposed using minutia pairs and convex core point which employs k-means clustering and candidate list reduction criteria to increase the recognition performance. Our proposal can effectively reduces the search space and number of candidates for fingerprint matching, and thus achieves higher matching scores and significantly improves the system retrieval performance. Experimental results over some of the fingerprint verification competition (FVC) and national institute of standards and technology (NIST) databases prove the superiority of the proposed approach against some of the well known indexing algorithms.

Keywords: Fingerprint indexing, Minutiae, Clustering, Singular points, Candidate list reduction, Ellipse

1. Introduction

Fingerprints are physiological characteristics of biometric recognition and have been extensively used in both forensic and non-forensic applications [49]. A fingerprint is the pattern of ridges (single curved segments) and valleys (regions that lies in between ridges) on the surface of a fingertip [41, 74]. Fig. 1 shows an example of gray-scale image of fingerprint and the details extracted from it.

A fingerprint recognition system may be called either a verification system or an identification system. The aim of verification systems is to focus on matching the fingerprint of a person with his stored fingerprint templates, i.e., matching module works in one-to-one comparison mode. In verification systems, the speed of a comparison mainly depends on how the similarity measure is evaluated between a query print (probe) and the fingerprint stored in the database (gallery), whereas the selection of the similarity measure usually depends on representations of the feature. On the other hand the aim of the fingerprint identification systems is to establish the identity of a person, given a query print and a database of enrolled fingerprints of different individuals to seek a match. In these systems, matching module works in one-to-many comparison mode [22, 39, 49, 52, 70]. If the number of templates in a database is N, thus identification systems can be viewed as a series of N one-to-one comparisons [49, 58].

Most of the well known fingerprint matching algorithms are fast and quite accurate to deal with small databases [59], but nowadays the size of most of modern fingerprint databases is very large and need a search on all gallery fingerprints which affect both accuracy and efficiency of fingerprint matching [7, 22, 52]. If there is a need for finding a person among these databases, it must be done in reasonable time, often shorter than a few seconds. Within this context, the bottleneck step in the identification process is the matching algorithm, because it must be performed once per each gallery to determine which one has the most similary with the probe.

There are various methods to reduce the search time and computational complexity, and to speed up the matching process in the literature [52, 58]. Generally, reducing the number of comparisons and increas-

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