Palmprint Recognition

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Palm print

Palm Patterns are utilized in many applications:

1. To correlate palm patterns with medical disorders, e.g. genetic disorders and Downs syndromes, to detect genetic abnormality.
2. “Fortune telling" in the Chinese culture: indication of the past and future based on the patterns.
3. It is believed that palm print is unique to individuals. They remain unchanged throughout at least a certain period during the adult life of an individual.

Palm print

We shall discuss these papers concentrating on the following aspects:

Acquisition- what kind of device is used and the type of "raw" information acquired.

Feature extraction- representational information

Matching Scheme- the invariant/discriminatory information. Which similarity/distance measure are used as matching score.

Performance of proposed system- in verification mode or identification mode.

Advantages and Limitations- of the proposed approaches.

Palmprint-Features

A PalmPrint consists of

Principal lines:- the heart line, the life line and the head line.

Regions: finger-root (I), inside region (II) and outside region (III)

Datum points:- end-points across the palm and their mid-point.

Other features:

Geometry features:-width of the palm, length of the palm and the area of the palm.

Wrinkle features:–these are lines other than the principal lines. They tend to be thinner and more irregular. They are classifieds as coarse wrinkles and fine wrinkles.

Delta point features:–these are defined as the center of a delta-like region in the palm print.

Minutiae features:–similar to finger print type of features.

Palmprint-Features

In general, the geometry features, principal line features and wrinkle features can be determined by some image processing techniques from the image.

Datum point determination: to locate the endpoints of each principal lines.

Properties of the principal lines:

- Each principal line meets the side of the palm at approx. right angle when it flows out of the palm;
- The life line is located at the inside part of the palm which gradually inclines to the inside of the palm in parallel at the beginning;
- Most of the life line and the head line flow out of the palm at the same point
- The endpoints are closer to the fingers than the wrist.

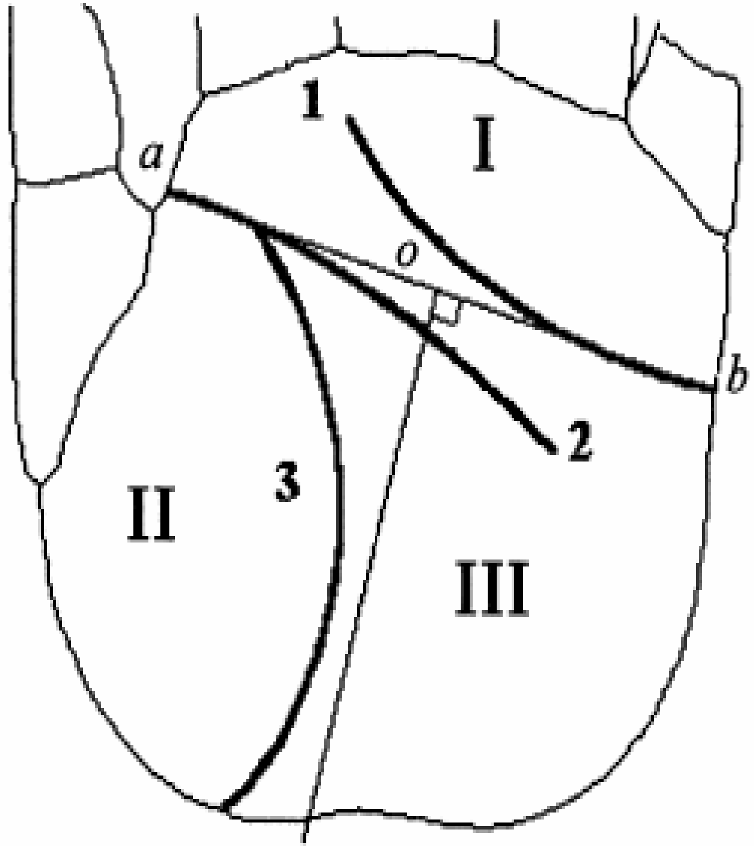


Fig. 1. Definitions of a palmprint: principal lines (1—heart line, 2—head line and 3—life line), regions (I—finger-root region, II—inside region and III—outside region) and datum points (a, b-endpoint, o-their midpoint).

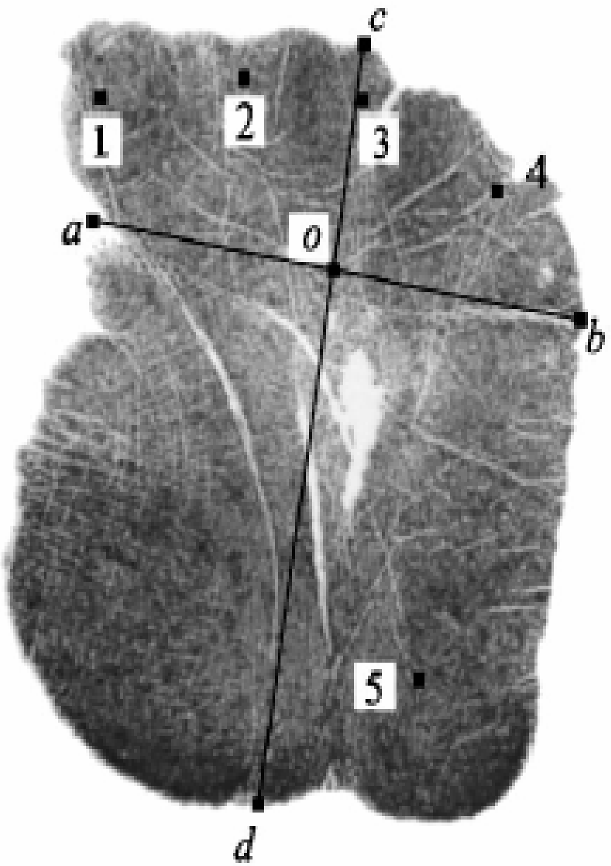
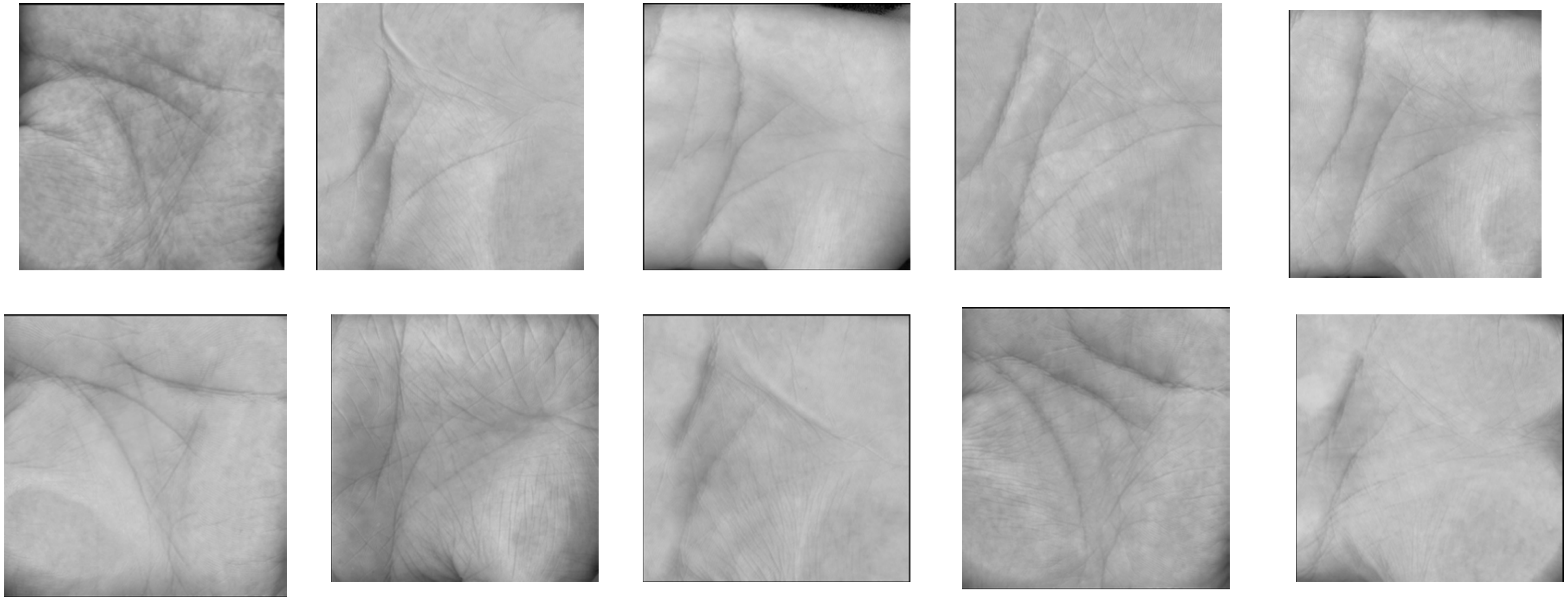
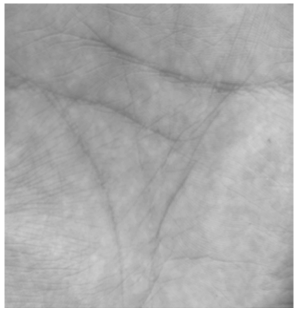
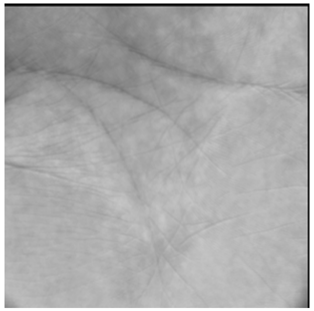


Fig. 2. Geometry features and delta point features of a palmprint, where c–d is the perpendicular bisector of segment a–b and points 1–5 are delta points.

Palmprint–Features







Types of features:

Pixel intensity

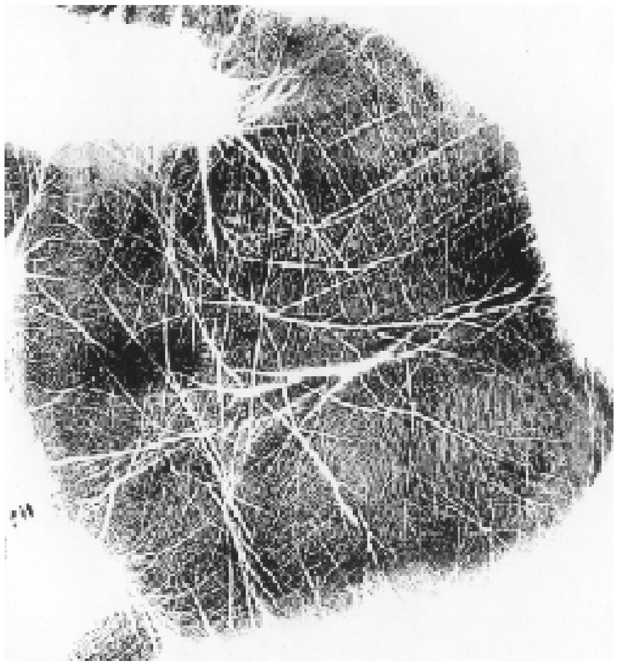
Direction or location of lines

Palmprint-Acquisition

Offline:

- Inked palm images
- Scanned into 400x400, 256 gray levels at 100 or 200 dpi (low resolution)
- Area of the palm (Region of interest) is “cropped” manually.
- Examples:

  Figure



Inked palm Image

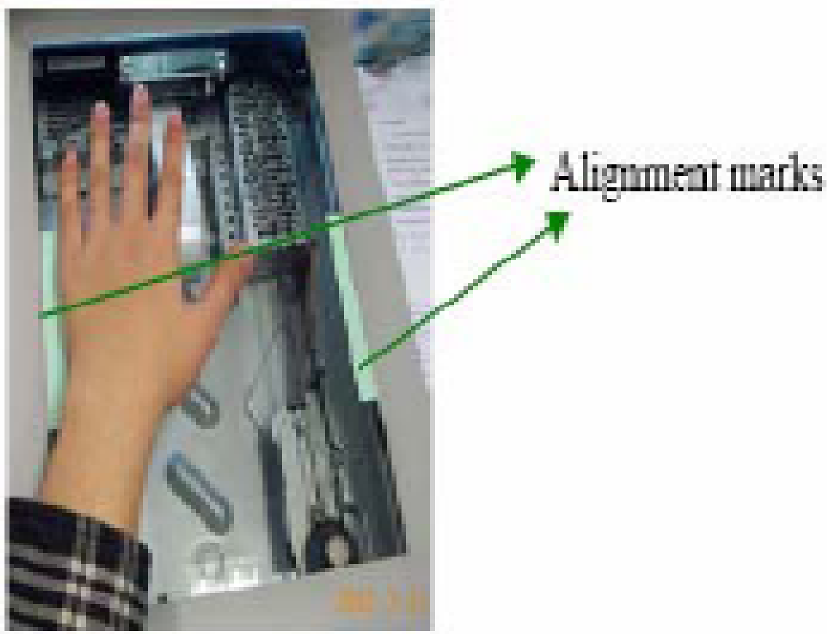
Palmprint–Acquisition

Online:

Directly from the scanner

•can be of high resolution

•slow



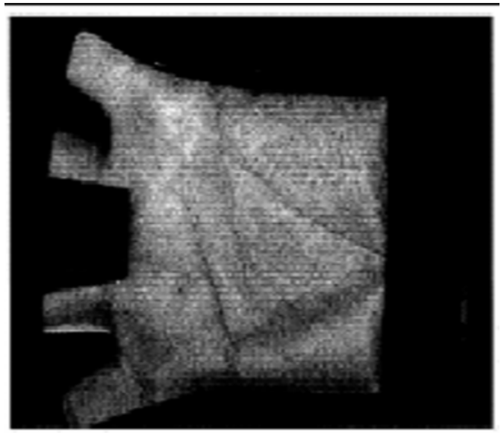
Palmprint–Acquisition

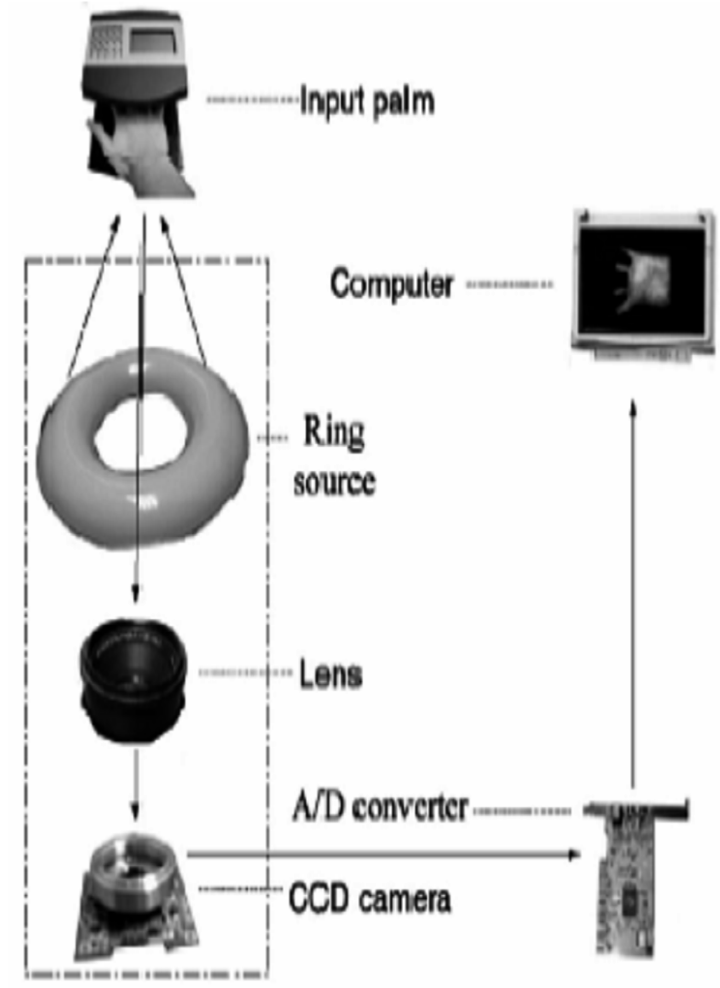
Online:

- Digital camera
- no contact
- full hand image is captured

Online Palm print Image Acquisition

- Digital camera
- 3 pegs to fix hand placement
- Image captured:
  Only the palm area





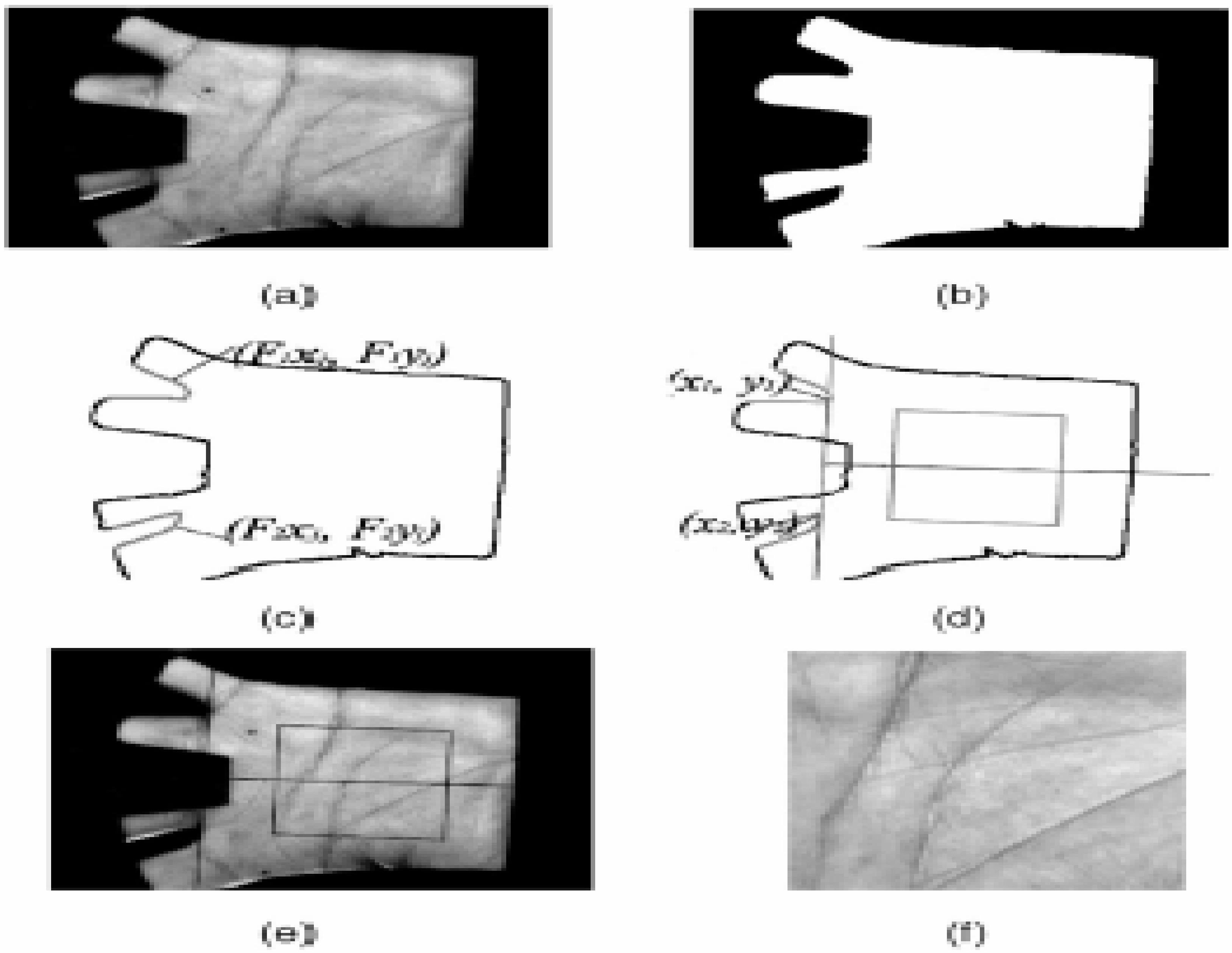


Fig. 3. The main steps of preprocessing. (a) Original image, (b) binary image, (c) boundary tracking, (d) building a coordinate system, (e) extracting the central part as a subimage, and (f) preprocessed

Feature Extraction Methods

- Elimination of creases
- Discrete finger and palm print extraction
- Gabor filter

Elimination of creases

- When fingerprint feature extraction methods are applied to palm prints, the orientation detection becomes a major problem.

- This is a new method for minutiae extraction method in palm print.

- The local properties of creases and ridges in palm prints resemble each other ,and so a feature extraction method for palm prints needs to have the ability to distinguish creases and ridges by their global properties.

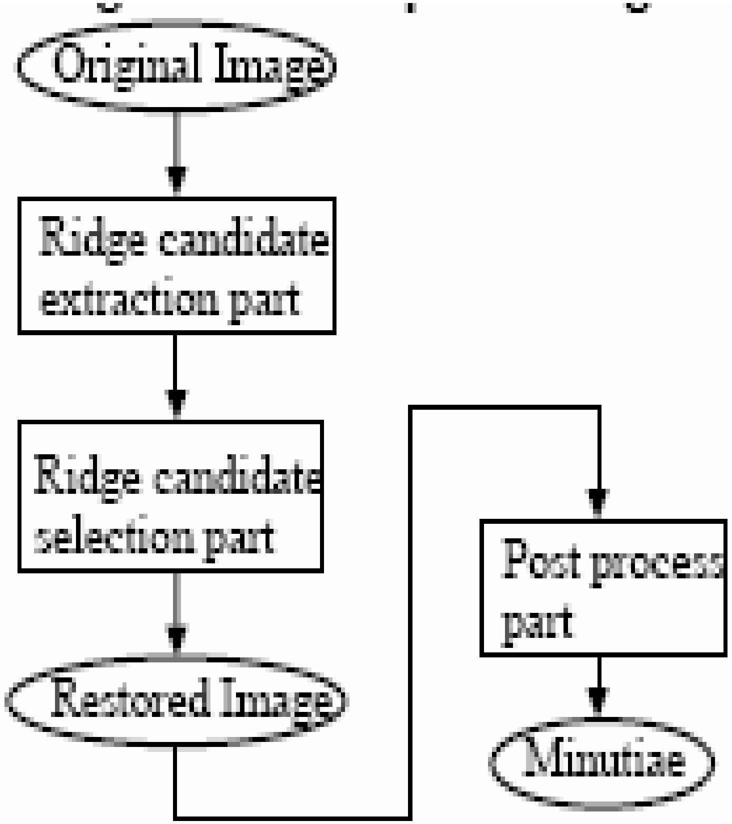


Figure 2. Block diagram of new method

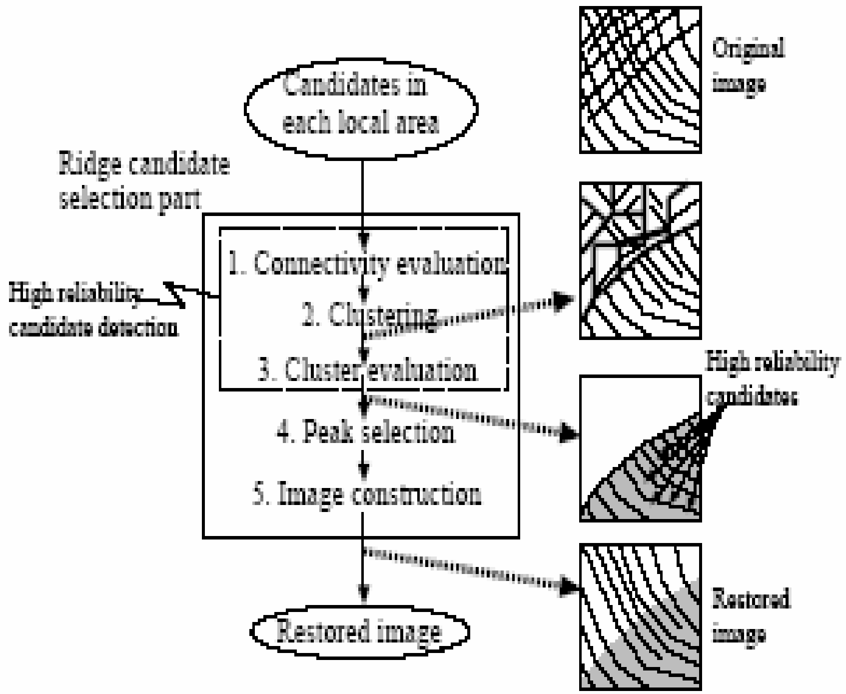


Figure 5. Block diagram of ridge candidate selection part

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- In the ridge candidate extraction part , the image is divided into small local area images, and several ridge candidates are detected by using only local information in each local area. These include both ridges and creases.
- Next, in the ridge candidate selection part, the candidates which represent the ridges are selected in each local area by using global information such as the continuity.
- An image is then constructed by the candidates which are selected in each of the local areas. This restored image does not have noise or creases.
- Then in the post process part, the image is binarized, thinned, checked for correct ability as the thinned image, and repaired.
- Finally minutiae are extracted from the thinned image.

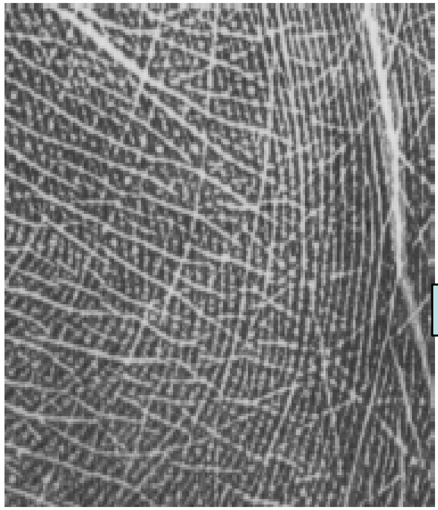

Figure 1. Palmprint image

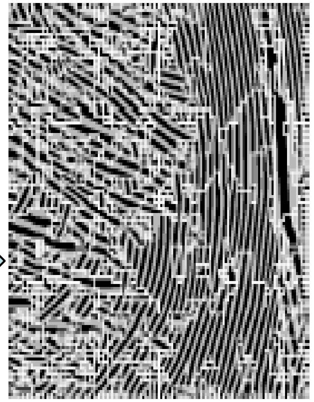

Figure 6. Restored image constructed from 1st candidates and connectivity evaluation result

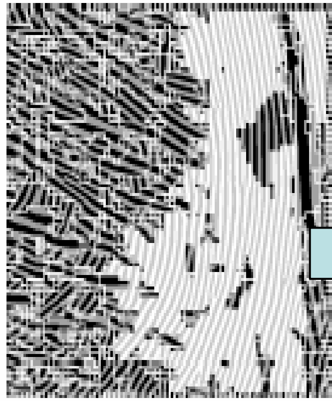

Figure 7. Restored image constructed from 1st candidates and cluster estimation result

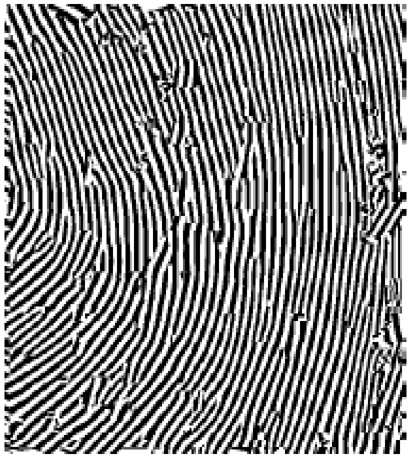

Figure 8. Restored image constructed by the selected candidates

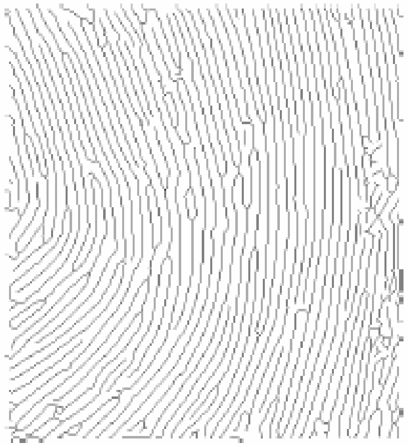

Figure 9. Thinned image obtained with proposed method

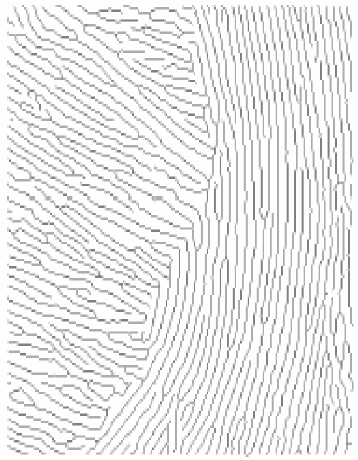

Figure 10. Thinned image obtained with a method for fingerprints[3]

Advantage

- Good method compared to the finger print feature extraction methods.

Disadvantage

- More processing time.

Discrete finger and palm print extraction

- The image acquisition of a palm gives data for both the palm geometry and the major palm creases for the feature extraction simultaneously.
- In the method feature of the palm print discrete points determined in relation to the finger geometry are extracted without using the pattern processing of the palm print.
- This makes the palm print feature extraction simple and accelerates the real-time result to within one second or so.

Proposed feature extraction is basically from anatomy of the finger and palm

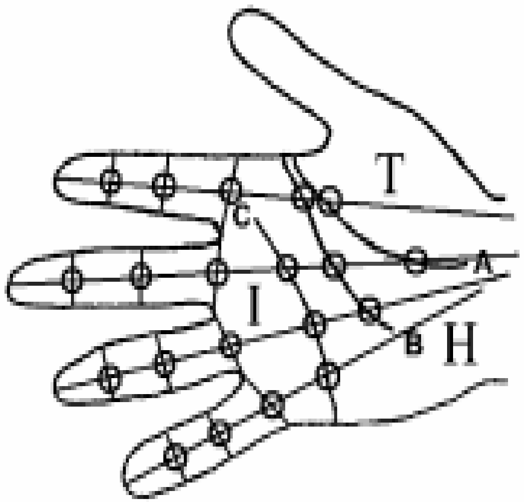

Fig. 1. Intersection points with circles. A: Thenar crease (line of life); B: Proximal transverse crease (line of head). C: Distal transverse crease (line of heart); I: Interdigital area; T: Thenar area. H: Hypothenar area.

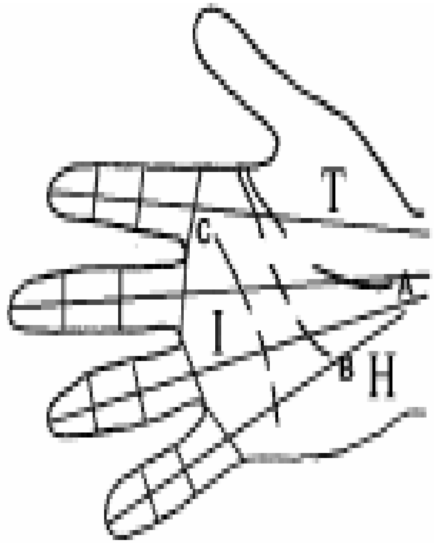

Fig. 2. Illustration of the tangential line segments at the intersection points on the palm. Palmar creases may be reconstructed by tracing these tangential line segments.

Finger Spreading and Skeletal Lines

Fig. 7. Comparison of each finger skeletal line when fingers are spread apart (white lines) and wider apart (black lines).

Feature Points

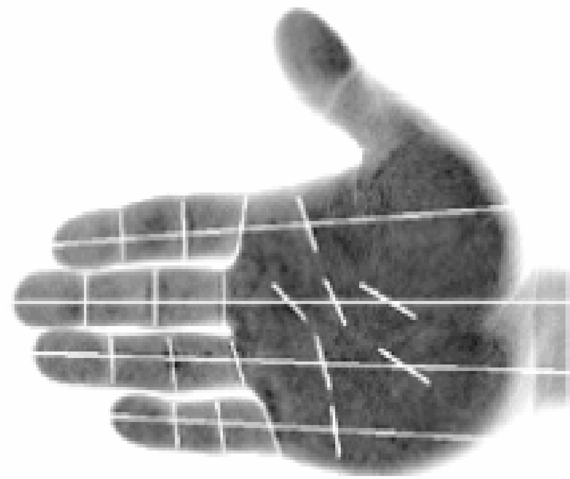

Fig. 5. Orientations at the intersection points in Fig. 3.

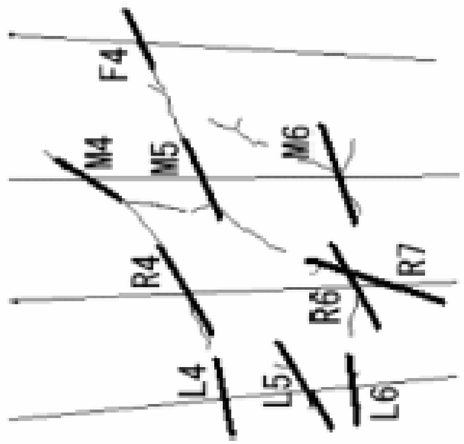

Fig. 8. Examples of detected orientations at the intersection points. F: the forefinger; M: the middle finger; R: the ring finger; L: the little finger.

Advantages

- Short processing time.
- High resolution is not required.
- Not sensitive to noise.

Disadvantages

- Matching is not best performed in case of fingers are widely spread.
- As principle lines may be same it is not that much reliable method.

Gabor filter

- Try to extract texture features from low-resolution palmprint images, and we propose a 2D Gabor phase coding scheme for palmprint.
- The circular Gabor filter is an effective tool for texture analysis [12], and has the following general form:
- where u is the frequency of the sinusoidal wave, controls the orientation of the function, and is the standard deviation of the Gaussian envelope

$$G(x, y, \theta, u, \sigma) = \frac{1}{2\pi\sigma^2} \exp\left\{-\frac{x^2 + y^2}{2\sigma^2}\right\} \exp\{2\pi i(ux\cos\theta + uy\sin\theta)\},$$

- To make it more robust against brightness, a discrete Gabor filter, , is turned to zero DC (direct current) with the application of the following formula:
- where (2n+1)2 is the size of the filter. In fact, the imaginary part of the Gabor filter automatically has zero DC because of odd symmetry. The adjusted Gabor filter is used to filter the preprocessed images.

$$\tilde{G}[x, y, \theta, u, \sigma] = G[x, y, \theta, u, \sigma] - \frac{\sum_{i=-n}^{n} \sum_{j=-n}^{n} G[i, j, \theta, u, \sigma]}{(2n+1)^2},$$

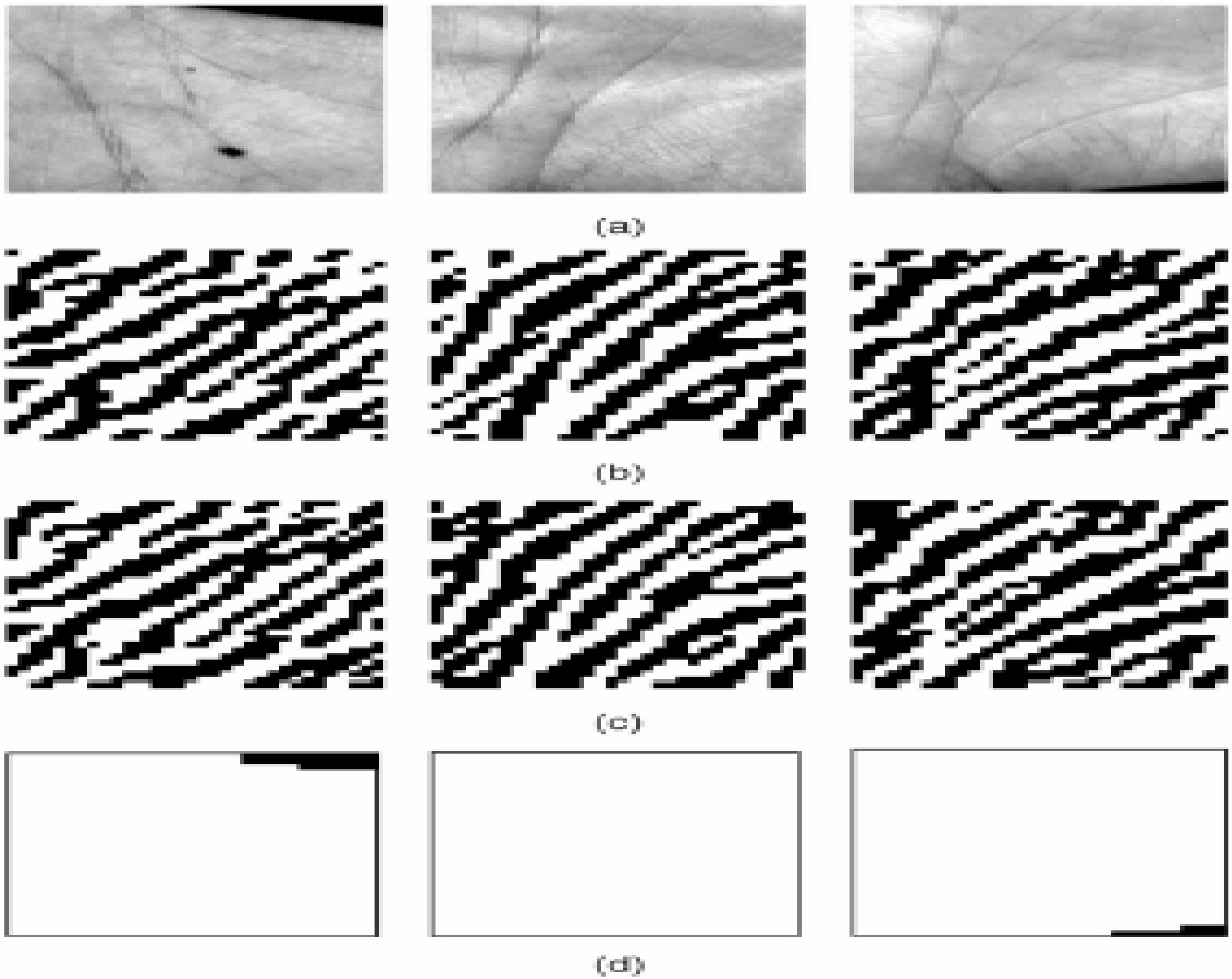

Fig. 7. Feature features obtained by 2D Gabor filtering. (a) Preprocessed images, (b) real parts of texture images, (c) imaginary parts of texture features, and (d) the corresponding masks.

Advantages

- Low resolution images are enough.
- Cheap

Disadvantages

- More processing time

Palmprint–Matching Scheme

1. EUCLIDEAN DISTANCE
2. HAMMING DISTANCE
3. HAUSDORFF DISTANCE
4. FEATURE MATCHING USING SKELETAL LINES

Palmprint–Matching Scheme

Matching –**Euclidean distances**

$$d_1 = \sqrt{((x_1(n_1) - x_1(n_2))^2 + ((y_1(n_1) - y_1(n_2))^2}$$
$$d_2 = \sqrt{((x_2(n_1) - x_2(n_2))^2 + ((y_2(n_1) - y_2(n_2))^2}$$

$$\varphi = |\alpha(n_1) - \alpha(n_2)|$$
$$\delta = |intercept(n_1) - intercept(n_2)|$$

- if both *d*1 and *d*2 are less than some threshold *D*, then it clearly indicates that two line segments are same;

Palmprint–Matching Scheme

- while two line segments overlap, they are regarded as one line segment if the midpoint of one line segment is between two endpoints of another line.

- verification function, *r*, is defined as

$$r = 2N / (N1 + N2)$$

  where *N* is the number of these corresponding pairs; *N1* and *N2* are the numbers of the line segments determined from two palmprint images, respectively

- In principle, it shows that two images are from one palm if *r* is more than some threshold *T.*

Palmprint–Matching Scheme

Normalized Hamming distance:--

degree of similarity between data sets.

Let P and Q be two palm feature vectors. The normalized hamming distance can be described as

$$D_o = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} P_M(i,j)\cap Q_M(i,j)\cap(P_R(i,j)\otimes Q_R(i,j)) + P_M(i,j)\cap Q_M(i,j)\cap(P_I(i,j)\otimes Q_I(i,j))}{2\sum_{i=1}^{N}\sum_{j=1}^{N} P_M(i,j)\cap Q_M(i,j)};$$

where PR,QR; PI,QI, and PM,QMare the real part, the imaginary part and the mask of P,Q, respectively.

Palmprint–Matching Scheme

•HAUSDORFF DISTANCE

Hausdorff distance (HD) is the ***'haximum*** distance ***of a set too the nearest point*** *in* ***the other set*** ".

Distance from set A to set B is **a *maxim in*** function, defined **as**

$$H(A,B) = \max\{h(A,B),\ h(B,A)\}$$

Line Segment Hausdorff Distance (LHD)

The **LHD** extends the concept to two sets of line segments, LHD is built on the distance ***(d(m,r))*** between two line segments ***M*** and ***t,*** which is defined as

$$d(m,t) = \sqrt{d_{\theta}^{2}(m,t) + d_{\parallel}^{2}(m,t) + d_{\perp}^{2}(m,t)}$$

Palmprint–Matching Scheme

In the above equation, ***do*** is defined in as

$$d_\theta(m,t) = \min(l_m, l_t) \times \sin(\theta(m,t)).$$

Where, ***l,*** and ***i,*** denote the lengths of ***m*** and t, and $\theta(m,t)$

represents the smallest interesting angle between ***m*** and ***i.***

Curve Segment Hausdorff Distance (CHD)

CHD measures the dissimilarity between two shapes based on the distances between two sets of curve segments .

Palmprint–Matching Scheme

FEATURE MATCHING USING SKELETAL LINES

A mesh is proposed and constructed by connecting laterally the corresponding intersection points on the adjacent skeletal lines.

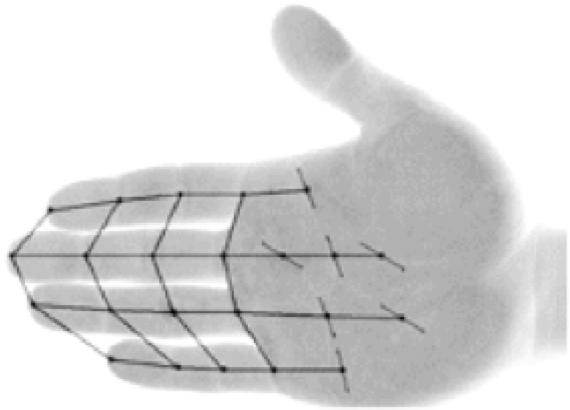

Fig. 9. Palm image with the mesh.

Palmprint–Matching Scheme

All the widths and lengths are personal and are combined with the oriented palmar intersection points. “Small in number but enough features” is summarized in this mesh.

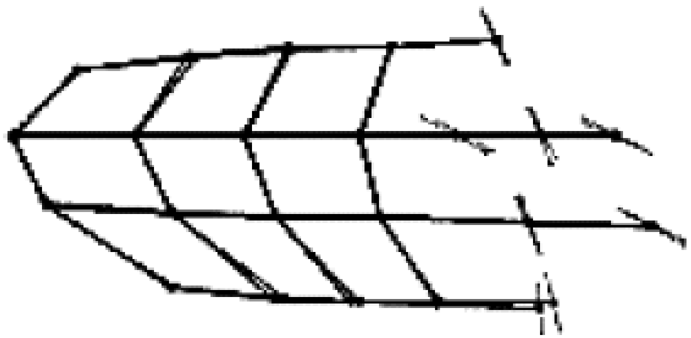

Fig. 10. Comparison of the enrolled and the new of the same palm.

In the figure, an intersection point of the line of heart and the little finger skeletal line slightly deviates, though all other points coincide

Palmprint–Matching Scheme

This is caused by a palm image variation due to the palm bending, though all the fingers are brought together.

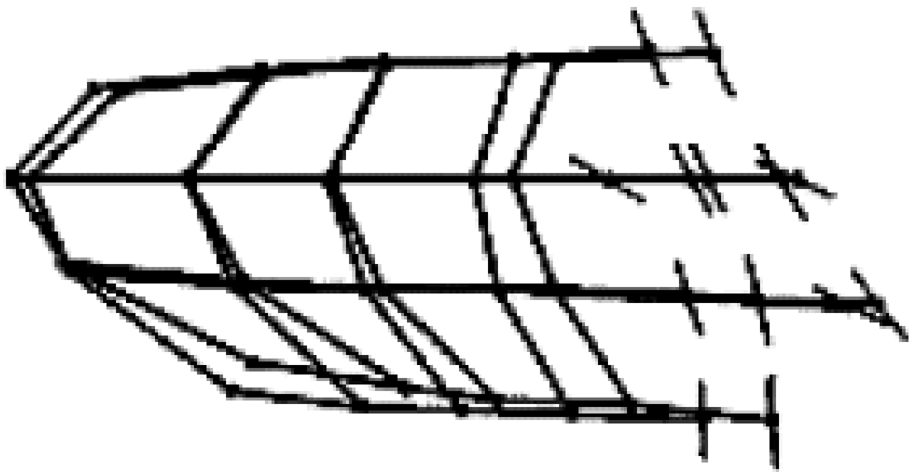

Fig. 11. Comparison of meshes for different palms.

The mesh deviation between the two, for example in Fig. 11, is evaluated by calculating the root mean square deviation (rmsd) value.

Palmprint–Matching Scheme

The matching metric used here is a parameter which is given as,

$$rmsd = (\Sigma \delta i^2 / N)^{1/2} \text{ where, } \delta i$$

is the positional difference at each mesh point and N is the total number of the mesh points to be compared.

The magnitude of the difference is measured in pixels and thereafter normalized by the parameters of the finger length and the palm width

Palmprint–Matching Scheme

Estimation and Correction of Palm Bending

Fig. 12. Front and side views of a palm.

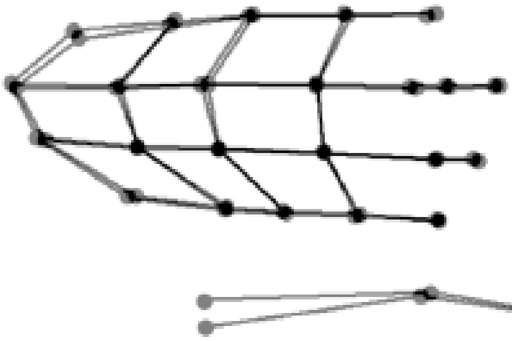

Fig. 13. Mesh deviation due to hand bending.

Palmprint–Matching Scheme

Rings and Mesh Points

Fig. 14. Palm images with rings.

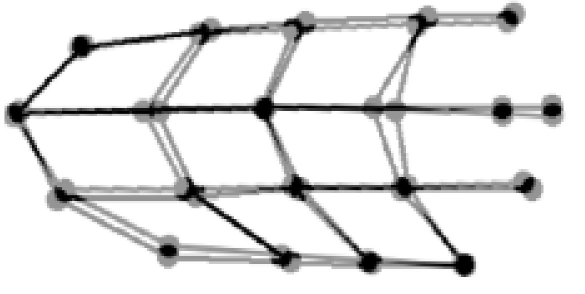

Fig. 15. Mesh deviation due to rings of the same palm.

References

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- Discrete Finger and Palmar Feature Extraction for Personal Authentication by Junta Doi*, Member, IEEE,* and Masaaki Yamanaka
- Online Palmprint Identification by David Zhang, Senior Member, IEEE, Wai-Kin Kong, Member, IEEE,Jane You, Member, IEEE, and Michael Wong
- Two novel characteristics in palmprint veriÞcation: datum point invariance and line feature matching by Dapeng Zhang*, Wei Shu

THANK YOU