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(71) Applicant *(for all designated States except US)*: **THE HONG KONG POLYTECHNIC UNIVERSITY** [CN/CN]; Hung Hom, Kowloon, Hong Kong (CN).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **ZHANG, Dapeng, David** [CN/CN]; C/o The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (CN). **NIU, Xuan** [CN/CN]; C/o The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (CN). **LU, Guang, Ming** [CN/CN]; C/o The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (CN). **KONG, Wai-Kin, Adams** [CN/CN]; C/o The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (CN). **WONG, Keung, Ming** [CN/CN]; C/o The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (CN).

(74) Agent: **CHINA SCIENCE PATENT & TRADEMARK AGENT LTD.**; 15/F., Bldg., B., Tsinghua Tongfang Hi-Tech Plaza, No.1 Wangzhuang Rd., Haidian District, Beijing 100083 (CN).

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(54) Title: METHOD AND APPARATUS FOR PALMPRINT IDENTIFICATION

(57) Abstract: A method of palmprint identification includes analyzing an area from an image of a palm to obtain texture data for the skin surface with the area. The texture data is compared to reference information in a database to determine the identity of an individual. An apparatus for capturing an image of a palm includes an enclosure with a window in it, and an image sensor and light source disposed within the enclosure and arranged to capture an image through the window. Protuberances are provided on the surface. The protuberances are arranged to be in known juxtaposition to a hand suitably placed on the window for capture of an image that includes the palm area of the hand.

Method and Apparatus for Palmprint Identification

Background to the Invention

1. Field of the Invention

The invention relates to biometrics identification, and in particular to a method for analyzing a palmprint for the identification of an individual. The invention also relates to apparatus for capturing a palmprint image for the identification of an individual.

2. Background Information

Using palmprint recognition as a method for personal identification is a new biometrics technology replacing fingerprints. Known methods include analyzing a palmprint to identify singular points, minutiae, and wrinkles in a palmprint image. These known methods require a high-resolution image as illustrated in Figure 1. This can be obtained by way of inked palmprints. However, these are messy and cannot be obtained passively for real-time identification.

To overcome the problem of inked palmprints some companies have developed high-resolution palmprint scanners and identification systems. However, these devices capturing high-resolution images are costly and rely on high performance computers to fulfil the requirements of real-time identification.

One solution to the above problems seems to be the use of low-resolution images. Figure 2 illustrates low-resolution images corresponding to Figure 1. In low-resolution palmprint images, however, singular points and minutiae cannot be observed easily therefore more easily identifiable wrinkles must play an important role in the identification. It is noted from Figure 2 however, that only a small proportion of wrinkles are significantly clear, but it is questionable whether they provide sufficient distinctiveness to reliably identify individuals amongst a large population.

Summary of the Invention

It is an object of the present invention to provide a method of biometrics identification, and in particular a method for analyzing a palmprint for the identification of an individual, which overcomes or ameliorates problems with prior art methods. It is a further object of the present invention to provide an apparatus for capturing a palmprint image, which overcomes or ameliorates disadvantages with prior art apparatus or at least which provides the public with a useful alternative.

According to a first aspect of the invention there is provided a method of biometrics identification including:

obtaining an image of an area of skin surface from an individual,

analyzing the image to extract texture features on the area of skin surface, and

comparing the texture features with reference information in a database.

According to a second aspect of the invention there is provided a method of biometrics identification including:

obtaining an image of a portion of an inner surface of a hand of an individual,

obtaining a sub-image of skin surface within a defined area of the inner surface of the hand,

analyzing the sub-image to obtain texture data for the skin surface, and

comparing the texture data with reference information in a database.

Preferably, the defined area is dependent on one or more characteristics of the hand.

Preferably, the one or more characteristics are the areas between fingers of the hand.

Preferably, the sub-image is obtained by steps including:

identifying at least two points representing the areas between fingers of the hand,

determining a coordinate system having a first and a second axis, wherein the two points are located on the first axis and are equidistant from the second axis, and

determining parameters of the sub-image within the coordinate system using the distance between the two points.

Preferably, the parameters of the sub-image include points in the coordinate system represented by:

(0.25D, 0.5D), (1.25D, 0.5D), (0.25D, -0.5D)

and (1.25D, -0.5D)

where D is the distance between the two points.

Preferably, there is a further step of normalizing the sub-image.

Preferably, analyzing the sub-image includes using a Gabor Filter.

Preferably, analyzing the sub-image includes segmenting layers of the sub-image with low resolution using Gabor analysis.

Preferably, the sub-image is segmented into two parts, a real part and an imaginary part, each part being stored as a vector.

Preferably, comparing the texture data with reference information in the database is based on a hamming distance of the form:

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

where P_R (Q_R) and P_I (Q_I) are the real part and the imaginary part.

According to a third aspect of the invention there is provided a palmprint image capture apparatus including:

an enclosure with a window in it,

an image sensor disposed within the enclosure and arranged to capture an image through the window,

a light source disposed to illuminate the window, and

at least one protuberance adjacent the window, wherein the protuberance(s) is/are arranged to be in known juxtaposition to a hand suitably placed on the window for capture of an image that includes the palm area of the hand.

According to a forth aspect of the invention there is provided a palmprint image capture apparatus including:

an enclosure having a window in it,

an image sensor disposed within the enclosure and arranged to capture an image through the window,

a light source disposed to illuminate the window,

a controller operable to control the image sensor and light source for capturing an image, and

at least one protuberance, wherein the protuberance(s) is/are arranged to be in known juxtaposition to a hand suitably placed on the window for capture of an image that includes the palm area of the hand.

Preferably, the protuberances are pegs or pins disposed to be between the two or more fingers of the hand suitably placed on the window.

Preferably, the light source is an annulus with the image sensor at its center.

Preferably, the image sensor is a Charged-Coupled Device (CCD) or Complementary Metal Oxide Semiconductor (CMOS) sensor.

Further aspects of the invention will become apparent from the following description, which is given by way of example only.

Brief Description of the Drawings

Embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates typical high-resolution palmprints images,

Figure 2 illustrates typical low-resolution palmprints images,

Figures 3 to 8 illustrate preprocessing of an image of the inside of a hand,

Figures 9 and 10 illustrate incorrect placement of a hand on a palm reader and the corresponding preprocessed image,

Figures 11 to 14 illustrate the preprocessed image, real and imaginary parts and the masks.

Figures 15 and 16 illustrate the difference in image quality between first and second collected images,

Figures 17 and 18 show verification test results for a method according to the invention,

Figure 19 illustrates a schematic of a palmprint image capture device according to invention,

Figure 20 is a plan view of the image capture surface of the device,

Figure 21 is a sectional view through A-A' of Figure 19, where a CCD camera is revolved by the circle light, and

Figure 22 illustrates a raw palm image captured by the apparatus.

Description of the Preferred Embodiments

A method of palmprint identification according to the invention comprises three parts: 1) obtaining an image of the palmprint of an individual, 2) analyzing the skin texture data from the image and 3) matching the skin texture data with information stored in a database. These steps are described in more detail below.

1) Obtaining an image of the palmprint of an individual

Referring to Figure 3, a low-resolution image of a portion the inside surface of a hand is obtained in known manner using a CCD camera. In order to extract identification data from the image a repeatable sub-image of the palm area must be identified using characteristics of the hand. In the preferred embodiment the holes between fingers are identified and used as the parameters to build a coordinate system in which parameters that define the sub-image can be found. The preferred embodiment has six main steps, which are given below.

Referring to Figure 4, the first step is to apply a lowpass filter, $L(u,v)$, such as Gaussian, to the original image, $O(x,y)$. Then, a threshold, T_p, is used to convert the convoluted image to a binary image, $B(x,y)$.

Referring to Figure 5 the second step is to obtain the boundaries of the holes, (F_ix_j, F_iy_j): *where* $i=1, 2$, between the fingers using a boundary tracking algorithm. The boundary of the hole between ring and middle fingers is not extracted since it is not useful for the following processing.

Referring to Figure 6, the third step is to compute the tangent of the holes $(F_i x_j, F_i y_j)$. If (x_1, y_1) and (x_2, y_2) are two points on $(F_1 x_j, F_1 y_j)$ and $(F_2 x_j, F_2 y_j)$, respectively the line (y = mx + c) passing through these two points satisfies the inequality, $F_i y_j$ $mF_i x_j + C$, for all i and j. The line (y = mx + c) is the tangent of the two holes. This line, represented by numeral 2 in Figure 6, is the Y-axis of the coordinate system for determining the location of the sub-image 1.

The fourth step is to find a line 3 passing through the midpoint of the two points that is perpendicular to line 2 to determine the X-axis and origin of the coordinate system. The two points lie on the Y-axis, equidistant from the X-axis.

The fifth step is to extract a sub-image 1 with a dynamic size on the basis of the coordinate system. The size and location of the sub-image 1 are based on the Euclidean distance (D) between the two points (x_1, y_1) and (x_2, y_2). The points 4, 5, 6, 7 representing the corners of the sub-image 1 in the coordinate system are (0.25D, 0.5D), (1.25D, 0.5D), (0.25D, -0.5D) and (1.25D, -0.5D) respectively. Thus the sub-image 1 is square with a distance along each side equal to the Euclidean distance and symmetrical about the Y-axis line 3. Because the sub-image is based on feature of the hand (the area between the fingers) it is repeatable for each individual hand.

Figure 7 shows the x and y axes 2, 3 of the coordinate system and the sub-image 1 overlaid on the raw image of Figure 3.

The sixth step is to extract and normalize the sub-image 1 to a standard size using bilinear interpolation for feature extraction. Figure 8 shows the extracted and normalized sub-image 1.

Once the palm sub-image 1 is obtained the next part of the method is undertaken.

2) Analyzing the skin texture of the image

The circular Gabor filter is an effective tool for texture analysis, and has the following general form,

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

where $i=\sqrt{-1}$; u is the frequency of the sinusoidal wave; θ controls the orientation of the function and σ is the standard deviation of the Gaussian envelope. Gabor filters are widely used in texture analysis and thus the skilled addressee will be familiar with their use for such purpose.

In order to make the texture analysis more robust to variations in image brightness a discrete Gabor filter $G[x, y, \theta, u, \sigma]$ is turned to zero DC with the application of the following formula:

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

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 use of the adjusted Gabor filter is to filter the preprocessed images. Then, the phase information is coded by the following inequalities,

$$b_r = 1 \quad if \quad \mathrm{Re}\left(\sum_{y=-n}^{n}\sum_{x=-n}^{n} \tilde{G}[x,y,\theta,u,\sigma] I(x+x_o, y+y_o)\right) \geq 0, \quad (3)$$

$$b_r = 0 \quad if \quad \mathrm{Re}\left(\sum_{y=-n}^{n}\sum_{x=-n}^{n} \tilde{G}[x,y,\theta,u,\sigma] I(x+x_o, y+y_o)\right) < 0, \quad (4)$$

$$b_i = 1 \quad if \quad \mathrm{Im}\left(\sum_{y=-n}^{n}\sum_{x=-n}^{n} \tilde{G}[x,y,\theta,u,\sigma] I(x+x_o, y+y_o)\right) \geq 0, \quad (5)$$

$$b_i = 0 \quad if \quad \mathrm{Im}\left(\sum_{y=-n}^{n}\sum_{x=-n}^{n} \tilde{G}[x,y,\theta,u,\sigma] I(x+x_o, y+y_o)\right) < 0, \quad (6)$$

where $I(x, y)$ is a preprocessed image and (x_0, y_0) is center of filtering.

Referring to Figures 9 and 10, since it is expected that some users will not place their hand correctly some non-palmprint pixels will be contain in the palm sub-image. A mask is generated to point out the location of the non-palmprint pixels. Because the image source can be considered a semi-closed environment, the non-palmprint pixels come from the black boundaries of the image background. Thus a threshold can be used to segment the non-palmprint pixels. Typically, feature size including mask and palmprint features is 384 bytes.

Figures 11 depict the preprocessed images, 12 depict the real part of the corresponding texture features, 13 depict the imaginary part of the corresponding texture features, and Figure 14 depicts the corresponding masks.

A useful discussion on the use of Gabor filters for texture analysis can be found in the following two publications. *A. Jain and G. Healey, "A multiscale representation including opponent color features for texture recognition", IEEE Transactions on Image Processing, vol. 7, no. 1, pp. 124-128, 1998*. And, *D. Dunn and W.E. Higgins, "Optimal Gabor filters for texture segmentation," IEEE Transactions on Image Processing, vol. 4, no. 4, pp. 947-964, 1995.*

3) Palmprint Matching

The real and imaginary features are represented as vectors, which are compared to vectors of stored palmprint data. Palmprint matching is based on a normalized hamming distance. For example, let P and Q be two palmprint feature matrixes. The normalized hamming distance can be described as,

$$D_o = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} P_M(i,j) \cap Q_M(i,j)\left((P_R(i,j) \otimes Q_R(i,j) + P_I(i,j) \otimes Q_I(i,j))\right)}{2\sum_{i=1}^{N}\sum_{j=1}^{N} P_M(i,j) \cap Q_M(i,j)}, \quad (7)$$

where P_R (Q_R), P_I (Q_I) and $P_M(Q_M)$ are the real part, the imaginary part and mask of P (Q), respectively; the result of Boolean operator, "$\otimes$", is equal to zero if and only if the two bits, $P_{R(I)}(i,j)$, equal to $Q_{R(I)}(i,j)$; $\cap$ represents an AND operator and the size of the feature matrixes is $N \times N$. It is noted that D_o is between 1 and 0. For prefect matching, the matching score is zero. Because of imperfect preprocessing, the features need to be vertically and horizontally translated and then matched again. Then, the range of vertical and horizontal translation is -2 to 2. The minimum of D_0's obtained by translated matching is considered as the final matching score.

The following experimental results illustrate the effectiveness of a system according to the invention.

Palmprint images were collected from 154 subjects using a palmprint scanner. Approximately 65% of the subjects were male. The age distribution of the subjects is shown in the following Table 1.

Ranges of Ages	Percentage
10-20	2%
21-30	80%
31-40	12%
41-50	3
51-60	2%
61-70	1%

Each subject provided two groups of images. Each group contained 10 images for the left palm and 10 images for the right palm. Totally, each subject provided 40 images to create an image database containing 6191 images from 308 different palms. The average time difference between the collection of the first and second groups of image from each subject was 57 days. The maximum and minimum time differences were 90 and 4 days respectively. After finishing the first collection, the light source was changed and the focus adjusted on the CCD camera so as to simulate image collection by two different palmprint scanners. Figure 15 and 16 show corresponding hand images captured in the first and second groups for one subject. The collected images were in two sizes, 384×284 and 768×568. The larger images were resized to 384×284; consequently, the size of all the test images in the following experiments is 384×284 with 75dpi resolution.

To obtain the verification accuracy of the palmprint system, each palmprint image was matched with all palmprint images in the database. A matching was noted as a correct matching of two palmprint images from the same palm of the same subject. The total number of comparisons was 19,161,145. The number of correct matches was 59,176.

A probability distributions for genuine and imposter are estimated by the correct and incorrect matching, respectively, is shown in Figure 17. Figure 18 depicts the corresponding Receiver Operating Curve (ROC), being a plot of genuine acceptance rate against false acceptance rate for all possible operating points. From Figure 18 it is estimated that a method according to the invention can operate at 96% genuine acceptance rate and 0.1% false acceptance rate; the corresponding threshold is 0.35. This result is comparable with prior art palmprint approaches and other hand-based biometrics technologies including hand geometry and fingerprint verification.

A method according to the invention utilizes low-resolution images and has low-computational cost. The verification accuracy is found to be comparable with known high-performance methods using high-resolution images.

The method can be used for access control, ATM and various security systems.

Figures 19 and 10 illustrate a palmprint image capture apparatus according to the invention. The apparatus includes a housing 1 with a flat top surface 2 on which a hand is placed, palm down, for the capture of the palmprint image. The surface 2 is opaque with a window 8 through which the image is captured. In the preferred embodiment the window 8 contains a glass panel. In alternative embodiments the window 8 may contain other transparent coverings, a lens or nothing (i.e. an open window).

An image sensor such as a charge coupled device (CCD) 4 is mounted within housing 1. A lens 5 is screwed on the CCD. The aperture of the lens 5 is orientated towards window 8 in surface 2.

An annular light source 6 is mounted around the lens 5 to illuminate an image in window 8. Mounting arms 7 support the annular light source 6 and screws 9 are used to mount the CCD firmly on the mounting arms 7. A palmprint image can be formed through this optical plane from lens 5 to CCD 4, then the digitized imagery data are transferred to an external processor such as a personal computer (not shown) for processing and manipulating.

Referring to figure 21, a plan view of the lens 5 and light source 6 through section A-A′ of Figure 19 is shown. The lens 5 is at the centre of the annular light source 6. The lens 5 is mounted on the top of the CCD 4.

Adjacent window 8 in surface 2 are a plurality of protuberances in the form of pegs 3 which are used to correctly position a hand on surface 2 with the palm area over the window 8. In use, a person places their hand on the surface 2 to locate pegs 3 between the fingers and thumb of the hand. This ensures that the hand is placed correctly on the apparatus for the capture of the optimal area of the palm through window 8.

Figure 22 shows an image of the target palm area captured through window 8. It is apparent that using an opaque surface 2 with a target window 8 ensures that the area of interest from the palm can be obtained accordingly. This image is acquired from CCD 4 by the personal computer for further processing.

A palmprint obtained by the apparatus is suitable for use in biometrics identification. The features and characteristics of the palmprint can be obtained and then compared to the database record to identify an individual. A number of techniques can be used to determine the characteristics of the palm in the image. One suitable technique is texture analysis. Texture analysis is suitable because it gives a high level of accuracy on low-resolution images.

The described embodiment uses a CCD image sensor. In an alternative embodiment a Complementary Metal Oxide Semiconductor (CMOS) sensor is used. The CMOS sensor yields lower resolution at a lower cost. However, this is ameliorated if texture analysis is used.

In the preferred embodiment the protuberances adjacent the window 8 are pegs 3. In an alternative embodiment the surface 2 with window 8 is made with a depression or concavity into which the hand can be placed palm down.

The apparatus can be used to capture an image for use in the method described.

Where in the foregoing description reference has been made to integers or elements having known equivalents then such are included as if individually set forth herein.

Embodiments of the invention have been described, however it is understood that variations, improvements or modifications can take place without departure from the spirit of the invention or scope of the appended claims.

What Is Claimed Is:

1. A method of biometrics identification including:

obtaining an image of an area of skin surface from an individual,

analyzing the image to extract texture features on the area of skin surface, and

comparing the texture features with reference information in a database.

2. A method of biometrics identification including:

obtaining an image of a portion of an inner surface of a hand of an individual,

obtaining a sub-image of skin surface within a defined area of the inner surface of the hand,

analyzing the sub-image to obtain texture data for the skin surface, and

comparing the texture data with reference information in a database.

3. The method of claim 2 wherein the defined area is dependent on one or more characteristics of the hand.

4. The method of claims 2 or 3 wherein the one or more characteristics are the areas between fingers of the hand.

5. The method of any preceding claim wherein the sub-image is obtained by steps including:

identifying at least two points representing the areas between fingers of the hand,

determining a coordinate system having a first and a second axis, wherein the two points are located on the first axis and are equidistant from the second axis, and

determining parameters of the sub-image within the coordinate system using the distance between the two points.

6. The method of claim 5 wherein the parameters of the sub-image include points in the coordinate system represented by:

(0.25D, 0.5D), (1.25D, 0.5D), (0.25D, -0.5D) and (1.25D, -0.5D)

where D is the distance between the two points.

7. The method of claim 5 or 6 including a further step of normalizing the sub-image.

8. The method of any preceding claim wherein analyzing the sub-image includes using a Gabor Filter.

9. The method of any preceding claim wherein analyzing the sub-image includes segmenting layers of the sub-image with low resolution using Gabor analysis.

11. The method of any preceding claim wherein the sub-image is segmented into two parts, a real part and an imaginary part, each part being stored as a vector.

12. The method of claim 11 wherein comparing the texture data with reference information in the database is based on a hamming distance of the form:

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

where P_R (Q_R) and P_I (Q_I) are the real part and the imaginary part.

13. A palmprint image capture apparatus including:

an enclosure with a window in it,

an image sensor disposed within the enclosure and arranged to capture an image through the window,

a light source disposed to illuminate the window, and

at least one protuberance adjacent the window, wherein the protuberance(s) is/are arranged to be in known juxtaposition to a hand suitably placed on the window for capture of an image that includes the palm area of the hand.

14. The apparatus of claim 13 wherein the protuberances are pegs or pins disposed to be between the two or more

fingers of the hand suitably placed on the window.

15. The apparatus of claims 13 or 14 wherein the light source is an annulus with the image sensor at its center.

16. The apparatus of any one of claims 13 to 15 wherein the image sensor is a Charged-Coupled Device (CCD) or Complementary Metal Oxide Semiconductor (CMOS) sensor.

17. A palmprint image capture apparatus including:

an enclosure having a window in it,

an image sensor disposed within the enclosure and arranged to capture an image through the window,

a light source disposed to illuminate the window,

a controller operable to control the image sensor and light source for capturing an image, and

at least one protuberance, wherein the protuberance(s) is/are arranged to be in known juxtaposition to a hand suitably placed on the window for capture of an image that includes the palm area of the hand.

18. The apparatus of claim 17 wherein the protuberances are pegs or pins disposed to be between the two or more fingers of the hand suitably placed on the window.

19. The apparatus of claims 17 or 18 wherein the light

source is an annulus with the image sensor at its center.

20. The apparatus of any one of claims 17 to 19 wherein the image sensor is a Charged-Coupled Device (CCD) or Complementary Metal Oxide Semiconductor (CMOS) sensor.

FIGURE 1

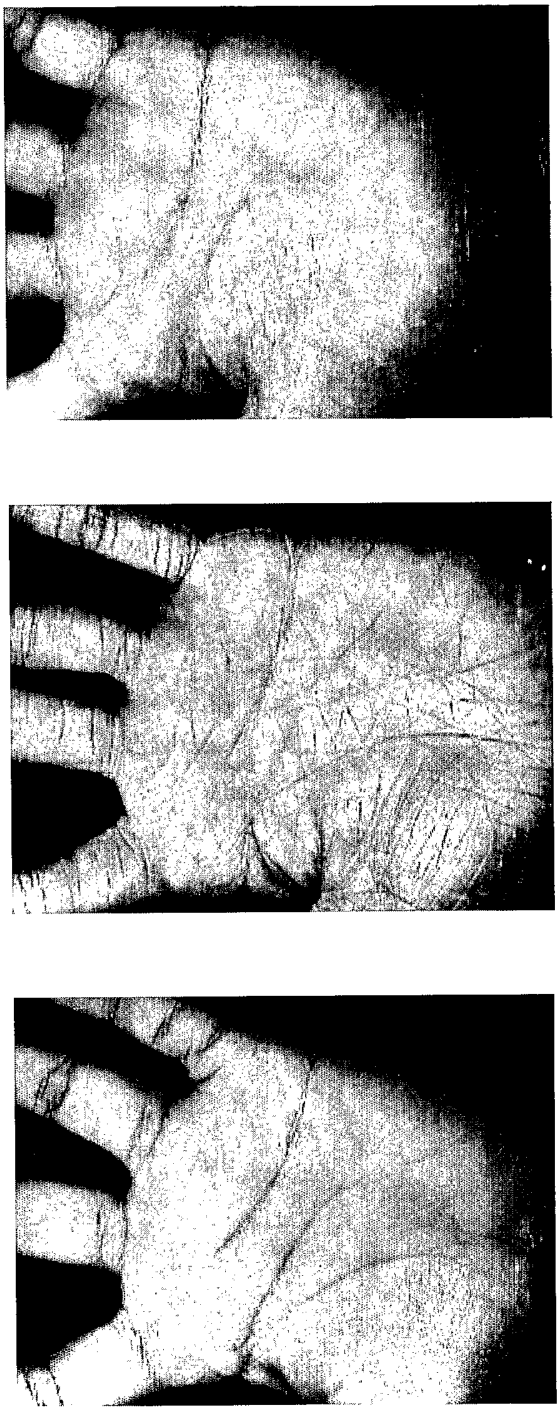

FIGURE 2

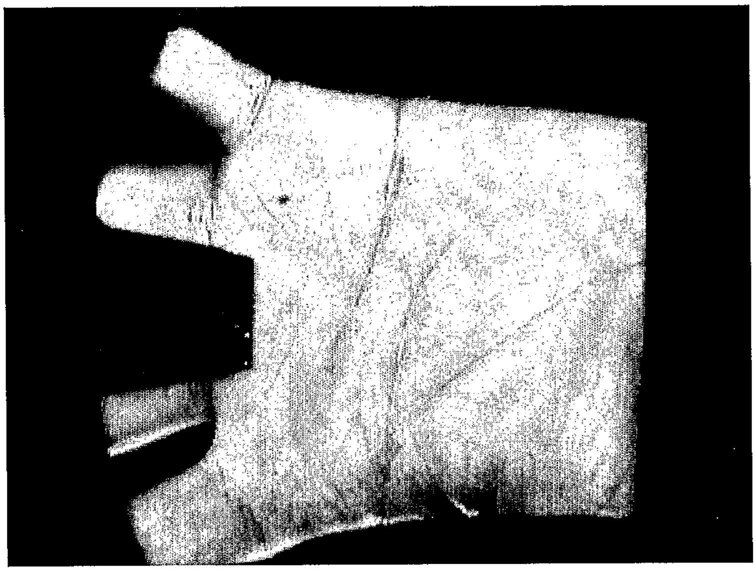

FIGURE 3

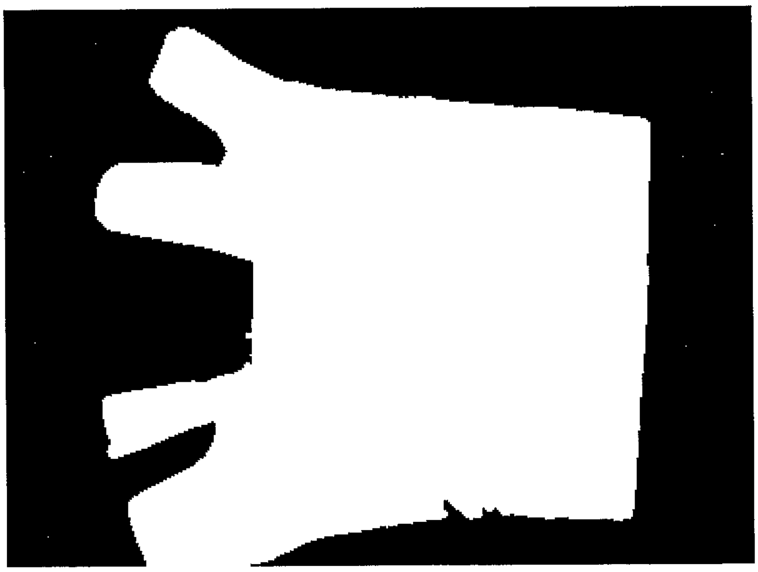

FIGURE 4

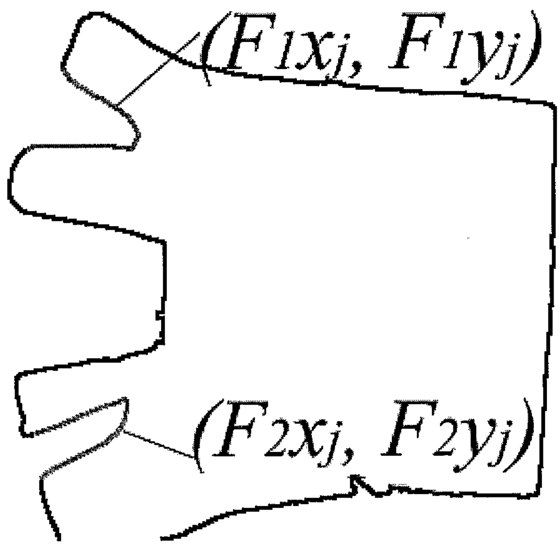

FIGURE 5

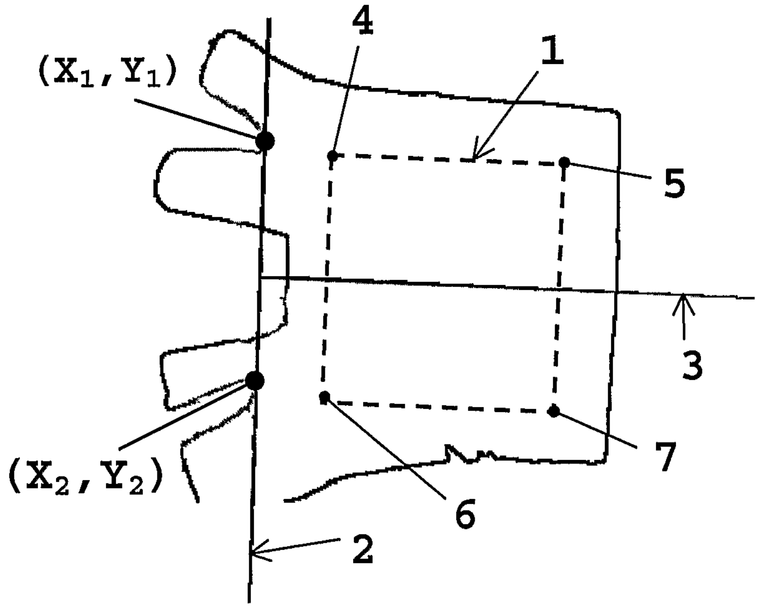

FIGURE 6

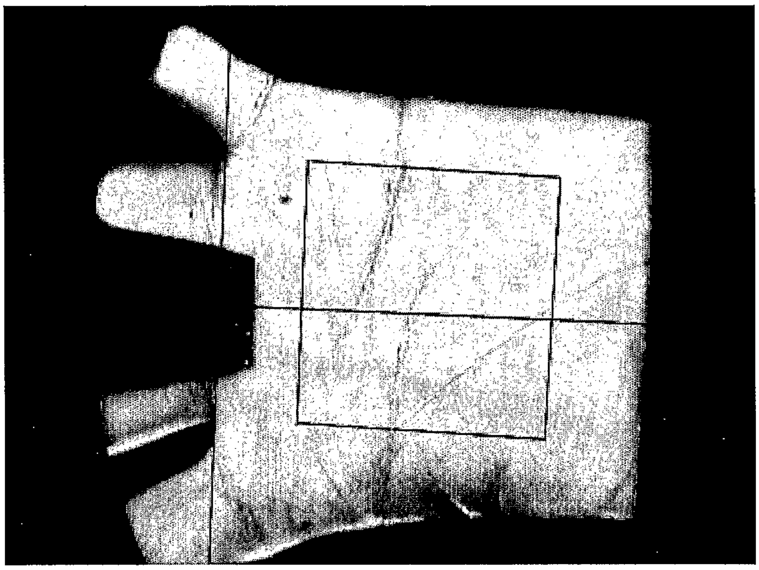

FIGURE 7

FIGURE 8

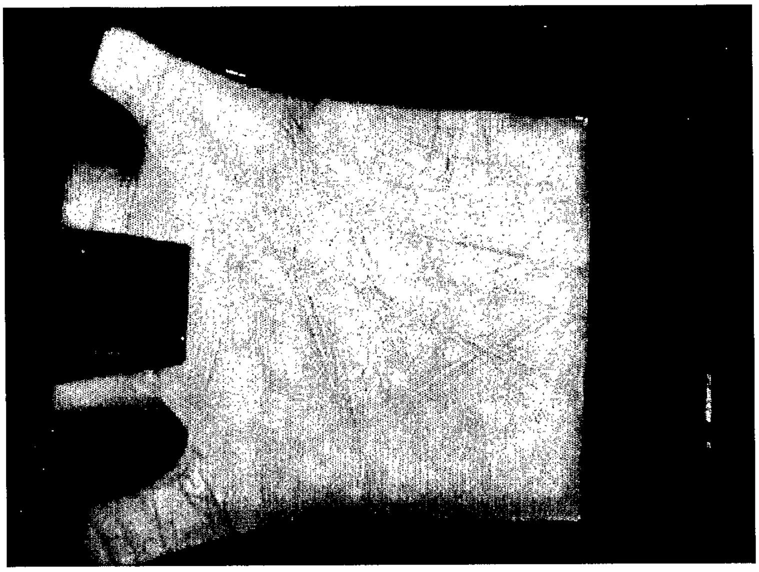

FIGURE 9

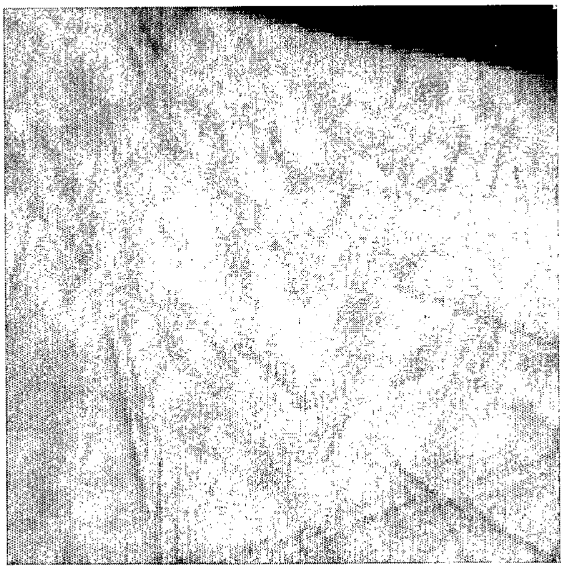

FIGURE 10

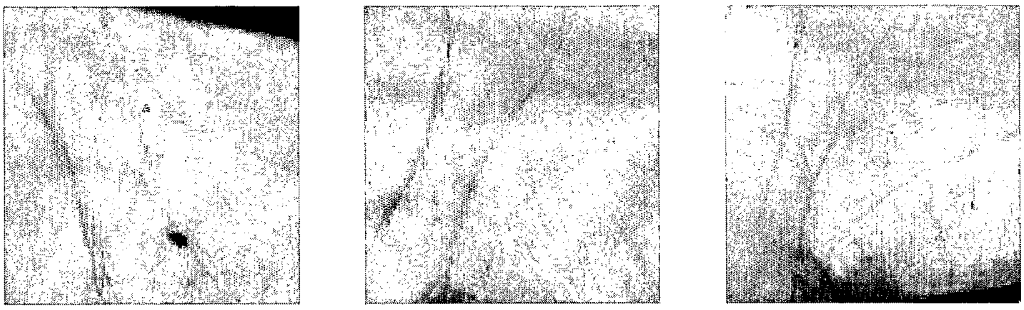

FIGURE 11

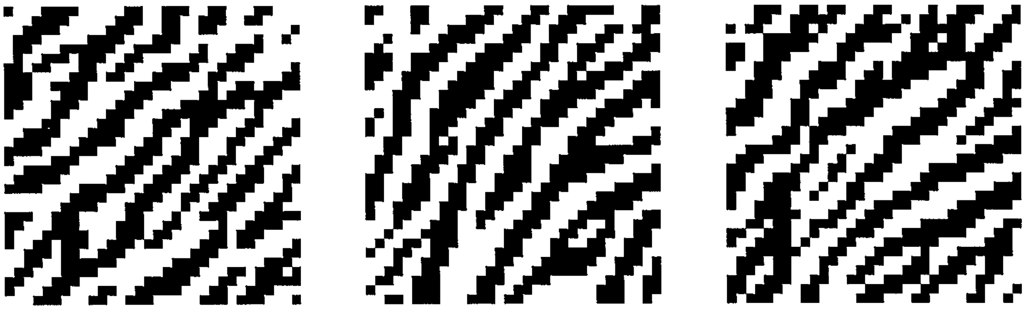

FIGURE 12

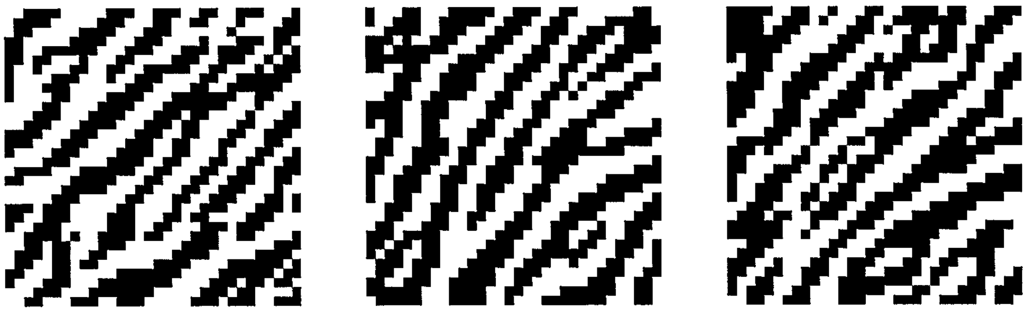

FIGURE 13

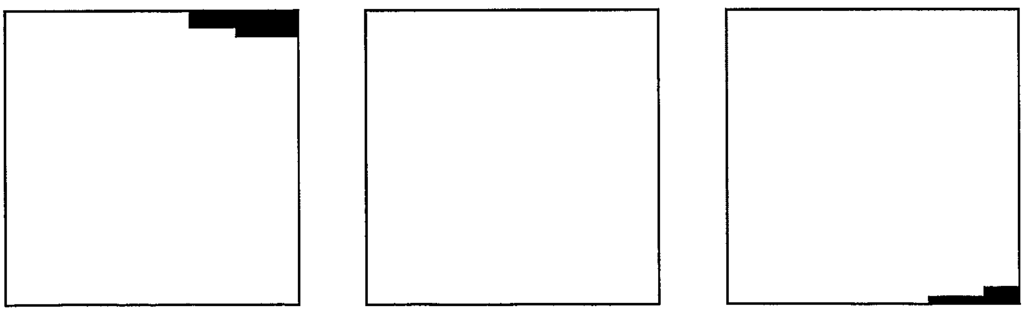

FIGURE 14

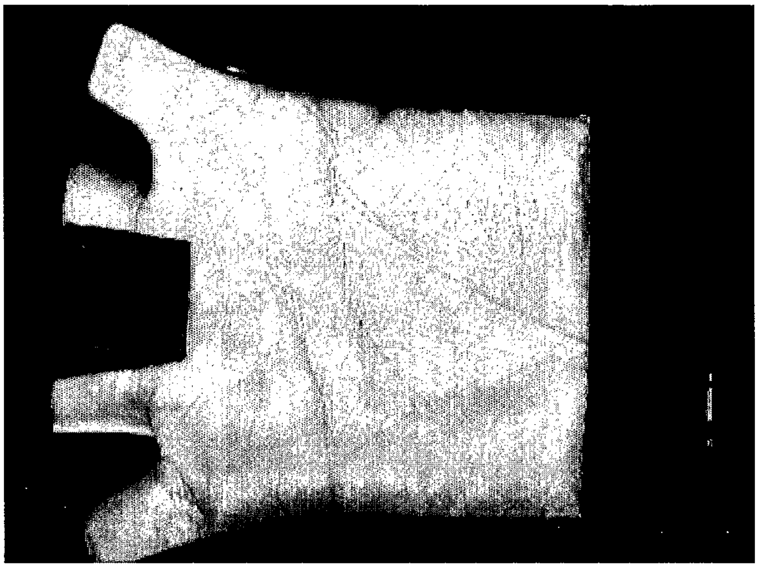

FIGURE 15

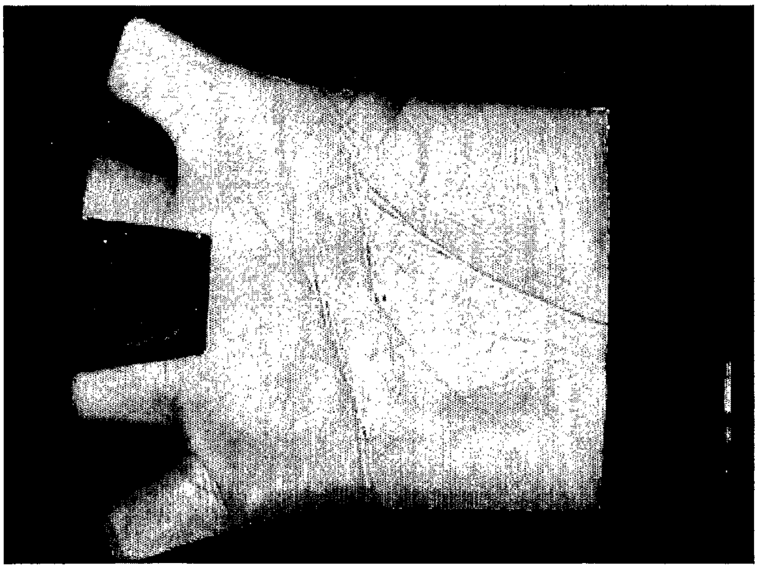

FIGURE 16

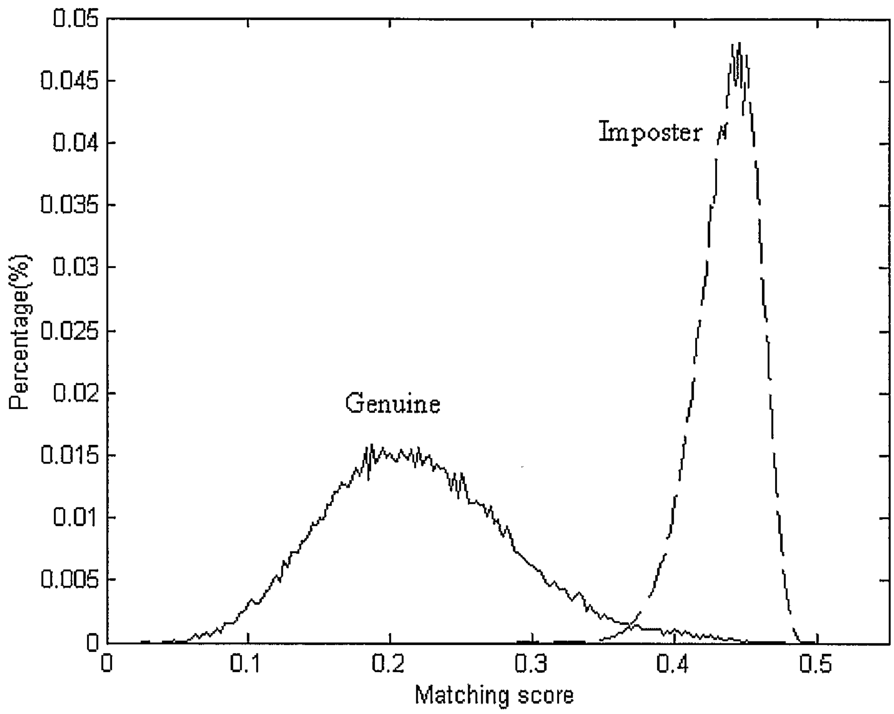

FIGURE 17

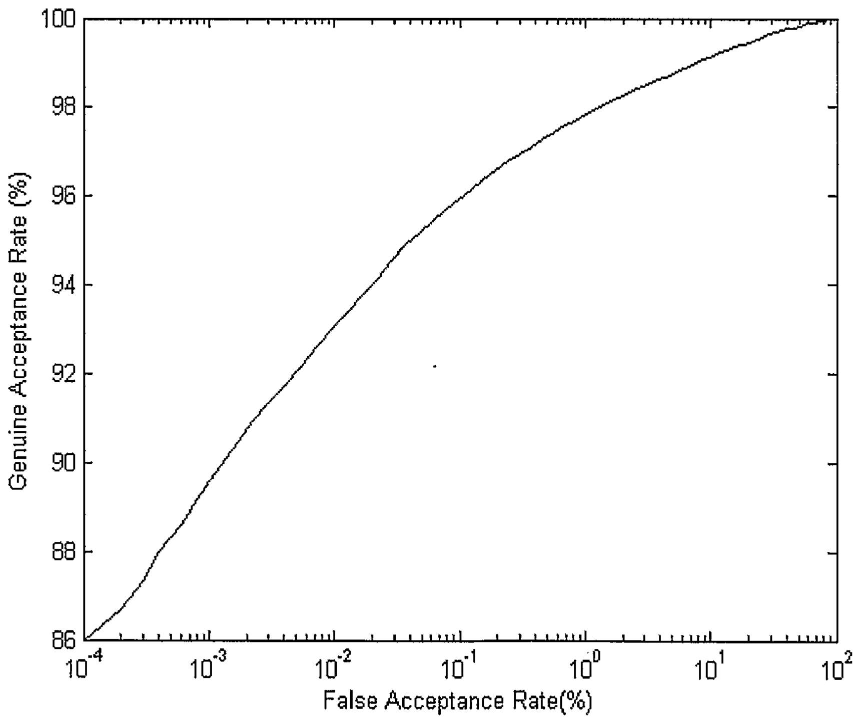

FIGURE 18

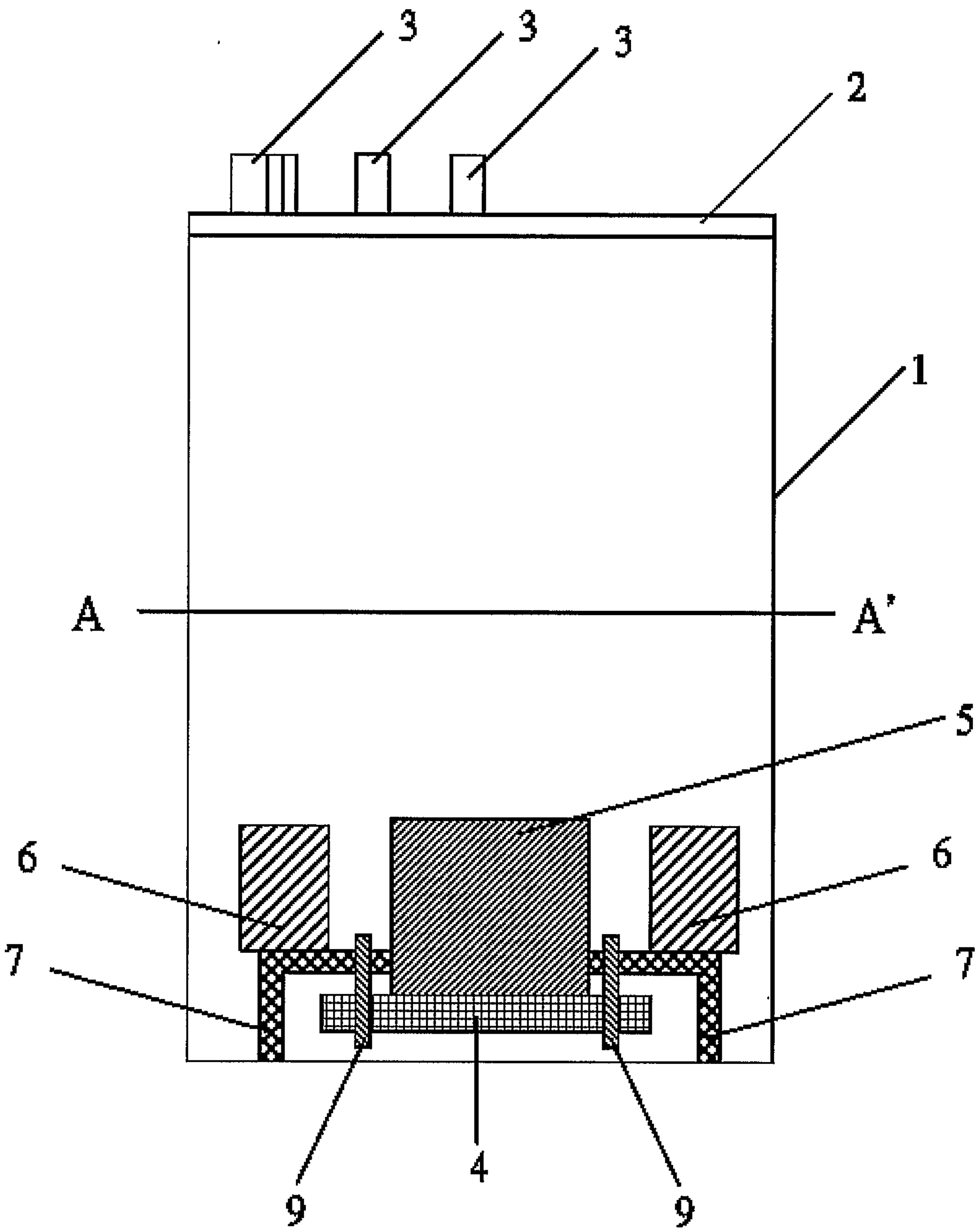

FIGURE 19

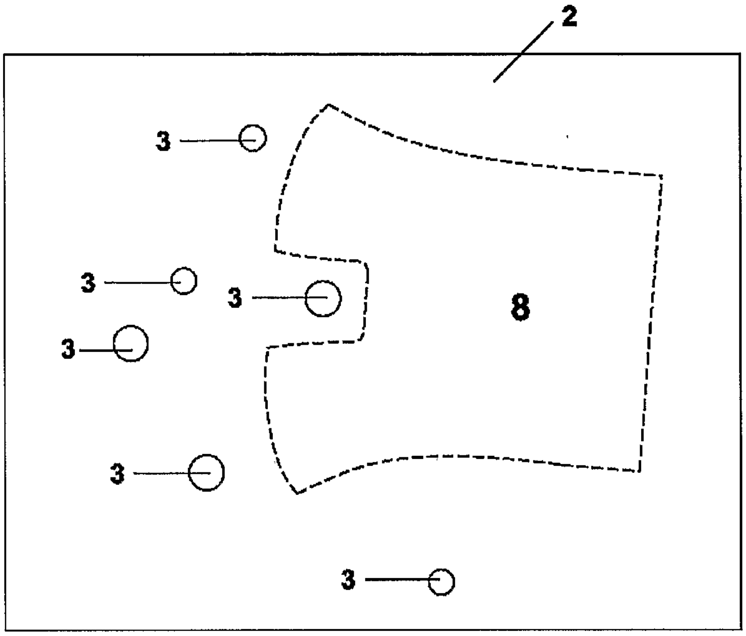

FIGURE 20

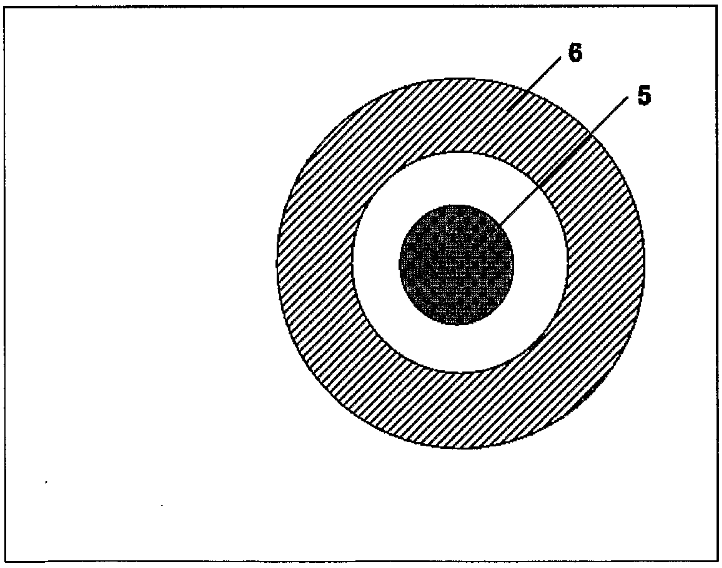

FIGURE 21

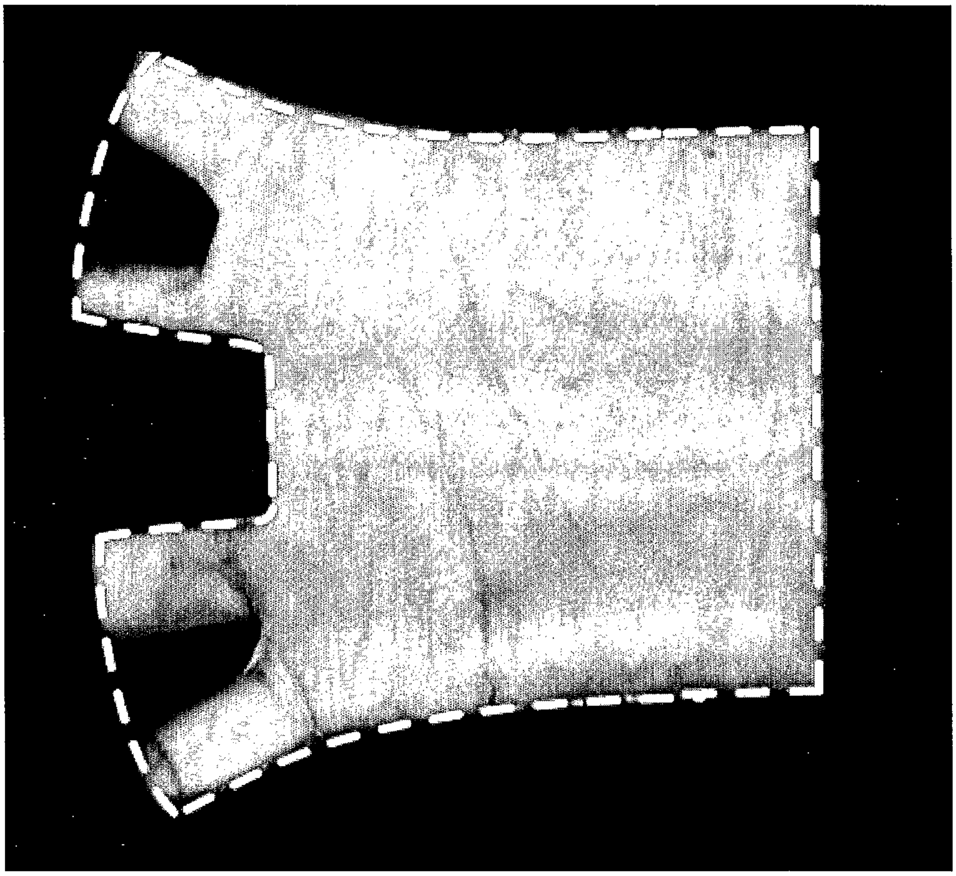

FIGURE 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN03/00816

A. CLASSIFICATION OF SUBJECT MATTER

IPC⁷ G06K 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC⁷ G06K 9/00; IPC⁷ G06K 9/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI EPODOC CNPAT PAJ palmprint; identification; image; finger; extract; compare; texture; fix; peg; pin;
掌纹；识别；图像；手指；提取；比较；纹理；固定；钉

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1223461A （NEC CORP） 21 July 1999 description page3-9，figure 1-7	1-4、
Y		5-8
A		9-12
Y	JP2002269562A （NEC CORP） 20 Sep 2002 page:4-7 ; fig:1-4.8	5-8
A		9-12
X	US5526436A （ASAHI et al） 11 June 1996 col.1-2,6-12; fig:9-11,14a-14b	13-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 27.Oct.2003 (23.10.03)	Date of mailing of the international search report 06 NOV 2003 (06.11.03)
Name and mailing address of the ISA/CN 6 Xitucheng Rd., Jimen Bridge, Haidian District, 100088 Beijing, China Facsimile No. 86-10-62019451	Authorized officer 3611 印 田竞 Telephone No. 86-10-62084976

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN03/00816

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN1223416 A	1999.07.21	CA2258431 C	2002.08.13
		EP0930580 A2	1999.07.21
		JP11203474 A	1999.07.30
		CA2258431 A1	1999.07.14
		SG72916 A1	2000.05.23
		KR99067885 A	1999.08.25
		TW424206 A	2001.03.01
		US6370263 B1	2002.04.09
		KR315279 B	2001.11.28
JP2002269562 A	2002.09.20		
US5526436 A	1996.06.11	DE4421242 A	1994.12.22