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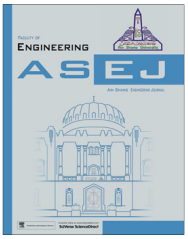

ELECTRICAL ENGINEERING

A medium resolution fingerprint matching system

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Abstract In this paper, a novel minutiae based fingerprint matching system is proposed. The system is suitable for medium resolution fingerprint images obtained by low cost commercial sensors. The paper presents a new thinning algorithm, a new features extraction and representation, and a novel feature distance matching algorithm. The proposed system is rotation and translation invariant and is suitable for complete or partial fingerprint matching. The proposed algorithms are optimized to be executed on low resource environments both in CPU power and memory space. The system was evaluated using a standard fingerprint dataset and good performance and accuracy were achieved under certain image quality requirements. In addition, the proposed system was compared favorably to that of the state of the art systems.

1. Introduction

Personal identification by means of biometric characteristics is now an integral part in many information systems. It has received more attention during the last decade due to the need for security in a wide range of applications. Among the biometric features, 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 [1].

The general framework of a fingerprint identification system (FIS) is depicted in Fig. 1 [2]. As shown, fingerprint matching is the last step in Automatic Fingerprint Identification System (AFIS). Fingerprint matching techniques can be classified into three types:

- Correlation-based matching,
- Minutiae-based matching,
- Feature-based matching like sweat pores and 3D matching [3].

The minutiae-based matching is the most popular and widely used technique, being the basis of the human based fingerprint comparison.

Many fingerprint identification systems had been proposed, but in most of them, pre-processing, alignment and orientation are required. Also, many of these systems require high resolution fingerprint images, large memory to store templates, large memory to match, and complex processing.

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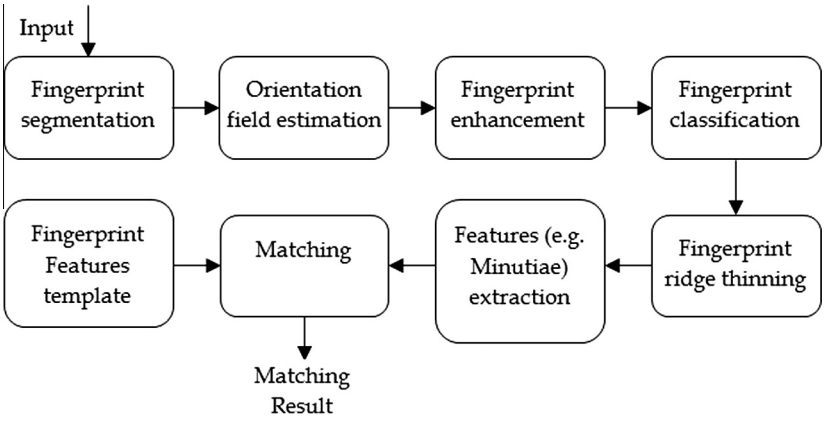

Figure 1 General block diagram for a fingerprint identification system.

This situation is not suitable for small devices with cheap fingerprint scanners, especially when massive identification processes are expected.

This work focuses on a novel feature representation scheme of fingerprints, which can be easily obtained from medium resolution (500 DPI) fingerprint scanners and that does not require any pre-orientation and alignment and in the same time requires very small memory size and simple matching processing.

This paper is organized as follows, the next section depicts related work, then the proposed fingerprint matching system is presented in Section 3. Section 4 presents the experimental results of evaluations followed by a conclusion and future work section.

2. Related work

This section presents some basic and the state of the art work in the field of fingerprint matching during the last 20 years. The focus was on the feature based matching. There is another approach by using filter banks, but it is an old one and does not give accurate results.

In [3], a hierarchical fingerprints matching method, namely Tangent Distance Sparce Weighted Random sample (TDSWR) method, using sweat pores as fingerprint features, by introducing the TD-Sparse-based method for coarse pore correspondence establishment and weighted RANdom SAmple Consensus (WRANSAC) for refinement. The proposed method measures the differences between pores based on the residuals obtained by the tangent distance and sparse representation technique, which makes the method more robust to noise and local distortions in fingerprints when compared with the existing Direct Pore matching (DP) [33] and Sparse Representation Direct Pore matching (SRDP) [34] methods. It then establishes one-to-many coarse pore correspondences, and assigns to each correspondence a weight-based on the difference between the pores in the correspondence. The final pore correspondences are obtained by adopting WRANSAC to refine the coarse pore correspondences. The experimental results demonstrated that the proposed method can more effectively establish pore correspondences and finally reduce the equal error rate (EER) by one order of magnitude in both of the two fingerprint databases used in the experiments (the best improvement on the recognition accuracy is up to 92%). However, the high computational complexity is one of the limitations of this method.

In [4], a minutia matching method was presented, describing elastic distortions in fingerprints by means of a thin-plate spline model, which is estimated using a local and a global matching stages. After registration of the fingerprints, according to the estimated model, the number of matching minutiae can be counted using very tight matching thresholds. For deformed fingerprints, the algorithm gives considerably higher matching scores compared to the rigid matching algorithms, while only taking 100 ms on a 1 GHz P-III machine. Furthermore, it was shown that the observed deformations are different from those described by theoretical models proposed in the literature.

The filter-based algorithm, in [5], uses a bank of Gabor filters [35], to capture both local and global details in a fingerprint as a compact fixed length "FingerCode". The fingerprint matching is based on the Euclidean distance between the two corresponding FingerCodes and hence it is extremely fast. However, the accuracy of the matching results is not high enough for accurate identification.

In [6], a fingerprint minutia matching technique was proposed, matching the fingerprint minutiae by using both the local and global structures of minutiae. The local structure of a minutia describes a rotation and translation invariant feature of the minutia in its neighborhood. It is used to find the correspondence of two minutiae sets and increase the reliability of the global matching. The global structure of minutiae reliably determines the uniqueness of fingerprint. Therefore, the local and global structures of minutiae together provide a solid basis for reliable and robust minutiae matching. This matching scheme is suitable for online processing for one to one matching but not on embedded devices and yet requires high resolution images.

In [7], three ideas are introduced along the following three aspects:

- Introduction of ridge information into the minutiae matching process in a simple and effective way, which solves the problem of reference point pair selection with low computational cost.
- Use of a variable sized bounding box to make their algorithm more robust to nonlinear deformation between fingerprint images.