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# Latent Palm Print Matching Based on Minutiae Features for Forensic Applications

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## ABSTRACT

In forensic application, palm print recognition receives significant attention because of the developing live scan palm print technology. In most forensic applications, the critical evidence obtained is those of latent palm prints. About 30% of the latent obtained from the crime scenes are of palms. Palm prints has large area of foreground, which consists of 1000's of minutiae points. Hence latent palm print matching requires development of novel strategies. Here we design a palm print matching strategy which is based on minutiae clustering. The minutiae match propagation is also considered for the minutiae correspondence. Minutiae clusters are formed based on the local minutiae features. Each cluster contains minutiae that contain similar local features. The correspondence between two palm print is done within the clusters. Mated minutiae pairs are considered by the Minutiae match propagation algorithm to determine the correspondence between the query palm print and the full palm print. Starting with the initial minutiae pair, the algorithm checks for further matches with the full palm print image.

## 1. INTRODUCTION

In most of the crime scenes the latent palm prints are raised as evidences for about 30%. Hence the latent palm prints has critical evidential values. The live-scan palm print technology is cost consuming and thus most of the existing techniques consist of low resolution images. High resolution palm print matching requires the use of minutiae points which are usually used in matching of finger prints. The techniques used for finger print matching cannot be appropriate for palm print minutiae matching because palm print has larger fore ground which might lead to feature extraction to a computationally demanding extent. Palm prints have large amount of creases which can lead to false minutiae conclusion and this makes it difficult to implement in palm print matching. The other reason for the difficulty of minutiae

matching in palm print is that the palm print images contain non-linear distortion than in finger prints. The palm print matching can be classified into three types like 1) Live-scan partial to full palm print matching 2) Full to full palm print matching 3) Latent to full palm print matching. As the latent palm prints are widely being collected in the crime scenes the forensic application are in need of efficient latent to full palm print matching algorithm. But latent to full palm print matching has many challenges like large nonlinear distortion, low image quality, small area of latent and a large number of noisy minutiae.

### 1.1 Matching Algorithms

Jain and Feng developed a latent to full palm print matching system. It was developed based on a region growing algorithm and also dealt with the creases. It uses Minutiae code as a feature to determine the minutiae similarity. The minutiae correspondences were established based on the top 5 similar minutiae pair matches.

J. Dai and J. Zhou proposed a palm print matching technique which uses multiple features. It fuses minutiae, principal line map ridge density map and orientation field. All the algorithms followed the strategy for finger print matching and hence had high computational complexity.

Die et al. to overcome this complexity came up with a segment based palm print matching. But this algorithm is developed for full to full palm print matching. For latent to full palm print matching it required manual alignment of the latent with the full palm print. This makes it infeasible for practice.

### 1.2 Contribution of This Paper

Minutiae clustering algorithm is proposed to reduce the complexity of latent to full palm print matching to a significant level. It is done by avoiding the consideration of different local characteristics of minutiae.

Minutiae match propagation algorithm for obtaining the feature correspondence between palm print is proposed. This algorithm is capable of identifying the true correspondences and rejects many imposter matchings.

## 2. MINUTIAE CLUSTERING

A minutia clustering is done by considering the local features of minutiae. The features considered are local ridge orientation and ridge period descriptor. Clustering is done by the K-means clustering algorithm.

Consider a reference minutiae  $m$ . Its local neighbourhood can be obtained by forming circles with radii  $r=1, \dots, L$ , with centre as minutiae  $m$ . The circle contains equally distributed sample points. At any sample point the ridge orientation is considered as the difference between the orientation at the sample point and the orientation of the ridge at the sample minutiae point. The ridge period descriptor at any point can be considered as the ridge period value at the specific point.

When the minutiae point is present in the boundary then the sample points might fall out of the foreground region. For such sample points we predict values from the nearest valid sample points. The distance between the orientation descriptor can be obtained by

$$\text{Dis} = \sqrt{\sum [(\cos 2\theta_i - \cos 2\theta_j)^2 + (\sin 2\theta_i - \sin 2\theta_j)^2]}$$

## 3. MINUTIAE MATCH PROPAGATION

In minutiae match propagation algorithm we use a fixed radius based minutiae structure descriptor. This is most suitable for large number of minutiae that are to be considered in palm prints. This algorithm consists of three steps: 1) Similarity measure of minutiae 2) Initial mated minutiae pair selection 3) Minutiae match propagation.

### 3.1 Similarity Measure of Minutiae

Minutiae matching are strongly dependent on minutiae similarity measure. To determine the similarity of the minutiae we consider three similarities. They are ridge orientation, ridge period descriptor and local minutiae structure. For a faster and accurate matching the region around the minutiae is tessellated into number of sectors according to local polar coordinates. The region is divided into  $R \times K$  sectors where  $R$  is the number of concentric circles

and  $K$  is the number of radial lines. The lines are formed such that they are equally spaced starting from the minutiae.

### 3.2 Initial Mated Minutiae Pair Selection

Minutiae pairs are selected and are used as seeds to search for the correspondence of minutiae with the palm print. With the mated minutiae pairs as reference the alignment of the latent is changed such that it matches with the alignment of minutiae pairs in the palm print. We compute the similarity for both weak and strong. The correspondence for the initial minutiae need not be one to one.

### 3.3 Match Propagation

For the match propagation we consider the query minutiae and the template minutiae. The minutiae pairs are pushed to the stack and we use a *matchstruct* function to check whether it matches with the templates. During match propagation we must consider about two constraints. The first constraint is to determine whether the selected minutiae pair is capable of serving as a reference with which the matches can be computed. The second constraint is to ensure the range up to which the distortions can be tolerated.

## 4. MATCH SCORE COMPUTATION

The initial minutiae pair that is selected can lead to a number of similar matches because of the local compatibility nature. From the false matches that are generated we need to choose the best match that could give us the accurate match. For this reason we go for the match score computation that could provide the detail of how well the minutiae from the query palm print matches with the template palm print image. When the first minutiae pair from the query palm print matches with the full palm print, the alignment of the query palm print is modified such that the minutiae pair is aligned exactly in correspondence with the minutiae pair in the full palm print image. The next pair of minutiae is then selected and checked for the correspondence with the template image. If the minutiae correspondence fails to match for more than 5 pairs the template palm print image is considered not to be matched and the next palm print image is selected for the match score computation process.

We compute three types of similarities such as 1) Ridge density map similarity 2) Orientation field similarity and 3) Average minutiae similarity.

## 5. CONCLUSIONS

The latent to full palm print matching that we have proposed is an efficient and robust algorithm and can also be applied for full to full palm print matching. As palm prints contain large number of minutiae we use minutiae clustering algorithm which groups minutiae into several clusters based on the local minutiae features. By this clustering mechanism the space of search can be greatly reduced. Minutiae match propagation ensures that the false conclusions on matching can be eliminated. The experimental results show that the computational complexity is much less. This algorithm can also be used for full to full palm print matching. Also by using this algorithm we don't require a rigid alignment of the palm prints.

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