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Rapid and brief communication

Fingerprint minutiae matching algorithm for real time system

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Abstract

Many fingerprint matching algorithms have been reported in articles in recent years. And people did fingerprint images matching through minutiae matching in most of the algorithms. In this paper, we proposed a new fingerprint minutiae matching algorithm, which is fast, accurate and suitable for the real time fingerprint identification system. In this algorithm we used the core point to determine the reference point and used a round bounding box for matching. Experiments done on a set of fingerprint images captured with a scanner showed that our algorithm is faster and more accurate than Xiping Luo's algorithm.

Keywords: Fingerprint; Matching algorithm; Minutiae; Core

1. Introduction

Fingerprints are most popularly used in biometric identification and recognition systems, because they can be easily used and their features are highly reliable. Fingerprint matching algorithm determines whether two fingerprints are from the same finger. Many fingerprint matching algorithms have been reported in articles in recent years [1–4]. In this paper, we propose a new fingerprint minutiae matching algorithm for real time fingerprint identification system.

To a fingerprint, one of the important features is the global characteristics [5]. Six major types of the fingerprints are shown in Fig. 1. To reduce the matching time and computational complexity, it is desirable to classify the input fingerprint into one of the types before matching.

Another important fingerprint feature is the local ridge characteristics [1]. To a certain extent, this feature exclusively determines the individuality of a fingerprint. There are two most prominent local ridge characteristics: ridge ending and ridge bifurcation. Both of them are called minutiae (see Fig. 2). A ridge ending is defined as the point where a ridge ends abruptly. A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges.

Another important fingerprint feature is the central point of the fingerprint, which is called fingerprint core [5,6]. The fingerprint core is the point of maximum curvature of the concave ridges [5].

Generally, a real time Automatic Fingerprint Identification System (AFIS) has the following process steps shown in Fig. 3. Our minutiae matching algorithm is used in the last step.

2. Minutiae matching

If two fingerprints come from the same finger, the positions and directions of their corresponding minutiae points should be close. Our algorithm is based on this point.

2.1. Minutiae and core

For a detected minutia point, it can be denoted as (x, y, d, t), where x and y are the coordinate values, d (takes the value from 0 to 360) is the direction of the minutia point and t is the type of the minutia (1 for ridge ending and 2 for ridge bifurcation).

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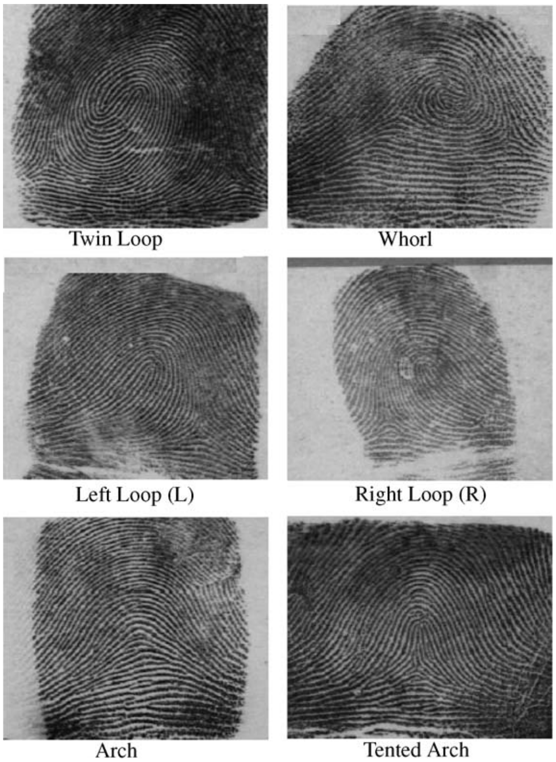

Fig. 1. Six major fingerprint classes.

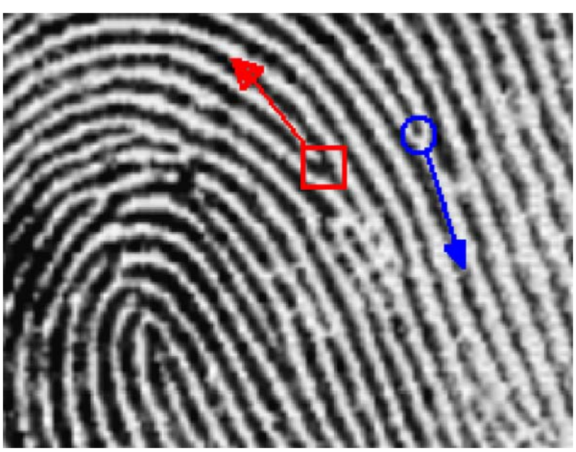

Fig. 2. Minutia (circle is ridge ending and rectangle is ridge bifurcation).

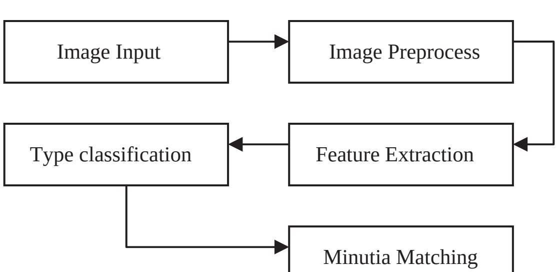

Fig. 3. AFIS process steps.

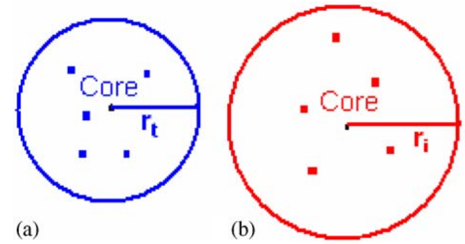

Fig. 4. Reference areas near core. (a) Template fingerprint. (b) Input fingerprint.

The fingerprint core we used is the point of maximum curvature of the concave ridges [5]. This point can be used to determine the reference point. A detected core can be denoted as (x_c, y_c), where x_c and y_c are the coordinate values.

For a template fingerprint image, denote the M minutiae points set as

$$P = \left((x_1^P, y_1^P, d_1^P, t_1^P), \ldots, (x_M^P, y_M^P, d_M^P, t_M^P)\right).$$

The template fingerprint core is denoted as

$$R = \left(x_c^P, y_c^P\right).$$

For an input fingerprint image, denote the N minutiae set as

$$Q = \left((x_1^Q, y_1^Q, d_1^Q, t_1^Q), \ldots, (x_N^Q, y_N^Q, d_N^Q, t_N^Q)\right).$$

The input fingerprint core is denoted as

$$S = \left(x_c^Q, y_c^Q\right).$$

2.2. Reference point selection

In order to determine the reference point, Luo [4] used the similarity of the minutiae linked ridges. Only when the similarity of the linked ridges reaches a predefined level, these minutiae points can be used as reference points. But it is complicated to calculate the similarity and much computation is involved.

We use the fingerprint core to determine the reference point, which simplified the calculating processes. If two minutiae points are reference pair, the distances to the core points should be close.

Firstly, take the core as the center of the template and input fingerprints, respectively. Then select a round area around the core as shown in Fig. 4. In these two areas, ensure that L same type minutiae points are included, e.g., all the minutiae are ridge endings. If the quality of the image is better, then L is smaller. The radii of the two round areas are r_t and r_i, respectively, as shown in Fig. 4. Then we use the larger area as the reference area. That is, the radius of the reference area is determined by

$$r_c = \mathrm{Max}(r_t, r_i).$$