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5 **PROCESS OF STORAGE OF BIOMETRIC FEATURES**

The invention generally relates to a method of processing biometric features to reduce electronic storage space required to store the biometric features.

10 The biometric features include but not limited to fingerprint, DNA, iris, retina, tissue and other features unique to an individual. More particularly the invention relates to a method of processing biometric features for electronic storage and to facilitate rapid comparison with a present biometric feature.

15 Various types of biometrics features as fingerprint, iris, and retina are used for identification and verification of individuals. The biometric features are extracted from raw data such as fingerprint images in case of fingerprint, iris images in case of Iris and retinal images for retina based biometrics identification and authentication systems.

20 The extraction of biometric features from the raw data is carried out using feature extraction algorithm as disclosed in prior art.

The biometric features contain individualistic characteristics of the biometrics raw data that is used for verification. For example, in case of fingerprint the information on the
25 individual characteristics of the fingerprint image includes, but is not limited to:

- (i) core points;
- (ii) ridge join points; and
- (iii) ridge line ending points

30 The individual characteristics of the features have unique individual properties such as:

- (i) direction;
- (ii) —angle; and
- (iii) relativity and other features

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5 The above listed properties and the characteristics are applicable for fingerprint. But in case verification using the retina, the characteristics include but are not limited to:

- (i) optical nerve core;
- (ii) ecudate density; and
- (iii) optical disc – eye ratio

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As stated for the biometrics types above, the characteristics vary for different types of biometrics and the extraction and recognition of the characteristics are disclosed in prior art documents.

15 The characteristics and their respective properties biometrics are referred in this description as “biometrics data”. The biometrics data must be able to be stored electronically into a database and also be retrievable when required, for identification and verification.

20 The storage of the biometrics data in its form requires around 200 bytes or above. This storage space requirement will not be a constraint for limited number of biometrics data. However for large number of biometrics data the 200 bytes or above requirement is a huge space requirement. For example for 100,000 individuals the minimum quantity of bytes required is $200 \times 100,000 = 20,000,000$ bytes.

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This storage space requirement is also a constraint in embedded environment where the biometrics technology is intended to be used such as smart card, and other prior art technologies as the space available for storage is limited.

30 It should be highlighted that compression technology and other prior art technologies that is commonly used cannot be used in this environment, as they are not efficient with small amount of data such as 200 bytes. This is because the header information defining the compressed data used during decompression is above 200 bytes; as a result the resultant compressed data will be above 200 bytes.

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5 The Lossy compression technique commonly used in graphical environments such as JPEG compression cannot be used for storage of biometrics data as any loss of data will impact the verification and identification performance.

10 One of the reasons the compression algorithm is not usable with biometrics data is that the compression is designed for generic data and based on the distribution of bytes within the content. The biometrics data is packed information of data structures used by the biometrics verification and identification algorithm wherein the bytes distribution is already compact.

15 The packed information includes but is not limited to information describing the biometrics features and its properties.

It is an object of the invention, to overcome such difficulties in compressing the biometrics data. New method that understands and processes the biometrics data to
20 compress its contents that results in efficient data storage of biometrics data is needed.

Another objective is to provide a method that stores global characteristics of the biometrics data for a set of similar data set within the biometrics data. The global characteristics of the biometrics data contain the information required to verify the
25 features.

It is yet another objective of the invention to ensure the important characteristics of the biometrics data are not eliminated during the compression stages that may impact the verification and identification.

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In most cases the global characteristics of a set of similar data is created or generated instead of identification and these characteristics are present within the biometrics data.

Another objective of the invention is to provide for a method that verifies two
35 compressed data of the biometrics data to ascertain their similarities.

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5 The invention discloses a process of recoding biometric features in recordable medium comprising several steps. Raw biometrics feature such as finger prints, palm prints, iris image, retina image and other biometrics feature or a combination thereof are extracted. The raw biometrics feature is segmented into at least two segment units. Anchor features and at least two other significant features in each segment are identified.

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The anchor feature consists of centre point in finger prints or palm prints, optic disc in retina image or lens section in iris image. The significant features consist of ridge join points, ridge line endings for finger prints or palm prints and macula and vessel density in retina, and lens and iris portion in iris image.

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The relativity in position of each significant feature in relation to the anchor feature is computed. The relativity includes one or more of the following; distance, direction or segments units. The minimum and maximum value of the relativity of each feature is computed. The values obtained in steps (iv) and (v) or in combination as feature are concatenated. Feature obtained in step (vi) are stored.

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In another aspect the invention discloses a process of recording biometric features in recordable medium without segmentation of the biometrics data. Raw biometrics feature such as finger prints, palm prints, iris image, retina image and other biometrics feature or a combination thereof is extracted. Anchor features and other significant features are identified. The relativity in position of each significant feature in relation to the anchor features is computed the relativity includes one or more of the following; distance, direction or segments units. The minimum and maximum value of the relativity of each feature is computed. The values obtained in steps (iii) and (iv) or in combination are computed. Feature obtained in step (v) are stored.

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The invention will be described with reference to preferred embodiments and to the enclosed figures in which:

Figure 1 shows the biometric features of a finger print.

35 Figure 2 show the biometric features of an retinal image.

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5 Figure 3 is a flow diagram of the process of identification of the global characteristics from the biometrics data set.

Figure 4 is a flow diagram of the process of verification of the two compressed generated for check their similarity.

With the use of fingerprint, say of a thumb, will be described.

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Upon successful retrieval of the biometrics features, the biometrics feature is segmented in regions as shown in Figure 4

The process requires the biometrics data that is biometrics features extracted from the
15 biometrics raw data obtained from the biometrics acquisition device for example, fingerprint image for fingerprint biometrics type.

Upon successful retrieval of the biometrics features, the biometrics feature is segmented in regions as shown in Figure 1

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In Figure 1, the features as indicated in black dots and the biometrics features are separated into 4 regions.

The fingerprint image is shown in the figure only for feature identification. The
25 fingerprint image is not part of the features

The four regions can be numbered as A (top-left), B (top-right), C (bottom-left), D (bottom-right).

30 In region A, there are four features the center feature within this region is selected as indicated by the black rectangle.

In region B, there are six features the center feature within this region is also selected as indicated by black rectangle.

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- 5 However in region C and D, there is only one feature hence the lone feature cannot be the center feature

After processing the regions A, B, C and D, the compressed data is generated as follows:

Region A:

10	A – Center Feature number	ex: 5
	B – Distance in area between feature 1 and A	ex: 9
	C – Distance in area between feature 2 and A	ex: 2
	D – Distance in area between feature 3 and A	ex: 6

Region B:

15	E – Center Feature number	ex: 8
	F – Distance in area between feature 1 and A	ex: 9
	G – Distance in area between feature 2 and A	ex: 6
	H – Distance in area between feature 3 and A	ex: 1
	I – Distance in area between feature 4 and A	ex: 3
20	J – Distance in area between feature 5 and A	ex: 4

In this example Region C and D are ignored.

The resultant compressed data will be ABCDEFGHIJ (one byte per character) and based on the above example values, the resultant compressed data will be 5926896134 (every digit occupies one byte and has the minimum value of 0 and maximum value of 127). For 25 this example the space required is only 10 bytes.

Next extraction of biometric data of a retinal image will be described.

- 30 As specified in the previous sections, the process requires the biometrics data that is biometrics features extracted from the biometrics raw data obtained from the biometrics acquisition device that is retina image in this example as retina biometrics type is used.

Upon successful retrieval of the biometrics features, the biometrics feature is segmented 35 in regions as shown in Figure 2.

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In Figure 2, the anchor features and the other significant features are indicated and the biometrics features are separated into 4 regions.

10 The retinal image is shown in the figure only for feature identification. The retinal image is not part of the features

The four regions can be numbered as A (top-left), B (top-right), C (bottom-left), D (bottom-right).

15 In region A, the relativity in location of the Anchor feature and the other significant features within the region is computed. The relativity in location includes but not limited to distance and/or direction and combination of both. The relativity in location is a value to define the location of a anchor feature or a significant feature within the regions A, B, C and D. The value can be determined by obtaining the positions of X co-ordinate and X
20 co-ordinate of a specific feature (anchor or significant). The method of expressing should be selected based on the least storage requirement. A example of selecting a method of expressing the location of a feature with the least storage requirement is as follows.

25 The location of a feature can be expressed as the distance apart of a feature from the Xp plane to get the X value and the distance apart of a feature from the Yp plane to get the Y value.

30 However in the above method of expressing the location of a feature requires two values and the storage requirements for the two values is around two bytes (one for every value) resulting in the need of twice the storage capacity. To reduce the need if an additional storage requirements, the two values (X and Y) that define the location of a feature within the region is reduced to a single value by computing the relation between the X and Y values.

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5 One such method of computing the relation is by directly multiplying the two values to get a single value. For example when the X position of the anchor point within region A is 5 and the Y position of the anchor point within region A is 4, by directly multiplying the values 5 and 4, a single value of 20 is obtained. The value 20 in this case defines the position of the anchor point in terms of area of a rectangle (or a square) that starts from
10 the starting position of the region A i.e. X position 0 and Y position 0 of the actual retina images.

However, other methods can be used to obtain a single value from two values and as available at <http://ieee.org>.

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Figure 3, is a flow diagram of the process of identification of global characteristics from the biometrics data. This process is an important step in generation of the compressed data from the biometrics data as in this process the biometrics data is processed and the global characteristics are identified.

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This process requires the biometrics data comprising of biometrics features extracted from the biometrics raw data obtained from the biometrics acquisition device that includes but not limited to finger print scanners for finger print, iris and retinal scanners for retina.

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The process starts with step 101 with the retrieval of the biometrics features from the stored database or from other processes that reproduce biometrics features from the biometrics raw data. The method of acquisition, extraction and validation is well known in prior.

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Upon successful retrieval of the biometrics features in the step 101, the features are segmented, that is divided into regions dependent on each biometrics such as but not limited to fingerprint, iris, retina, DNA in step 102.

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5 With every region from step 102, in step 103, the anchor feature is identified and the relativity of all other features with the anchor features is extracted. The relativity is any one of the properties prominent in the region. The properties include but not limited to distance in length, angle and distance area.

10 In step 104, if there are more regions, the process continues from step 103 but when no more regions are available the process continues from step 105.

In step 105, for every region, the minimum and maximum value of properties of the features that describe the relativity with anchor feature is extracted and concatenated
15 resulting the compressed data.

The compressed data from the step 105 can be stored in the database or in the files part of file system for later usage.

20 The process ends in the step 106.

Figure 4 is a flow diagram of the process of verification of two compressed data generated for checking their similarity. This process is used for identification and verification of an individual using biometrics

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This process requires the biometrics data such as biometrics features extracted from the biometrics raw data obtained from the biometrics acquisition device that includes but not limited to finger print scanners for finger print, iris scanners for iris and retinal scanners for retina.

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The process starts with step 201 with the retrieval of the biometrics features from the stored database or from other process that output the biometrics features from the biometrics raw data. The method of acquisition, extraction and validation or known prior art.

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- 5 Upon successful retrieval of the biometrics features in step 201, compressed data is obtained for the biometrics features obtained in step 201. The compress data is obtained using the process in Figure 1 with the retrieved biometrics features as the input.

- 10 In step 202, compressed data stored in the database for the individual is retrieved. The compressed data will be stored with an identifier such as but not limited to generated number, or identity card number.

- 15 In step 203, upon successful retrieval of the compressed data in step 202, for every region in the test compressed data from the database (in step 202), the anchor feature and the relativity information is compared with the information in the live compressed data (in the step 201). Exact match checking tests the comparison.

- 20 In the step 204, the number of successful matched, is identified and if the value is above the half the number of regions, then the two compressed data is similar and or else they are not.

The process terminates in the step 205.

- 25 The significant features include the Blood Vessels, Macula point (circle) and Macula Region. This processing of obtaining the relativity in location is carried out for regions B, C and D

After processing the regions A, B, C and D, the compressed data is generated as follows:

Region A:

- 30 A1 – Center/Anchor Feature number ex: 20
 A2 – Location of Macula ex: 15
 A3 – Location of Macula Region ex: 7
 A4 – Location of Blood Vessels ex: 21

Region B:

- 35 B1 – Center/Anchor Feature number ex: 10

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5	B2 – Location of Macula	ex: 10
	B3 – Location of Macula Region	ex: 5
	B4 – Location of Blood Vessels	ex: 16

In this example Region C and D are ignored.

- 10 The resultant compressed data will be ABCDEFGHIJ (one byte per character) and based on the above example values, the resultant compressed data will be 20 15 7 21 10 10 5 16 (every number occupies one byte). For this example the space required is only 10 bytes.

15 In Figure 4, the features as indicated in black dots and the biometrics features are separated into 4 regions.

The fingerprint image shown in the figure is only for feature identification. The fingerprint image is not part of the features

- 20 The four regions can be number as A (top-left), B (top-right), C (bottom-left), D (bottom-right).

In region A, there are four features, the center feature within this region is selected as indicated by the black rectangle.

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In region B, there are six features the center feature within this region is also selected as indicated by black rectangle.

30 However in regions C and D, there is respectively only one feature hence the lone feature cannot be the center feature

After processing the regions A, B, C and D, the compressed data is generated as follows:

Region A:

- 35 A – Center Feature number
B – Distance in area between feature 1 and A

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C – Distance in area between feature 2 and A

D – Distance in area between feature 3 and A

Region B:

E – Center Feature number

F – Distance in area between feature 1 and A

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G – Distance in area between feature 2 and A

H – Distance in area between feature 3 and A

I – Distance in area between feature 4 and A

J – Distance in area between feature 5 and A

In this example Region C and D are ignored.

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The resultant compressed data will be ABCDEFGHIJ (one byte per character). For this example the space required is only 10 bytes.

CLAIMS

1. A process of recoding biometric features in recordable medium comprising the steps of:

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- (i) extracting raw biometric features such as finger prints, palm prints, iris image, retina image and other biometric features or a combination thereof;

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- (ii) segmenting the raw biometric features into at least two segment units wherein each segment unit consists of at least one anchor feature and at least two other significant features, wherein the anchor feature consists of:

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- (a) center point or at least one auxiliary point in finger prints or palm prints,
(b) optic discs in retina image, or
(c) lens section in iris image,

and wherein the significant feature consist of:

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- (a) ridge join points, ridge line endings for finger prints or palm prints, or
(b) macula and vessel density in retina, and lens and iris portion in iris image;

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- (iii) computing relativity in position of each significant feature in relation to the anchor feature wherein the relativity includes one or more of the following: distance, direction or segment units, and wherein the distance includes relativity position between the anchor feature and the significant feature;

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- (iv) computing the minimum and maximum value of the relativity of each feature;

- (v) concatenating the values obtained in steps (iii) and (iv) or in combination as feature; and
- (vi) storing of feature obtained in step (v).

- 5 2. A recordable medium as claimed in claim 1 wherein the medium includes hard disk, smart card, smart tokens or any other data storage medium.